润新 RUNXIN

RUNLUCKY 润莱

润景 RUNJING

"Runxin Pavilion" Product Introduction

润新阁 产品介绍

2024 First Edition

企业使命 Runxin's mission

让人们能够更方便、更经济地用上健康、安全的水。

Let people could use healthy and safe water more conveniently and economically.

Preface

Adopting special ceramic materials, after precision processing, it is used as the component for passing liquid through the valve. Due to the high-precision fitting and relative rotation of flat or spherical surfaces, the opening, closing, reversing, and flow rate of liquid can be controlled. Its excellent performance such as low torque, wear resistance, and corrosion resistance has changed people's cognition regarding the traditional structure valve (low torque, durable).

In recent years, with the rapid development of industrial and agricultural production and urbanization, problems such as industrial wastewater, secondary water supply pollution in high-rise buildings, groundwater pollution and agricultural irrigation water waste have become increasingly serious. The demand for water treatment equipment and water-saving equipment is growing day by day. The technology of automatic control valves for water treatment systems began in the United States, mainly using rubber piston structure and cam structure, and its sealing parts are rubber and plastic, which are prone to impurities and wear, and are not durable. Runxin company developed control valve with ceramic hermetic head faces sealing structure for water treatment system firstly in 2003. It uses high flatness ceramic sealing disk as the sealing part, which has the characteristics of good sealing performance, convenient positioning, good interchangeability, long service life etc. Through continuous series development and automated and large-scale production, more than 150 models of control valves have been formed, such as water treatment capacity 1-50m^3/h, time clock type and meter type, manual and automatic, LED or LCD and indicator light display, etc. It has widely used in fields such as filtration, softening, and special water treatment, and has been exported to 157 countries and regions.

Runxin company applies special ceramic sealing technology to the field of domestic water treatment and developed nearly 100 kinds of residential softener with different functions and appearances, as well as ceramic hard sealing wireless auto shut-off valve, disk prefilter, whole house water filter, shower softener, RO system, manual water purifier and other series of products for different water quality conditions and water use scenarios worldwide. Runxin company also designed special functions such as mobile remote control and intelligent leakage protection. The products are welcomed by users in 54 countries and regions.

Runjing ceramic hard sealing ball valve is a breakthrough technological achievement of Runxin company special ceramic hermetic head faces sealing to spherical sealing. Its valve core and valve seat are made of corundum ceramic or silicon carbide. It has the characteristics of low torque, good wear resistance, good corrosion resistance and durability. It can not only be used in conjunction with Runxin control valve, but also used in sewage treatment, petroleum, chemical industry, lithium battery production, printing and dyeing, metallurgy and other industries. It has been exported to 34 countries and regions.

In 2023, China domestic agricultural water consumption reached 376.64 billion cubic meters. In

recent years, various parts of the country have experienced a high temperature weather above 40 ℃. In response to the problems of horticultural plants were injured, crop yields were reduced, agricultural water-saving, as well as traditional irrigation equipment plastic ball valves and diaphragm valves are not resistant to wear, easy to leakage, and not durable. Runxin company is based on ceramic hard sealing ball valve, IoT and photovoltaic technology, and has developed an efficient water-saving irrigation system- Runjing intelligent irrigation valve. It has formed a series of products such as high flow disk filtration system, water and fertilizer integrated machines, integrated valve combined with metering and controlling, and residential intelligent irrigation valve. And has been used in agricultural irrigation, municipal garden irrigation, golf course irrigation and garden balcony irrigation in Xinjiang, Hubei, Inner Mongolia, Hebei, Zhejiang and other places.

In recent years, Runxin company has developed rapidly and continuously introduced new products. In order to enable dealers and users to have a more systematic understanding of Runxin's technological characteristics, product research and development, and enterprise commission of **"Let people could use healthy and safe water more conveniently and economically."**, we have compiled this book with easy language to introduce the characteristics and applications of Runxin company's four major product categories. We hope that more people can have a more intuitive and in-depth understanding of Runxin company's core technical characteristics and products research and development.

This book was written with the participation of personnel from the R&D department, sales department, marketing department, production department, QC department, and other departments of Runxin company. There are some shortcomings in the book due to our limited knowledge and we sincerely appreciate if readers and experts can give their criticisms, point out mistakes and make corrections.

Editor

May,2024

润新 RUNXIN RUNLUCKY 润莱 润景 RUNJING

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Runxin Full Series Product Search

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1. Control valve for water treatment systems

Control valve used in water treatment systems is different from other products such as butterfly valve, gate valve and ball valve. It has multiple functions and channels, and usually has functions such as service, backwash and fast rinse etc. In addition, the softener valves also has functions such as brine & slow rinse and brine refill. The direction of water flow is also different for each function.

Before 2003, China did not have its own automatic control valves for water treatment systems and generally used multiple valves with manual control. For systems with a flow rate of less than 50m³/h, the multi-valve system was difficult to install, expensive, and the manual operation was complex. Each function switch is required opening and closing several valves, and the volume is also large, making it difficult to popularize. Automatic control valves were entirely dependent on imports and were monopolized by American valve. At that time, the control valves were like strategic materials. When the containers ordered for control valves had not yet arrived, the market prices would increase; once the containers arrived, the market prices would decrease. If the control valve was broken, it has to be sent to the United States for testing to determine whether the issue was with the valve itself or due to installation or other problems. The after-sales costs were exorbitant, a plastic part that cost a few cents could be sold for dozens of CNY.

Depending on its years of experience in applying ceramic sealing technology to solar water heating control valve, Runxin applied ceramic hermetic head faces sealing technology to control valve in water treatment systems (referred to as: Runxin valve) and developed the control valve for filter system in 2003. Thereby breaking the monopoly of foreign control valve in China. After years of series development, Runxin has now developed a range of products with water production capacities from 1 m³/h to 50 m³/h. These include control valve for filter, softener, and special water treatment (such as iron and manganese removal, fluoride removal, deoxygenation, etc.). At present, **Runxin has over 30 series and over 150 specifications of products**, such as manual type, automatic type, down-flow regeneration softener, up-flow regeneration softener, floating bed softener, single valve control, one valve with two tanks, one valve with three tanks, our products **have been exported to 157 countries and regions and hold a significant market share of nearly 80% in the domestic industrial sector**, are widely used in fields, including filter systems, boiler feed water softener systems, RO pre-treatment systems, and residential water treatment systems. **Runxin valve is completely different from foreign control valves, according to different water quality, different process conditions, and different flow path designs, it meets the requirements of different customers.**

1.1 Domestic and foreign control valve comparison

1.1.1 Piston valve structural features

Piston valve is driven by an motor to pull the piston up and down in the partition grid formed

by rubber and plastic to achieve the five functions required for softener. When the piston is pull up and down, it remains in place at corresponding positions to form the five functions. For actual positioning, it is necessary to convert the up and down movement of the piston into a circular positioning, which has low accuracy. The valve seals with a piston and rubber, which is poor resistance to impurities, poor wear resistance, and easy to leak. Generally, after one year of use, the piston and rubber need to be replaced, resulting in high maintenance costs. See Figure 1-1.

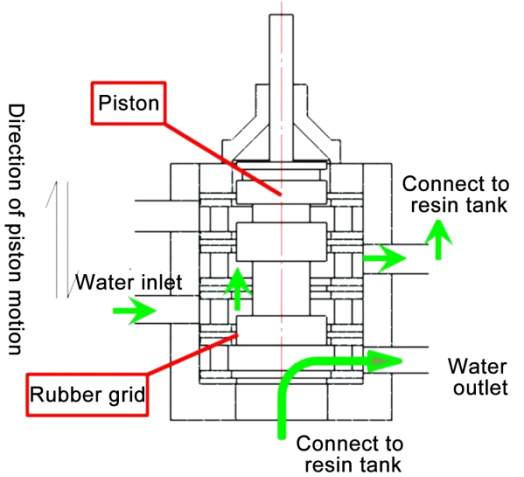


Figure 1-1 Piston valve structure

1.1.2 Cam-structured valve structural features

Cam-structured valve is equipped with seven plate valves on the valve body, each controlled by a corresponding cam on the camshaft. When the motor rotates the camshaft, the seven plate valves are actuated out of phase to open and close, thereby achieving the five functions required for softener.

Due to the incorporation of seven plate valves, the principle is simple, but the structure is complex, the volume is large, so the manufacturing precision required is high, the manufacturing process is complicated, and the relative cost is also high. See Figure 1-2.

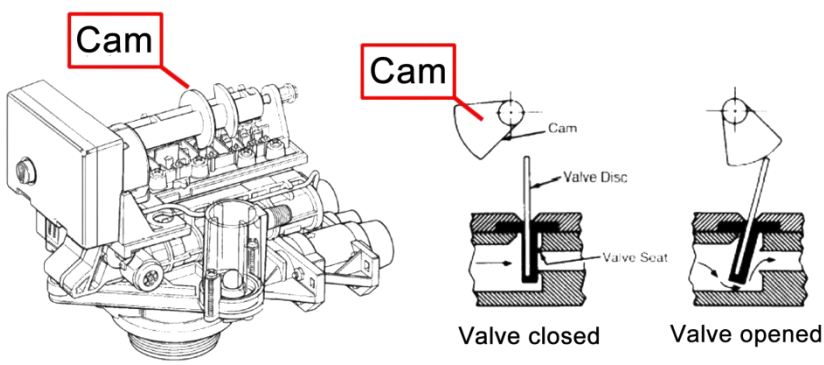


Figure 1-2 Cam structure

1.1.3 Runxin ceramic hermetic head faces valve structural features

Runxin valve is a control valve with a hermetic head faces structure. It features multiple through-holes on a high-flatness, radially fixed static plate within the valve body, which are interconnected with the water inlet, outlet, drain, top and bottom water distributor interfaces and brine draw port. The high-hardness, high-flatness ceramic moving disk is equipped with through-holes and blind holes. It rotates on the fixed disk and achieves the required five functions by stopping at different rotational angles. See Figure 1-3.

The moving disk rotates within a 360° circumference, which allows it to form the necessary functions while also positioning itself on the circumference with high positioning accuracy.

The moving disk is made of corundum ceramic, which is sintered at an ultra-high temperature of 1680°C, with high hardness and wear resistance. After precision machining, both the moving and fixed disk achieve a high-flatness of up to 0.3 micron, ensuring excellent sealing performance and resistance to impurities.

Ceramic materials are resistant to alkali and low concentrations of acid, which makes them suitable for systems that require acid and alkali for regeneration, such as in ion exchange beds.

The hermetic head faces sealing structure allows for operation under pressure, which means that there is no need to close the water inlet during the working process.

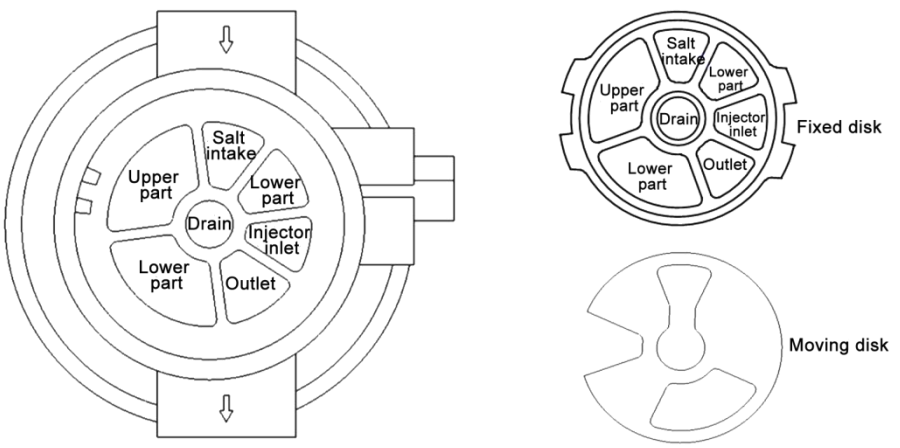


Figure 1-3 Runxin hermetic head faces valve structure

1.1.4 Multi-valve control system structural features

A multi-valve control system is the assembly of multiple valves together using pipelines. It uses a controller to control the staggered opening and closing of these valves to achieve the required functions. Typically, a filter system requires five sets of two-way valves to achieve functions, such as service, backwash, and fast rinse. A softener system requires seven sets of two-way valves and one injector to achieve functions, such as service, backwash, brine & slow rinse, brine refill, and fast rinse. See Figure 1-4.

Due to in vitro integration, the pipeline system is complex, the installation is troublesome, the pressure resistance is not high, there are many potential leak points, and the cost is high. It is generally used for industrial systems with a water production capacity exceeding 50m³/h and where the inlet water pressure is not high.

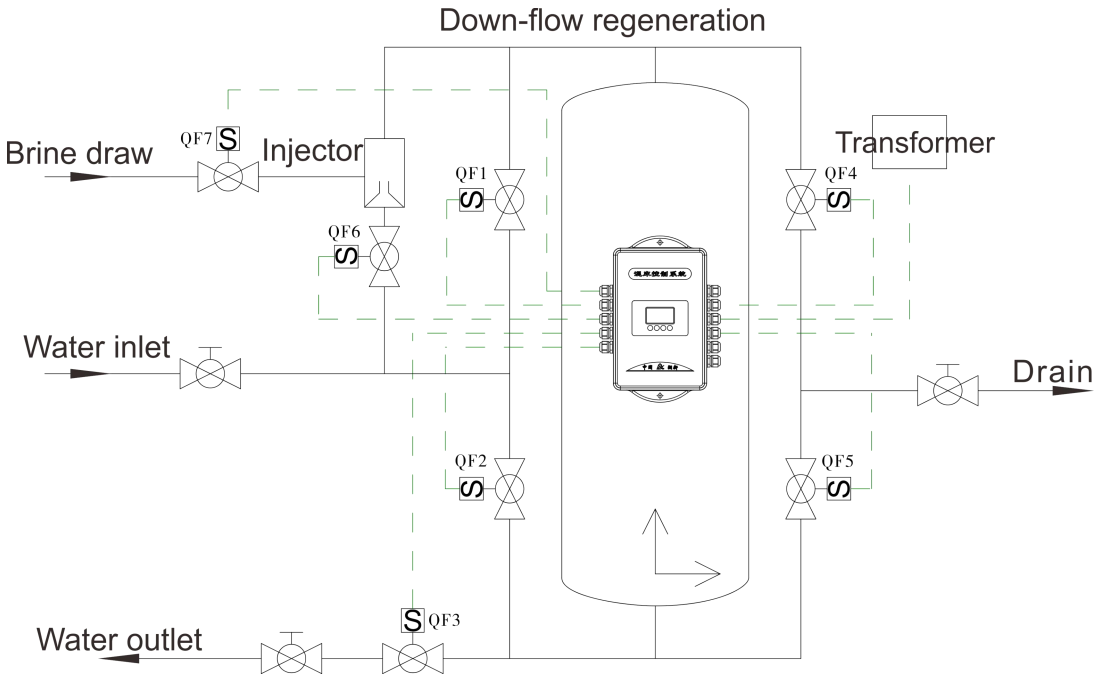


Figure 1-4 Multi-valve system with softener function

1.2 Runxin valve classification and model

Runxin valve can be classified in various ways based on different characteristics. According to their functions, they can be divided into filter, softener, and special water treatment (such as iron and manganese removal, fluoride removal, deoxygenation, etc.). In terms of control method, it can be divided into manual and automatic types. Softener valve can be classified according to the start of regeneration into time, meter, and online monitoring types. According to the flow direction of the regeneration liquid, it can be divided into down-flow softener, up-flow softener, down/up-flow softener and floating bed softener. Based on the number of exchange tanks, they can be divided into one valve with one tank, one valve with two tanks, and one valve with three tanks. According to different display methods, automatic valves can be divided into LED display, indicator light display, digital tube display, LCD display, etc.

1.2.1 Filter valve

Generally, natural water (such as groundwater, river water, or lake water) often contains more particulate impurities, suspended solids, organic matter, and colloids. To prevent the growth of bacteria during the water supply process, residual chlorine is added to the tap water as a disinfectant

upon leaving the water plant. Filter systems are primarily used to remove these substances, with the main filter media including materials like quartz sand, activated carbon, garnet, iron ore, and anthracite coal. Garnet, iron ore, and anthracite coal are typically used in multi-media filters, while quartz sand and activated carbon are commonly used filter materials.

Quartz sand filters are mainly used to remove large particulate impurities, suspended solids, and colloids from water. Activated carbon filters are mainly used to remove turbidity, organic substances, and residual chlorine. Mainly used to filter systems, RO pre-treatment systems, and swimming pool filter systems. When used in RO pre-treatment systems, they are generally used to reduce turbidity and minimize residual chlorine to prevent membrane fouling and damage. The residential filter systems mainly use activated carbon filtration is predominantly utilized to eliminate residual chlorine from tap water and improve taste. Swimming pool filter systems are mainly designed to filter out impurities and floccule in swimming pools and to refill water in the pools.

The filter valve is the core of the filter system, mainly used to change the flow channel and has functions such as service, backwash and fast rinse. The backwash of filter system is mainly triggered by several methods, such as time, meter, or the pressure differential at the inlet and outlet. Since the turbidity of the incoming water can vary, it is relatively reasonable to use a pressure differential between the inlet and outlet for backwash, but it requires the installation of a differential pressure sensor, which is more costly. Since our company developed the filter valve in 2003, we now have introduced a variety of series, including manual filter valve, automatic filter valve(with LED display, P series, Q series, etc.), residential filter specialized valve and swimming pool filter valve，etc.

1.2.1.1 Manual filter valve

The manual filter valve can switch functions by rotating the handle, such as service, backwash and fast rinse.

Runxin currently has manual filter valves with water treatment capacities ranging from 1 m³/h to 30m³/h. The main models include F52, F56 series, F77BS, F112BS and so on. The specification and size shown in Table 1-1. The maximum water treatment capacity listed in the table represents the flow rate of the control valve at a pressure drop of approximately 0.2MPa. It is necessary to select the matching tank body based on the filtration rate of the filter media and the intensity of backwash.

Table 1-1 Manual filter valve specification and size table

New model	Old model	Inlet/ outlet	Drain	Base	Riser pipe	Max. water treatment capacity m³/h	Remark
51101A	F52	1/2″F	1/2″F	M82×3	Φ16.5	1	
51104	F56A	1″F	1″F	2.5″-8NPSM	1.05″OD	4	
51104C	F56AC	1″F	1″F	2.5″-8NPSM	1.05″OD	4	Side control
51102	F56E	1/2″F 3/4″F	1/2″F 3/4″F	2.5″-8NPSM	1.05″OD	2	

New model	Old model	Inlet/ outlet	Drain	Base	Riser pipe	Max. water treatment capacity m^3/h	Remark
51102C	F56EC	1/2″F 3/4″F	1/2″F 3/4″F	2.5″-8NPSM	1.05″OD	2	Side control
51204K	F56K	1″F	1″F	2.5″-8NPSM	1.05″OD	4	
51106	F56F	1″F	1″F	2.5″-8NPSM	1″D-GB	6	
51108	F56L	1.5″M	1.5″M	4″-8UN	1.25″D-GB	8	
51110	N56D	2″F	1.5″F	4″-8UN	1.5″D-GB	10	
51215	F77BS	2″M	2″M	4″-8UN	1.5″D-GB	15	
51240	F112BS	DN65	DN65	DN80(Top & bottom strainer)		40	

1.2.1.2 Automatic filter valve

Automatic filter valve is controlled by a microcontroller program that activates the motor to perform backwash and fast rinse when the time, meter, or pressure differential are reached the set value. When the turbidity of the inlet water is high, the program can be set to repeat the backwash process multiple times (F-00) to enhance the backwash effect. For example, F-01: service → backwash → fast rinse → backwash → fast rinse → service. There are various models of automatic filter valves, including F67, F71, N75, F99B, N77B, F95B, F111B, F147B, F112B, and F96B. The specification and size shown in Table 1-2. The maximum water treatment capacity listed in the table is the flow rate of the control valve at a pressure drop of approximately 0.2MPa. It is necessary to select the appropriate tank based on the filtration rate of the filter media and the intensity of backwash.

Table 1-2 Automatic filter valve specification and size table

Model	Old model	Inlet/ outlet	Drain	Base	Riser pipe	Max. water treatment capacity m^3/h	Remark
53502	F71B	3/4″M	3/4″M	2.5″-8NPSM	1.05″OD	2	
54502	F71P1	3/4″M	3/4″M	2.5″-8NPSM	1.05″OD	2	
55502	F71Q1	3/4″M	3/4″M	2.5″-8NPSM	1.05″OD	2	
53504S	F67B	1″F	1″F	2.5″-8NPSM	1.05″OD	4	
54504	F67P1	1″F	1″F	2.5″-8NPSM	1.05″OD	4	
53506S	F67B-A	1″F	1″F	2.5″-8NPSM	1″D-GB	6	
53504C	F67I	1″F	1″F	2.5″-8NPSM	1.05″OD	4	Side mounted
55504	F67Q1	1″F	1″F	2.5″-8NPSM	1.05″OD	4	
53508	F134	1.5″M	1.5″M	4″-8UN	1.25″D-GB	8	
53510	N75A	2″M	2″M	4″-8UN	1.5″D-GB	10	

Model	Old model	Inlet/ outlet	Drain	Base	Riser pipe	Max. water treatment capacity m^3/h	Remark
53510B	N75B	2″M	2″M	4″-8UN	1.5″D-GB	10	Top/ Side mounted
55510	N75Q	2″M	2″M	4″-8UN	1.5″D-GB	10	
53520	F95B1	2″M	2″M	2″M(Top & bottom strainer)		20	Side mounted
53520B	F111B1	2″M	2″M	4″-8UN	2″D-GB	20	Top mounted
53530	F147B	2.5″M	2.5″M	2.5″M(Top & bottom strainer)		30	Side mounted
53540B	F112B1	DN65	DN65	DN80(Top & bottom strainer)		40	Side mounted
53550	F96B1	DN80	DN80	DN100(Top & bottom strainer)		50	Side mounted

According to different display methods, automatic valves can be divided into LED display, digital tube display and indicator light display etc.

LED display control valve: It uses a Hall component for positioning and customized LED module for display. The control board is equipped with signal output connector, pressure relief connector, interlock connector, remote handling connector and so on.

P series control valve: Adopts optocoupler positioning, and the display adopts a combination of digital tubes and indicator lights. The control board is equipped with signal output connector, interlock connector, remote handling connector, RS-485 port, etc.

Q series control valve: Adopts optocoupler positioning and a digital tube display. Q series is a more cost-effective control valve than the P series.

Among them, the P series and Q series control valves are only available in models with a water treatment capacity of less than $10m^3/h$, namely the F67, F71 and N75.

Table 1-3 Runxin valve control board interface application functions

Function name	Application	Explanation
Signal output connector b-01	Outlet solenoid valve or electronic ball valve.	If system strictly require no hard water flow from outlet or controlling the liquid level in water tank.
	Inlet pump.	Increase pressure for regeneration or rinse. Use the liquid level controller to control inlet pump to ensure there is water in tank.
Signal output connector b-02/Pressure relief connector	Inlet solenoid valve or electronic ball valve, or bypass pressure relief.	When inlet pressure is high, it needs to close water inlet when valve is rotating to protect motor.

Function name	Application	Explanation
Interlock connector	To ensure only one control valve regeneration or rinse in system.	Use in RO Pre-treatment, water supply together but regeneration in turn. Second grade ion exchange equipment, etc.
Remote handling connector	Receive signal to make the control valve rotate to next position.	It is used for online monitoring system, PC connection, and realizes automatic or remote control of valve.
RS-485 connector	Real-time data transmission.	Connects with PLC, computer, etc., communicates with the control valve in real time.

1.2.1.3 Residential filter specialized valve

In addition to the above functions, the residential filter special valve also has a close function. It can close the control valve and cut off the water supply upon receiving a signal. For example, if there is a leak in the pipeline, the leak sensor will send a signal that triggers the valve to close, preventing further water leakage and potential damage. The main model of this type of valve is the F67N and so on.

1.2.1.4 Swimming pool filter valve

Swimming pool filter is a type of filter system that mainly use quartz sand for filter. In addition to functions of in service (filter), backwash, and rinse, it also functions such as closed, waste and recirculation. At present, there are two main ways to control the filter of swimming pool in the market: 1. Manual swimming pool filtration valves that use rubber and plastic components for sealing. During the rinsing process, the handle must be pressed down and turned to switch positions. To prevent the rubber parts from falling off during the position-switching process, it is necessary to shut off the inlet pump. These manual valves are not resistant to wear and are prone to leaks; they are also operationally cumbersome, requiring the pump to be shut off before switching positions. 2. The use of multiple manual butterfly or ball valve, controlled by a controller to operate automatic valve and achieve the desired functions. This method results in a complex piping installation and is inconvenient for after sales maintenance.

Runxin has developed a swimming pool filter valve using ceramic hermetic head faces sealing technology, which is resistant to impurities and has excellent sealing performance. During the switching of positions, there is no need to shut off the water supply, the valve can be operated under pressure. Backwash can be initiated based on time or the pressure differential at the inlet and outlet, and it features a RS-485 port for linkage with the pump. There are models such as F138, F139, with a water treatment capacity of 12m³/h-24m³/h, and their specification and size can be found in Table 1-4.

Table 1-4 Swimming pool filter valve specification and size table

Model	Old model	Inlet/ outlet	Drain	Riser pipe	Max. water treatment capacity m^3/h	Base		Remark
						Central circle	Bolt circle diameter	
53512C	F138C	1.5″	1.5″	—	12	—		Side mounted
53524	F139A	2″	2″	1.5″ D-GB	24	Suitable for tank diameter with 150mm		Clamp
51524	F139AS	2″	2″	1.5″ D-GB	24	Suitable for tank diameter with 150mm		Clamp
53524B1	F139B1	2″	2″	1.5″ D-GB	24	φ174	8*φ8.5	Flange
53524B2	F139B2	2″	2″	1.5″ D-GB	24	φ204.5	8*φ8.5	Flange
53524B3	F139B3	2″	2″	1.5″ D-GB	24	φ247	12*φ8.5	Flange
53524C	F139C	2″	2″	—	24	—		Side mounted

1.2.2 Softener valve

Tap water, groundwater, and other water sources contain certain amounts of calcium and magnesium ions, with higher concentrations found in the groundwater of northern regions. The calcium and magnesium ions in water can form scale, and the rate of scaling increases significantly when the water temperature exceeds 55°C. The thicker the scale, the worse the heat transfer, leading to greater energy consumption. For every 1mm increase in the thickness of the scale in a boiler, the energy consumption can increase by 3%-5%. Therefore, in water heating systems, the inlet water needs to be softened. The requirements for boilers are even more strict, steam boilers require an inlet water hardness of less than 1.5 mg/L, and hot water boilers require an inlet water hardness of less than 30 mg/L.

The process of removing all or part of the calcium and magnesium ions from water is softening. A water softener system consists of control valve, resin tank, filter media (resin), top and bottom strainer, riser pipe, brine tank, etc. The control valve is the core of the softener system and has functions such as softening, backwash, brine & slow rinse, brine refill and fast rinse. The regeneration of the softener system is typically triggered based on time, meter, or the hardness of the inlet water. Since the outlet water flow rate from the system may not be constant, the time-based triggering method is not very precise and is only suitable for situations where the requirements for the quality of the outlet water are not too high. Monitoring the hardness of the effluent water is costly and is not widely used at present. The most used method is meter-based regeneration. Residential softeners generally use a combination of time and meter, that is, meter delayed type; industrial systems, which have higher requirements for the quality of the outlet water, mostly use the meter immediate type, meaning that regeneration occurs immediately when the volume is reached.

Runxin currently has a range of softener valve with water treatment capacities from 1 m³/h to 50m³/h. The offerings primarily consist of manual softener valve and single-tank automatic softener valve (LED display, P series and Q series with digital tube display). Based on the different regeneration methods, the valves are further categorized into down-flow softener valve, up-flow softener valve, down/up -flow softener valve and floating bed softener valve, etc.

1.2.2.1 Manual softener valve

The manual softener valve is by rotating the handle 360 ° to achieve five functions: service, backwash, brine & slow rinse, brine refill and fast rinse .

Runxin produces manual softener valves with a water treatment capacity ranging from 2m³/h to 40m³/h. The main models include the F64 series, F77AS, F112AS, etc. The specification and size table shown in Table 1-5.

Table 1-5 Manual softener valve specification and size table

New model	Old model	Inlet/ outlet	Drain	Brine line connector	Base	Riser pipe	Max. water treatment capacity m³/h	Tank size (in)	Remark
61202	F64B	3/4″F	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″	DF
61202C	F64BC	3/4″F	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″	Side control
61104	F64A	1″F	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～18″	DF
61204C	F64AC	1″F	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～18″	Side control
61206	F64F	1.5″ M	3/4″M	1/2″M	4″-8UN	1.25″D-GB	6	10″～24″	DF
61210	F64D	2″M	1″M	1/2″M	4″-8UN	1.5″D-GB	10	10″～30″	DF
61215	F77AS	2″M	1.5″M	3/4″M	4″-8UN	1.5″D-GB	15	24″～42″	DF
61240	F112AS	DN65	DN65	3/4″M	DN80 (Top & bottom strainer)		40	36″～63″	DF
71202	F64C	3/4″F	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″	UF

1.2.2.2 Single-tank automatic softener valve

A. Down-flow regeneration softener valve

Down flow regeneration softener valve refers to control valves where the direction of the brine flow is the same as the service water flow, which is from top to bottom. The regeneration process typically includes service to invalid → backwash → brine & slow rinse → brine refill → fast rinse → service to provide softened water. During the regeneration process, when the brine flows from the top to the bottom of the resin tank to the protective layer of resin, the brine, after the exchange

reaction, not only has a very low concentration of Na^+, but also contains a large amount of exchanged Ca^{2+} and Mg^{2+}. Therefore, it is necessary to increase the amount of salt used to ensure the regeneration of the bottom layer of resin, which results in higher salt consumption. However, the down-flow regeneration process is simple and easy to control, that is why down-flow regeneration softener valves are the most widely used. We offer the most models in this type of control valve, including the F63, F65, N74, N77A, F95A, F112A, F96A, F147A, and others. Their specifications and dimensions can be found in Table 1-6.

Table 1-6: Down-flow regeneration softener valve specification and size table

New model	Old model	Inlet/ outlet	Drain	Brine line connector	Base	Riser pipe	Max. water treatment capacity m^3/h	Tank size (in)	Remark
63602	F65B3	3/4″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″	
64502	F65P1	3/4″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″	
65503	F117Q1	3/4″F	3/4″F	3/8″M	2.5″-8NPSM	1.05″OD	3	6″～14″	
63604	F63C3	1″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～18″	
64504	F63P1	1″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～18″	
65505	F116Q1	1″M	1″M	3/8″M	2.5″-8NPSM	1.05″OD	5	10″～18″	
63608	F133A	1.5″M	3/4″M	1/2″M	4″-8UN	1.25″D-GB	8	24″～30″	
63610	N74A3	2″M	1″M	1/2″M	4″-8UN	1.5″D-GB	10	10″～30″	
63615	F99A3	2″M	1.5″M	3/4″M	4″-8UN	1.5″D-GB	15	14″～36″	
63618	N77A3						18	14″～42″	
63620	F95A3	2″M	1.5″M	3/4″M	2″M(Top & bottom strainer)		20	24″～48″	
63620B	F111A3	2″M	1.5″M	3/4″M	4″-8UN	2″D-GB	20	24″～48″	
63630	F147A3	2.5″M	2.5″M	3/4″M	2.5″M (Top & bottom strainer)		30	24″～42″	Side mounted
63640	F112A3	DN65	DN65	3/4″M	DN80 (Top & bottom strainer)		40	24″～60″	Side mounted
63650	F96A3	DN80	DN80	3/4″M	DN100 (Top & bottom strainer)		50	48″～63″	Side mounted

B. Up-flow regeneration softener valve

Up-flow regeneration softener valve refers to control valves where the direction of the brine flow is opposite to the service water flow, typically with the service water flow moving from top to bottom and the brine & slow rinse water flow moving from bottom to top during regeneration. During up-flow regeneration, the brine first contacts the less exhausted protective layer of the resin. By the time it reaches the most exhausted resin layer, the Ca^{2+} and Mg^{2+} exchanged have been discharged, and the concentration is reduced, allowing a lower concentration of Na^+ to regenerate. This results in lower salt consumption and better regeneration effects.

Up-flow regeneration has the advantages of saving salt and water, with the prerequisite being the prevention of resin layer disordered. To avoid resin layer disordered during backwash, when the water turbidity is low, it is not necessary to backwash with each regeneration cycle. Runxin's up-flow regeneration softener valves can be set to determine the backwash interval times based on the water turbidity (F-00), enabling multiple cycles of service followed by a single backwash. For example, F-03 indicates that backwash occurs every three cycles; during the first three cycles of regeneration, the first cycle is to brine draw without backwash. On the fourth cycle, backwash is performed first, followed by brine draw. The main models include F68 and F69, with specification and size table shown in Table 1-7.

Table 1-7: Up-flow regeneration softener valve specification and size table

New model	Old model	Inlet/ outlet	Drain	Brine line connector	Base	Riser pipe	Max. water treatment capacity m³/h	Tank size (in)
73602	F69A3	3/4″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″
74502	F69P1	3/4″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″
75502	F69Q1	3/4″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″
73604S	F68A3	1″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～18″
73604	F68C3	1″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～18″
74504	F68P1	1″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～18″
75504	F68Q1	1″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～18″
73605	F92A3	1″M	NPT3/4	3/8″M	2.5″-8NPSM	1″D-GB	6	10″～24″

C. Down-flow and up-flow regeneration softener valve

Down-flow and up-flow regeneration control valves have both down-flow and up-flow regeneration functions. They can be set according to actual needs through programming, mainly used for residential softener systems. The main models include F79, F82, F105, F136, etc., with specification and size table shown in Table 1-8.

Table 1-8: DF and UF regeneration softener valve specification and size table

New model	Old model	Inlet/ outlet	Drain	Brine line connector	Base	Riser pipe	Max. water treatment capacity m³/h	Tank size (in)
82602H	F79D	3/4″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	2	6″～12″
82604H	F82D	1″M	1/2″M	3/8″M			3.5	6″～16″
82603	F136	1″M	1″M	3/8″M			3	6″～14″
82602E	F105A	3/4″M	1/2″M	3/8″M			2	6″～12″
82604E	F97A	3/4″M	1/2″M	3/8″M			4	6″～18″

D. Floating bed softener valves

Floating bed control valves operate with water flow from bottom to top during service, causing the resin to float overall. During regeneration, the resin falling back, and the water flow direction during brine & slow rinse is from top to bottom. It is also a type of up-flow regeneration.

Floating bed have the advantages of high service flow rate, high output, low regeneration agent consumption, and good outlet water quality. However, due to there is no backwash, impurities and dirt in the resin are not easy to clean, and the resin needs to be cleaned externally. Therefore, the inlet water turbidity requirement is relatively high. Additionally, once the service stops, the resin will fall, so the floating bed should service continuously, and the pressure should not be too low. It is not suitable for service with frequent stops and starts.

Floating bed control valves are mainly used for continuous operation softener systems with high hardness water. The main models include F98C, F88C, F77CS, F95C, etc., with specification and size table shown in Table 1-9.

Table 1-9: Floating bed softener valve specification and size table

model	Old model	Inlet/ outlet	Drain	Brine line connector	Base	Riser pipe	Max. water treatment capacity m^3/h	Tank size (in)	Remark
93604	F83A3	1″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	4	6″～14″	Raw water for regeneration
93606	F98C	1″M	1/2″M	3/8″M	1″M (Top & bottom strainer)		6	14″～18″	Continuous water supply with one valve and two tanks
93610	F88C	1.5″M	1″M	1/2″M	1.5″M (Top & bottom strainer)		10	18″～20″	
91215	F77CS	2″M	1.5″M	3/4″M	4″-8UN	1.5″D-GB	15	20″～30″	Raw water for regeneration
93620	F95C3	2″M	1.5″M	3/4″M	2″M (Top & bottom strainer)		20	24″～36″	Softened water for regeneration
91240	F112CS	DN65	DN65	3/4″M	DN80 (Top & bottom strainer)		40	36″～48″	Raw water for regeneration
93640	F112C3	DN65	DN65	3/4″M	DN80 (Top & bottom strainer)		40	36″～48″	Softened regeneration

Next, we will design and manufacture control valves with a smaller water resistance for industrial fields with a water treatment capacity of less than $10m^3/h$; according to the requirements of residential control valves, we will develop control valves with a smaller volume, larger flow, and more complete functions for residential softener; and according to the requirements of the swimming pool field, we will develop more control valves for swimming pools filtration.

1.2.2.3 Continuous water supply softener valves

When water-using equipment such as boilers requires continuous water supply, a single-tank water softener cannot provide softened water during the regeneration process, and the regeneration process usually takes about 2 hours. This necessitates the provision of a water tank sufficient to supply the equipment's water needs for 2 hours. Additionally, the accompanying water softener must be significantly larger than the water-using equipment, which can be costly and may lead to water shortages. Therefore, it is necessary to have a continuous water supply system in place. Runxin valve offers various methods to achieve continuous water supply.

A. Continuous water supply softener valve with one valve and two tanks

Continuous water supply softener valve can achieve one valve control two tanks, requiring only one brine tank. When one tank resin becomes ineffective, the other tank resin starts working, and the ineffective tank resin begins regeneration, cycling in this manner. At present, our company has control valves for one in service one standby continuous water supply with a water treatment capacity of 3m³/h, 6m³/h and 10m³/h, available in both top mounted and side mounted configurations. The models include F73, F88A, F98A, F135, F137, etc. Due to the larger tank size of the F137, we have designed a expansion joint for easier installation and maintenance, no need to move the resin tank when installing or replacing the resin. The specification and size table shown in Table 1-10.

Table 1-10: Continuous water supply softener valve with one valve and two tanks specification and size table

New model	Old model	Inlet/ outlet	Drain	Brine line connector	Base	Riser pipe	Max. water treatment capacity m³/h	Tank size (in)	Remark
17603	F73	1″M	1/2″M	3/8″M	2.5″-8NPSM	1.05″OD	3.5	6″～14″	DF & UF
17606	F98A	1″M	1/2″M	3/8″M	1″M (Top & bottom strainer)		6	20″～24″	UF
17610	F88A	1.5″M	1″M	1/2″M	1.5″M (Top & bottom strainer)		10	20″～30″	UF
17606	F137	1″M	3/4″M	1/2″M	4″-8UN	1.5″D-GB	6	20″～24″	DF
17610T	F135	1.5″M	3/4″M	1/2″M	4″-8UN	1.5″D-GB	10	20″～30″	DF

B. Two valves with two tanks for continuous water supply

A control valve for continuous water supply used in a one valve with two tanks system is structurally complex due to the need to control two tanks, and typically has a water treatment capacity of 10m³/h or less. For continuous water supply systems that require a water treatment capacity exceeding 10m³/h, we can adopt "two sets of meter type softener systems + a three-way valve". By interlocking the two control valves and coordinating with the three-way valve, the function of continuous water supply with one in service one standby can be achieved. Alternatively, a "two sets of meter type softener systems + two sets of straight way valves" can be used, controlled

by a controller to achieve the same functionality. These methods can support continuous water supply systems with a water treatment capacity ranging from 2m³/h to 50m³/h.

The working process is as follows: when the meter of the water outlet valve of the working tank reaches the set value, the control valve requires regeneration and sends a signal to the three-way valve to change direction. Another tank that has finished regenerating starts to treat water, while the exhausted tank undergoes regeneration, and this cycle continues. A similar principle applies when using double two-way valves with a one in service one standby controller.

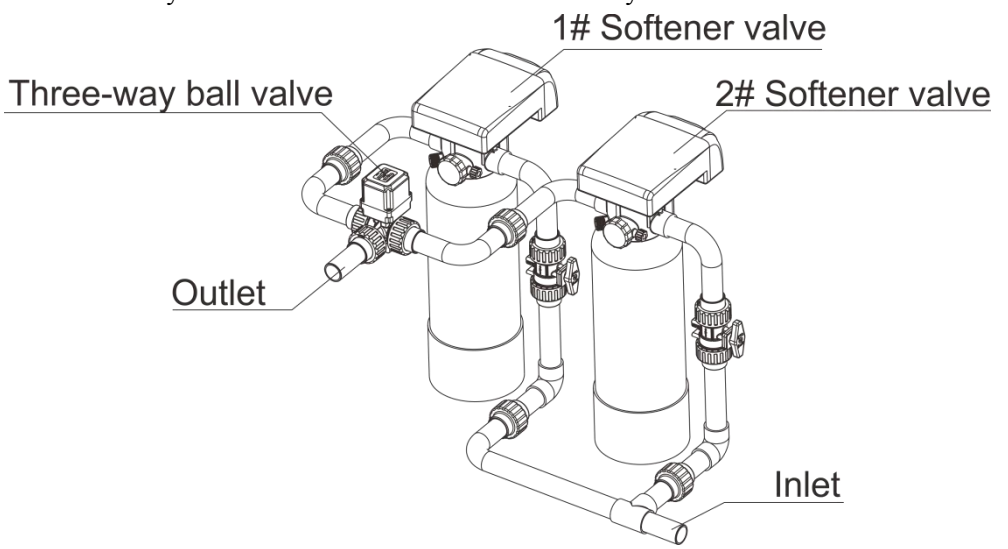


Figure 1-5 Two valves with two tanks for continuous water supply system

C. One valve with three tanks for two in service one standby system

Due to the vast territory of China and the high hardness of groundwater in some areas, which can exceed 500mg/L, it is difficult to meet the requirements for steam boilers that demand water hardness below 1.5mg/L using a single-tank softener. In 2016, Runxin company developed a one valve with three tanks continuous water supply control valve, model F118, to address areas with high water hardness. Using one valve to control three tanks, with two tanks service in series and the third tank for regeneration or on standby, ensuring continuous water supply and effective treatment of high hardness water. It can handle water with high hardness levels up to 16mmol/L, with a water treatment capacity of 4m³/h. After regeneration, the regenerated tank is in a standby state, and a rinse is performed before switching. The entire set of equipment requires only one brine tank. The regeneration process can be selected via the program to be either in a down-flow or up-flow mode. The regeneration can be performed with either softened water or hard water, which can increase the volume of water treated per unit volume of resin by more than 50%. This significantly enhances the working exchange capacity of the resin and reduces the consumption of salt and water.

The launch of this product also solves the problem of floating beds not being suitable for raw water with high turbidity. The company currently has two models with water treatment capacities of 2m³/h and 4m³/h. The service process is shown in Figure 1-6.

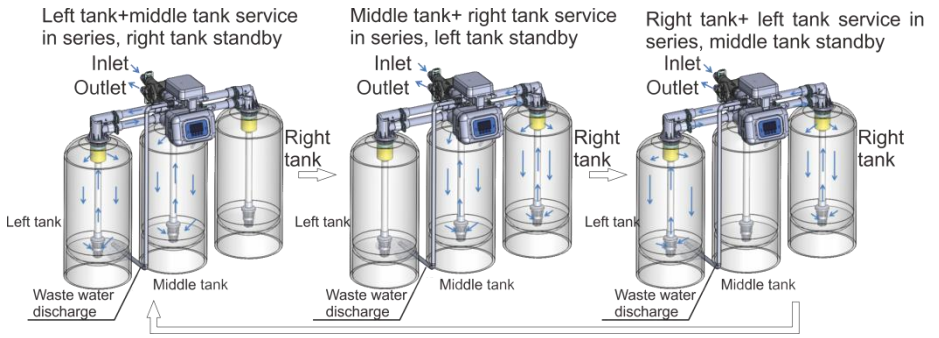


Figure 1-6 One valve with three tanks for two in service one standby service process of the system

1.2.3 Multi-valve systems

Since the maximum water treatment capacity of a single water treatment control valve is currently only up to 50m³/h, to meet market demand, our company has combined available product, the Runjing ceramic hard sealing ball valve, launch F109 multi-valve controller. By matching 5-11 pieces of Runjing ball valves, a filter, softener, and mixed-bed water treatment system can be formed. When paired with Runjing DN65 ball valves, the flow rate can reach 75m³/h; with Runjing DN80 ball valves, the flow rate can reach 100m³/h. The multi-valve system has the functions of interlock, one in service one standby, and RS-485 communication capabilities, providing a convenient and cost-effective solution to system programming issues in large flow water treatment equipment, greatly satisfying the needs for large flow water treatment.

1.2.3.1 Filter multi-valve system

By using a controller combined with 5 sets of Runjing ball valves, and controlling the opening and closing states of different ball valves, a filter system can be combined and applied for water treatment, achieving functions such as filter, backwash, and fast rinse. The installation of the ball valves is shown in Figure 1-7.

1.2.3.2 Softener multi-valve system

By using a controller combined with 7 sets of Runjing ball valves and a injector, and controlling the opening and closing states of different ball valves, a softener system can be combined and applied for water treatment, achieving functions such as producing soft water, backwash resin, down-flow or up-flow brine draw for regeneration resin, brine refill to the brine tank, and fast rinse the resin. The installation of the ball valves is shown in Figure 1-8 for a down-flow softener system, which can also be changed to a up-flow softener system by connecting the injector outlet to the lower part of the tank.

1.2.3.3 Mixed-bed deionization multi-valve system

By using a controller combined with 11 sets of Runjing ball valves, acid and alkali injectors, a conductivity meter, and a compressed air source, and controlling the opening and closing states of

different ball valves, a mixed-bed system can be applied for producing ultrapure water in water treatment, achieving functions such as producing pure water, backwashing resin, settling and layering, alkali drawing, acid drawing, washing acid and alkali, draining, mixing and fast rinse. The installation of the ball valves is shown in Figure 1-9.

1.2.3.4 One in service one standby multi-valve system

By using two sets of equipment, when the controllers are interlocked, a one in service one standby filter system as shown in Figure 1-10 can be formed; a one in service one standby down-flow regeneration softener system as shown in Figure 1-11; and a one in service one standby up-flow regeneration and brine refill with soft water softener system as shown in Figure 1-12.

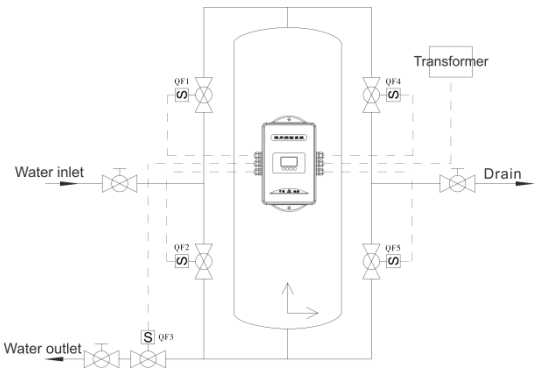


Figure 1-7 Multi-valve system used for filter

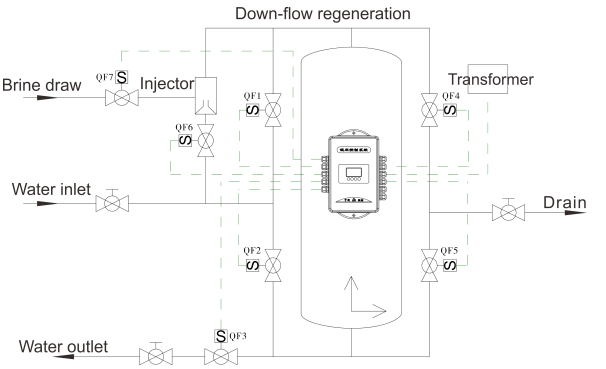


Figure 1-8 Multi-valve system used for DF softener

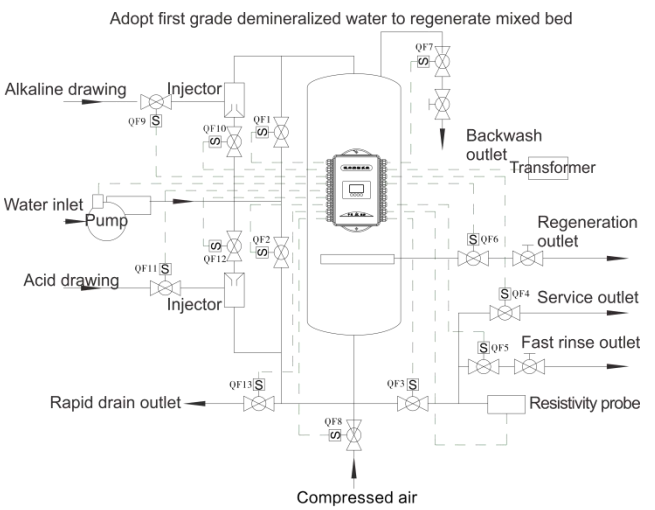


Figure 1-9 Mixed-bed deionization multi-valve system

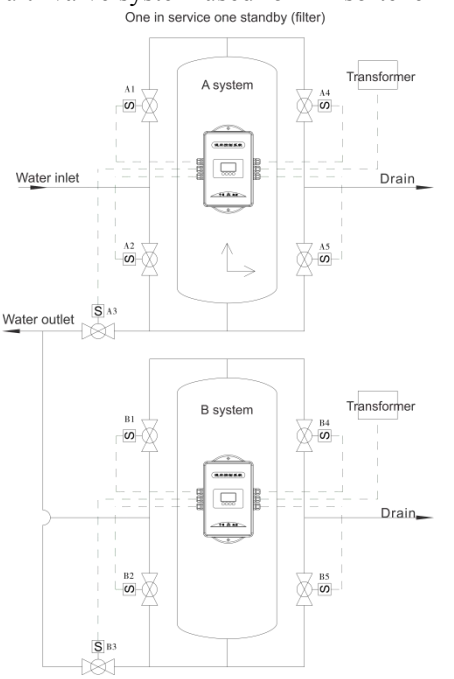


Figure 1-10 One in service one standby filter multi-valve system

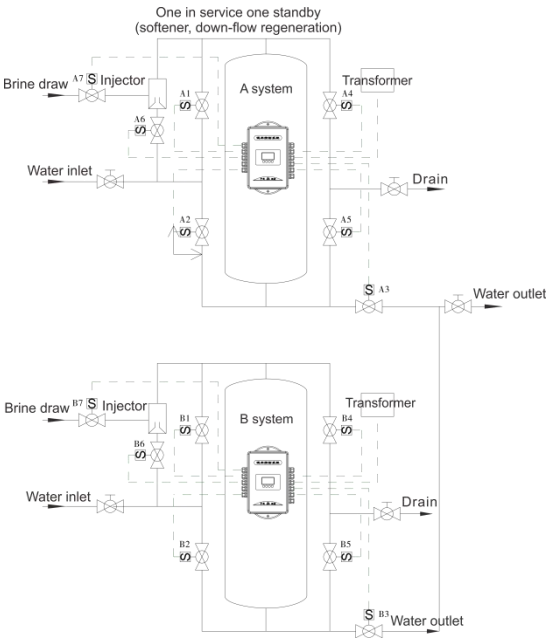


Figure 1-11 One in service one standby DF regeneration softener system

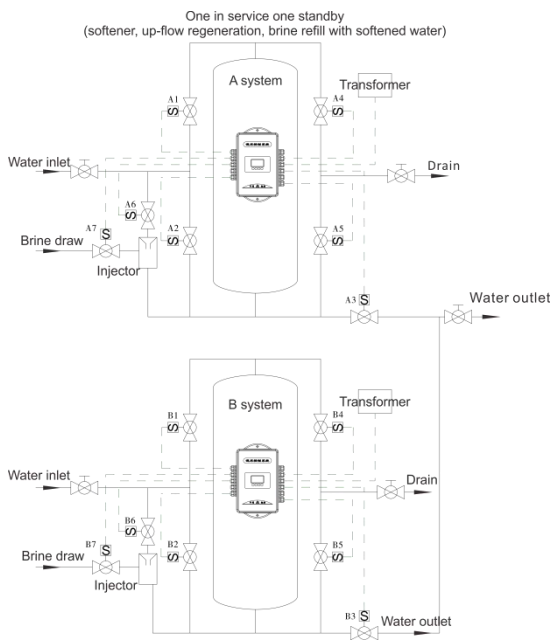


Figure 1-12 One in service one standby UF regeneration and brine refill with soft water softener system

1.2.4 Application cases of filter and softener valve

1.2.4.1 Manual filter valve application case

Installation Time / Location: December 27th, 2014, in Guatemala

Product Model: Manual filter valve F56A, F64A, flow rate 4m³/h

The system is applied to a small-scale bottled water treatment, consisting of two F56A1 manual filter valves and one F64A manual softener valve forming a pre-treatment system (as shown in Figure 1-13). The tanks are filled with quartz sand, activated carbon, and resin to remove impurities, residual chlorine, and hardness from the water. The treated water is used as the inlet for the RO membrane. Except for the replacement of filter materials, the system has been operating normally to date.

Figure 1-13 Manual pre-treatment equipment

1.2.4.2 Automatic filter valve application case

Installation Time / Location: April 2014, in a food factory in Lithuania

Product Model: N75A automatic filter valve, backwash flow rate 10m³/h

The user is a food production company, and the treated water is mainly used for water in food production. Due to certain odors and impurities in the local water quality, two sets of N75A activated carbon filter systems (as shown in Figure 1-14) are used, and a disinfection device is installed at the outlet for disinfection. The two sets of filter systems are connected in parallel, with staggered backwash to ensure continuous water supply. No issues have been reported to date.

Figure 1-14 N75A Automatic filter system

Installation Time/Location: August 2016, in a village in Tianjin City

Product models: F71 automatic filter valve, F65 automatic softener valve, backwash flow rate 2 m³/h

In recent years, China has introduced many policies to solve the problem of drinking water in rural areas. In a remote rural area of Tianjin, due to the difficulty in using water in the area, most of the drinking water is groundwater, which contains many harmful substances such as impurities, heavy metals, and bacteria. In order to solve the problem of drinking water for villagers, F71 automatic filter valve and F65 automatic softener valve are used for pre-treatment, and then filtered through RO membrane. Pure water enters the water tank for villagers to take water for drinking. As shown in Figures 1-15.

Figure 1-15 RO pre-treatment system

1.2.4.3 Swimming pool filter valve application case

Installation Time/Location: September 2023, a private villa in Linyi, Shandong

Product model: F139C

The user's original swimming pool filter equipment was manual, and switching operations required turning off the pump to release pressure, which was inconvenient. An upgrade was sought, and the F139C swimming pool valve was installed, which only required changes to the existing equipment's piping. After the modification, the system can operate under pressure, and it initiates flushing based on the differential pressure between the inlet and outlet, which is more precise. Additionally, remote communication is possible through the RS-485 port, allowing the user to view and operate the device's working conditions on the control panel without the need to manually operate in the confined equipment room. The user is very satisfied with the upgraded system. As shown in Figures 1-16.

Figure 1-16 Swimming pool filter equipment

1.2.4.4 Multi-valve filter system application case

Installation Time/Location: December 20th, 2023, a certain town in Yushu City, Jilin Province

Product model: F109 multi-valve system

To solve the rural drinking water issue, the Yushu City Water Conservancy Bureau has made significant efforts to promote rural water improvement projects, investing in 6 sets of 50m³/h, 24 sets of 35m³/h, and 24 sets of 20m³/h filter equipment, which has comprehensively improved the quality of rural drinking water. As shown in Figure 1-17, for the drinking water renovation in a town in Yushu City, due to the use of groundwater with many impurities the system has a low filter flow rate. Therefore, a controller is used to control the ball valves for backwash of the system, and five sets of systems are connected in parallel to serve as a pre-treatment system for the reverse osmosis equipment.

Figure 1-17 Multi-valve filter system

1.2.4.5 Mixed bed demineralization multi-valve system application case

Installation time / location: May 10th, 2023, an Egyptian Industrial Fertilizer Company

Product Model: F109B mixed bed demineralization multi-valve system

The water treatment workshop of this company requires ultra-pure water with a treatment volume of 12m³/h. After pre-treatment, it undergoes primary RO desalination treatment and then mixed bed treatment. To ensure continuous water supplying, the system is designed as a single-stage reverse osmosis + one in service one standby mixed bed system. The mixed bed uses ball valves and F109B mixed bed controller to achieve the function, as shown in Figure 1-18. Its electrical conductivity, SiO_2, and other indicators of the output water meet the requirements of the production process. The equipment has been running stably so far.

Figure 1-18 Mixed bed demineralization multi-valve system

1.2.5 Special water treatment

1.2.5.1 Iron and manganese removal system

Iron and manganese containing groundwater is widely distributed in the United States, Russia, and the Northeast of China, among other places. Excessive iron and manganese elements can damage equipment and cause discomfort to the human body. Colorless iron-containing groundwater drawn from the well gradually turns into a turbid reddish-brown after placed a period, and the higher the iron content, the darker the color. Iron ions easily promote the growth of iron bacteria in the pipeline, forming a viscous film inside the pipeline, causing pollution to domestic and production water, and damaging the pipeline. Water with high iron content entering boilers and heat exchange equipment is prone to the formation of iron oxide scale and corrosion under the scale, and water with high iron content entering ion exchangers can easily cause resin poisoning.

When the manganese content in the water > 0.1mg/L, it can cause an unpleasant taste in drinking water and discoloration of utensils and laundry. If the divalent manganese compounds in the solution are oxidized, precipitation will form, causing scaling. When the manganese content in

the water reaches 0.2mg/L, a layer of coating will form on the inner wall of the water pipe, which will flow out with the water flow, causing black sedimentation. Excessive intake of manganese by the human body can cause poisoning, with early symptoms including fatigue, dizziness, headache, insomnia, weakness in the lower limbs, etc., and severe poisoning can also cause speech disorders. Manganese-containing water can color the water and have a smell and foul odor, affecting the quality of industrial products such as textiles, papermaking, brewing, and food, and will also pollute household appliances, and washing clothes will leave light black or light gray stains.

Our developed products use filter media (such as manganese sand) to remove iron and manganese after compressed air aeration (main models include F67, F71, N75 filter valves + F107 aeration device), and ozone oxidation followed by specialized filter media filtration for removal iron and manganese (F142).

A. Compressed air aeration method

The compressed air aeration method refers to the water treatment technology that groundwater is drawn up through a deep well pump, and the water is treated by the compressed air aeration and oxygenation process. Compressed air is directly introduced into the water inlet main pipe, and after the aeration device (Patent No.: ZL201520119864.5) rotates and mixes the air and water at high speed for full aeration, it enters the aeration tank for secondary drop aeration, and finally enters the manganese sand filtration tank. The working process is shown in Figure 1-19.

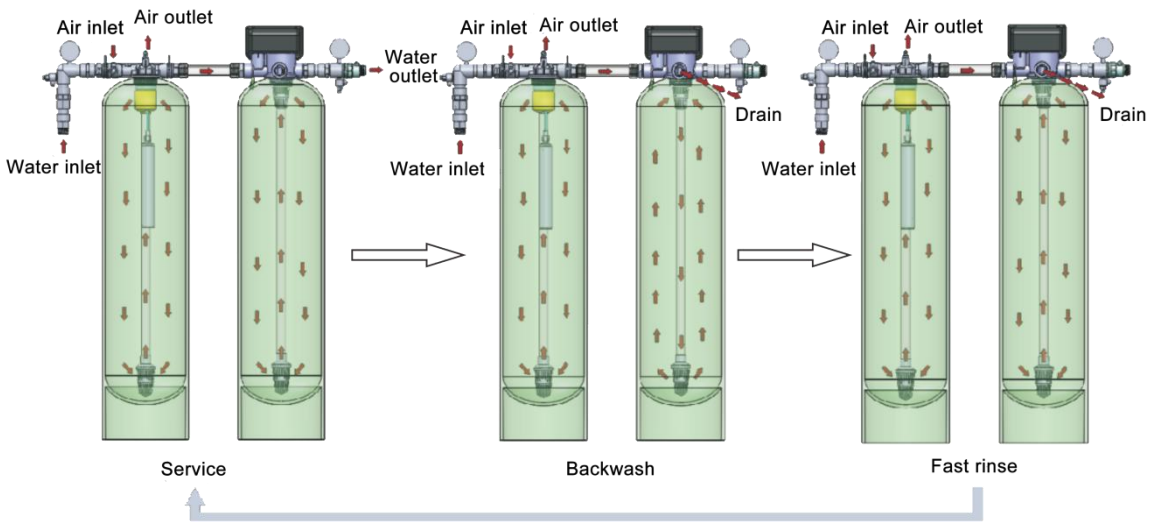


Figure 1-19 Compressed air aeration method

B. Ozone oxidation method

Ozone has stronger oxidability. An ozone generator is added to the filtration system to promote the oxidation of divalent iron and manganese with ozone, and then it is removed through iron and manganese removal filter materials. Some families in the United States, who live far from cities and have high iron and manganese content in their groundwater, often use the ozone oxidation method due to the difficulty of laying water pipes and limited space.

The equipment consists of an aeration tank and a filtration tank. The ozone generated by the ozone generator enters the aeration tank, and the filtration tank is filled with special iron and manganese removal filter materials. Runxin multi-tank in series softener valve F142 (Patent No.: ZL202022865712.3) is used for automatic control. The water treatment process is service → backwash → fast rinse → entering ozone → service. The process is shown in Figure 1-20.

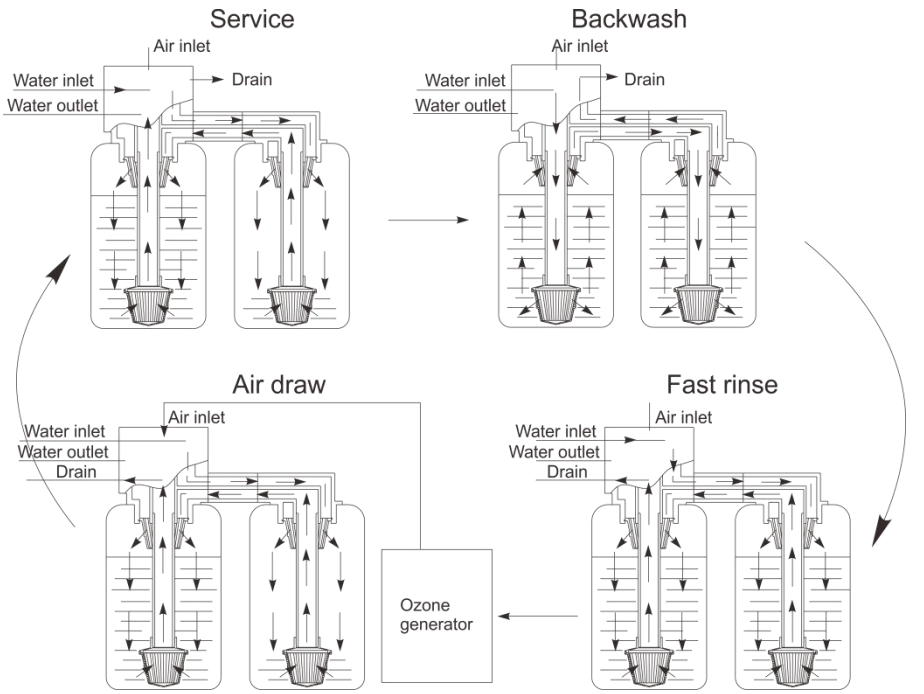


Figure 1-20 Ozone oxidation method

1.2.5.2 Fluoride removal system

In some areas of China, such as Shanxi, the Northeast, Inner Mongolia, and the Southwest, the fluoride content is high, exceeding the national standard. In some places in India, the fluoride content is also excessive. Excessive intake of fluoride can lead to dental fluorosis and skeletal fluorosis, with mild cases causing rough tooth surfaces and enamel shedding, and severe cases causing total skeletal deformation and paralysis, which shows its harm. There are many methods to remove fluoride, and the common ones are as follows.

Fluoride removal agent adsorption method: The fluoride-containing water is filtered through a fluoride removal agent at a certain filtration rate, and the filtered water can meet the requirements of the fluoride content in drinking water. Commonly used fluoride removal agents include calcium phosphate, bone charcoal, activated alumina, modified resin, etc.

Desalination method for fluoride removal: Common methods such as electrodialysis, reverse osmosis, and ion exchange for desalination treatment can remove fluoride while desalinating. However, these desalination water treatment processes are more complex than simply using a fluoride removal agent, and the equipment investment is also higher.

JM-1 type fluoride removal filter material treatment: The JM-1 type fluoride removal filter material is a porous substance with a pore size of 0.5nm to 1.6nm, and it has a very large specific surface area. It uses both adsorption and ion exchange methods to remove fluoride. The JM-1 type fluoride removal filter material does not contain active aluminum, and the fluoride removal reaction formula is:

F- (fluoride-containing water) + R (fluoride removal filter material) →FR (retained substance) + H_2O

Runxin valve application and characteristics in the fluoride removal system: Traditional fluoride removal systems use multiple solenoid valves or ball valves, which have the disadvantages of being troublesome to control and not wear-resistant. Runxin's multi-port valve uses ceramic hermetic head faces sealing technology and the acid and alkali resistance of corundum ceramics, integrating the main pipeline and valves into one main valve, solving the problems of not being wear-resistant and not resistant to corrosion by regenerating liquid. And the operation is simple. In the fluoride removal process, it adopts "down-flow filtration and purification, up-flow regeneration", and during regeneration, it saves water and regenerating agent, and the regeneration is thorough.

1.2.5.3 Deoxygenation system

Excessive oxygen content in water can cause oxidation and corrosion of equipment such as boilers. The common deoxygenation methods on the market include thermal deoxygenation, vacuum deoxygenation, sponge iron deoxygenation, and chemical deoxygenation methods, etc. We have designed a dedicated dual-chamber ambient temperature sponge iron deoxygenation control valve F85 (13504), which uses professionally produced sponge iron to react with oxygen in the water, thereby generating a soft flocculent substance that is insoluble in water, and then flushing away the impurities through backwashing. The consumption of sponge iron is very low, and it is generally replenished once every 3-6 months according to the treated water volume and water quality, resulting in low operating costs. Sponge iron has a large specific gravity and requires a high backwashing intensity. The sponge iron deoxygenation system adopts a tank body with left and right chambers, and the left and right tanks operate simultaneously during operation, with separate chamber backwashing, which can double the backwashing intensity and achieve the flushing effect. Commonly used filter valves, such as N75 and N77, can also be used to design the system and configure the tank based on the backwash flow rate, and to design the water treatment capacity based on the service flow rate of the filter material.

1.2.5.4 Mixed bed system

In industries such as chemical, electronics, electroplating, and monocrystalline silicon fabrication, ultra-pure water is required. Currently, there are many methods for producing ultra-pure water, mainly including: pre-treatment + two-stage RO + polishing resin, pre-treatment + RO + EDI and other membrane treatment methods, pre-treatment + anion and cation bed + mixed bed ion exchange treatment methods. With the increasing maturity of membrane treatment technology, the

use of ion exchange methods is becoming less and less. Mainly due to the high requirements of ion exchange methods for valve and mixed bed regeneration, the early mixed bed all used 11 control valves and controller to cooperate to achieve the various functions required by the mixed bed: service → backwashing and layering → settling → pre alkali feeding → acid and alkali feeding → acid and alkali washing → drainage and mixing → rapid discharge → fast rinse → service. The system is shown in Figure 1-21.

Traditional mixed bed system usually uses at least 11 valves to control pipelines. We have developed a dedicated control valve for mixed beds by using ceramic hermetic head faces sealing technology and the acid and alkali resistance of corundum ceramics. The main pipelines and valves are integrated into one main valve, and the flow channel of the valve is automatically controlled to switch. In addition, 5 electronic valves are controlled to cooperate with the main valve to complete the mixed bed water treatment process. At present, the maximum flow rate of the mixed bed system is 4m³/h. If a larger flow rate is required, a mixed bed multi-valve system composed of Runjing ceramic hard sealing ball valves can be used, with a flow rate of up to 50m³/h. The system is shown in Figures 1-22.

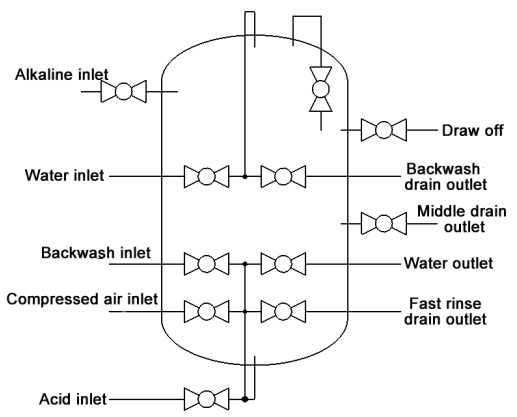


Figure 1-21 Traditional mixed bed system

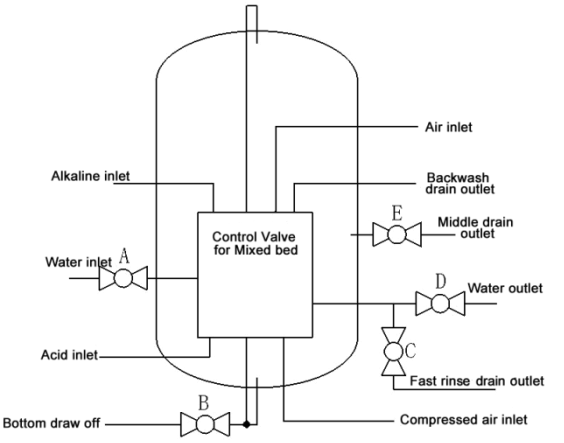


Figure 1-22 Runjing ball valve mixed bed system

1.2.6 Special water treatment system application cases

1.2.6.1 Iron and manganese removal system application case

Installation Time/Location: August 7th, 2013, at a military service station in Yushu City, Jilin Province

Product Model: N56D1

The underground water in the Yushu area has a high content of iron and manganese, which greatly affects the lives of local residents. To address this issue, the local government has sought cost-effective solutions and ultimately adopted the water treatment plan provided by Changchun Runxin Valve's agent, Jilin Hongye Company. The plan uses Runxin N56D1 manual control valve, a stainless steel tank with a diameter of 1.2 meters and a height of 2.2 meters, filled with iron and manganese removal filter material to form an iron and manganese removal system, as shown in

Figure 1-23. The system has been in operation since September 2013 and has been running normally, achieving good economic and social benefits.

Figure 1-23 Iron and manganese removal filtration equipment

1.2.6.2 Deoxygenation system application case

Installation Time/Location: May 16th, 2015, at a pharmaceutical factory in Lanzhou

Model: N75A1/N75B1

After a period of use, a boiler at a pharmaceutical factory in Lanzhou was found metal oxygen corrosion, with the metal wall thinning, which seriously affected the boiler's pressure-bearing capacity and the safety of the boiler. Runxin valve's Lanzhou agent, Gansu Jieming Zhichen Company, provided a solution by using N75A automatic filtration valve and F90D disk prefilter with a capacity of 40m³/h to form two sets of sponge iron deoxygenation systems, working in parallel to supply water, as shown in Figure 1-24, to ensure that the oxygen content in the water meets the national standard requirements and prevent oxygen corrosion of the boiler. It has been operating normally so far.

Figure 1-24 Deoxygenation system

1.3 Other

1.3.1 Bypass valve

The residential softener is installed at the main water inlet of the home. When in use, all the water that comes out is softened. However, when watering plants or other situations that softened water is not needed, bypass function is necessary. Additionally, when the water softener requires maintenance or media replacement, the accompanying bypass valve allows for maintenance without the need to dismantle the water pipes. Therefore, we have developed a bypass valve to complement the residential softener, capable of performing functions such as service, partial bypass, close, and full bypass. Bypass valves of different specifications can be matched with different models of control valves, with the specification and size table shown in Table 1-11.

Table 1-11 Bypass valve specification and size table

New model	Old model	Inlet/ outlet	Matching control valve pipe diameter	Center distance of matching control valve (mm)	Remark
41104	F70A	1″M	1″F	50	Matched with F63/F68
41102	F70B	3/4″M	3/4″M	65 or 70	Matched with F65/F69
41204	F70C	1″M	1″F	50	Matched with F63/F68/F82
41202	F70D	3/4″M	3/4″M	50	Matched with F79
41206	F70F	1″M	NPT 1″ or 1″M	50	Matched with F92/F82
41304	F70G	3/4″M 1″M	3/4″M 1″M	50	Matched with F63/F68/F79/F82/F136
41302	F70H	3/4″M	3/4″M	50	Matched with F67N/F105/F117/F126

1.3.2 Hardness online monitoring device

The regeneration of the water softening equipment (or water softener) is typically triggered by two methods: time and volume. Using a set regeneration time to trigger regeneration is straightforward, but water usage varies by period, resulting in different amounts of water treated per cycle. Sometimes the resin may already be ineffective, while at other times it may still treat a significant amount of softened water. A method that calculates the water treatment capacity based on the resin amount and the raw water hardness, then triggers regeneration based on the volume used, is superior to the time-based approach. However, for areas that use groundwater or are in some coastal regions, the original water hardness will fluctuate with the seasons, and the regeneration effect of the resin will vary each time. Sometimes a lack of salt can lead to incomplete regeneration of the resin, causing the water treatment capacity to vary as well. To make rational use of the resin, the best approach is to start regeneration when the water hardness at the outlet does not meet the requirements. For this purpose, we have developed a hardness online monitoring device. It takes a certain amount of water from the softened water outlet, adds a specific amount of mixed reagent, and

after thorough mixing, uses a color sensor to detect the color of the mixture to determine whether the softened water at the outlet is qualified. It has the following characteristics:

A. It uses a fixed volume of a moving disk hole and a mixing chamber to take the reagent and water sample, ensuring consistency in the amounts of water and reagent;

B. To conserve reagent or ensure outlet water quality, the program offers various timing modes: a) The detection period can be set according to water quality requirements, ranging from 0-300 minutes, allowing for periodic detection; b) By inputting parameters such as the volume of resin, the raw water hardness, and the average hourly water usage, the system automatically calculates the total runtime. The program has a higher detection frequency after resin regeneration and when resin is about to expire, and a lower frequency during the intermediate process;

C. When the reagent is depleted, the system will alert and switch to a time-based hourly count until more reagent is added.

This device qualitatively detects the hardness of outlet water of the softening system, with commonly used detection reagents of 1.5ppm and 30ppm. It sends signals according to the set program and is suitable for steam boilers, hot water boilers, and water softening systems with high requirements for water hardness control.

1.3.3 Electronic tee valve

The electronic tee valve F80 was initially created to address the backwashing issue of ultrafiltration membranes. It was later discovered that when paired with two flow control valves, it could form a one in service one standby system. Designed with ceramic hermetic head faces sealing technology, it has the capabilities to switch directions and shut off. This model has a water production capacity of up to 20m³/h and can be paired with N77, F95, F111 to form a one in service one standby system.

1.3.4 Disk prefilter

During the after-sales service of control valves, it was observed that in many environments where control valves are used does not meet standard requirements. High water turbidity and the presence of large particulate impurities such as plastic bags and stones sometimes lead to valve malfunctions. To solve the issue of pre-filtration in areas with poor water quality, we have developed disk prefilters with a water production capacity ranging from 6m³/h to 40m³/h. The filter elements can be disassembled and washed repeatedly, and equipped with a sewage storage room, regularly open the ball valve to drain. The specifications and sizes are detailed in Table 1-12.

Table 1-12 Disk prefilter specification and size table

New model	Old mode	Inlet/ outlet	Drain	Filter precision	Working pressure	Maximum water treatment capacity (m³/h)
45006	F90A	1″M	3/4″M	150 Microns	0.15～0.6MPa	6
45012	F90B	1.5″M	3/4″M	150 Microns	0.15～0.6MPa	12

New model	Old mode	Inlet/ outlet	Drain	Filter precision	Working pressure	Maximum water treatment capacity (m^3/h)
45020	F90C	2″M	3/4″M	150 Microns	0.15～0.6MPa	20
45040	F90D	2.5″M	3/4″M	150 Microns	0.15～0.6MPa	40

1.3.5 Check valve (bottom valve for water pumps)

Due to solar water heater tanks being installed on rooftops, after a day of heating, the water temperature in the tank can reach up to 90°C or even 100°C. When the municipal water supply is interrupted, the hot water in the tank can flow back into the inlet pipe. Since the inlet pipes are generally made of plastic material, which is not temperature-resistant, the backflow of hot water can cause damage to the inlet pipes and loss of hot water. Therefore, it is necessary to install a check valve at the household water inlet to prevent the incoming water from flowing out and to prevent the backflow of hot water.

Commonly available check valves on the market typically use rubber and plastic or metal seals, pre-compressed by springs. These products have certain issues, such as: during the water intake process, it is necessary to overcome the spring's elastic force to open, which results in a certain pressure loss; rubber parts used for sealing may not seal well when encountering impurities, leading to leaks.

Runxin check valve features a ceramic hermetic head faces sealing structure, utilizing a high planarity ceramic moving disk that seals with a high planarity fixed disk. When opening, it only needs to overcome the gravity of the moving disk, offering strong resistance to impurities and no deformation.

We have developed check valves with copper and plastic valve bodies, in various sizes including 1/2", 3/4", 1", 1.25", 1.5", and 2". In the residential field, copper or plastic check valves of 1/2" and 3/4" sizes are mainly used. To prevent large particulate impurities in the incoming water, we have also developed 1/2" and 3/4" filtered check valves and shut-off filtered check valve, among other products.

Check valves can also be used as bottom valves for water pumps to prevent water from flowing back into the pipes when the pump is not in use. The next time the water pump starts, it may need to add water to the pipes before it can operate. Existing water pump bottom valves generally use a metal block that seals against the metal valve body with the aid of a spring. Metals are prone to corrosion, and impurities can easily get caught in the spring, leading to a failure to seal properly. After the water pump is stopped, water in the pipes can slowly leak out, and need to add water to the pipes before the pump can be restarted. The check valve with ceramic hermetic head faces sealing overcomes these drawbacks.

Next, we are considering the production of a 1.25" bypass valve and check valves in sizes 2.5" and 3" to be used as bottom valves for water pumps.

2. Whole House Purification (Softening) Product

2.1 Disk prefilter

Water that enters the home may be contaminated by transport through corroded pipes, turbidity from pipe repairs, or pollution in secondary supplies in high-rise buildings. To protect electrical appliances for household water use (such as water heater, washing machines, and intelligent toilet lids), **a protective impurity filter must be installed when any new building is constructed, according to a German government regulation (DIN 1988) passed in 1988.**

By utilizing ceramic hermetic head faces structure and disk filtration technology, our company has developed backwash prefilters that differs significantly from other prefilters on the market.

Table 2-1 Classification of common disk prefilter on the market

	Filter screen type	Filter screen type	Disk filter type
Picture			
Feature	Stainless steel filter screen with a bottom drain valve.	Stainless steel filter screen with a backwash device, which can be backwashed regularly.	Disk design for high precision and efficiency in automatic backwash, intelligent water leakage protection and with a micro pressure drop check valve.

2.1.1 Technical principle of Runlucky disk prefilter

Disk prefilter is the first safety protection for household water purification, which is installed after the water meter and on the main inlet pipe. It can filter large particle impurities such as sediment and rust in tap water, protecting the pipelines, faucets, washing machines, and other household appliances, as well as subsequent water purification equipment.

Runlucky disk prefilter uses Runxin valve with hermetic hard sealing technology as the core controller, which allows for rapid flow path switching. The filtration unit consists of over 100 food-grade PP material disks with numerous grooves, pressed together by a spring mounted at the top. During filtration, the disks are pressed tightly by the spring and water pressure, forming a filtration unit of 50-80 microns. Impurities are trapped on the outside of the disks or in the gaps, while clean water flows out from the inside.

When it's time to wash, the control valve changes the flow path, so that water flows from inside to outside, creating a pressure difference from bottom to top to push against the spring, making the disks expand evenly and rotate rapidly to wash away the impurities. Impurities are instantly washed away with water flow. This achieves true backwash and maintains good filter performance over a long period of use. You can watch the principle of high efficient backwash of Runlucky disk prefilter by scanning QR code 2-1.

Figure 2-1 Scan to watch the principle

2.1.2 Comparison with filter screen type disk prefilter

A. Runlucky disk prefilter uses disk filter element, which offers high filtration accuracy and is less prone to blocking. In contrast, the stainless steel filter screen element has a fixed pore size, making it more susceptible to blocking by impurities.

B. Runlucky disk prefilter is equipped with a control valve, allowing backwash to ensure all impurities are removed without any residue. In comparison, filter screen type prefilter uses forward flushing, siphon cleaning or brush washing, which may not be as effective in completely removing impurities and require regular maintenance with a brush.

C. Runlucky disk prefilter uses ceramic valve core, which is sintered at 1680°C and finely ground, the hardness is just after diamond and sapphire in nature, offering excellent wear resistance, good sealing performance and a longer service life. In contrast, most filters on the market use rubber gaskets, which can easily age and deform over time, posing a risk of leakage.

D. Runlucky disk prefilter is installed upside down with the filter bottle facing up, which is more conducive to the discharge of impurities from the bottom without residue. The stainless steel filter screen type usually has a separate valve at the bottom, making automatic control difficult.

2.1.3 Function and characteristics of Runlucky disk prefilter

A. Filtration accuracy reaches 50-80 microns, effectively removing particulate impurities and flocculent matter.

B. Comes with a built-in base and is equipped with a universal interface for convenient installation.

C. Equipped with micro pressure drop check valve, which can prevent backflow of water into

the home from generating “charges of air water”. It could also prevent damage to water treatment equipment due to negative pressure.

D. The filter bottle is made of high-molecular explosive-proof material, resistant to high pressure and water hammer impact, with test data exceeding national standards (our test standard is passing a 35 kg water pressure burst and 120,000 water hammer tests), ensuring high reliability.

E. When the control valve is flushed, raw water flows out without interrupting the water supply.

F. The automatic model has light, with the light turning on when the operation buttons are pressed.

G. It has a dual-mode design for time and meter, automatically initiating backwash when the time or meter reaches the set value.

H. Equipped with a shut-off function and a flow meter, the program has three levels of intelligent leakage protection. When the flow exceeds the set peak flow, the water flow time exceeds the set time, or the leakage sensor installed on the ground detects a leakage, the control valve will automatically close to prevent water leakage and potential damage.

2.1.4 Classification of Runlucky disk prefilter

They are classified by control method into manual and automatic; by display method into digital tube and LCD display; and by water treatment capacity into 1.5m³/h and 2.5m³/h. The model specifications are shown in Table 2-2.

Table 2-2 Runlucky disk prefilter model specifications

Model	Rated flow rate m^3 /h	Inlet/ outlet	Control method	Display method	Dimension (Width * depth * height mm)	Remark
RL-Q01AS	1.5	3/4″M	Manual	—	244*215*334	
RL-Q01BS	1.5	3/4″M	Manual	—	194*145*305	Non-universal
RL-Q01A	1.5	3/4″M	Automatic	Digital tube	244*207*311	
RL-Q02A	2.5	1″M	Automatic	Digital tube	302*267*383	
RL-Q02B	2.5	1″M	Automatic	LCD	302*365*372	
RL-Q02BS	2.5	1″M	Automatic	—	260*274*372	

Hygiene Permit Approval Number: Zhejiang (12) Health Water Character (2022) No. 0030

Product specification or model: RL-Q01、RL-Q02

2.2 The whole house water filter

The water entering homes from high-rise secondary water supply and old water supply networks may contain rust, suspended solids, heavy metals, organic substances, and other harmful

substances. Sometimes, the first glass of water from the tap in the morning has a pungent smell, which is the smell of bleach powder. Tap water is disinfected with residual chlorine to prevent bacterial growth, but residual chlorine can severely affect human health. Therefore, it is necessary to treat it upon entering the home.

A famous Japanese scholar wrote that **in order to solve the problem of microorganisms and their reproduction issues generated by adsorption devices such as activated carbon and membrane treatment, a backwash device should be set up to backwash regularly** in his book "*Construction Internal Good Quality Water-Safety Drinking Water"*. Therefore, the key to the whole house water filter is: first, the effect of the filtered water, the turbidity and residual chlorine removal, which is mainly related to the quality of activated carbon; second, it must have a backwash function. An ideal device should be able to automatically perform backwash on the filter elements and materials at regular intervals, which can not only prevent secondary pollution caused by long-term use, such as pollutant accumulation and bacterial breeding, but also greatly extend the service life of the filter elements and materials, reducing subsequent maintenance costs.

Our company has developed a series of whole house water filters with ceramic hard sealing control valves, which are compatible with our residential softeners, suitable for contemporary consumer concepts, more convenient to use, and more economical.

2.2.1 Technical principle of Runlucky whole house water filter

Runlucky whole house water filter uses activated carbon, quartz sand, KDF, and other filter materials to adsorb residual chlorine, odors, heavy metals, organic substances, algae, and filter out harmful substances such as rust and suspended solids. It is suitable for whole house water purification and is generally installed anywhere after the main water valve and before household equipment to ensure the safety of household water and improve the taste of drinking water.

Runlucky whole house water filter is driven by Runxin valve, which is adopted with hermetic head faces structure. Its main patented technology is to integrate the functions required by each flow channel on the hermetic head face sealing disks, and two (or more) ceramic disks with multiple through holes or blind holes and high flatness are fit with composite disk. The fixed disk is fixed, and moving disk rotates concentrically according to program setting, with the flow channel on valve body, it achieves the designed necessary flow channels, changes the channel rapidly, which could realize the function of controlling liquid flow direction of each status.

Runlucky whole house water filter, through its control valve, can be set to operate for a certain meter or for a certain period. Once the set value is reached, the control valve can instantly change the direction of the water flow for backwash. Water enters from the bottom of the tank, passes through the activated carbon, causing the activated carbon to rub against each other. The particulate impurities, suspended pollutants, and flocculated substances trapped in the gaps of the activated carbon are then expelled from the top of the tank, passing through the control valve's drain. See Figure 2-2 for the working process diagram.

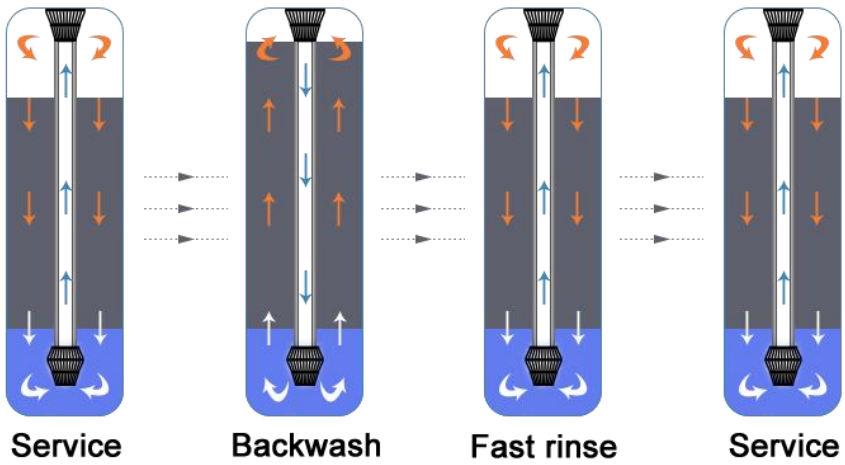


Figure 2-2 Working process diagram of Runlucky whole house water filter

2.2.2 Function of Runlucky whole house water filter

A. Using high-quality coconut shell activated carbon as filter media, it can effectively absorb the odor in water. Coconut shell activated carbon is a high-quality activated carbon produced from coconut shell raw materials, with a strength of up to 95% and strong adsorption capacity (iodine adsorption value≥950mg/g), which is better than ordinary wood and coal-based activated carbon in adsorption residual chlorine and other odors.

B. Users only need to set the current time, regeneration time, and raw water residual chlorine, etc., to achieve permanent memory even in the event of a power outage.

C. It has an intelligent backwash function. The system automatically starts regeneration according to the user-set service time/volume and regeneration time. The control valve instantly changes the flow path, allowing the particulate impurities, suspended pollutants, and flocculated substances trapped in the gaps of the activated carbon to be expelled, restoring the water production capacity of the filter material.

D. After long-time use, the adsorption capacity of the filter material will decrease. When the set number of days has passed or a certain total amount of purified water has been reached, the system will display a filter material maintenance interface, reminding the user to maintain and replace the filter material.

E. It has an intelligent water leakage protection function, which can set the peak flow rate or continuous water flow duration. When the set value is exceeded, a leakage signal is received from the leakage sensor, the control valve automatically cuts off the water supply to prevent property damage caused by leakage.

F. Some models can be interconnected via WIFI. Through the Runlucky Smart Link APP, users can monitor the water capacity, water usage, remaining water, service time, filter material aging reminders, fault reminders on their smartphones, and adjust various parameters of each status.

2.2.3 Classification of whole house water filter

Runlucky whole house water filters include black tank, DR, DN, S, V series, etc. The main corresponding control valves are F71D, F67D, F71Q, F67Q, F71H, F67H, F67NH, etc. The rated water flow rates are 1.0m³/h, 1.2m³/h, 1.5m³/h, 2.0m³/h, 2.5m³/h. The model specifications are shown in Table 2-3.

Table 2-3 Runlucky whole house water filter model specifications

Model		Control valve	Regeneration mode	Rated water flow rate m³/h	Whether contains KDF	Dimension (Width * depth * height mm)
Black tank series	J60	F71Q	Time type	1.5	No	265*265*560
	J120	F67Q		2.0	No	265*265*1025
	J150	F67Q		2.5	No	265*265*1248
DR series	J60DR	F71H	Time type	1.5	No	281*281*566
	J120DR	F67H		2.0	No	281*281*1036
	J150DR	F67H		2.5	No	281*281*1305
DN series	J50DN	F71H	Time type	1.0	No	255*230*517
	J60DN	F67NH	Meter delayed type	1.5	Yes	281*281*604
	J120DN	F67NH		2.0	Yes	281*281*1074
	J150DN	F67NH		2.5	Yes	281*281*1303
S series	J55S	F67NH	Meter delayed type	1.2	No	300*380*537
	J120S	F67NH		2.0	No	300*380*1047
V series	J55V	F71D	Time type	1.2	No	318*360*539
	J120V	F67D		2.0	No	318*360*1049

Hygiene Permit Approval Number: Zhejiang (12) Health Water Character (2021) No. 0022

Product specification or model: RL-J50、RL-J55、RL-J60、RL-J120、RL-J150

2.3 Residential softener

On March 5th, 2015, Phoenix TV's "Behind the Headlines with Wentao", talking about the Chinese rush to buy toilet lids in Japan in 2015, Ma Weidu asserted: Chinese people buy Japanese toilet lid, a year later must scold Japanese goods is not good. The use of toilet lid needs to heat the water, high hardness water heating easy to produce scale, so that the toilet lid inside the pipeline blocked. The hardness of water in most parts of China is higher than that in Japan, as a result, the well-received toilet lid in Japan is "dissatisfied with soil and water" in China.

Industrial softener typically use a resin tank and a brine tank, which are bulky and not easily promoted in the household market. Runlucky has developed an integrated residential softener suitable for home use, which installs the tank inside a blow molded cabinet, with the remaining space serving as the salt tank. This design is aesthetically pleasing and convenient for on-site installation. It is equipped with a bypass valve, is convenient and quick replacement of the resin when it becomes ineffective after long-term use, reducing after-sales service time.

2.3.1 Technical principle of Runlucky residential softener

Residential softener applies ion exchange technology, where the sodium ions in the functional groups of the resin replace the calcium and magnesium ions in the water, achieving the goal of removing scale (calcium carbonate, magnesium carbonate). The control valve of residential softener automatically completes the switching of status according to a pre-set program, thus realizing the various processes such as service, backwash, brine & slow rinse, brine refill, fast rinse, etc. The ion exchange illustration can be seen in Figure 2-3.

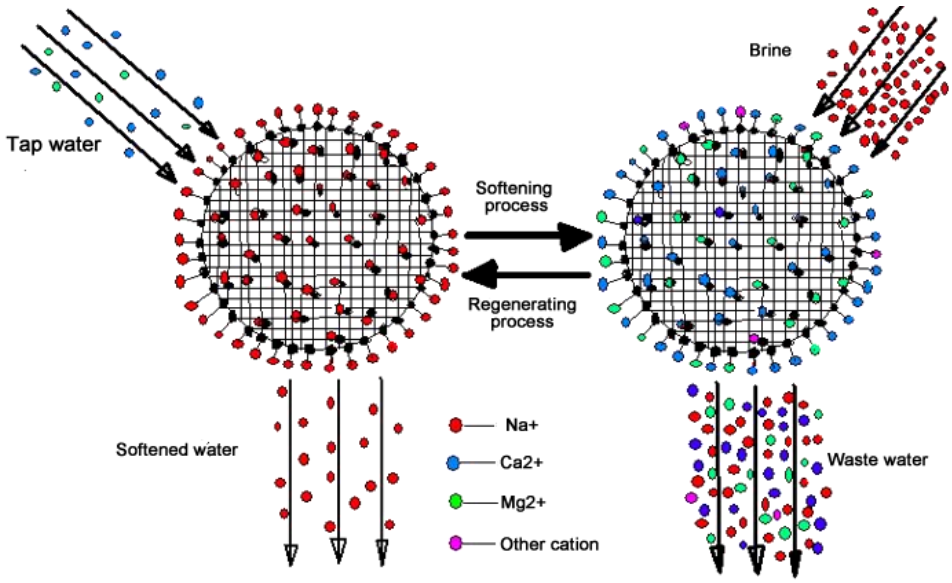


Figure 2-3 The ion exchange illustration of residential softener

2.3.2 Function of soft water

A. Bathing with soft water leaves the skin without tightness and with a delicate luster.

B. Soft water promotes cell tissue regeneration and can effectively inhibit fungi.

C. Washing hair with soft water makes the hair soft, elegant, and dandruff-free, without dryness or roughness, and the hairstyle retains its natural luster.

D. For wall-mounted furnaces or water heaters, the number of repairs is greatly reduced, the life of the water heater is more than doubled, and the gas or electricity consumption of the water heater is reduced by 29% to 32%. The water pipe do not scale or become blocked.

E. Clothes washed by soft water is soft, clean, and brightly colored. The life of the clothes is increased by 33%, and the amount of laundry detergent used is reduced by 55%. Dishes and porcelain are kept as good as new, with no water stains, and the amount of detergent used is reduced by 53%.

F. Toilets, sinks, and bathtubs no longer become yellow and scale-laden, producing an odor. The small holes of the shower nozzle are no longer blocked with white scale, the water flow is smooth and unobstructed.

2.3.3 Function of residential softener

A. Can automatically calculate water treatment capacity and start regeneration program based on the set raw water hardness and regeneration time.

B. Can use a bypass valve or an adjusting screw for the mixed water function to adjust the hardness of the softened water output.

C. Long outage indicator and clock calibration prompt: The set regeneration time, backwash, brine time, fast rinse and other time parameters can achieve permanent memory even in the event of a power outage. If the power is cut for more than 3 days, it is only necessary to adjust or calibrate the current time.

D. If there is no button operation within 1 minute, the buttons will automatically lock to effectively prevent incorrect operation.

E. Regeneration mode is meter delayed type: When the remaining water capacity is zero, it does not start regeneration. It must wait until the current time reaches the regeneration time to start regeneration.

F. Brine dry mode: Generally, during the operation of a residential softener, the brine tank has salt water inside, it means the resin tank is constantly soaked in brine, which may contaminate the brine. Contaminated brine may be absorbed into the resin tank, affecting the resin and the water quality of the output; brine dry mode means that during the operation of residential softener, there is no water in the salt tank. When regeneration is needed, the salt tank is filled with water 4 hours before starting of regeneration. So during the service state, the brine tank is always dry, it will not pollute brine.

G. Vacation mode: When users go on a trip or are away for an extended period, they can set the residential softener to the vacation mode. In this mode, the residential softener draws the salt water into the resin tank, keeps the control valve on the closed position to prevents the resin from failing. After the user coming back and releasing the mode, the residential softener will enter the normal operation status. The vacation mode has the following functions: firstly, it can solve the problem of resin failure or break when it is not used for a long time; secondly, after returning from vacation, soft water can be used without regeneration; thirdly, it can prevent the back-end system (such as water heater, etc.) from leakage to cause loss; fourthly, it can prevent resin agglomeration and breed bacteria.

H. Brine refill with softened water: The regeneration effect is good. It can save salt. Firstly, softened water contains sodium ions, which can increase the concentration of sodium ions in brine and achieve the effect of salt saving. Secondly, the brine tank can be cleaned. In some places, such as Russia, the raw water contains iron ion. If refill with the raw water, the iron ion will oxidize and turn red during salt dissolving or placing, causing the brine tank to change color.

I. With WIFI function: A residential softener with WIFI function allows for the installation of an app on your mobile phone. The residential softener can be installed in the WIFI signal coverage area, paired, and can be queried or controlled through the mobile phone.

J. Salt shortage alarm: Determine the amount of salt used for one regeneration of the residential softener through program calculation. Determine whether the brine tank is lacking salt based on the amount of salt added each time and the number of regenerations. When lack of salt, the resin may experience problems such as poor regeneration and unqualified outlet water. When lack of salt, the display screen will remind customer, and the residential softener with WIFI function will also remind customer of the shortage of salt on the mobile app.

K. Leakage protection function: If the control valve has a closing function, it can set the peak flow rate or continuous water output time. If the actual usage is over the above set value, or it receive signals from leakage sensor, the valve will close to prevent further water damage.

L. Proportional brine draw and brine refill: Some European countries like Italy, the law stipulates that residential softeners must regenerate every four days. When the water usage is low during these days and does not reach the water treatment capacity, much of the resin is still effective. The program can automatically adjust brine draw and brine refill according to the actual water usage ratio to the set water production volume. Therefore, using a proportional brine draw and brine refill can save water and salt.

M. Resin maintenance/replacement reminder: During the operation of the residential softener, the program automatically accumulates the number of regenerations. When the regeneration number reaches alarm number, the display board will show "Maintenance/replace resin." in service status.

N. 50N Two tanks simultaneous water supply softener, two tanks working in parallel, regenerate separately, continually supply softened water.

2.3.4 Classification of Runlucky residential softener

2.3.4.1 Common residential softener:

Common residential softener come in split and integrated types. Split residential softener has separate brine tank and cabinet, making them easy to install and maintain with the control valve externally accessible. Integrated residential softener has the resin tank installed within a blow-molded cabinet, with the excess serving as the brine tank, saving space and being the current mainstream residential softener.

In developed countries in Europe and America, residential softener are widely used, typically installed in basements, storage rooms or balconies. The domestic residential softener currently available in domestic market generally follow the traditional product structure of European and American countries, with large sizes and a rugged appearance, requiring spacious areas for installation. With the irreversible urbanization in China, the living space in residential commercial housing is very limited. As a new member of water treatment related household appliances, when there is not much choice for installation space, the cabinet becomes an ideal installation location. The height and depth of this location are limited, so we have developed some residential softener suitable for under-cabinet installation. Generally, they are about 550mm in height or less, suitable for residential softener installed in compact kitchen sinks or cabinets. The water hardness that can be

treated by the residential softener installed in the cabinet is generally below 350ppm (except for ultra-high hardness models).

2.3.4.2 Two tanks softener(50N)

For residential softener installed in cabinets, the volume can't be large, but to achieve whole-house softening, the required flow rate must reach 2 m^3/h. For this application, our company has developed a special Runxin valve that can be matched with two tanks for parallel water output. When the water treatment capacity of one tank is completed, it will start regeneration immediately. After regeneration, it resumes parallel water production with the two tanks. This system provides continuous and uninterrupted water supply. When the water supply is paralleled, the instantaneous flow rate can reach $2m^3/h$ under an inlet and outlet water pressure drop of 0.1Mpa. It has the following features:

A. Compact size, suitable for under-cabinet installation, saving space;

B. Two tanks in parallel output, staggered regeneration, with a single tank rated flow rate $1m^3/h$ and two tanks rated flow rate $2m^3/h$.

C. Efficient regeneration of softened water, saving salt;

D. Salt shortage alarm, pre-set salt addition amount, and display board shows adding salt when there is no salt.

2.3.4.3 Two in service one standby high hardness softener (100M)

In some cities or rural areas in Northern China, the hardness of tap water or groundwater can be as high as over 700ppm. Due to the limited height of resin filling in a single tank residential softener, it is difficult to process to below 30ppm. Traditional residential softener, when the water hardness reaches the upper limit of outlet, most of the resin has become ineffective (with some protective layer resin still effective), and it must be regenerated before it can be put back into operation to service. The hardness of raw water is often tens to hundreds of times that of output water. If all resin is invalidated before regeneration, it can be utilized to the greatest extent, and the overall salt consumption will also be reduced. It is evident that traditional residential softeners do not have a high resin utilization rate.

For the softening treatment of high-hardness water, multi-stage series fixed beds or floating beds are commonly used, and softened water must be used for regeneration to achieve better regeneration levels for the resin. This requires the addition of a regeneration pump and pipeline to achieve soft water regeneration. Then, we have developed a two in service one standby high-hardness residential softener with the following features:

A. One valve controls three tanks, with two tanks in series for water supply and the other tank for regeneration standby;

B. After the first tank becomes ineffective and starts regeneration, the original second tank becomes the first grade, and the standby tank becomes the second grade. This greatly improves the

utilization rate of the resin, saving salt and water consumption for regeneration, providing continuous soft water supply. At the same time, the tanks that have been regenerated serve as the second stage, resulting in better water softening effects;

C. It can handle high hardness water with hardness up to 16mmol/l (800mg/l);

D. Efficient regeneration of softened water, with a 50% increase in resin utilization and a 50% reduction in salt consumption.

Since the official launch of the residential softener in 2012, our company has developed more than 40 different appearances, with control valves of various functions, offering more than 100 types of residential softeners to choose. Common residential softener appearances include C, D, E, J, L, M, N, S, T, HO, V, simple models, etc. The main control valves include models F117P, F117Q, F79, F105, F105WIFI, F120, F126, F136, F140, etc.; they can be filled with resins such as Sunresin resin, DuPont resin, and Rohm Haas resin, etc.; the rated water flow rate are: 0.8m³/h, 1.0m³/h, 1.2m³/h, 1.5m³/h, 1.6m³/h, 1.8m³/h, 2.2m³/h, 2.5m³/h, 2.8m³/h, 3.0m³/h. The model specification table is shown in Table 2-4.

Table 2-4 Runlucky residential softener model specification

Model		Control valve	Regeneration type	Rated water flow rate m³/h	Dimension (Width * depth * height mm)
C Type	R60C	F117P	DF	1.2	260*440*629
	R110C	F117P	DF	2.2	260*440*1092
D Type	R55D	F79	UF	1.0	230*250*515+230*258*390
	R100D	F79	UF	1.8	281*281*566+230*258*390
E Type	R100E	F105	UF	1.8	371*490*582
	R150E	F105	UF	3.0	410*492*1045
HO Type	R100HO	F117Q	DF	1.8	316*485*615
	R150HO	F117Q	DF	3.0	316*485*1070
J Type	R80J	F105WIFI	UF	1.5	320*470*598
	R120J	F105WIFI	UF	2.8	325*475*1055
L Type	R115L	F105WIFI	UF	2.5	384*480*788
	R150L	F105WIFI	UF	3.0	392*484*1072
	R200L	F136	UF	3.5	392*484*1300
S Type	R90S	F105WIFI	UF	1.6	320*450*537
	R115S	F105WIFI	UF	2.5	320*450*715
	R150S	F105WIFI	UF	3.0	320*450*1047
V Type	R90V	F105	UF	1.6	321*448*534
	R150V	F136	UF	3.0	321*448*1044

Model		Control valve	Regeneration type	Rated water flow rate m^3/h	Dimension (Width * depth * height mm)
One valve with two tanks	R50N	F126	DF/UF	0.8	465*263*462
One valve with three tanks	R100M	F120	UF	1.8	587.8*402.8*523.5
T Type	R60T	F117Q	UF	1.2	475*265*566.5
Simple type	R150A	F116E3Y	UF	3.0	312*480*1060

Hygiene Permit Approval Number: Zhejiang (12) Health Water Character (2021) No. 0023

Product specification or model: RL-R60、RL-R90、RL-R100、RL-R110、RL-R150

Hygiene Permit Approval Number: Zhejiang (12) Health Water Character (2022) No. 0006

Product specification or model: RL-R30、RL-R50、RL-R55、RL-R80、RL-R90、RL-R100、RL-R115、RL-R120、RL-R150、RL-R200

Note: Residential softener suitable for suites and flat-floor apartments generally use a water treatment capacity of $2m^3/h$ - $5m^3/h$, with resin tank specifications of 0917, 1015, 1017; residential softener suitable for large flat-floor apartments and villas generally refer to a water treatment capacity of $4m^3/h$ - $8m^3/h$, with resin tank specifications of 1035, 1044, or above. With a fixed amount of resin filling, the rated water treatment capacity is related to the raw water hardness.

2.4 Shower softener

Softened water bathing has become a fashion in modern life, providing a great experience for people in hard water areas. Due to pipeline reasons, many families that have already been renovated cannot install a traditional residential softener, or the large volume of the residential softener makes it impossible to install due to limited space. To address the above issues and allow users who can't install a residential softener to enjoy softened water bathing, a shower softener used with water heaters has been specially designed. It not only prevents scaling of the water heater but also allows users to easily use softened water. Runlucky shower softener (RL-S30) has the following features:

A. Compact size, breaking the limitations of the site, which can be installed in the bathroom, kitchen, etc., and can be either floor-standing or wall-mounted;

B. It uses an innovative dynamic regeneration technology - soaking energy-saving regeneration mode, saving salt and water, with a 30% improved effect;

C. Salt shortage alarm, equipped with an infrared salt level detection device, when there is no salt, the display board shows adding salt, accompanied by a beep;

D. Brine dry mode, independent salt storage, separate water refill, and immediate salt dissolution and regeneration;

E. Intelligent leakage protection, built-in leakage protection device, intelligent detection, automatically switches to bypass mode when a leakage is detected, protecting the safety of domestic water use.

2.5 Point of use RO system

The end RO system, also known as the pure water machine, is a water purification device that uses multiple filter elements for water quality purification treatment. It adopts physical methods such as filtration, adsorption, and reverse osmosis to remove impurities such as flocs, heavy metals, bacteria, viruses, etc., from the water to obtain pure water. There are several pain points with the large-capacity reverse osmosis pure water machines currently on the market:

A. Large-capacity machine lose pump pressure when not making water, resulting in a higher TDS for the first cup of water, and a larger amount of water needs to be discharged to reach a normal TDS value;

B. Fixed the waste water ratio discharge, leading to easy blocking of the waste water valve in high hardness areas, which causes the filter elements to block in a short period of time.

In response to the above issues, Runlucky has independently developed an RO machine that uses high-quality filtration materials and RO membranes. Some models use a "pure water return function," with high water quality, low wastewater ratio, intelligent leakage prevention, and long life characteristics.

2.5.1 Technical principle of Runlucky RO system

It uses PP filter element and carbon fiber composite filter element as pre-treatment, which then enters a reverse osmosis membrane with a precision of 0.0001 microns after a high-pressure pump, making the water meet the requirements for direct drinking. When the pure water faucet is closed, the pure water flows back to flush, reducing the TDS of the first cup of water. An integrated water circuit board design is used, with a special ceramic seal for water stoppage, which is lighter in torque, more wear-resistant, and has a longer lifetime compared to the traditional RO machine's rubber ring sealing method.

2.5.2 Runlucky and RO machine feature

A. Ultra-grade water efficiency, the membrane flux is more than 10% higher than the conventional configuration, and the rated total pure water quantity is high;

B. It has a filter lifetime prompt function, with the display board showing the filter life status, allowing you to always know the status of the filter element;

C. It uses pure water return technology, with automatic pure water return flushing, which can prevent the water from standing for a long time and reduce the TDS value of the first cup of water (RL-C600A, RL-C800D);

D. Water quality TDS sensor inside, which can automatically control the wastewater solenoid valve to adjust the wastewater ratio according to the original water TDS value, reasonably reducing the waste water discharge and better protecting the RO membrane (setting required for the first use);

E. Patented ceramic core check structure (Patent No.: CN202121449812.6), as shown in Figure 2-4, uses a special ceramic sealing disk, which is more wear-resistant, the bidirectional check design

ensures no water drips when changing the filter elements in either direction (RL-C600A, RL-C800D);

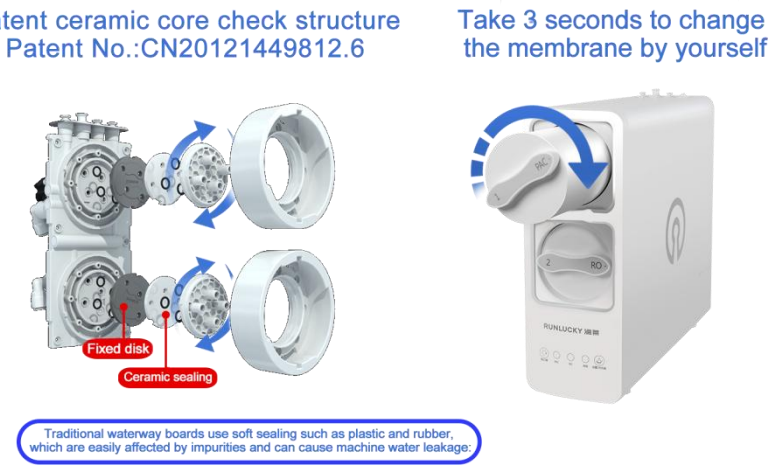


Figure 2-4 Patent ceramic core check structure

F. Two water Outlets design, providing purified water and pure water, meeting the needs for differentiated water use (RL-CA100, RL-C600A, RL-C800D)

G. Integrated water circuit board, fewer interfaces, strong resistance to explosion and water hammer, no leakage after more than 100,000 water hammer tests, as shown in Figure 2-5 (RL-C100A-YA, RL-C400A-YA, RL-C600A, RL-C800D);

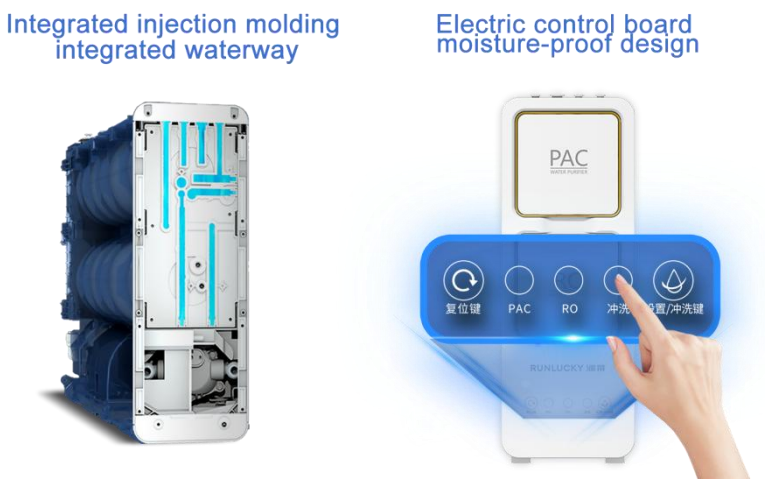


Figure 2-5 Design diagram of integrated injection molding integrated waterway, electric control board moisture-proof

H. Equipped with high-quality PAC carbon fiber composite filter element, strong water permeation and adsorption capacity;

I. Leakage protection function, equipped with a sensor, when the sensor detects a leakage, the machine automatically shuts off the water supply to prevent continuous water leakage from causing greater damage (RL-C600A, RL-C800D).

2.5.3 Runlucky RO system classification

Runlucky's current RO machine models include: RL-C02, RL-C100A-YA, RL-CA100, RL-C400A-YA, RL-C600 (Type A), RL-C600A-KA, RL-C800 (Type D), etc.; with water treatment capacities of 100G, 400G, 600G, 800G; filter element quantities include: 2 stages, 3 stages, 4 stages; water outlet faucets are available in one and two options. The model specifications are shown in Table 2-5.

Table 2-5 Runlucky RO system model specification

Model	W.T.C	Filter element quantities(stages)	Water outlet way	With pressure tank or not	Dimension (Width * depth * height mm)	Hygiene Permit Approval Number
RL-C02	100G	4 stages	One outlet	Yes	469*123*354	Guangdong Health Water Character [2022] – 12 No. S0187
RL-C100A-YA	100G	4 stages	One outlet	Yes	378*130*425	(Jiangsu) Health Water Character (2023) No. 3200-0002
RL-CA100	100G	4 stages	Two outlets	Yes	153*467*389	Zhejiang (12) Health Water Character (2024) No. 0026
RL-C400A-YA	400G	2 stages	One outlet	No	419*171*422	(Jiangsu) Health Water Character (2022) No. 3200-0177
RL-C600A	600G	2 stages	Two outlets	No	142*445*389	Zhejiang (12) Health Water Character (2022) No. 0072
RL-C600A-KA	600G	3 stages	One outlet	No	150*380*400	Zhejiang (04) Health Water Character (2023) No. 0022
RL-C800D	800G	2 stages	Two outlets	No	255*466*264	Zhejiang (12) Health Water Character (2022) No. 0072

2.6 Water filter

Tap water is treated with bleach at the source to prevent bacterial growth during transportation. Tap water can also become contaminated with mud and sand and other impurities as it flows through the pipeline, leading to secondary pollution. There are also issues with high-rise buildings where water supply is not cleaned in time, causing water pollution that enters homes. As people's awareness of health and environmental protection increases, there are various requirements for kitchen water usage in some households. For example, when cooking, they prefer water that has been purified; for cleaning countertops, tap water is sufficient; and during winter, they would like to use hot water for washing dishes. The water faucet on the market generally filter tap water, and if hot water is needed, another faucet is required, without a backwash function. During the purification process, when dirt attaches to the surface of the filter element, the filter element must be removed for cleaning.

For this application, our company has developed a water filter that integrates multiple functions such as providing purified water (filtered by the filter element), providing cold raw water, adjusting warm water, providing hot water, backwash the filter element, and closing (Patent No. ZL201720649270.4). The filtration accuracy reaches 1 micron (the thickness of a hair strand is about 70-100 microns), which can filter out harmful impurities such as parasites, mud, suspended solids, bacteria, algae, and residual chlorine from the water. Once it is installed, there will be no more turbid water output. The flushing principle of the water filter is shown in Figure 2-6.

Figure 2-6 Flushing principle diagram of water filter

2.6.1 Runlucky water filter technical principle

Runlucky water filter is equipped with two water inlets, one for cold water and one for hot water (which can be connected to a small kitchen appliance or hot water pipe), featuring a multi-functional flow control valve and a high molecular composite filter element with a filtration accuracy of 1 micron. The control valve allows for the dispensing of cold water, hot water, and mixed-temperature water without passing through the filter element; when water is not needed, the handle can be turned to the closed position. It is also possible to control the valve to allow cold water to enter from the outside of the filter element, pass through the filter element, and then flow out from the purifying water outlet on the inside; for backwash, the control valve directs cold water to flow through the inside of the filter element, flushes the filter element, and then exits from the outside through another outlet. All these functions can be achieved within a 160° rotation of the handle.

2.6.2 Runlucky water filter functions

A. The filter element uses a high molecular composite filter element with a filtration accuracy of 1 micron, which can effectively remove rust, silt, algae, and harmful substances such as volatile phenol, chloroform, and carbon tetrachloride from the water, addressing pollution from water supply networks and secondary water supply.

B. There are two outlets, allowing for differentiated water supply: one outlet provides purifying water, and the other provides raw cold water, mixed-temperature water, hot water, and drain water for backwash the filter element.

2.7 Auto shut-off valve

With the increasing popularity of water appliances in recent years, more and more users are using water appliance products such as pre-filters, the whole house water filter, and residential softener. Due to varying product quality, unstable water pressure, and improper installation, there may be potential leaks that could lead to water flooding in homes and cause significant losses.

There are many water leakage protection products on the market, most of which use ball valves as the main control valve. The core of the ball valve is made of metal or plastic, which can be easily scratched by impurities, and if not used for a long time, the torque will be heavy. When it is necessary to close the valve, it may not close properly or tightly, still posing a risk of flooding; there is no built-in power supply, water leakage occurs during a power outage and it cannot be turned off.

To address the above issues, our company has designed and developed a ceramic hard sealing ball valve as the control valve using spherical sealing technology. The ball and the valve seat are both made of ceramic, with low torque and resistance to scratching; it has a built-in rechargeable lithium battery that allows the valve to close even during a power outage.

2.7.1 Runlucky auto shut-off valve technical principle

The ceramic hard sealing auto shut-off valve is a patented product of Runlucky (Patent No. ZL2020206170859). It consists of a main control valve and a water immersion detector. The main control valve uses a special ceramic hard sealing structure with low torque and good wear resistance. The detector is installed at a low position in the home where water leakage is likely to occur. When a leak occurs and water covers the detector's probe, the detector senses the leak and immediately sends a signal. Upon receiving the signal, the main control valve immediately shuts off the water supply to prevent further damage. You can scan Figure 2-7 to watch a video.

Figure 2-7 Scan to watch the auto shut-off valve video

2.7.2 Feature of Runlucky auto shut-off valve

A. The valve core and seat of the main control valve are made of special ceramics sintered at 1680℃, with high hardness and good wear resistance. After matching and grinding, it has good sealing.

B. The detector can be combined with both wired and wireless connections, providing multi-point monitoring. The wireless detector is compact and does not occupy space, making it suitable for placement in kitchens, bathrooms, equipment rooms, and other low-lying areas where water leakage and accumulation may occur. The wireless detector emits a signal, and the main control valve receives the signal. The sensing distance is long, with no interference up to 50 meters, capable of penetrating 1-2 non-load-bearing walls.

C. After the detector senses a leak, the main valve can be quickly closed within 5 seconds to prevent further property damage due to water leakage.

D. Long battery life, the main control valve is equipped with a built-in lithium battery, which can last for 24-48 hours after being fully charged, providing leak protection even during power outages.

2.7.3 Classification of auto shut-off valve

Runlucky auto shut-off valves come in several models, including F104H, F104I, and F104K, with interfaces such as G1/2, G3/4, and G1. For detailed model specifications, please refer to Table 2-6.

Table 2-6 Runlucky auto shut-off model specifications

Model	Connector size	Connector specification	Installation location	Maximum detection distance
F104H	G3/4	Single connector	Main inlet pipe	50 meters
F104I	G1	Double connector	Main inlet pipe	50 meters
F104K	G1/2	/	Under cabinet RO machine cold water pipe	0.8 meters

2.8 Multi-functional and high flow filter housing

Market feedback indicates that the granular activated carbon whole house water filter in whole house purification system is time-consuming and costly to replace filter element. To address this issue, Runlucky has developed a high flow filter housing (Patent: 2022223322616) suitable for various filter elements that can be quickly replaced. The filter element can use PP filter element or carbon fiber filter and is installed at the main water inlet or under cabinet to intercept particulate

matter, rust, silt, chlorine, and other substances, protecting subsequent water-using equipment.

Runlucky multi-functional and high flow filter housing is similar to pre-filters, filtering the entire house's tap water. However, it has a filtration accuracy of up to 5 microns, which is much higher than that of pre-filter. The use of the filter housing is more flexible, as it can be paired with different filter materials to achieve varying filtration effects. When paired with a PP filter element, it can remove large particulate impurities such as rust, sand and red worm from the water; when paired with a carbon fiber filter, it can adsorb chlorine and odors. The biggest difference between the filter housing and pre-filter is that the pre-filter uses a disk filter with backwash, and the filter elements do not need to be replaced for life; the filter housing requires regular filter replacement to ensure filtration effectiveness, and the specific product selection depends on the scene and needs. The filter housing has the following features:

A. It uses a control valve with ceramic hermetic head faces structure, ensuring reliable sealing.

B. It integrates service, bypass and closed functions, allowing for filter replacement without the need to shut off the main water supply.

C. A 3/8'' connector is installed at the outlet, which can be used as a pre-treatment for RO machines.

D. The cost of replacing filter element is low, with high filtration accuracy. The PP filter element has a filtration accuracy of 5-10 microns. The carbon fiber filter has a filtration accuracy of 5-20 microns, capable of removing chlorine, effectively inhibiting bacteria, decolorizing, and improving taste.

E. It features a pressure relief button that can be pressed during filter replacement to easily release the pressure inside the bottle.

2.9 Manual water purifier

Surface water such as mountain spring water, river water, and lake water contains impurities and bacteria, making them unsuitable for direct use. However, clean water is needed for outdoor activities like barbecues or road trips. A manual water purifier can be used to treat such water, making it safe for use.

Runlucky manual water purifier (Patent: ZL202021434962.5; (Hygiene Permit Approval Number: Zhejiang (12) Health Water Character (2022) No. 0047) mainly consists of a PP filter element for removing impurities and an ultrafiltration membrane for removing turbidity and microorganisms. Ceramic check valves are installed at both sides of the piston. By using the principle of negative pressure generated by the air pump, when the piston is pulled by hand, the river water first passes through a plastic mesh with a gap of 0.3mm placed at the front end in the water to intercept large impurities and flocculent substances. It then enters the PP filter element through a hose, filtering out silt and impurities, and finally enters an ultrafiltration membrane with a filtration accuracy of 0.01-0.1 microns. The resulting water can be used for washing vegetables, cooking, or emergency drinking water in special circumstances, and it can be safely consumed after boiling. It

has the following features:

A. It uses high-precision PP filter element and ultrafiltration membrane filters for a two-stage filtration process, with a filtration accuracy of 0.01-0.1 microns, capable of removing 99.9% of bacteria and most harmful substances from the water.

B. It features ceramic hermetic head faces micro pressure drop check valve with good sealing performance. The hand press operation is easy, and the suction range reaches 2 meters, allowing for the absorption of water from deeper depths.

C. The design is hand-operated, eliminating the need for electricity, making it convenient for use whenever needed.

D. It has a compact size and is portable. It can be easily carried in a backpack without taking up much space, eliminating the hassle of carrying bottled water.

E. The ultrafiltration membrane filter can be removed and washed by hand for reuse, reducing usage costs.

F. The water output can reach 1.5L/min, with an average output of about 3 bottles of 500ml mineral water per minute, saving time and labor.

2.10 Filter check valve

In high-rise residential buildings exceeding seven floors, secondary water supply is commonly used: some have water tanks on the rooftop, while others use variable frequency water supply for different floor levels. When residents are away for a long time and the water supply is interrupted, air can enter the pipes. When the water supply resumes, the pressurized water can force air through the water meter into the resident's home, causing the water meter to spin. When many users on the same floor use water, the water pressure drops, and the compressed air can push the water in the pipes back towards the water meter. When the water pressure falls below a certain level, the variable frequency pump starts, repeating the process and causing the water meter to spin, which results in additional water costs. To prevent this issue, a filter check valve F132 can be installed after the water meter.

The check valve is a valve that automatically opens and closes based on the flow of the fluid. It is an automatic valve that allows flow in only one direction, meaning it only allows water to enter and not to exit. After installing a check valve at the main water inlet, the water entering the home will not flow back under any conditions, preventing the water meter from spinning unnecessarily and avoiding additional water costs.

2.10.1 Runlucky filter check valve technical principle

Runlucky check valve uses **a ground ceramic disk as the fixed sealing disk** and a ground and polished ceramic slider as the moving sealing disk. When the moving slider is in contact with the fixed sealing disk, under the combined action of the slider's weight and the fluid pressure, it seals to prevent backflow. This structure is called hermetic head faces sealing check valve and is a micro

pressure drop check valve. It only needs to overcome the weight of the ceramic slider to open, with low opening pressure and minimal pressure loss, requiring less than 10cm of water column to open. Additionally, to prevent impurities from entering the subsequent system, a filter made of a 60-mesh stainless steel mesh is installed at the front end of the check valve.

Common check valves on the market use rubber sealing and rely on spring force as the preload force. They use the interaction between the spring force and water pressure to seal the rubber against the corresponding plastic or metal to achieve the check function. When opening, a certain water pressure is required to overcome the spring force, resulting in some pressure loss, and the presence of a spring makes them less resistant to impurities.

2.10.2 Runlucky filter check valve characteristics

A. It uses high hardness and high flatness ceramic fixed sealing disks and ceramic sliders for sealing, with low opening pressure, minimal pressure loss, and resistance to impurities.

B. The Y-type structure offers low fluid resistance.

C. It prevents water backflow from the rear equipment, preventing unnecessary water costs.

D. It equipped with a standard copper connector and features a detachable 304 stainless steel mesh for easy cleaning.

E. It has a shock-absorbing design, resistant to water hammer impacts.

F. It has a large flow capacity, with a flow rate of 3.5m³/h under a 0.1MPa pressure drop.

2.11 Spring filter

In areas where municipal tap water supply is not available, spring water, well water, or stream water may be used as drinking water. These water sources are easily contaminated by domestic waste, pesticides, fertilizers, and animal excrement, and may contain parasites and bacteria. Additionally, the water contains more impurities, especially during rainy days when a large amount of silt is present, severely affecting normal water use in rural areas. This water quality must be treated before it can be used.

To address this, our company has developed a spring filter, which consists of a Runlucky pre-filter, a Runlucky whole house water filter, and an ultrafiltration membrane, effectively treating impurities and harmful substances in spring water to improve rural water usage.

Depending on the actual water quality in different regions, the spring filter can adopt different combinations and use different water treatment processes to solve various water quality issues. For example, a combination of a Runlucky pre-filter, a multi-functional and high flow filter housing, a whole house water filter, and a residential softener can be used as a set of equipment.

For situations where the spring water has a high drop and a certain amount of pressure, the spring water can be directly introduced into the spring filter through a pipeline. When the spring water drop is less than 20 meters and the pressure is low, a booster pump can be installed at the front end of the spring filter to achieve the required flow.

2.12 The whole house water filter and residential softener application cases

2.12.1 Residential softener application case

Installation time/location: May 16th, 2022, a community in Pingdu city, Qingdao, Shandong province

Product model: RL-R50N

The customer is a man who was recommended by a family decoration company and may not be very familiar with the residential softener. He did not choose a residential softener before the renovation, and after the water and electricity were modified and the cabinets were completed, his wife wanted to install a residential softener. At that time, the space was limited, and considering the flow issue, the Runlucky under cabinet model 50N was selected, which can be well installed under the cabinet saving space. See Figure 2-8.

Figure 2-8 Residential softener 50N installed under the cabinet

2.12.2 Shower softener application case

Installation time/location: December 27th, 2022, Dongyuan Qicheng, Hongshan district, Wuhan, Hubei province

Product model: RL-S30

The owner's home was delivered as a fully decorated house, and the owner is a university teacher who is very knowledgeable about the benefits and experience of soft water. However, after searching many brands on the market, there was no soft water solution for fully decorated houses. By chance, they visited a Runlucky offline store and saw the shower softener, saying they finally found the desired shower softener and arranged for installation at that day. The local water hardness is 168ppm, and it has been used for over a year. The customer feedback is that bathing and washing hair are very comfortable, the effect is very good! See Figure 2-9 for the installation.

Figure 2-9 Shower softener installation site

2.12.3 Water filter application case

Installation time/location: December 23rd, 2017, Putaojingyuan, Wenzhou, Zhejiang province

Product model: RL-W02

The user was in an old community with aging water pipes. The original faucet would produce impurities in the water. After learning the Runlucky water faucet has a purification function and can be manually backwashed without the need for disassembly and cleaning, and can be used in conjunction with a small kitchen appliance with both cold and hot water connections, they installed water faucet to replace the original one. See Figure 2-10 for the installation.

Figure 2-10 Water faucet installation site

2.12.4 Manual water purifier application case

Usage time/location: August 5th, 2023, Binpeng Petroleum Xiguan Bridge gas station, Zhuozhou city, Baoding, Hebei province

Product model: RL-W20

In August 2023, Zhuozhou city suffered from flooding, and the affected areas experienced a water and power outage. The frontline rescue personnel were unable to obtain clean water for washing. At that time, our Hebei agent rushed to the aid at night, bringing hundreds of sets of manual water purifiers, which effectively solved the problem of providing clean water for the rescue personnel. See Figure 2-11 for the usage.

Figure 2-11 Manual water purifier rushing to aid the disaster area in Zhuozhou, Hebei

2.12.5 Spring filter application case

Installation time/location: November 1st, 2017, a housing in Huaixi town, Pingyang county, Wenzhou, Zhejiang province

Product: Spring filter

The user's house is backed by a mountain. When the tap is turned on after a long period of non-use, there would be gravel in the water, and the water would be yellow and turbid. Each time this happened, it was necessary to let the tap run for a long time before the water would return to normal. After installing the Runlucky spring filter, it effectively solved the problem of impurities and turbidity in the household water supply, providing clean water. See Figure 2-12 for the installation.

Figure 2-12 Spring filter installation site

In the field of domestic water treatment, we plan to create whole house water filters that are convenient for changing filter elements or filter materials; residential softeners with more aesthetic designs, saving salt and water; and manual water purifiers with greater flow rates in the future.

3. Ceramic Hard Sealing Ball Valve

Ball valve was born in the 1950s, as the most common types of valves in the market, there have been many models of ball valves, it is believed that we are familiar with ball valve. It is a kind of valve whose opening and closing part is a ball, and it is driven by the valve shaft and revolved on its axis. It is featured with small fluid resistance and quick opening and closing, and widely used in pipeline transportation system. Someone may ask: In this case, why does the Runxin company still insist on developing ball valve? The following will introduce the development background of Runjing ceramic hard sealing ball valve.

In 2007, when we designed the 18m³/h softener valve N77, its brine draw connector needed a DN20 control valve, which required that the water resistance should not be too high to affect the precision of the brine draw, so we chose the ball valve. However, at that time, the ball valve was purchased from suppliers. Its ball core is stainless steel, the valve seat is PTFE, the quality is unstable, and easy to leak. As we learned, the China standard of ball valve allowed certain leakage, but the brine draw ball valve we used cannot have leakage. So, we had to select the purchased ball valves to use. For this reason, we specially designed a ball valve test platform to check the sealing of the purchased ball valves, which seriously affects our production capacity and quality.

Considering that the ceramic hard sealing technology was matured and applied to many Runxin valve, in 2011, based on flat ceramic core, Runxin company decided to develop ceramic ball valve, which would be used to control the brine draw of high flow rate softener valve. After several years of application, the stable quality and reliable sealing are verified. After that, we have developed many kinds of ball valves with various specifications and different control methods, which have been applied in water supply treatment, chemical, sewage and other fields.

3.1 Characteristics of ceramic hard sealing ball valve

Runjing ceramic hard sealing ball valve has many distinctive features compared with common valves, such as high hardness, low torque, good corrosion resistance, and reliable sealing, etc.

3.1.1 High hardness

Ball valve is mainly classified into two categories: soft sealing ball valve and hard sealing ball valve. Common soft sealing ball valve is sealed with plastic or stainless steel ball core and PTFE valve seat. The sealing surface is made of soft material, which is not resistant to impurity particles, easy to wear and leak. For Runjing ceramic hard sealing ball valve, the ball core and seat are made of special ceramic materials, which is sintered by 1680℃ or 2200℃ ultra-high temperature. The Rockwell hardness HRA≥85, is second only to diamond and sapphire, 7-9 times as much as steel, equivalent to tungsten-cobalt alloy lathe, and it can adapt to various high wear and erosion working conditions.

(Note: Rockwell hardness is a method and quantity value of measuring the hardness of objects, mainly used in metal materials. The measurement method is using a certain load to press a specified

indenter into the tested material and evaluate the soft and hard performance of the tested material by the deformation size of local plastic on the surface of the material.

Test: using the ball core or valve seat to scratch the glass, it can be easily scratched on the glass, indicating that its hardness is higher than the glass. As Figure 3-1 shows:

Figure 3-1 Ceramic hardness test

3.1.2 Low torque

After precision machining and paired grinding of ceramic ball and valve seat, the concave and convex spherical surfaces are almost completely fitted to realize the relative rotation. The surface roughness as low as 0.1 micron, the elastic deformation of the material is small, with good self-lubrication. Therefore, the torque of ceramic hard sealing ball valves in only 1/5 or even 1/10 of the traditional ball valves. The torque comparisons of ball valves are shown in Figure 3-2.

The low torque of the ball valve can achieve low power consumption. Runxin used this feature to develop the residential wireless auto shut-off valve, which is installed in the main inlet of the whole house to realize auto shut-off when leakage happens. The power consumption is very low, which is only 0.0014 WH for a single opening and closing. Two batteries can support opening and closing for 4,000 times.

size		N·m	
DN	NPS	1.0MPa	1.6MPa
DN15	1/2"	1.0N·m	2.0 N·m
DN20	3/4"	1.0N·m	2.0 N·m
DN25	1"	1.7N·m	3.2 N·m
DN32	1-1/4"	3.2N·m	6.5 N·m

VS

size		N·m	
DN	NPS	0.6MPa	1.6MPa
DN15	1/2"	15N·m	19N·m
DN20	3/4"	20N·m	30N·m
DN25	1"	20N·m	30N·m
DN32	1-1/4"	30N·m	50N·m

Figure 3-2 Torque comparison between Runjing ceramic hard sealing ball valve and traditional ball valve.

Test 1: you can try to compare the operation of Runjing manual ceramic ball valve and traditional soft sealing ball valve, feel the difference in torque. You also can use digital torque wrench to synchronize the data and transfer it to the computer (or TV, phone).

Test 2: put the leakage sensor on the ground, and open the auto shut-off valve to make the water flow out from outlet. Pour some water on the sensor, you can see that the auto shut-off valve is immediately closed, and the water stops flowing.

3.1.3 Good corrosion resistance

The special ceramic has excellent chemical stability. Our ceramic formula adds some special elements, making it do not react with most acids, alkalis, organic solvents, and other chemical medium, with excellent corrosion resistance. At present, our ball valves have been used in a variety of acids, alkalis, and special media such as hydrochloric acid, sulfuric acid, seawater, industrial wastewater and so on.

We will also conduct regular inspections, immersing the ball core and valve seat in acid and alkali for 15 days to check its corrosion resistance.

Table 3-1 Chemical corrosion resistance of common materials

Medium	Temperature	ZrO_2	**$95Al_2O_3$**	**SiC**	S i_3N_4	FKM	PPO	SS304	SS316
20%HCL	60℃	A	A	A	B	A	A	C	B
20%HCL	95℃	A	A	A	C	A	A	--	C
90%H_2SO_4	60℃	A	A	A	A	A	A	C	B
90%H_2SO_4	95℃	A	A	A	B	A	A	C	C
60%H_3PO_4	60℃	A	A	A	C	A	A	C	A
60%H_3PO_4	95℃	A	A	A	C	A	A	C	A
10%HF	60℃	C	B	A	A	A	A	C	B
46%HF	95℃	C	C	A	C	A	A	--	C
60%HNO_3	60℃	A	A	A	C	A	A	A	C
60%HNO_3	95℃	A	B	A	C	A	A	B	C
30%NaOH	60℃	A	B	A	B	A	A	A	A
30%NaOH	95℃	B	B	A	C	A	A	B	A

A: there is no corrosion or corrosion can be ignored when material is in the medium, it is recommended to use;

B: there is slightly or less corrosion when material is in the medium, it is suitable for use;

C: the material is moderately or mostly corroded in the medium, it is not recommended to use;

3.1.4 Reliable sealing

Ceramic valve core and seat are grinded precisely in pairs to ensure no leakage. It also can be used for air sealing. It has the feature of long lifetime. After testing by the National Quality Supervision and Inspection Center of Valve Products (Zhejiang), Runjing DN32 ceramic hard sealing ball valve has no leakage for 1 minute after opening and closing 1 million times under 0.6MPa. Runjing DN125 ceramic hard sealing ball valve has no leakage for 1 minute after opening and closing 950 thousand times under 0.6MPa.

Test: dip some water on the valve seat, rotate the ball around the valve seat, pick up the ball, and you can see the valve seat will adhere to the ball. It is indicated that the valve core is tightly attached to the valve seat, forming a vacuum state. The atmospheric pressure presses the valve seat tightly onto the ball, reflecting its excellent sealing performance. As Figure 3-3 shows.

Figures 3-3 Sealing test of ceramic hard sealing ball valve

From the above introduction and test, compared with traditional plastic and metal ball valves, it is obvious that Runjing ceramic hard sealing ball valve has great advantages in good wear resistance, erosion resistance, corrosion resistance and durability, etc.

3.2 Ball valve classification

Since 2012, we have further serialized the size and various control functions of ball valves to form a complete series of Runjing ceramic hard sealing ball valves, mainly including the following product series.

3.2.1 Classified by material of ball core

The ball core has two options of 95 alumina and silicon carbide. The alumina ball core can resist the corrosion of strong acids (except hydrofluoric acid) and all kinds of alkalis at low concentration and room temperature. Silicon carbide can be applied to various concentration of acids, alkalis, and other medium, whose corrosion resistance performance is even more excellent. In terms of production cost, silicon carbide ball core cost is 3-5 times that of alumina ball valve.

3.2.2 Classified by material of valve body

Plastic and stainless steel valve bodies are available. Plastic valve bodies mainly include PPH, UPVC, PPO, which has high strength and good corrosion resistance. Among them, UPVC and PPO has greater corrosion resistance to acids and alkalis. Stainless steel valve body mainly adopts 316 materials, which can be used for organic solvents and low corrosive medium.

For DN100 and below ball valves, there are plastic body and stainless-steel body for optional. For ball valve bigger than DN100, the valve body is mainly stainless steel.

3.2.3 Classified by connection way

The connection way can choose thread, flange, glue, hot melting, clamp, and others. It can be selected according to the connection situation of pipeline when design the pipeline system. For example, the DN20 ball valve with thread connection can be changed to glue or hot melting connection by replacing the connector.

3.2.4 Classified by control method

It can be classified into manual, electric, pneumatic and pulse pilot pneumatic/hydraulic ball valve, etc.

The electric ball valve adopt motor to drive the ball valve opening and closing, which has two control types of switching and regulating. The regulating motor can adjust the opening degree of the ball valve, which can control the fluid flow, pressure, temperature and so on. The opening and closing speed of ball valve is slow, and generally is around 3 seconds - 3 minutes, which will not produce water hammer in the pipeline.

According to the wiring, the electric ball valve can be classified into two-wire, three-wire, timing, power reset, two-wire or three-wire with position feedback and other control methods. Timing ball valve can be set according to the 7-day (one week) as one cycle. User can set the valve opening and closing time for each day of the week, up to five groups of opening and closing time per day. Power reset ball valve is similar to solenoid valve, and it has built-in battery. When the external power failure, the battery can be discharged to drive the motor, and the valve is automatically reset.

Pneumatic ball valve can select actuator according to torque, which is opened and closed by the actuator driven by the compressed air. Fast opening and closing speed (about 1-2 seconds).

3.2.5 Classified by structure

It can be classified into straight way and three-way ball valves. Three-way ball valve has L-type and T-type for optional.

3.3 HVAC valve

HVAC valves are usually used for residential or commercial heating control. It is composed of inlet and outlet pipes, usually have 3, 4, 5 or even up to 10 channels. It can be controlled manually or automatically. Automatic HVAC valve can automatically adjust the opening degree of valves through

the intelligent control program, combined with the sensor technology to monitor the indoor temperature.

HVAC valve has a large market (every household need it in northern China), but existing HVAC valves on the market adopt soft sealing ball valves, which usually use stainless steel ball and PTFE valve seat. As the hot water in the heating pipeline is easy to scale, it is easy to damage the sealing surface of the valve and make it difficult to open and close. HVAC ball valves with soft sealing are easy to leak, not durable, difficult to open and close or damage when there is no operation for a long time, etc. Runjing HVAC valve with ceramic hard sealing ball valve adopt the special ceramic for the ball core and valve seat which have characteristics of good wear resistance, low torque, better solving the above problem.

The series of products are being developed and perfected.

3.4 Ball valve for printing and dyeing

Printing and dyeing valve is primarily used to control the addition of different components into the dye during the fabric dyeing process. Currently, T-type three-way valve is generally used, which require no residue after the addition of each dye to prevent contamination and color bleeding, or else it could affect the quality of the entire batch of fabric.

The high-end printing and dyeing valve commonly used in the market is largely imported from Europe and other countries, which is expensive. The sealing technology used is soft sealing, which is not resistant to wear and not durable. Ceramic hard sealing technology for printing and dyeing valve can effectively avoid the problems associated with soft sealing ball valve, with has good sealing performance during use and a long lifetime.

Next, we will consider developing ball valve for high-pressure, ball valve for high-temperature, gas-specific ball valve, and refrigeration-specific ball valve, and so on.

3.5 Application of ceramic ball valve

Runjing ceramic hard sealing ball valve have been applied in the industry for over a decade, widely used in fields such as wastewater treatment, dyeing, photovoltaics, chemical industry, hydrometallurgy, papermaking, lithium battery production, biological pharmaceutical, intelligent fluid control, and rural drinking water improvement project. The product's quality is stable and reliable and suitable for various applications, and it has been exported to 34 countries and regions worldwide.

3.5.1 Application in water treatment system

In some water treatment systems that use groundwater or surface water for filtration or softening, the raw water may contain particulate impurities such as silt and suspended solids. The valves are required to be resistant to wear and erosion. The commonly used control valve for water treatment systems typically is with a water capacity less than 50m³/h. Developing a control valve for a larger water capacity would result in a larger size, higher

R&D investment costs, and limited market demand. Using a multi-valve system consisting of Runjing ceramic hard sealing ball valve and F109 controller can achieve different flow rates according to the diameter of the matched ball valve, achieving a processing flow rate of over 100m³/h. The control is convenient, and operation is stable, and maintenance can be completed in a short time by replacing a ball valve, offering flexible and efficient after-sales service. See Figure 3-4.

Figure 3-4 Ball valve used in rural drinking water improvement project

On pure water equipment, compared to solenoid valves, Runjing ceramic hard sealing ball valve open and close smoothly, which is less prone to water hammer and have a smaller size of actuator, lower power consumption, and a longer service lifetime. Solenoid valve only have two states which are open and close, without feedback signal function. Runjing electric ball valve can be made with feedback signal, based on actual usage requirements, can be selected with features such as timed opening and closing, power reset, three-wire controlling, and remote control via mobile phone. See Figure 3-5.

Figure 3-5 Ball valve used in RO system

3.5.2 Application in iron and manganese removal system

There are various methods for treating water with special characteristics. Compared with water purification equipment such as softening system and filtration system with activated carbon, special water treatment equipment requires a slower filtration flow velocity, a larger rinse flow velocity, and a more complicated treatment process. Take iron and manganese removal device as example, after aeration treatment, the ferrous ion will oxidize into ferric ion and form iron oxides that are insoluble in water, which we commonly call "iron rust mud". When design systems with butterfly valves and soft sealing ball valves, the "iron rust mud" which is oxidized anytime and anywhere, can easily enter the sealing parts of the valve through the water flow, causing permanent damage to the soft sealing parts and causing equipment broken.

The hard sealing feature of ceramic ball valve, make it impossible for the "iron rust mud" to destroy the sealing surface, prolonging the service lifetime of ball valve. If the rust is accumulated on the closed sealing surface, because of the light torque of ceramic ball valve, it makes easier to operate the ceramic ball valve and is not easily stuck. In iron and manganese removal system, the regeneration system usually uses a high concentration of acid or alkali solution to regenerate and activate the media. The corrosion resistance of ceramic hard sealing ball valve can ensure that the valve sealing parts will not be easily corroded due to strong acid or alkali solutions. Ceramic hard sealing ball valve can be well used in iron and manganese removal system and will not be easily damaged. See Figure 3-6.

Figure 3-6 Ball valve used in iron and manganese removal system

3.5.3 Application in wastewater and seawater treatment

In wastewater and seawater treatment systems, acids, alkalis, seawater, brine solutions, and other substances may cause corrosion to valves. Runjing ceramic hard sealing ball valve adopt special ceramic materials with good corrosion resistance as sealing parts, suitable for

various acids, alkalis, and special media such as hydrochloric acid, sulfuric acid, sodium hydroxide, seawater, and industrial wastewater. Its applications are shown in Figure 3-7 and Figure 3-8.

Figure 3-7 Ball valve used in wastewater treatment equipment

Figure 3-8 Ball valve used in seawater desalination equipment

3.5.4 Application in lithium battery production

In the production process of positive electrode materials for lithium batteries, it is strictly forbidden to contain copper (Cu), zinc (Zn) and other metal elements in relevant pipes and valve materials. If there are metal elements such as copper (Cu) and zinc (Zn) in the material, these metals will be oxidized at the positive electrode and then reduced at the negative electrode. When the metal element at the negative electrode accumulates to a certain extent, the hard edges and corners of the deposited metal will pierce the diaphragm, causing the battery to self-discharge, thereby bringing accident potential, even causing an explosion accident.

Runjing ceramic hard sealing ball valve adopts special ceramic valve core with good wear resistance and corrosion resistance, and the valve body adopts engineering plastic or SUS 316L stainless steel. After strict testing, they do not contain copper (Cu) and zinc (Zn) elements, which can better meet the production process requirements of lithium battery cathode materials. They have been used in the lithium battery industry in large quantities, and various performance indicators have been affirmed by customers.

Figure 3-9 Ball valve used in anode material solid transportation of lithium batter

4. Intelligent Irrigation Product

Traditional irrigation methods like flood and furrow irrigation have a very low utilization rate of water resources, are labor-intensive, and have low production efficiency. They do not allow for precise irrigation tailored to the specific habits of plants, which can lead to overwatering or uneven distribution of water. This can negatively impact plant growth, as well as the yield and quality of crops. In China, water resources are relatively scarce, and the shortage of water in major grain-producing areas has a significant impact on the country's overall food security. To ensure food production and to eliminate reliance on natural conditions, China has put forward a plan to vigorously develop high-standard farmland. The goal is to establish 800,000 square kilometers of high-standard farmland and 73,000 square kilometers of high-standard farmland equipped with efficient water-saving irrigation systems by the year 2030. The aim is to integrate technology into agriculture by intelligent and smart irrigation systems. In recent years, the occurrence of extreme drought conditions during the summer has become more frequent, and with the ongoing rise in labor costs, the costs associated with green maintenance in parks and industrial areas have also increased. As a result, the need for implementing smart irrigation systems in these locations has become more pressing.

Runjing intelligent irrigation valve is an efficient and automated water-saving irrigation system which is developed based on ceramic hard sealing ball valve, combined with sensor technology, wireless communication technology, and intelligent control technology. It monitors the environmental temperature, humidity, soil moisture, and other parameters in garden or agricultural production in real time. It can remotely control irrigation through mobile phones / computers, and digital technology can be accessed for visual, centralized and efficient management in the central control room. We have developed irrigation products, such as pulse electric ball valves, pulse pilot pneumatic/hydraulic ball valves, disk filter with high flow, water and fertilizer integrated machines, etc., which can be matched with IoT 4G controllers and LORA wireless networking to achieve long-distance communication.Combined with sprinkler irrigation, micro-sprinkler, drip irrigation and other methods, it can be widely used in intelligent irrigation in farmland, orchards, greenhouses, flower gardening, community greening, courtyard greening and other occasions, changing the traditional heavy and inefficient manual irrigation method.

Runjing ceramic hard sealing ball valve, disk filter, water and fertilizer integrated machine have passed the testing of Beijing Zhongshui Runke Certification Co., Ltd. (a national product certification organization recommended by the Ministry of Water Resources and approved by the CNCA) and have obtained the certificate of water-saving products.

4.1 Comparison with existing products

At present, the irrigation systems on the market mainly use electromagnetic diaphragm valves, plastic ball valves, etc. Many electromagnetic diaphragm valves still rely on imports from Israel and

the United States. There are some disadvantages in the use of these valves.

The component for passing liquid through of the electromagnetic diaphragm valve are sealed with rubber and plastic, which is a soft sealing structure. Rubber or plastic is easy to age, is not resistant to impurities and wear, is prone to leakage, and has a short service life.The flow channel of the liquid in the valve chamber is corner flow channel, with a relatively large flow resistance and a small flow rate; the maximum specification of these valves generally is DN100; the valve needs to overcome the elastic force of the spring when opening, and may not open when the water pressure is low.

The plastic valve core of the plastic ball valve is not resistant to impurities and wear, is prone to leakage, has high torque, and is easily stuck. The valve shaft and handle are easily broken due to excessive torque.

The valve core of Runjing ceramic hard sealing ball valve has the advantage of high hardness, impurities resistance, wear resistance, corrosion resistance to fertilizer liquid, good sealing, long service life, low torque, and low power consumption. The maximum specification can reach DN200 and can adapt to larger irrigated area. Ceramic ball valve is used in the irrigation field and can well overcome the shortcomings of electromagnetic diaphragm valves and plastic ball valves. The performance comparison is shown in Table 4-1.

Table 4-1 Performance comparison table for commonly valves used in irrigation

Item	Electromagnetic diaphragm valve	Plastic ball valve	Ceramic hard sealing ball valve
Sealing parts	Soft sealing: rubber and plastic	Soft sealing: plastic ball or stainless steel ball with plastic seat	Hard sealing: ceramic ball and ceramic seat
Flow channel	Corner flow channel, large water resistance	Straight flow channel, small water resistance	Straight flow channel, small water resistance
Sealing performance	Not resistant to impurities and easy to leak	Not resistant to impurities and easy to leak	Resistant to impurities and good sealing
Lifetime	Rubber ages easily and has a short lifetime	Easy to leak, short lifetime	Wear resistance and long lifetime
Torque	Low torque, high requirement for water pressure	High torque, and the handle is easy to break	Low torque, no requirements for water pressure
Size	Maximum size DN100	Maximum size DN200	Maximum size DN200

4.2 Intelligent irrigation system products

4.2.1 Ceramic hard sealing disk filter

The water quality of agricultural irrigation is generally not very good. It usually uses groundwater or surface water such as river water and lake water, which contains a large amount of impurities, particles, floc, etc. In order to prevent the sprinkler used in the sprinkler irrigation and drip irrigation from clogging, the irrigation water needs to be filtered. The ceramic hard sealing disk filter that we developed can filter the raw water.

Ceramic hard sealing disk filter is mainly composed of disk filter unit, ceramic hard sealing electronic tee valve and controller. The controller can automatically start backwash based on the time, flow rate or differential pressure, and use filtered water for backwash. The filtration precision is available in 50 microns, 100 microns or 130 microns, which can effectively filter impurities such as large particles and floc in the water. According to the flow rate requirements, 1-16 sets of disk filter units can be configured, with a flow rate of 30-450m^3/h. In addition to being used for water filtration in agricultural irrigation, it can also be used for water filtration used in industries (such as textiles, papermaking, and building materials), HVAC system water filtration, sewage and wastewater treatment, municipal water supply filtration, and agricultural irrigation water filtration.

Currently, the common disk filter on the market generally adopts three-way diaphragm valves to change directions. The three-way diaphragm valves are sealed with rubber, which are not resistant to impurities and are prone to leakage. In addition, they may not be opened when the water pressure is low, which is a huge problem. It affects the service lifetime of the disk filter and the stable operation of the entire filtration system. Runjing ceramic hard sealing disk filter uses three-way valve with ceramic flat surface hard sealing or ceramic spherical surface hard sealing to control the direction change. The Rockwell hardness HRA of the ceramic material is ≥85, the sealing is reliable, and it is resistant to abrasion of sediment and impurities with long service lifetime, greatly improving the stability of the disk filter.

4.2.2 Water and fertilizer integrated machine

Water and fertilizer integration is a technology that dissolves fertilizer in irrigation water and delivers them to the vicinity of plant roots through pipeline system controlled by valves according to the water and fertilizer needs of plants. It can effectively control the amount of irrigation water and fertilizer and improve the utilization rate of water and fertilizer. Water-soluble solid fertilizers and liquid fertilizers are usually used in the market. Fertilizers have a certain degree of corrosiveness. When solid fertilizers are used, the dissolution may not be complete and there will be certain particulate impurities.

The control valves used in the water and fertilizer integrated machines on the market generally use solenoid valves or plastic ball valves, which are soft sealing structure and are not resistant to impurities, abrasion, and fertilizer solution corrosion.

Runjing water and fertilizer integrated intelligent irrigation system, equipped with Runjing ceramic hard sealing ball valves to control irrigation and fertilization pipelines, is resistant to abrasion by sediment and impurities, and is resistant to corrosion by water and fertilizer solutions. It has a long lifetime, can be used for regular and quantitative irrigation and fertilization, and can be controlled on-site and remotely and intelligently in irrigation areas. It also has functions such as PH and EC value detection and automatic liquid level control of fertilizer bucket.

4.2.3 Irrigation systems and valves

Valves used for agricultural irrigation are very different from industrial valves. Generally, agricultural irrigation valves are not installed centrally, and the distance between each valve is far, up to two or three kilometers. Many places do not have municipal electricity; they are installed outdoors and exposed to sunlight and rain. It is required to be waterproof, UV resistant, and weather resistant. Therefore, valves for agricultural irrigation have their own unique requirements and characteristics.

4.2.3.1 Irrigation products

Model RJ-ZG01: A range of two-wire and three-wire ceramic hard sealing ball valves for DN15-DN200 specifications, which can be matched according to the size of the pipeline.

Model RJ-ZG02: Composed of controller, ceramic hard sealing ball valve, and sensors, it is suitable for single-way irrigation in situations with municipal electricity and tap water or pressurized water sources (such as having a water tank on the mountain to irrigate crops below).

Model RJ-ZG03: Consisting of controller, water pump, ceramic hard sealing ball valve, and sensors, it can irrigate 2-8 lines and is suitable for situations with municipal electricity but without tap water or pressurized water sources. It is equipped with water pump, making it suitable for irrigation using river water, well water, lake water, etc.

Model RJ-ZG04: Comprised of solar panel, battery, controller, ceramic hard sealing ball valve, and sensors, it is suitable for situations without municipal electricity but with pressurized water source. The solar panel charges the battery to power the controller and valves. Equipped with 60-watt solar panel and a DC12V Runjing electric ball valve, it can operate continuously for 60 hours after a full charge.

Model RJ-ZG05: Includes solar panel, battery, controller, water pump, ceramic hard sealing ball valve, and sensors. It is suitable for areas without municipal electricity and without a pressurized water source. It can effectively solve the problem of irrigating farmland, orchards, and gardens in remote areas without electricity or with shortage of electricity, drawing water from underground, rivers, lakes, and ponds for irrigation. Equipped with 500-1000 watt solar panel and a DC24V Runjing electric ball valve, it can sustain irrigation for 4-6 hours with an average of 6 hours of sunlight per day.

4.2.3.2 Residential irrigation products

For family users who enjoy planting flowers, when family members are away on business trips

or vacations, watering the green plants on the balcony or in the courtyard becomes an issue. Unlike pets, which can be placed in pet boarding centers, houseplants cannot be moved around easily.

To address this, we have developed an economical model of intelligent irrigation valves for residential use, featuring ceramic hermetic head faces for good sealing and long life, with low power consumption. There are two types: timer control and 4G IoT control.

RJ-ZG06 Model: A residential timer intelligent irrigation valve powered by dry batteries, which can be programmed for precise watering times and durations to achieve scheduled, measured automatic watering. It features rain sensing, automatically stopping watering when it rains, and has an anti-clog filter at the inlet. Its size is about the size of an adult's hand, and it can deliver a flow rate of 2m³/h under a pressure drop of 0.1MPa, meeting the irrigation needs of a 200 ㎡ area. It is suitable for various watering scenarios such as potted plants, balcony flower pots, courtyard gardens, and vegetable fields. Compared to using hoses and watering cans, the residential intelligent irrigation valve makes watering easier, convenient, practical, and affordable.

RJ-ZG07 Model: A residential 4G IoT intelligent irrigation valve, which not only has the function of ZG06, but can also be remotely controlled the irrigation by mobile phone app for irrigation (sharing permissions to achieve multi person management); Can be configured with a humidity sensor to automatically control watering based on soil moisture conditions.

4.2.3.3 Pulse ceramic hard sealing ball valve

Irrigation valves are generally installed at a certain distance from the controller, and it is necessary for the controller to control multiple valves. If wired connections are used, the construction cost is high, and some terrains are not conducive to construction. To solve this problem, we have developed a pulse ball valve that opens when it receives a forward pulse signal and closes when it receives a reverse pulse. The pulse valve has low power consumption, with a standby current of ≤10μA, and can operate for 1-3 years without charging when powered by a battery. It can also be powered by a solar panel and lithium battery. Combined with an IoT 4G controller, it can achieve long-distance wireless communication through LORA wireless networking, allowing for remote monitoring through PC or mobile app, and can be programmed to control the sequential opening and closing of each group of valves.

Generally, models with specifications ranging from DN20 to DN100 use plastic valve bodies and are motor-driven. Valves above DN100 use metal valve bodies and are pilot-operated with hydraulic or pneumatic actuation. Large-diameter ball valves above DN100, if electrically driven, would consume more power. Pilot-operated pneumatic or hydraulic valves use a low-power-consuming electric pilot valve to switch positions for direction change, utilizing the pressure of liquid or gas to actuate the valve.

4.2.3.4 Integrated valve combined with metering and controlling (DN50)

China is facing a scarcity of water resources. In order to achieve water-saving and precise irrigation, and cultivate water saving awareness, many regions require payment for agricultural water

usage, necessitating the measurement of irrigation water. Currently, butterfly valves or diaphragm valves are mainly used in combination with flow meters (as shown in Figure 4-1). Due to the fact that diaphragm valves are angle flow channels and flow meters require straight pipe length ten times of pipe diameter in front and five times' after to ensure accuracy, the two products are far apart, making installation difficult. Additionally, the control parts of the two products also require information exchange, making control inconvenient.

We have developed an integrated valve combined with metering and controlling by utilizing the feature of Runjing ceramic hard sealing ball valve that can achieve full bore. The flow meter is built-in the valve. It saves pipeline space, has precise measurement, combines measurement and control, and is easy to control. It can use various control methods such as wired connection, 4G, LORA, etc.

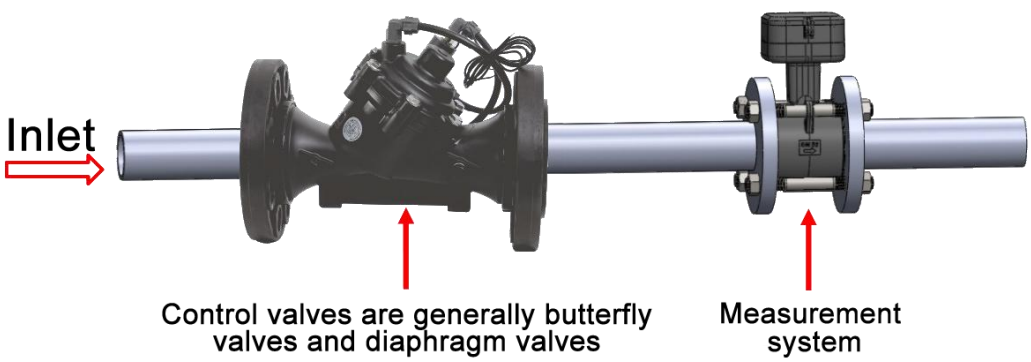


Figure 4-1 common integrated system combined with metering and controlling

4.2.3.5 Integrated valve combined with metering and controlling (DN80 three-way)

In northwest regions such as Xinjiang, where crops like cotton and grapes are grown, drip irrigation technology is widely used. Sometimes, a single irrigation area for field crops can cover tens of thousands of acres. Typically, a water tank is constructed at a higher elevation during system design to serve as a water source for irrigation, utilizing the natural water pressure generated by the height difference for drip irrigation. In such irrigation areas with significant height differences, it is crucial to ensure stable pressure in each irrigation branch to prevent high pressure caused by the height difference from bursting the drip irrigation pipes. This is generally achieved by adjusting the opening of different valves to maintain stable water pressure.

DN80 three-way integrated metering and controlling valve can achieve bottom in, left out or bottom in, right out, allowing one valve to control two irrigation channels, effectively functioning as two valves and significantly saving costs. The opening of the ball valve can be adjusted via pressure or flow sensors. The valve features a photovoltaic power supply, low power consumption, and is configurable with LORA wireless communication.

4.2.4 Intelligent irrigation house

In the process of agricultural production, the working environment of farmers is relatively poor, and they work in the fields for a long time, exposed to wind, sun, and rain. With the development of the economy and society, in recent years, most farmers engaged in frontline agricultural production are over 60 years old, and there are fewer and fewer young people willing to become farmers. Future agricultural production must change the impression of traditional agriculture in order to attract more young people to engage in agricultural production. Based on this idea, Runxin company proposed to build intelligent irrigation houses in irrigated areas. Install equipment such as the Runjing intelligent irrigation valve, high flow disk filter, water and fertilizer integrated machine, etc. inside the house, with a TV as a monitoring screen, electric fans, water purification equipment, washing equipment, etc. can also be installed. The roof of the house is covered with solar panels for use by the indoor TV, fan, monitoring equipment, etc. Remote centralized visual management can be achieved via mobile phones or computers.

Table 4-2 Intelligent Irrigation House Specification and Size Table

Number	Length × Width × Height	Supporting Equipment
1	4×3×3.2	Three sets of disk filter, water and fertilizer integrated machine, etc
2	5×3×3.2	Six sets of disk filter, water and fertilizer integrated machine, etc
3	6×3×3.2	Nine sets of disk filter, water and fertilizer integrated machine, etc

Note: Equipped with irrigation ball valves of various calibers, suitable for irrigation applications ranging from 10 to 1000 acres.

In the next step, in the field of irrigation, we plan to develop a larger flow disk filter system and a series of irrigation ball valves that can adjust pressure and flow.

4.3 Application cases of intelligent irrigation valve

Since its launch in June 2022, Runjing intelligent irrigation valve has been successfully deployed in various locations, including the Fengze Garden Ecological Agricultural Park in Jingzhou, Hubei, the Sanhu Yellow Peach Planting Demonstration Garden in Jiangling, Hubei, the Tian Sai Winery Grape Plantation in Korla, Xinjiang, the Zhejiang Academy of Agricultural Sciences, the Orange Boutique Garden in Sanyang Wetland, the Qidu Future City Agricultural Park in Wenzhou, Tianhui Country Garden in Hebei, Hanlin Huafu in Inner Mongolia, the Lucheng District Government in Wenzhou, Ma'an Pool Park in Wenzhou, Lianghu Park in Lishui, and the Dongfang Golf Course in Wenzhou, with positive results.

4.3.1 Application in agricultural irrigation

The application of intelligent irrigation technology in agricultural planting provides an efficient, precise, and sustainable irrigation solution for farmers, which helps to optimize the growth environment for crops and improve both yield and quality.

4.3.1.1 Wenzhou Sanyang wetland 100000 square oranges planting garden

Wenzhou's "Sanyang Wetland" is hailed as the green lung of the city, with a dense network of waterways that divide it into more than 160 islands of varying sizes. The Oranges produced here is highly favored by people in the Wenzhou region and across the country. The Sanyang Wetland's Orange Boutique Garden, which covers over 100000 square meters, originally used manual river water extraction for irrigation and fertilization. This method was labor-intensive, with a rough approach to irrigation and fertilization, leading to high cultivation costs.

The site has now been retrofitted with the Runjing intelligent water and fertilizer integrated irrigation system. This system can provide a balanced and precise supply of water and fertilizer directly to the root soil of fruit trees according to their growth needs, enhancing the trees' absorption efficiency of water and nutrients. It reduces the cost of fertilization and maintenance and allows for remote controlled of watering and fertilization by mobile phone or computer, achieving water and fertilizer saving and reducing the intensity of manual labor.

The system is equipped with a high flow disk filter system integrated with a ceramic hard sealing three-way valve, which can filter out silt, flocculent matter, and other impurities from river water, improving the quality of the irrigation water and preventing nozzle blockages. It features an automatic backwash triggered by time or pressure differential; a water and fertilizer integrated machine that automatically waters and fertilizes the Oranges when needed, requiring only periodic addition of fertilizer to the tank; and a DN80 large-diameter Runjing ceramic hard sealing ball valve for controlling the opening and closing of each irrigation branch, which is resistant to wear from silt and water-fertilizer solutions and has a long service life. (See Figure 4-2)

In similar situations such as agricultural field irrigation and large-scale flower and tree irrigation, the use of the Runjing high flow disk filter system and the ceramic hard sealing ball valve intelligent water and fertilizer integrated irrigation system can greatly reduce planting and maintenance costs, save irrigation water and fertilizer, and improve crop yield and quality.

Figure 4-2 application of intelligent irrigation valve in 100000 square meters of the Orange Boutique Garden in Sanyang Wetland, Wenzhou

4.3.1.2 Hubei Jiangling Sanhu Yellow Peach Base

Sanhu Yellow Peach is a specialty of Jiangling, Jingzhou City, Hubei, and is also a Chinese national geographical indication product. The total area of Hubei Jiangling Sanhu Yellow Peach Modern Agriculture Demonstration Park is 66,667 square meters, including 6,667 square meters of greenhouse cultivated yellow peaches. In recent years, the demonstration park has adopted new planting concepts and utilized advanced modern agricultural planting techniques for standardized planting management of yellow peaches. The 6,667 square meters greenhouse for yellow peaches cultivation has been retrofitted with the Runjing intelligent water and fertilizer integrated irrigation system, equipped with several solar-powered Runjing ceramic hard sealing ball valves, which are resistant to corrosion from water-fertilizer solutions, wear, and have a long service life. The installation and maintenance costs are low, and there is no need for digging ditches or laying cables. (See Figure 4-3)

The system adopts water-fertilizer integration technology combined with drip irrigation, allowing for automatic irrigation and fertilization based on soil moisture conditions, as well as precise watering and fertilization controlled remotely by mobile phone or computer. This effectively conserves irrigation water, reduces labor intensity and cultivation costs, and aids in increasing the yield of yellow peaches.

Figure 4-3 application of intelligent irrigation valve in the Sanhu Yellow Peach Base in Jiangling, Hubei Province

4.3.1.3 Xinjiang Korla Tian Sai Winery

Grapes are one of the most characteristic and representative economic specialties of Xinjiang, known for their sweetness, tender flesh, juiciness, delicious taste, and rich nutrition. The local grape processing industry is also highly developed. Tian Sai Winery in Korla City, Xinjiang, is an experiential winery that integrates grape cultivation, wine production, thematic tourism, and wine culture promotion. It has a 1.3 million square meters vineyard, which previously used manual irrigation and faced issues such as rough irrigation methods, high labor intensity, and easy damage to plastic valves.

A 33,333 square meters grape planting area of Tian Sai Winery has been retrofitted with

Runjing intelligent irrigation valves, equipped with multiple solar-powered DN65 Runjing ceramic hard sealing pulse electric ball valves. These valves are resistant to wear and have a long service life. The system uses LORA wireless networking to enable long-distance communication, eliminating the need for digging ditches or laying cables, resulting in low installation and maintenance costs. (See Figure 4-4)

The system allows for remote controlled by mobile phones, making irrigation operations more convenient. It is also equipped with a mini weather station that provides an intuitive display of meteorological data such as light intensity, rainfall, wind speed, wind direction, temperature, and humidity, as well as soil moisture, pipeline pressure and EC parameters. This enables more efficient, accurate, and scientific irrigation, significantly saving irrigation water, reducing labor intensity and cultivation costs, and enhancing grape yield and quality.

Figure 4-4 application of intelligent irrigation valve in Xinjiang Korla Tiansai Winery

4.3.2 Application in municipal garden irrigation

The introduction of greening intelligent irrigation systems in urban landscaping and residential property management can greatly reduce labor costs and green space maintenance costs, standardize plant watering, improve green space quality, add dynamic landscape elements to gardens and communities, and enhance the overall environmental quality.

4.3.2.1 Wenzhou Lucheng District Government

Wenzhou Lucheng District Government has a large green space with scattered green belts. The previous manual watering method required three workers to take turns watering, with an average watering time of over 8 hours per day, resulting in high labor costs. Additionally, the traditional method of dragging hoses for watering was quite rough, leading to uneven watering and inadequate coverage for large areas and higher plants.

In June 2022, more than 1,400 square meters of green space within the Wenzhou Lucheng District Government compound, including lawns, flower beds, shrubs, and trees, were retrofitted with 6 sets of RJ-ZG02 Runjing intelligent irrigation valves, along with multiple three-way control electric ball valves and various types of sprinklers such as swing, rotary, and mist types to meet the

irrigation requirements of different plants in vertical greening. The system enables precise watering based on soil moisture and remote controlled by a mobile app, effectively reducing the burden of manual labor and significantly improving irrigation efficiency and water resource utilization efficiency. (See Figure 4-5)

Figure 4-5 application of intelligent irrigation valve in Lucheng District Government, Wenzhou

4.3.2.2 Lishui Lianghu Park

Lishui Lianghu Park, located in the center of Lishui City, Zhejiang Province, covers an area of 666,667 square meters and serves as an urban park integrating ecological conservation, leisure fitness, educational entertainment, and urban image display. A 4,500 square meters green area within the park is equipped with Runjing intelligent irrigation valves.

The green area features a Runjing intelligent irrigation house, which uses photovoltaic power generation to supply water to the irrigation pump. The house is equipped with Runjing intelligent irrigation valves, ceramic hard sealing disk filter, and other equipment, protecting the irrigation equipment from the elements and extending their service life, facilitating maintenance and centralized management.

The ceramic hard sealing disk filter effectively filters out impurities such as silt and suspended solids from lake water, improving the quality of irrigation water and preventing blockages in pipelines and nozzles, reducing water waste and conserving water resources. It is controlled by a ceramic hard sealing three-way valve, which is resistant to impurities and wear, and can perform automatic backwash based on time or pressure differential, removing trapped dirt and extending the service life of the irrigation equipment.

The system is equipped with several solar-powered Runjing ceramic hard sealing pulse electric ball valves, which have low torque, are wear-resistant, durable, and can be controlled by LORA wireless networking. They can automatically water based on soil moisture conditions and can be remotely controlled by a mobile app or computer to adjust the watering area and duration, greatly improving irrigation efficiency, saving water, reducing maintenance costs, and enhancing the quality of green spaces in parks.

Figure 4-6 application of intelligent irrigation valve in Lishui Lianghu Park

4.3.2.3 Shijiazhuang Tianhui Country Garden

Traditional garden and community green space maintenance has many shortcomings, such as high-water consumption, significant human subjective influence, high maintenance difficulty, and rising labor costs, thus an intelligent garden irrigation solution is necessary.

The Tianhui Country Garden residential area in Qiaoxi District, Shijiazhuang, covers an area of over 30,000 square meters with a beautiful environment and high greenery rate.

More than 5,000 square meters of the green area originally used manual watering, which was labor-intensive and time-consuming for green space maintenance. Now, the area has been retrofitted with RJ-ZG02 Runjing intelligent irrigation valves, which can be set for timed watering and automatically water based on soil moisture conditions. They can also be remotely controlled by a mobile phone or computer. The system is equipped with several solar-powered Runjing ceramic hard sealing pulse electric ball valves that have low torque, are wear-resistant, corrosion-resistant, durable, and have simple and low-cost maintenance. (See Figure 4-7)

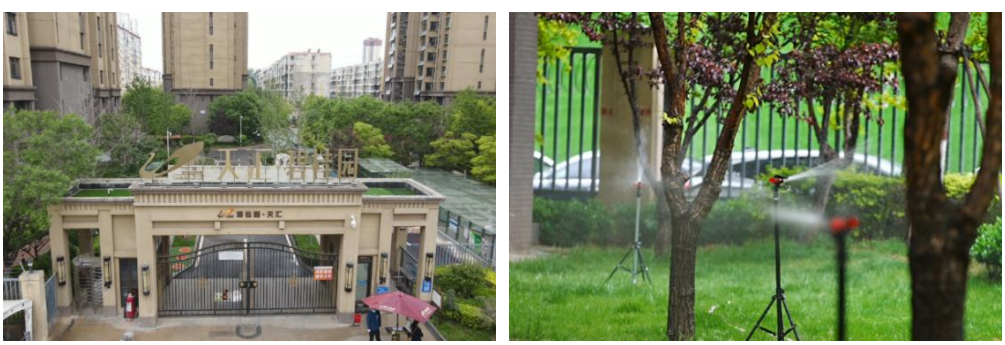


Figure 4-7 application of intelligent irrigation valve in Shijiazhuang Tianhui Country Garden

4.3.3 Application in villa garden irrigation

Private courtyards and balcony flower houses are becoming increasingly popular, and the installation of intelligent irrigation systems has become a popular configuration for convenient and efficient irrigation management and maintenance of courtyard landscape green plants.

In a villa garden in Yongjia County, Wenzhou, the original method of manually pulling hoses for watering was labor-intensive, with limited coverage in a given time, resulting in low watering

efficiency, high management difficulty, and high costs. Additionally, manual watering can easily lead to overwatering, wasting a large amount of water resources, and potentially causing yellowing and death of plant leaves, affecting the aesthetics of the green space. (See Figure 4-8)

The garden has now been retrofitted with RJ-ZG03 Runjing intelligent irrigation valves, equipped with 8 Runjing ceramic hard sealing ball valves, which are resistant to wear from silt and other impurities and have a long service life. They can be remotely controlled by mobile phone for watering, combining drip irrigation, micro-irrigation, and spray irrigation technologies to meet the irrigation needs of a variety of greenery such as lawns, potted plants, shrubs, and vegetable gardens. This significantly reduces the labor intensity and maintenance costs, saves water for irrigation, adds a dynamic landscape.

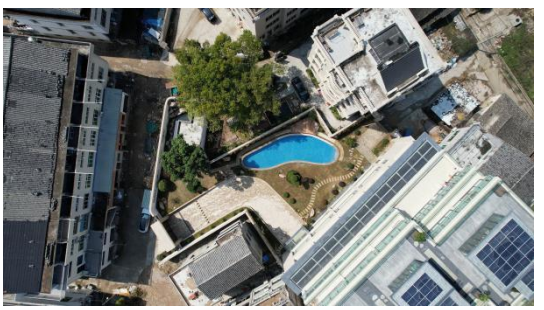



Figure 4-8 application of intelligent irrigation valve in a villa garden in Yongjia, Wenzhou

4.3.4 Application in golf course irrigation

Water is the lifeblood of golf courses, and irrigation is a crucial means of turf maintenance. If the water content in the turf of a golf course drops to 60%, the turf grass will wilt or even die. Therefore, timely irrigation is necessary to replenish the moisture of grass.

The original irrigation system at the Yangyi Dongfang Golf Course in Wenzhou used a diaphragm-type pressure relief valve as the pressure relief device, which had issues such as inaccurate control, aging of diaphragm rubber parts, easy piston jamming, and valve failure due to blockage of the pressure adjustment component, leading to pipe bursts and easy damage to the valve. The system has now been retrofitted with Runjing ceramic hard sealing electric regulating ball valves for pressure relief, along with Runjing DN100 stainless steel electric regulating ball valves. After testing, the customer expressed satisfaction with the stable operation of the system, precise pressure relief, and steady pressure control.

The turf of the golf course originally drew lake water, using manual valves that workers opened for irrigation every day, which was labor-intensive. The system has now been retrofitted with Runjing intelligent irrigation valves, equipped with nearly 200 solar-powered DN40 Runjing ceramic hard sealing pulse pilot liquid control ball valves, which are resistant to wear from silt and other impurities in the lake water, achieving efficient and intelligent irrigation. (See Figure 4-9)


Figure 4-9 application of intelligent irrigation valve in Wenzhou Oriental Golf Course

4.4 Intelligent irrigation valve field test

Under the technical guidance of Gong Shihong, the former deputy director of the Water Resources Institute of the China Institute of Water Resources and Hydropower Research and the director of the Agricultural Water-saving Equipment Branch of the China Agricultural Water-saving and Rural Water Supply Technology Association, Runxin Company, in cooperation with Beijing Zhongshui Runke Certification Co., Ltd and the National Agricultural Irrigation and Drainage Equipment Quality Inspection and Testing Center, has carried out a series of durability tests on the Runjing Ceramic Hard Sealing Ball Valve Intelligent Irrigation Product Line under Actual Working Conditions" at the Shaanxi Donglei Yellow River Water Diversion Project, the Turpan City Water Science Institute Irrigation Test Station in Xinjiang, the Qing'an Irrigation Test Station in Heilongjiang, and the Weishan Irrigation District Yanggu County Pumping Station in Liaocheng City, Shandong. These tests assess the applicability of the Runjing ceramic hard sealing ball valve and intelligent irrigation valve product line in extreme and complex environments such as high-turbidity Yellow River water projects, extremely hot, and extremely cold regions, providing actual data support and basis for subsequent technology research and development and market application.

4.4.1 Test One: Shaanxi Donglei Yellow River Irrigation Project (high turbidity Yellow River water body)

The Yellow River is the most important birthplace of Chinese civilization, known as the mother river of China, and is the second-longest river in China. The "yellow" in the Yellow River actually refers to the sediment, as it produces 1.6 billion tons of sediment annually, earning it the title of the river with the highest sediment content in the world. The Donglei Yellow River Irrigation Project in Weinan, Shaanxi, is the highest-lift and largest-flow electrical pumping project in Shaanxi Province, using the Yellow River as its water source. The water contains a large amount of sediment, with a maximum of 9.5kg/m³, and is located in Heyang County, Weinan City, Shaanxi Province.

This test project involves creating a bypass on the pipeline that directly draws water from the Yellow River, installing various specifications of Runjing ball valves (DN20-DN200) with plastic and stainless steel valve bodies, alumina and silicon carbide valve cores, as well as DN50 integrated valve combined with metering and controlling, The on-site use tests are carried out to evaluate the

wear resistance, weather resistance, lifespan, torque, and other performance indicators of the Runjing ceramic hard sealing ball valve intelligent irrigation series products in high turbidity Yellow River diversion project water bodies.

Figure 4-10 test one: Shaanxi Donglei Yellow River Irrigation Project (high turbidity Yellow River water body)

4.4.2 Testing Two: The Irrigation Experimental Station of The Water Science Institute in Turpan, Xinjiang (extreme heat, surface temperature of 80°C)

Turpan City is located in the central part of the Xinjiang Uygur Autonomous Region and has a typical continental temperate desert climate, with abundant sunlight and heat, and extremely dry conditions. It is known as "the land of fire" and "the treasury of wind." During the summer, the surface temperature is often above 70°C, and in some places, it can even reach 80°C. There is a saying that "you can roast eggs in the sand pits" and "bake pancakes on the stones."

This test evaluates the torque, high-temperature resistance, and wind-sand resistance of a series of products, including DN20-DN150 caliber, pulse electric and hydraulic ball valves, silicon carbide ball valves, and DN50 integrated valve combined with metering and controlling in actual field conditions. The purpose is to examine the adaptability of the Runjing ceramic hard sealing ball valve intelligent irrigation product series in extremely hot regions.

Figure 4-11 testing two: The Irrigation Experimental Station of The Water Science Institute in Turpan, Xinjiang (extreme heat, surface temperature of 80°C)

4.4.3 Testing Three: Qing'an National Irrigation Test Station, Suihua City, Heilongjiang Province (extremely cold region, extreme low temperature of -40°C)

The Qing'an Irrigation Test Station is located in the Heping Irrigation Area of Qing'an County, Suihua City, Heilongjiang Province. It is a key national irrigation test station, covering more than 180000 square meters, including more than 113333 square meters of paddy fields. It is situated around 46 degrees north latitude, with distinct seasonal changes and significant differences in climate across the four seasons. The winters are extremely cold, often accompanied by strong winds and snowfall, with extreme low temperatures around -40°C.

This test conducts on-site performance testing on DN20-DN150 caliber, pulse electric controlled alumina and silicon carbide ball valves, as well as DN50 integrated valve combined with metering and controlling and other series of products, aiming to test the adaptability of the Runjing ceramic hard sealing ball valve series products in extremely cold areas.

Figure 4-12 testing three: Qing'an National Irrigation Test Station, Suihua City, Heilongjiang Province (extremely cold region, extreme low temperature of -40°C)

4.4.4 Test Four: Weishan Irrigation District Yanggu County Pumping Center,Liaocheng City, Shandong Province (Yellow River irrigation area water body, sediment content of 13kg/m³)

The Weishan Irrigation District is located in Liaocheng City, Shandong Province, with a designed irrigation area of 5.4 million acres. It is the largest Yellow River irrigation area downstream of the river and ranks fifth among the largest irrigation areas in the country.

In this test, Yellow River water is drawn into a water tank for cyclical testing, with a sediment content of 13kg/m³. The main purpose of this study is to conduct on-site testing on the performance of DN20-DN150 caliber Runjing ball valves, including resistance to sediment impurities, wear resistance, and durability, in order to verify the adaptability of the Runjing ceramic hard sealing ball valve series products in high sediment content water bodies.

Figure 4-13 test four: Weishan Irrigation District Yanggu County Pumping Center, Liaocheng City, Shandong Province (Yellow River irrigation area water body, sediment content of 13kg/m³)

4.4.5 Test conclusion

The test evaluation report issued by Beijing Zhongshui Runke Certification Co., Ltd.:

A. After the optimization of the flow channel of the seal ring of ceramic hard sealing ball valve, **it effectively reduces the accumulation of silt and sand within the flow channel, and the torque remains stable;**

B. Under high temperature, high dust and sand, and severe cold conditions, there is no significant change in the torque of the ceramic hard sealing ball valve, which proves that **the ceramic hard sealing ball valve can still maintain stable performance under these extreme environmental conditions;**

C. The sealing performance of the ceramic hard sealing ball valve is good under conditions of high silt content, high temperature, high dust and sand, and severe cold, with no leakage observed. This confirms that **the ceramic hard sealing ball valve can still effectively prevent leakage under these harsh conditions.**

D. The external dimensions and the ball core of the ball valve show no significant changes under conditions of high silt content, high temperature, high dust and sand, and severe cold. This demonstrates that the structure and materials of **the ceramic hard sealing ball valve possess stability and durability under extreme environmental conditions.**

Figure 4-14: Director Gong Shihong is guiding work at the test project site.

Company profile

Wenzhou Runxin company was founded in 2000 and mainly focuses on researching, developing, and manufacturing multi-functional flow control valve for water treatment systems (Runxin valve), Runlucky residential (commercial) water treatment equipment, Runjing ceramic hard sealing ball valve and ball valve for intelligent irrigation system (Runjing intelligent irrigation valve), which are energy-saving, healthy, and environmentally products. It has been recognized as a National New High-tech Enterprise, National Specialized, Fined, Peculiar and Innovative “Little Giant” Enterprise, National Green Factory, National Intellectual Property Advantage Enterprise, Zhejiang “Hidden Champion” Enterprise, Zhejiang Patent Model Enterprise, Wenzhou Industrial Leading Enterprise, Wenzhou “The Most Beautiful Factories”, and has been awarded as Zhejiang Export Famous Brand, Wenzhou Charity Award · Institutional Donation Award and other honors.

National New High-tech Enterprise

National Specialized, Fined, Peculiar and Innovative “Little Giant” Enterprise

National Green Factory

Zhejiang “Hidden Champion” Enterprise

Zhejiang Export Famous Brand

The Wenzhou Charity Award

The recognition of **National New High-tech Enterprise** has mainly based on the ability of enterprises to continuously conduct research, development, and transformation of scientific technological achievement, whether it has core independent intellectual property rights, the enterprises need to be a knowledge and technology-intensive economic entity. Runxin company has always attached importance to intellectual property protection and conversion work, as early as 2005 began to apply for PCT international patents and obtained the Runxin valve invention patent authorization from the United States, Russia, India, South Korea, Mexico in 2009. In 2011, Runxin obtained the invention patent authorization from 10 EU countries, and established a patent reward system and has obtained more than 130 patents, including 15 invention patents, 88 utility model patents. The majority patents have been implemented and successfully converted.

National Specialized, Fined, Peculiar and Innovative "Little Giant" Enterprise refer to "small but strong" and "small but excellent" enterprises with strong technological innovation ability, high market share, key core technologies and excellent quality. The application objects must have been recognized as the provincial-level "Hidden Champion" Enterprise or a "Hidden Champion" alternative Enterprise, high threshold, which is the highest level and the most authoritative honorary title in the assessment of small and medium-sized enterprises in domestic. Runxin company has mastered the core technology of special ceramic production and processing. The core product Runxin valve in domestic industrial market share is nearly 80%, ranked in the global market segments of the top three, and was awarded the title of Zhejiang "Hidden Champion" Enterprise in 2021.

The selection of **National Green Factory** is an important measure for the Ministry of Industrial and Information Technology to implement the "'The Fourteenth Five-Year' Plan for Industrial Green Development" and "The Implementation Plan for Peaking Carbon Dioxide Emissions in the Industrial Filed" and pushing the industrial filed reach the peak carbon dioxide emissions and carbon neutrality. In accordance with the principle of "Opt for the best among the good and prefer to have less but of higher quality", typical enterprises that achieve green and high-quality development in various industries are selected through a strict process of enterprise application, local review, expert evaluation, and comprehensive assessment, with high credibility. Since Runxin company was established, it attaches great importance to the development of green productivity, integrates "green" into product design, continuously promotes automation and intelligent technology transformation, invests nearly 3 million CNY to establish photovoltaic generation system, voluntarily upgrades the green packaging of all series of products, and always adheres to the road of green low-carbon sustainable development. At present, Runxin company's comprehensive utilization rate of industrial hazardous solid waste is 93.6%. The utilization rate of environmentally materials has reached 100% and has been ranked as an A-class enterprise in the comprehensive evaluation of "Profitability Per Unit Area" for many consecutive years.

In order to achieve the optimization and upgrading of Zhejiang foreign trade and move towards high-quality development, Department of Commerce of Zhejiang Province has organized the recognization of **"Zhejiang Export Famous Brand"** since 2008. The main conditions for the selection of "Zhejiang Export Famous Brand" are more than three years of export performance, positive net assets. Passed the internationally accepted quality management system certification, the export value of the previous year was not less than 10 million US dollars. Runxin company since the inception of the global vision, as early as 2004 to obtain self-import and export rights, open the road to foreign trade. Up to now, Runxin valve has been exported to 157 countries and regions, Runlucky complete machine has been exported to 54 countries and regions, Runjing ball valve has been exported to 34 countries and regions around the world.

The Wenzhou Charity Award is the highest award in the field of charity established by the Wenzhou Municipal People's Government, among these awards, the Institutional Donation Award aims to recognize **enterprises or other organizations that donate large amounts of money and goods, making outstanding contributions within the selection cycle.** "Surpass myself, dedicate to society" is the enterprise spirit of Runxin company. As early as 2003, Runxin company launched the "Charity Day Donation" activity at its inception, contributing targeted donation to Lucheng District and Shanfu Town Charity Branch for more than 10 consecutive years. In 2019, the company donated nearly 1million CNY to build "Eternity" sculpture of the youths. In 2020, donated 800 thousand CNY to build the youths "Once story" sculpture. In 2022, donated 1million CNY to build Wenzhou Central Hospital green emergency channel "Runxin corridor". Up to now, Runxin company has donated more than 5million CNY to various public welfare activities such as earthquake relief, caring for students and helping families in need.

International certification is indispensable for exporting products to the world. For many years, **NSF certification** has been recognized as the most authoritative certification in the global water treatment industry. The NSF (National Sanitation Foundation) was founded in 1944, is an independent, not-for-profit non-governmental organization. The difficulty of NSF certification is that the certification process is detailed and demanding, and all product ingredients are disclosed and not concealed, and health and safety standards are met. Second, annual flight inspection. Third, the NSF certification standards should meet three 9 and above, that is 99.9%. Fourth, the industry pass rate is less than 10%. Fifth, the process of water purification products shall not produce secondary pollution.

Since August 2010, Runxin valve has continuously passed the United States NSF certification every year. Runlucky residential softener was listed by NSF in 2020 and officially passed NSF certification, which can be found on NSF official website (www.nsf.org). In addition, Runxin valve and Runlucky complete system have also passed the **EU RoHS Environmental Protection Certification** that restricts the use of harmful heavy metals in electrical and electronic products and **CE certification** that meets the unified safety, health and environmental protection requirements of the EU, as well as the **French Health and Safety ACS Certification, the United Kingdom UKCA Certification, and the Russian EAC Certification**. Runjing ceramic hard sealing ball valve, integrated water and fertilizer intelligent irrigation system, disk filter has passed strict testing, water saving performance in line with the energy efficiency standards or technical regulations confirmed by the relevant water saving product certification body, passed the **Water Saving Product Certification.** Runxin company has passed **ISO9001:2018 International Quality Management System**, Intellectual Property Management System, Occupational Health and Safety Management System, Environmental Management System, Energy Management System and other certifications.

The United States
NSF Certification

EU
RoHS Certification

EU
CE Certification

France
ACS Certification

The United Kingdom
UKCA Certification

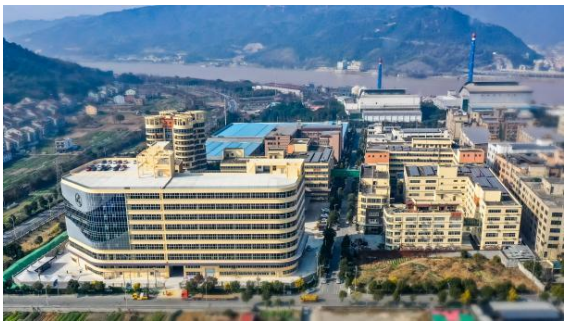
Russian
EAC Certification

Water Saving
Product Certification

Quality Management
System Certification

Production capacity

Runxin company has established production bases in Shanfu Town, Lucheng District, Wenzhou City, and Lishui Economic Development Zone in Lishui City. **covering an area of over 86,666 m^2 with construction area of over 200,000 m^2**. Having nearly a thousand pieces of large-scale equipment, including more than 350 CNC machines. The annual production capability of control valve can reach **3,000,000 sets** , ceramic hard sealing ball valve can reach **500,000 sets** and residential (commercial) water treatment systems can reach **400,000 sets**.



Factory in Shanfu Town


Factory in Lishui City

(Wholly owned subsidiaries: Zhejiang Runlucky Purification Technology CO, LTD.)

Runxin factory in Shanfu Town has **120 sets of high precision servo injection molding machines**, 25 sets of servo manipulators, more than 80% of injection mold parts have been fully automated for injection molding production, the annual production of over 2,100 tons of raw materials, including ABS, glass fiber reinforced ABS and PPE, ultra wear-resistant PPS, nylon PA66 and PA6, POM, PP, PPH as so on. It has 26 sets of mold making equipment, including machining center, wire electrical discharge machining, electric pulse processing lathe, milling machine, etc. with **nearly 1,800 pairs of molds** designed and manufactured independently. It has **57 sets of CNC lathes**, 17 sets of machining center, 2 sets of CNC precision automatic lathes, 12 sets of turn-mill combination, 12 sets of automatic machining robots, which complete precision machining of 500,000 control valves and ball valve accessories per month. **More than 130 sets of CNC precision machining equipment for ceramic sealing parts**, including flat grinder, flat polishing machine, ball mill, cylindrical grinder, milling machine, fully automatic cleaning line and so on, which have completed over 350,000 pieces of sealing parts per month. There are **14 assembly and packaging production lines**, including 2 automatic assembly lines for manual control valve, 2 automatic assembly lines for electronic control valve, and 1 automatic assembly line for high flow rate control valve. During the assembly of all products, to achieve detection constant value of torque, high-precision air tightness test, automatic laser marking tracking code, and fully automatic packaging.


Injection workshop 3000T Injection molding machine& servo manipulators

CNC workshop

Automatic assembly line of control valve

Automatic assembly area of accessories

MES production visualization execution system

Runlucky factory in Lishui City has **22 sets of high precision servo injection molding machines, 9 sets of large blow molding machines**, 3 sets of pipe extruders, 6 sets of robots, 9 sets of servo manipulators, more than 520 pairs of molds, the annual production of over 1,000 tons of raw materials, including HDPE, ABS, PP, PPH and so on. residential softener cabinet, shell and mainly accessories have been fully automated production. It has automatic welding equipment for strainer and automatic processing and assembly equipment for brine valves, the main accessories achieve automatic processing and assembly; 3 dust-free workshops and 6 assembly and packaging lines for complete system, to achieve automatic and precise filling of resin and activated carbon, detection constant value of torque, air tightness test, automatic packaging and palletizing on the assembly line.

Blow molding workshop

Injection workshop

Assembly line for complete system

Ultrasonic automatic welding machines

Runjing intelligent irrigation valve pipe production line

Mold warehouse

In addition, Ningbo Runda Ceramic Technology Company was founded by Runxin company as its controlling shareholder, is in Fenghua District, Ningbo City, covering an area of approximately 11,333 m^2 with a construction area of nearly 20,000 m^2. It produces 5,000,000 sets of ceramic disks and ceramic balls annually; Hankcraft Runxin LLC is joint venture company. It locates in Wisconsin, USA and provides a full range of residential and commercial water treatment products to North American customers.

Ningbo Runda company

Hankcraft Runxin LLC

Quality control

Quality is the foundation of an enterprise and the essential lifeline for its survival and development. Runxin company's Quality Control Center has a team of 25 professionals in inspection, measurement, and testing, it has established Type Laboratory, Water Quality Inspection Office, Microbiological Laboratory, Measuring Room and Testing Center, equipped with more than **130 industry-advanced testing equipments**, such as Three-Coordinate Measuring Machines, Optical Image Measuring Instrument and Roundness Tester. As well as **nearly a thousand measuring instruments, formulated 18 testing and inspection systems and 18 measurement standards,** it can conduct strictly test and experiment the whole process from raw material supply to finished product delivery according to standards. It has established Provincial-level Enterprise Technology Center, Zhejiang Water Supply and Treatment System Research Institute, Provincial-level High-tech Enterprise Research and Development Center.

Runxin selects high-quality suppliers and establishes the corresponding assessment and management procedure to strictly control the product entry. For each batch of core ceramic parts was proceed of appearance, form and position tolerance, roundness, flatness, hardness, bending strength,

compressive strength, metallographic analysis, and acid and alkali resistance tests about 15 item tests. For each batch of plastic raw materials was proceed of tensile, bending, impact strength tests, Vicat softening temperature, thermal deformation temperature, and melt flow rate about 6 item tests. For each batch of rubber parts was proceed of appearance, size, hardness, density, permanent deformation under compression, heat air aging resistance, and cold resistance about 8 item tests. For each batch of electrical components was proceed of pulse group interference, electrical stability tests, no-load noise, aging, and protection level about 32 items tests. For each batch of metal parts was proceed of material analysis and salt spray tests about 5 item tests. For each batch of resin was proceed of exchange capacity, color, COD increase, and density about 8 items; For each batch of activated carbon was proceed of moisture content, iodine adsorption value, methylene blue adsorption value, and total dissolved solids about 9 item tests. For each batch of plastic spray-painted parts was proceed of adhesion, resistance to wiping, and hardness at high and low temperatures about 5 item tests. For each batch of packaging material was proceed of thickness, burst strength, edge pressure strength, and adhesion strength about 7 items tests. All must be qualified before being put into production.

All batch-produced products must undergo strict type testing to ensure that the products meet the use requirements of various environments. For each batch of Runxin control valve was proceed of 25 kg pressure burst, 16 kg static pressure, and 100,000 cycles of pressure, rated flow rate, electrical safety performance, service life, transportation vibration, and drop about 10 item tests. For each batch of Runjing ball valve was proceed of 35 kg pressure burst, 24 kg static pressure, and 100,000 cycles of pressure, mud resistance, high and low temperature resistance, cold and hot shock, and protection level about 8 item tests. For each batch of Runlucky complete system was proceed of 35 kg pressure burst, 24 kg static pressure, and 100,000 cycles of pressure, rated flow rate, water treatment capacity, regeneration water consumption, residual chlorine adsorption, insulation performance, noise, and stacking about 13 item tests. Strict retention of each batch of samples, with detailed markings of name, batch number, quantity, sampling time, sampler, production date, etc., as the basis for quality.

The production process strictly adheres to the principles of initial inspection, routine inspection, and final inspection for each batch. The assembly process is 100% tested for water and air pressure, comprehensively inspecting product materials, appearance, size, weight, torque, sealing, processing and assembly technology, and order requirements.

From the finished product to storage, each batch of Runxin control valve, Runjing ball valve, and Runlucky complete system must go through more than 10 inspection processes, including order work order verification, packaging identification, appearance, random accessories, assembly quality, sealing performance, and electrical safety, to ensure that each product can meet the user's requirements.

Testing Center

Sample Storage Room

Three-coordinate automatic measuring machine

Product Quality Management Traceability System

Marketing

Adhering to the industry and insisting on innovation, Runxin company has taken a distinctive path of high-quality development, which industrializing, marketing, and globalizing the production and processing of special ceramics. It has attracted attention from leaders of national ministries and commissions, academicians of the Chinese Academy of Sciences and the Chinese Academy of Engineering, experts, scholars, leading enterprises in the industry, and domestic and foreign merchants. It has been invited **twice to participate in the CCTV "Dialogue with Chinese Brands" and "Dialogue with Brands" talk shows. Several corporate documentaries have landed on the CCTV platform**, such as "Extraordinary Craftsman: Be Gentle and Meek, Keep Innovation," " Start a New Chapter of Healthy Water," and "Hidden Champion: Small Valve with Big Vision, Measure the Road of Champion Innovation"**.** The company has been featured in reports by CCTV's Financial Channel (CCTV-2), CCTV's Science and Education Channel (CCTV-10), and China Global Television Network (CGTN) multiple times.

Founder, Honorary Chairman Mr.Yang and General Manager Mr.Wu visited CCTV "Dialogue brand China" "Dialogue brand" column

Several corporate documentaries have landed on the CCTV's platform

Central Media has repeatedly focused on the Runxin high-quality development

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Runlucky WeChat Official Account

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