

# TAIWAN KIMAX CONTROLS INC.

Energy-saving applied to industrial circhydraulic recovery  
turbine power generation systemulating water system



**KIMAX 專業經營於工業各個領域**

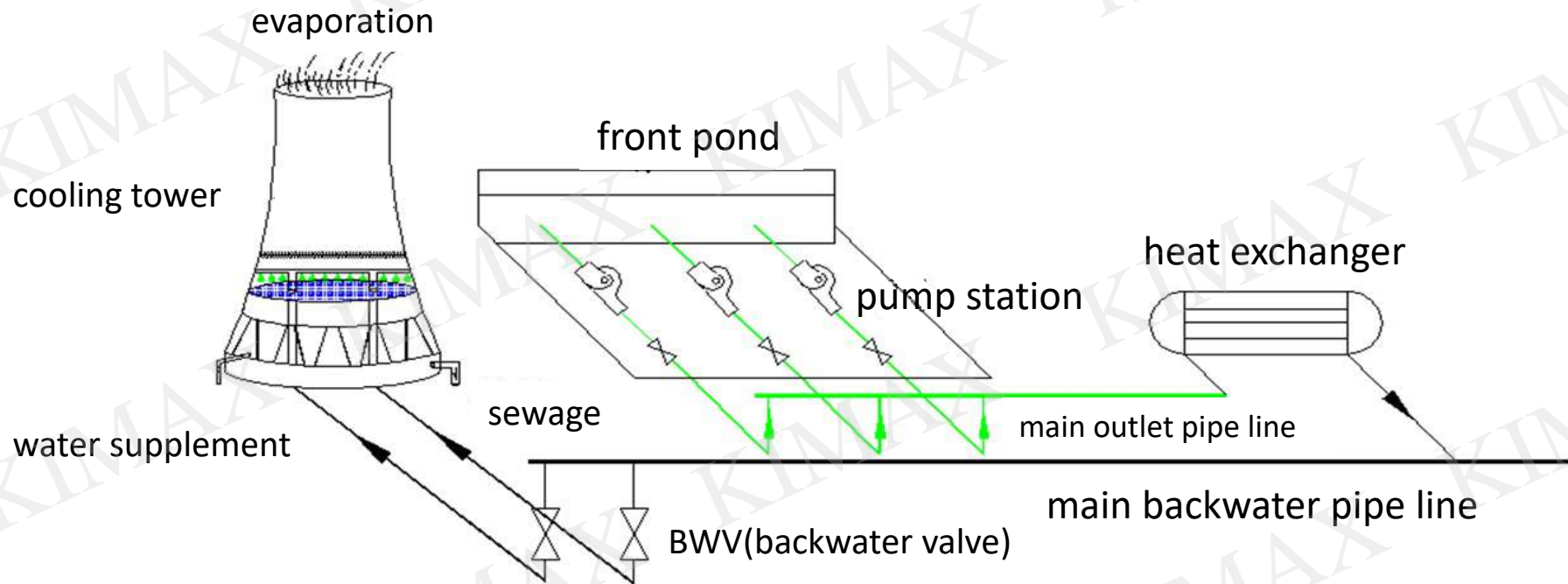
**Professional management in all areas of industry.**

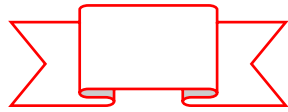


# Introduction to Industrial Circulating Water System

## Industrial circulating water system

- An open water supply system that uses water as a cooling medium for recycling. It consists of heat exchange equipment, cooling towers, fans, pumps, pipelines and related equipment.





# Advantages

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## ➤ Widely used

More than 2,000 sets are used in circulating water systems in coal, chemical, thermal power, metal smelting and other industries.

## ➤ High power consumption

Occupy 20%~30% of the total power consumption of the factory.

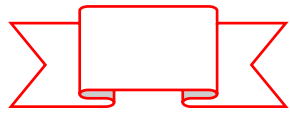
## ➤ Energy-saving potential advantages

There is a lot of waste of residual energy in industrial circulating water. Not only causes energy waste, but also affects the service life of heat exchange equipment and valves.

## ➤ Various energy saving methods

According to the system operation status diagnosis, select the appropriate energy saving combination strategy.

For example: hydraulic recovery turbine, intelligent control, system pressure reduction, pipe network optimization, ternary flow impeller customization, etc.



# Calculation

## How to save energy ?

- System energy consumption calculation formula

$$\sqrt{3}U \cdot I \cdot \cos\varphi \cdot \eta_{\text{Motor}} = \rho \cdot g \cdot Q \cdot H / \eta_{\text{Pump}}$$

$P_{\text{Motor shaft}}$

$P_{\text{Pump shaft}}$

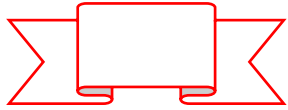
- Calculation formula for surplus pressure recovery

$$P = 9.81Q \cdot H_{\text{Residual}} \cdot \eta_{\text{Pump set}}$$

Hydraulic turbine  
power  
generation/driving.

- Realize energy saving:

- 1. Hydraulic power recovery turbine power generation/driving.
- 2. Reduce shaft power consumption.



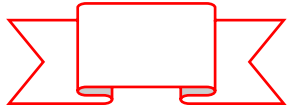
## □ Power generation by surplus pressure in circulating water

The device is an integrated electromechanical and control system consisting of a micro hydroelectric power generation unit, a four-in-one control cabinet and a circulating water safety guarantee mechanism.

It can effectively recover the residual energy of the circulating water system, has no interference to the system operation, and is safe, stable and reliable.



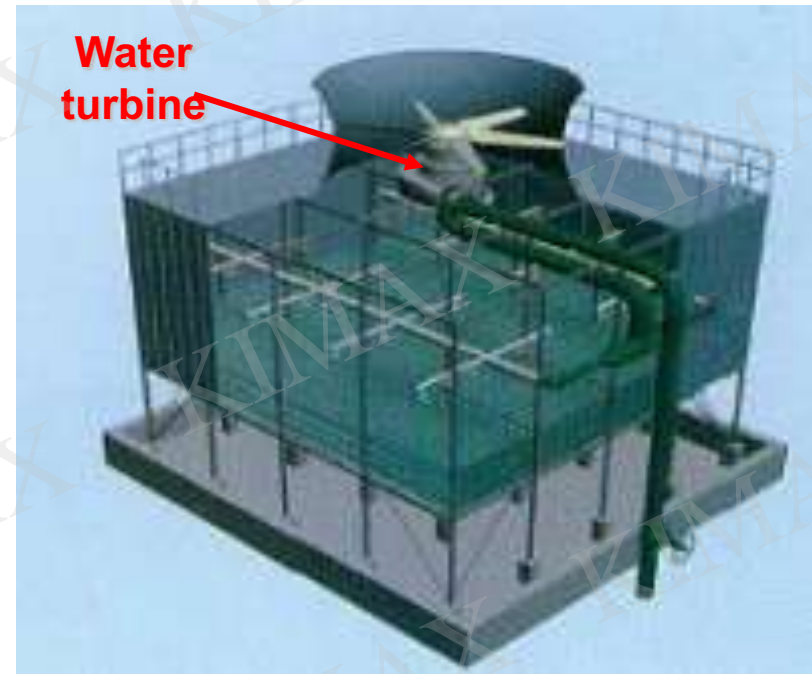


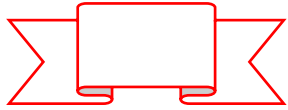


## □ Using the surplus pressure of circulating water to drive the fan

### Advantages of CTWT

- Replace the motor, reduce power consumption, and high recovery efficiency.
- It is suitable for occasions with large surplus pressure, large flow of single tower and stable operation.
- Special ultra-low speed ratio hydraulic turbine for cooling tower fan. The series of products have complete models, stable operation, low vibration, and domestic leading technology.





## □ How to achieve system energy saving?

### ➤ Improve pump efficiency

Custom-designed high-efficiency pumps to match system requirements;

### ➤ Reduce waste of heat exchanger flow

Reduce the waste of flow by reducing the temperature difference of the heat exchanger.

### ➤ Reduce the temp. of circulating water

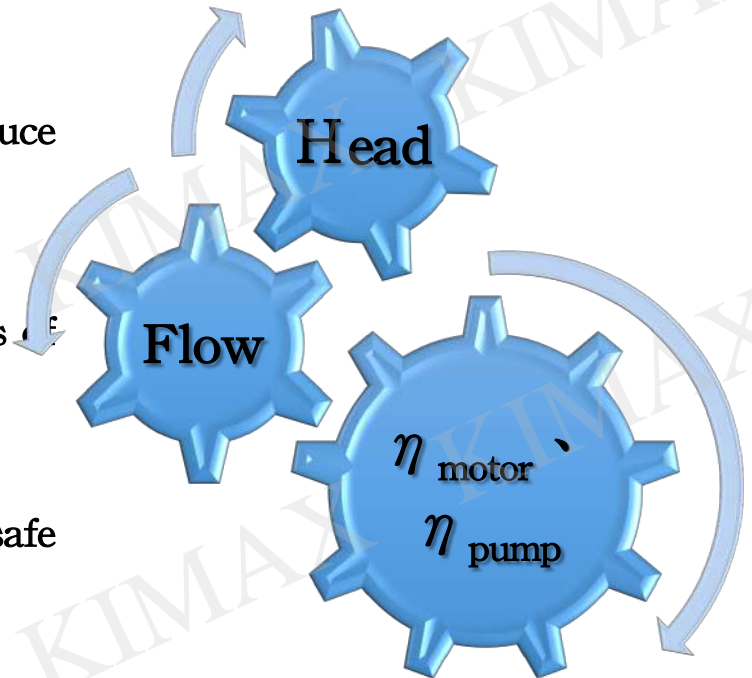
Optimize the operation of the cooling water tower to reduce the outlet water temperature;

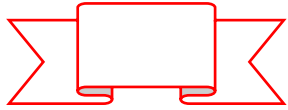
### ➤ Reduce pipe network resistance

Optimize the pipe network and reduce the resistance loss of the pipe network.

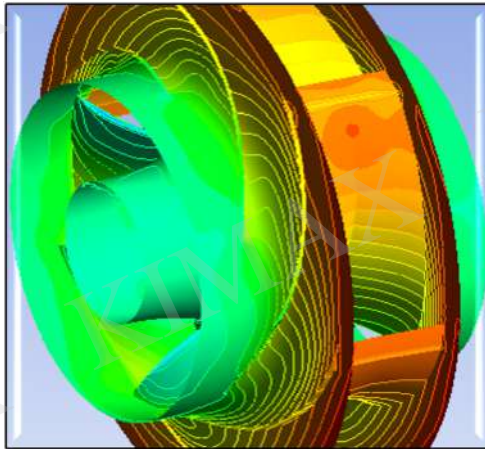
### ➤ Optimize smart control sys.

Professional intelligent control strategy to ensure the safe operation of the system.





## □ How to achieve system energy saving?



**HEAD**

- Ensure the pressure difference between the supply and return water and reduce the water supply pressure;
- Optimize the flow resistance of the pipe network to reduce pressure loss;

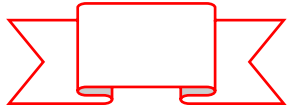
**FLOW**

- Reduce the circulating water temperature and enhance the heat exchange capacity;
- Reduce the waste of flow by reducing the temperature difference of the heat exchanger.

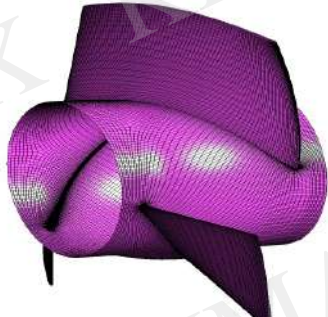
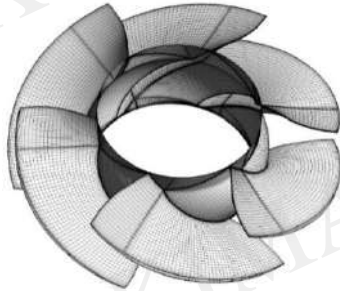
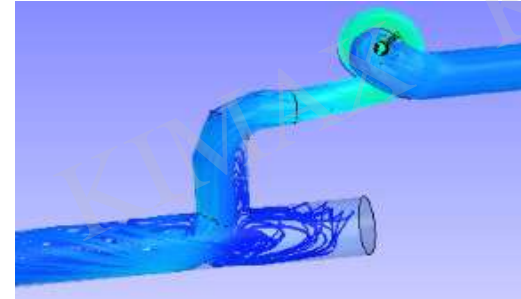
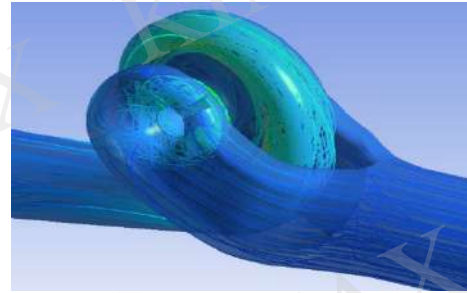
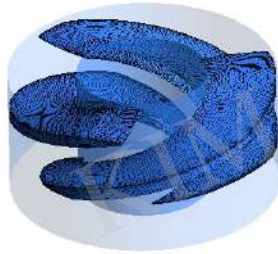
$\eta_{\text{motor/pump}}$

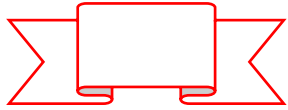
- Customized design of ternary flow improves pump efficiency.
- Match the pump capacity to avoid overqualified.



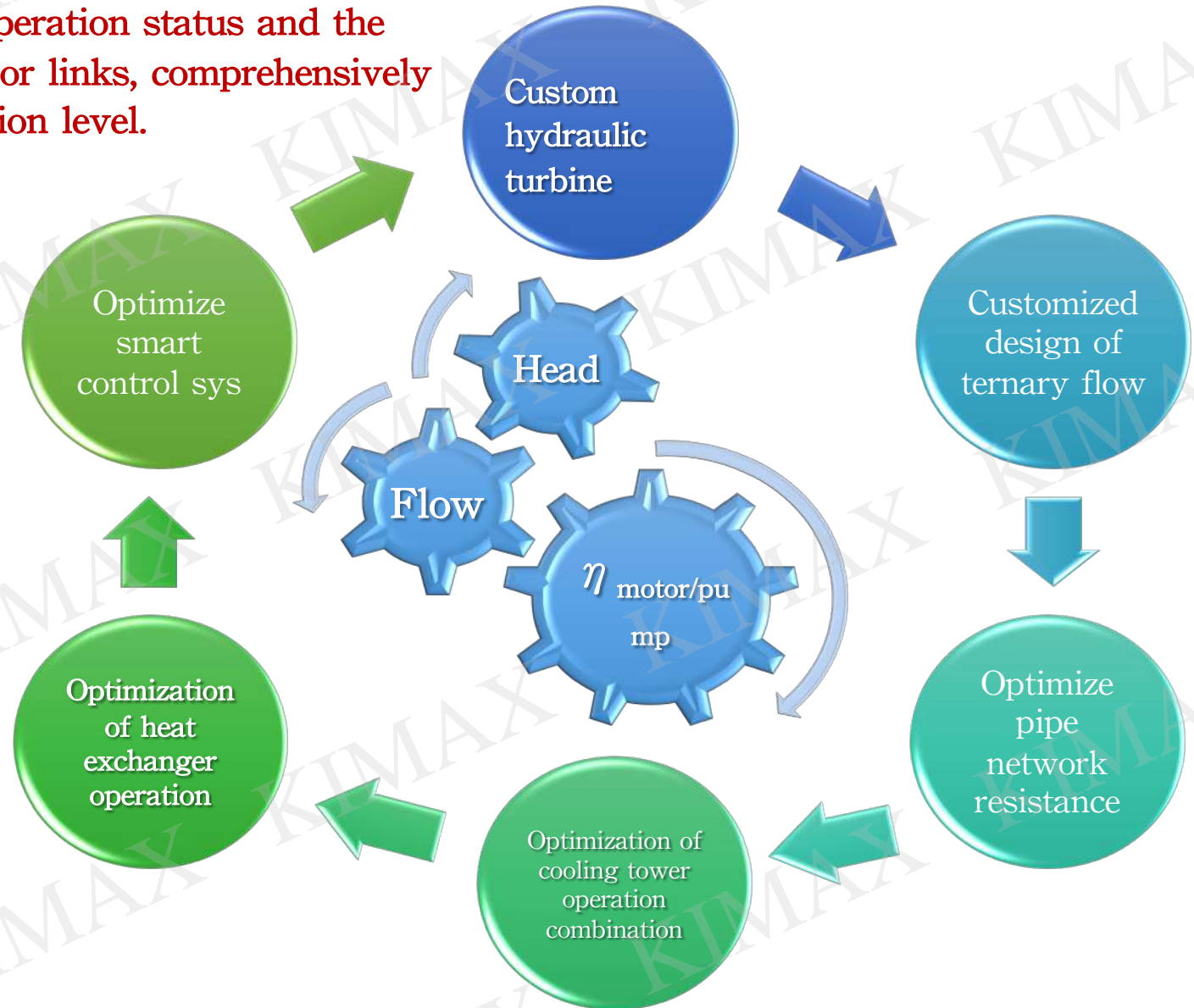


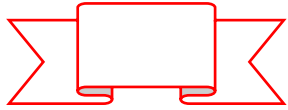
➤ Customized design of ternary flow





According to the system operation status and the combination of the six major links, comprehensively improve the system operation level.





## □ Circulating water energy saving-residual pressure power generation

### ➤ Field measurement

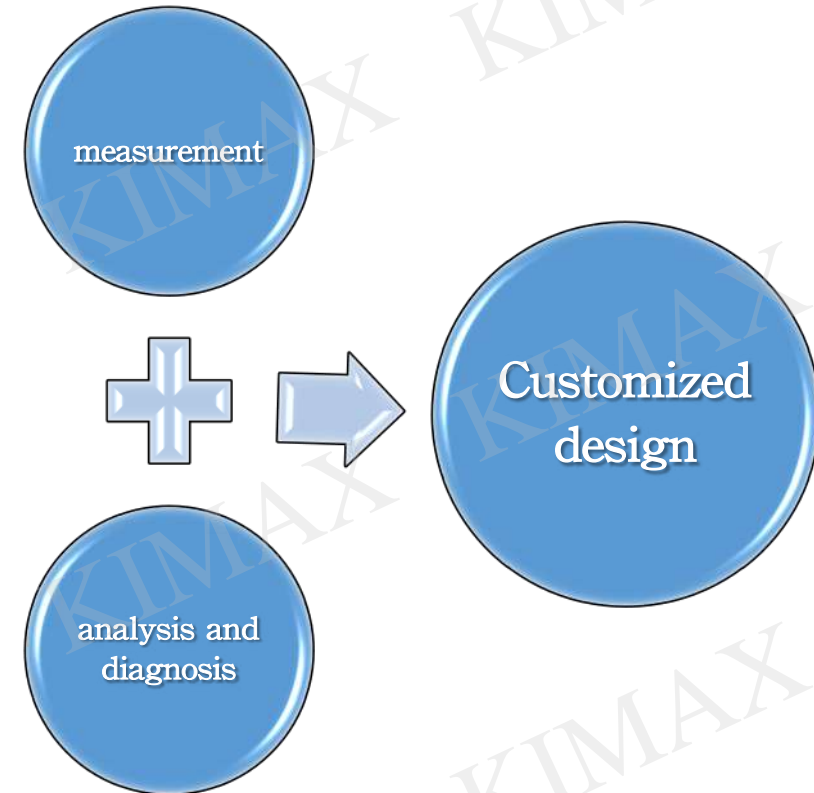
Comprehensive inspection of pumping stations, installations, pipe networks, cooling towers, and control systems;

### ➤ Energy-saving analysis and diagnosis

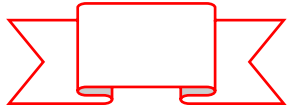
Analyze system flow, head, pump efficiency, pressure loss, seasonal operation characteristics, process requirements, etc., and diagnose operation conditions and energy-saving space;

### ➤ Customized design

Custom-designed hydraulic recovery turbine uses the surplus pressure of circulating water to generate electricity.

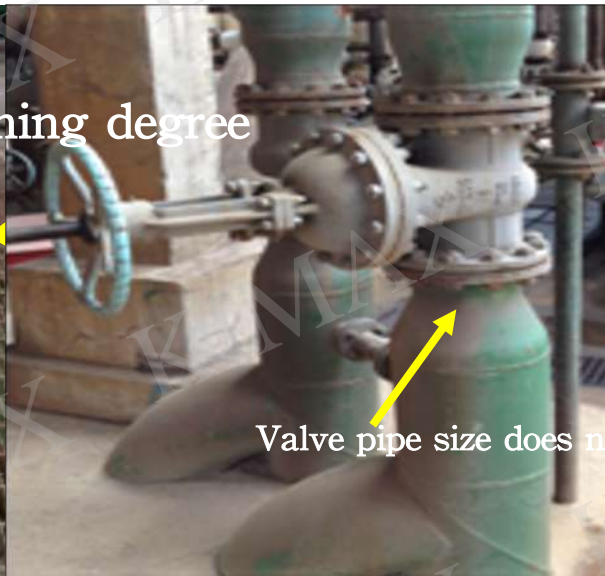
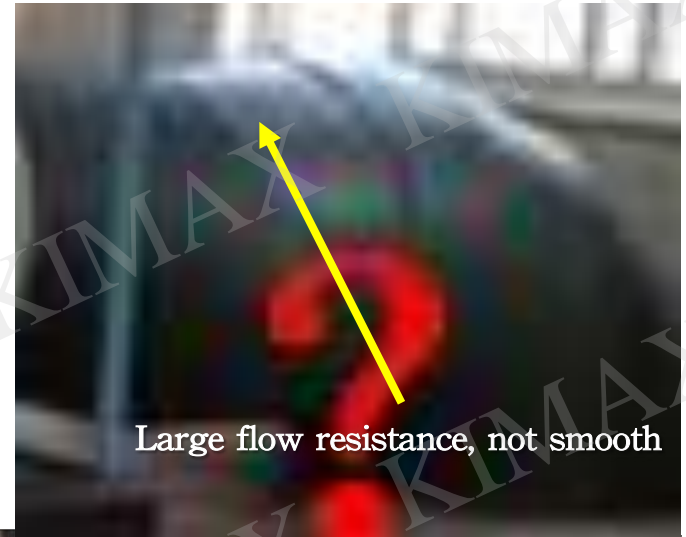




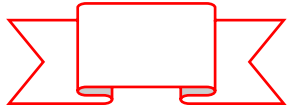


## □ Hydraulic waste is everywhere in the pipe network

- Large head loss of high resistance valve
- Small valve opening and large pressure loss
- Mismatched size, loss of scaling pipe diameter
- The pipeline is not smooth and the flow resistance is large







## Hydraulic loss of pipe network

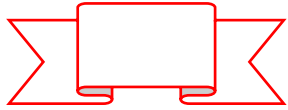
Synthetic ammonia plant: The head loss of the pump outlet branch is about 11m;

Methanol plant: The head loss of the branch of the pump outlet is about 15m.

Changing the unreasonable pipe network structure and operation mode can reduce the pressure loss of the pipe network.

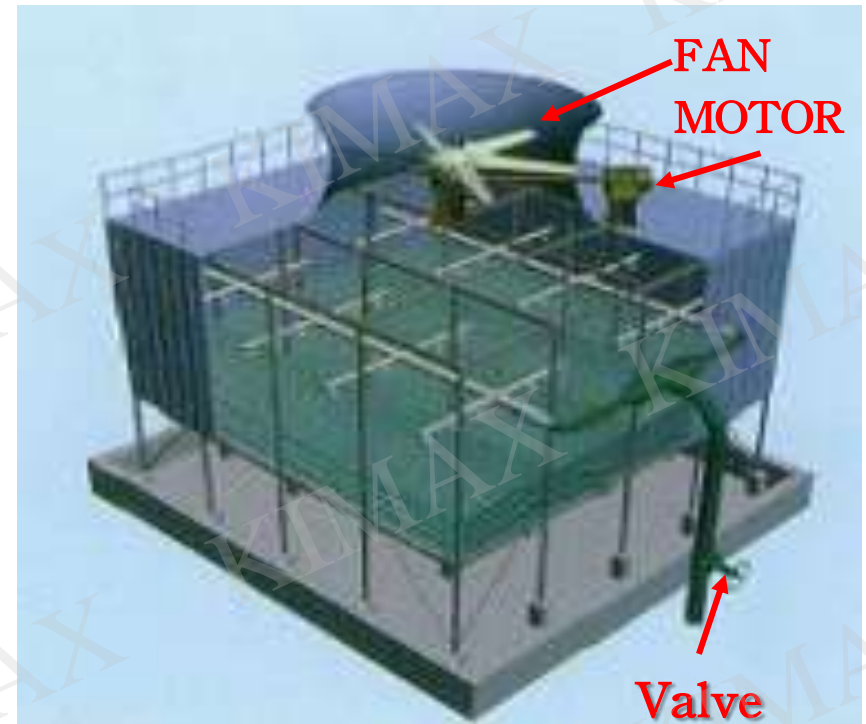


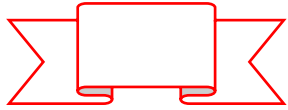
Name	Pump station No.	Outlet pressure/elevation	Main pipe pressure/elevation
Synthetic ammonia	PA-1#	0.49MPa/-0.62m	0.36MPa/1m
	PB-2#	0.50MPa/-0.62m	
	PC-3#	/	
Methanol	PA-1#	0.56MPa/-0.59m	0.38MPa/1m
	PB-2#	0.55MPa/-0.59m	
	PC-3#	/	



## □ The small opening of the backwater valve causes a large hydraulic loss

- The design purpose of the backwater valve is to distribute the flow of each tower or to overhaul.
- In production, it is mostly used to increase the back pressure, reduce the rich water energy of the system design, adjust and limit the system flow, and there is a large pressure difference before and after the upper tower valve.
- The pressure lost at the upper tower valve can be recycled and used to generate electricity or drive fans.





❑ The hydraulic energy stored in the return valve

- Recoverable surplus pressure : Height of cooling tower water distributor=10m; System back pressure =30m; When reserve 2m margin, estimate the recoverable residual pressure of the system.

$$H=30m-10m-3m=17m$$

- Hydraulic energy : Average flow rate of single branch=8500m<sup>3</sup>/h; The energy contained in a single branch pipe=394kW; The total hydraulic capacity of the 5 branch pipes is about 1970kW.

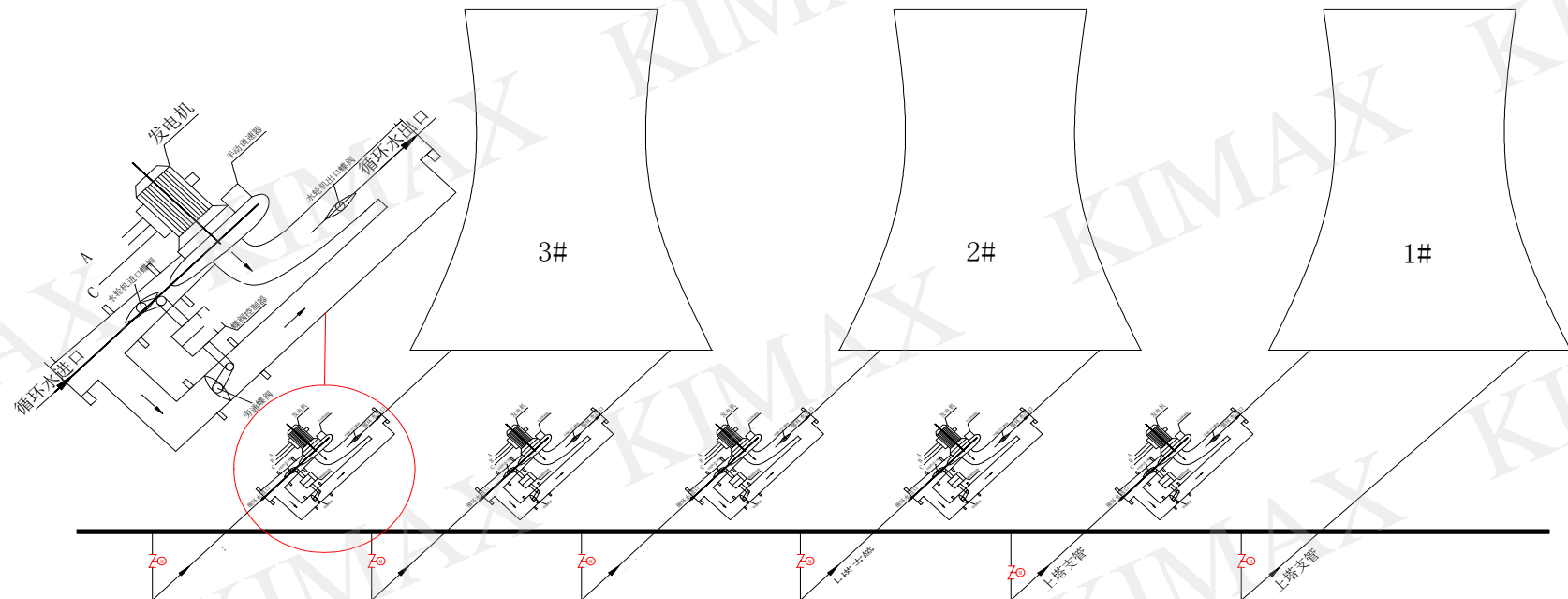
$$P = 9.81Q \cdot H_{Residual} = 9.81 \times 8500/3600 \times 17 = 394kW$$

Tower No.	Branch	Height	Upper tower valve opening	Main pressure before valve MPa/Height m
1#	1#-1	10m	10°	0.286/2.5
	1#-2		10°	0.288/2.5
2#	2#-1		10°	0.287/2.7
	2#-2		15°	/
3#	3#-1		30°	0.276/2.7
	3#-2		Disable	/

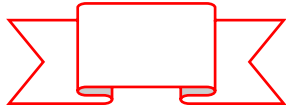


## □ Determine the installation plan for residual pressure power generation

- According to the combined operation of the summer and winter pumping stations of the circulating water system and the on-site environmental conditions of the cooling water tower, determine the surplus pressure parameters of the upper tower branch pipe and the basic water energy parameters, select the installation plan to determine the installed capacity and turbine model, and the efficiency is up to 85%. The output power of the generator is incorporated into the plant power system for direct consumption.

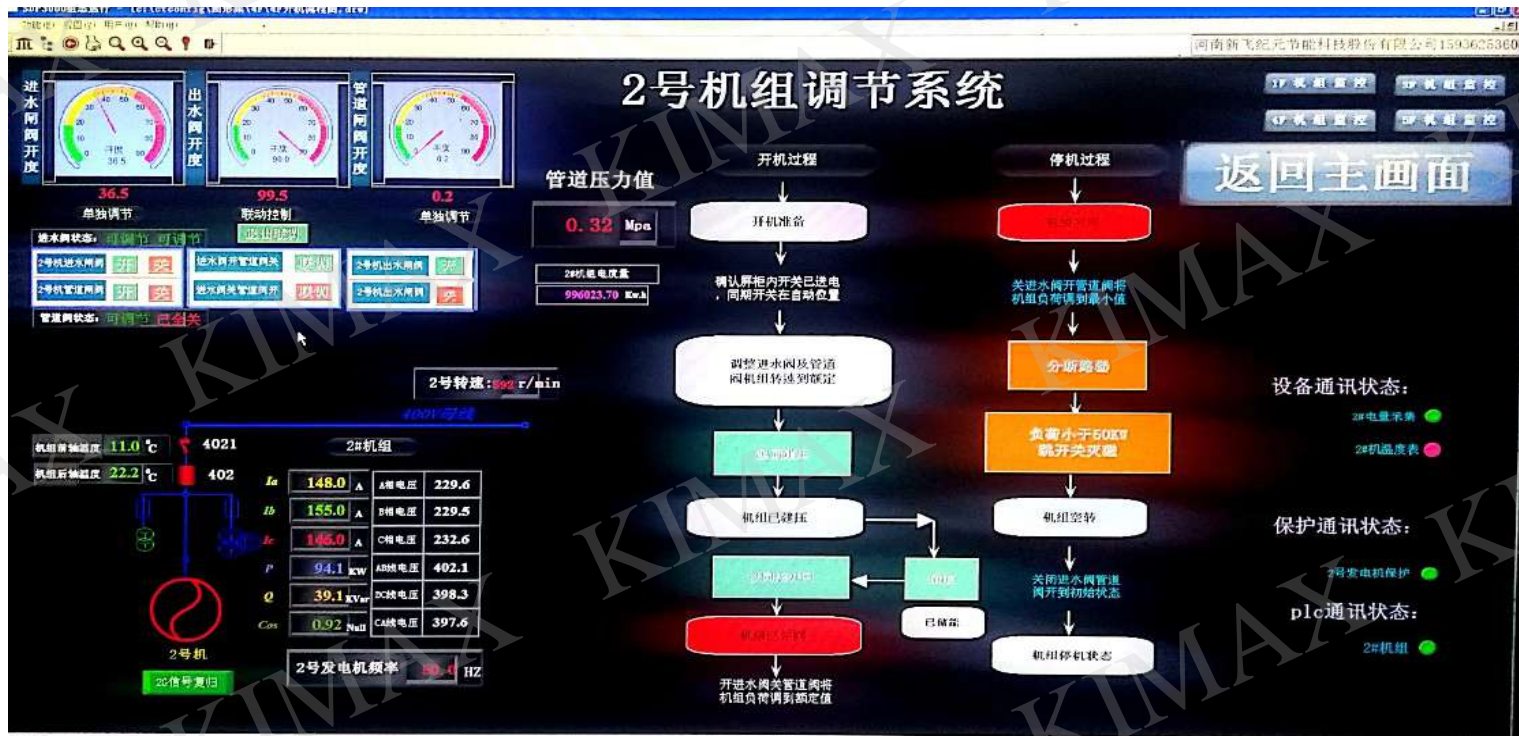


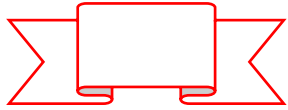




## Benefits of surplus pressure power generation

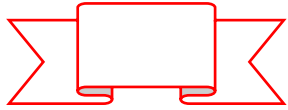
- The total investment yield is about 50%, and the static investment payback period is about 2 years;
- Improve system automation level, reduce labor intensity, and be safe and reliable;
- Realize the value of carbon emission reduction and other 300gce / kWh, with good social and economic benefits.





## □ Mature technology and wide application

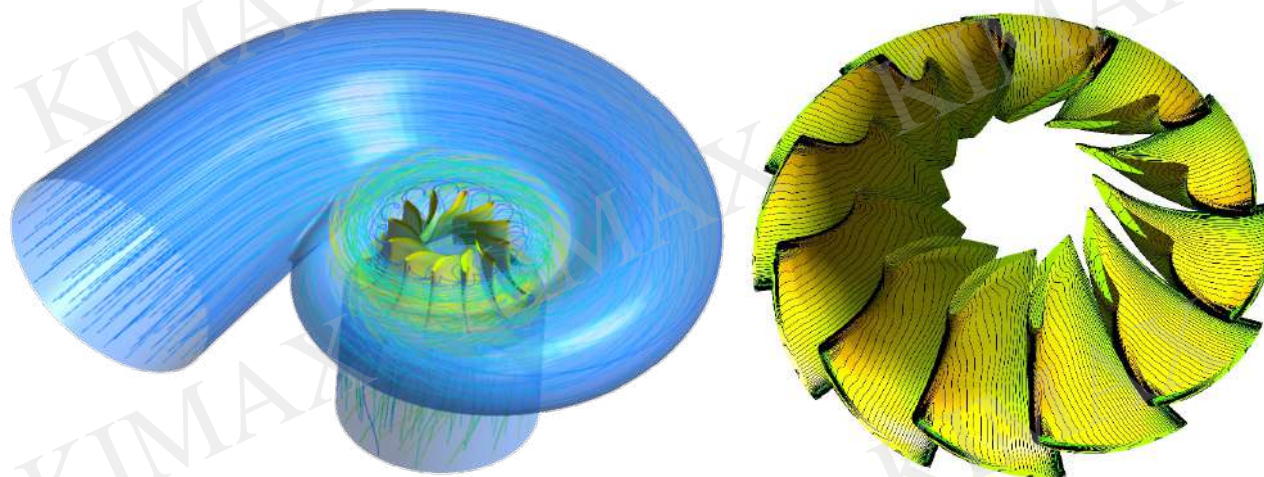
No.	Corporation	Qty (set)	Power	Operating time
1	Anhua Group of Henan Energy and Chemical Group	7	250 kW	2016.9
2	Xuzhou Tengda Coking Methanol Branch Factory	2	100 kW	2015.9
3	Oriental Hope Aluminum Co., Ltd.	10	30~50 kW	2012.6
4	Xuzhou Weitian Chemical Co., Ltd.	2	125 kW	2017.1
5	Xinxiang Zhongxin Chemical Co., Ltd.	5	200 kW	2018.10
6	Henan Kaixiang Fine Chemical Co., Ltd.	6	160 kW	2019.6
7	Yima Coal Industry Comprehensive Energy New Energy Co., Ltd.	6	160 kW	2019.5

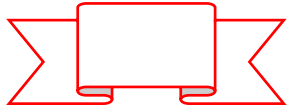


## ❑ Customized design of surplus pressure power generation equipment

### ➤ Customized design of impeller based on CAD-CFD

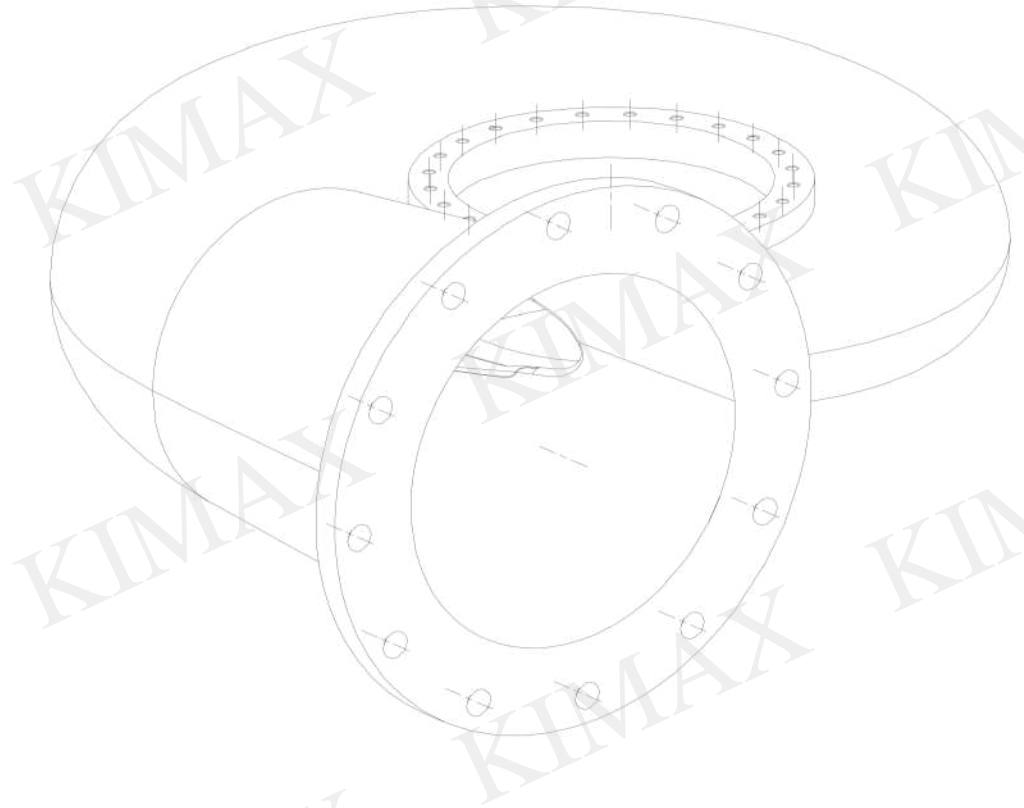
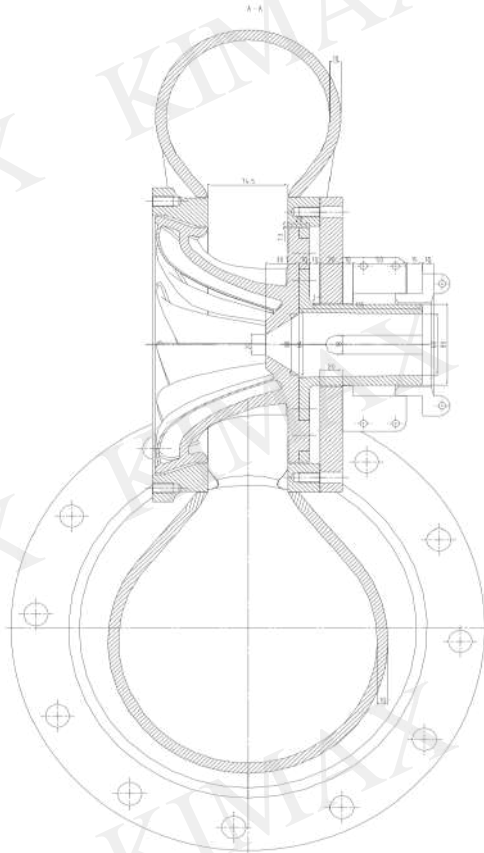
The hydraulic recovery turbine impeller is re-optimized and designed on the basis of the high-efficiency hydraulic turbine impeller, and comprehensively considers the installation angle, wrap angle, number of blades, inlet height and other parameters to optimally match the equipment performance with the system requirements. The hydraulic recovery turbine is different from the backflush pump, the unit has a high efficiency, up to 85%.



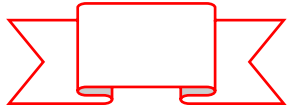


## ▣ Customized design of surplus pressure power generation equipment

### ➤ Structural design







## Wide flow coverage

Model No.	Head(m)	Flow(m <sup>3</sup> /h)	Power(kW)	Speed(rpm)	Diameter(m)
XFHL100	4-18	800-1500	10-43	500-3000	0.23-0.33
XFHL150	5-23	1500-2000	20-85	500-3000	0.26-0.38
XFHL200	6-28	2000-3000	35-150	500-3000	0.29-0.42
XFHL300	8-37	3000-4000	60-269	500-3000	0.33-0.48
XFHL400	10-44	4000-5000	100-430	500-3000	0.36-0.52

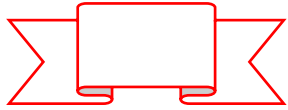
Head: The fluid pressure of the pipeline used to drive the generator.(Pressure into turbine)

Flow: Flow into turbine.

Power: The amount of electricity generated.

Speed: turbine speed

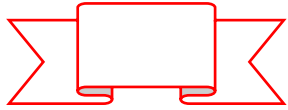
Diameter: ID of turbine's blade.



## Features of surplus pressure power generation equipment

- “Two Fulcrums” complete arrangement
  - It adopts advanced two-point fulcrum arrangement, short axial dimension and simple structure.
  - Highly integrated, integrated equipment for generating sets, electrical primary circuits, and control equipment. Users only need to connect the equipment to the pipeline, which greatly improves work efficiency.
  - The turbine and the motor share the shaft, easy to install, no need to adjust the shaft for later maintenance/installation, and simple to disassemble/install.





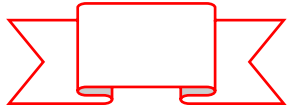
## Features of surplus pressure power generation equipment

### ➤ Intelligent integration of control system

- Integrate the excitation system (synchronous equipment), synchronization grid-connected system, speed control system, and safety protection system into an integrated device;
- Misoperation fault-tolerant control strategy, uses pulse signal to switch valves intermittently with small opening, and the inlet valve and bypass valve are logically related to prevent accidents caused by misoperation.
- High degree of automation, unattended operation of the unit, simple on/off, and remote control system can be completed.







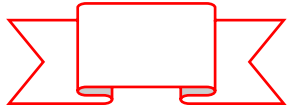
## Features of surplus pressure power generation equipment

### Intelligent integration of control system

- The function of remotely transmitting operating data can be monitored remotely by logging in with a mobile phone.
- Intelligent fault diagnosis, maintenance information reminder.







## **□ Features of surplus pressure power generation equipment**

### **➤ Customization, stable and efficient**

- According to the system requirements, the maximum efficiency reaches 85%.
- The non-moving guide vane can be customized, the hydraulic model is simple, and the reliability is higher. Compared with the traditional unit of the same capacity, the hydraulic efficiency is high, and it is especially suitable for small-capacity systems.

### **➤ Asynchronous power generation, price advantage**

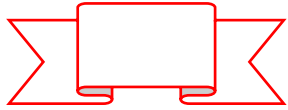
- Optional non-synchronous power generation system, no brushes and slip rings, non-synchronous synchronization, simple control, low failure rate, and low overall price compared to synchronous generator sets.

### **➤ Economical and efficient, high comprehensive income**

- One-time input, no consumption in operation, and high overall benefit of reducing carbon emissions;

### **➤ Safety redundancy, high reliability**

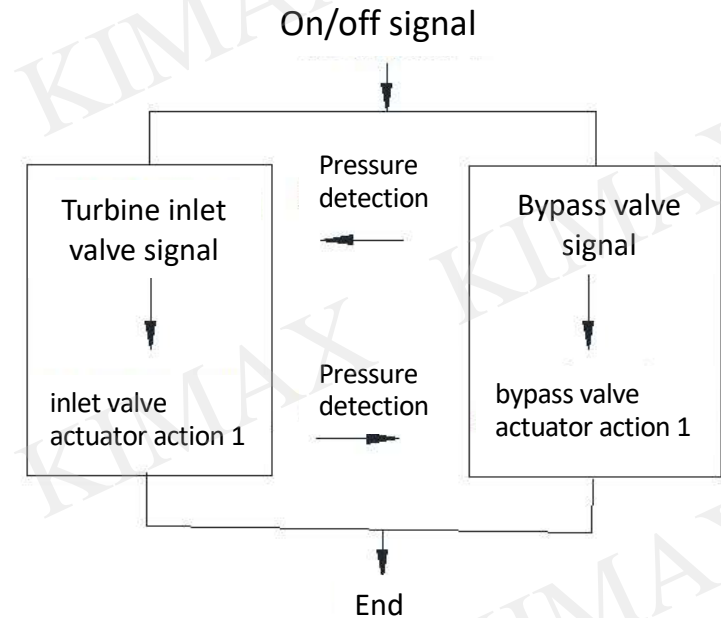
- Set up multiple protection measures for circulating water system, machinery and electricity.

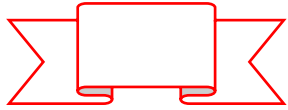


## □ Protection System

➤ Ensuring the normal and stable work of circulating water is the first priority

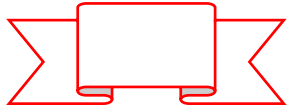
- Ensure that the circulating water is not interrupted abnormally under any circumstances.
- During the start-up process, the gradual opening of power generation circuit valve and the gradual closing of the bypass circuit are performed simultaneously by a joint control method;
- When the unit is shut down, the logic method is to open the bypass valve and then close the turbine guide vanes.
- Does not reduce the reserve hydraulic energy of the system, and does not affect the original pressure and flow of the system.





## □ Protection System

- Control and protection of circulating water power generation device
  - ◦ The control and protection of circulating water power generation devices include generator protection, hydraulic turbine protection, and reverse power protection (to prevent the generator from operating as a motor).
  - The fault-tolerant strategy of valve misoperation, one step at a time, a smaller angle, multiple operations and confirmations, to prevent accidents caused by misoperation.
  - The fault/emergency shutdown control system is automatically completed, and the circulating water is always kept unblocked.
  - Use dual power supplies as hot standby for each other, automatic switchover in failure, high reliability.



## □ Protection System

### ➤ Unit mechanical and electrical protection

- Generator protection: In order to ensure the safety of the unit, overvoltage, undervoltage, overload, and overcurrent protection are set up for the generator, and it will stop automatically when it fails.
- Circulating water protection: In order to ensure the unblocked circulation of the circulating water, the bypass valve is automatically opened when the unit load condition is suddenly disconnected from the grid through interlocking.
- Generator negative power protection: In order to prevent the water turbine output from being reduced to below no-load conditions due to the reduction in the water volume of the circulating water system, cause the generator to change to the motor operation and absorb the system's active power problem. This system is specially designed to reversible power protection device, set the action node on the smart watt-hour meter, when the power meter reverses, drive the trip coil to disconnect the unit from the system.