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## WATER TREATMENT TECHNOLOGIES & PRODUCTS

SUNRUI MARINE ENVIRONMENT ENGINEERING CO.,LTD





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Sunrui Marine Environment Engineering Co., Ltd is a subsidiary of China Shipbuilding Industry Company Limited. The company headquarter is located in Qingdao, with the branch in Shanghai and the offices in Tokyo and Singapore. It is a professional high-tech engineering company which engaged in the research and development, design, manufacture, engineering and project contacting of corrosion control and water treatment technologies.

It has many years of experience of research and achievements popularization of anticorrosion and water treatment field. It has set up more than 40 state and military standards on corrosion control, anti-fouling and marine coating. The products of the company have been granted the certifications of DNV, CCS, LR, BV, NK, ABS and AMS of USCG. It has been granted highest contracting certification of conformity of quality, environment and occupational health and safety system certification management.

It has mainly engaged in research and design of cathodic protection, chlorine electrolysis, ballast water treatment, seawater desalination, electrolytic anti-fouling of ship and offshore platforms, sewage treatment, coating protection technology and the production of construction test and engineering procurement construction (EPC).

The products of Sunrui are applied to protect ships and submarine lines, transportation, storage and transportation pipelines, electric power, petrochemical, municipal, environmental protection and other industries. It has undertaken national infrastructure projects. The products are exported to more than thirty countries and regions.



Sunrui industrial park



**Qualification & Honor**



Certification of safety production



Highest contracting certificate in anti-corrosion area



High tech enterprise certification



Key high-tech enterprise of national torch program



The supplier certificate of Chinese petroleum and natural gas group



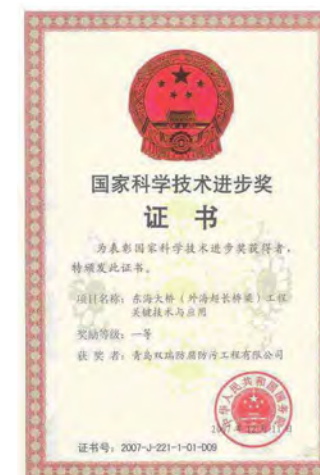
A member unit of China Water Enterprises Association Desalting Branch



The supplier certificate of Datang International Power Generation Co., Ltd



A member unit of CGNPC nuclear power equipment domestic joint research and development center



The 1th prize of national technology progress



Work safety standardization two grade enterprise of Shandong province



AAA credit rating enterprise of Shandong province



Management system certification of quality, environment, occupational health and safety



Observing contracts and keeping promise enterprise of Shandong province



A-class tax credit rating enterprise of Qingdao



## Chlorine Electrolysis Industry

Sunrui is the earliest and largest enterprise which has been engaged in research and development of electrolytic chlorine industry for 30 years. It has strong financial strength and technical reserves to be the only enterprise in domestic which has electrolysis chlorine project running performance for nuclear power system at present. The company has kept 90 percent share of nuclear power stations anti-fouling market and 70 percent share of thermal power station anti-fouling market.



### Formation and Development

Sunrui began to research chlorine electrolysis technology and design antifouling equipment in 1980s. The chlorine electrolysis system was applied as the antifouling equipment of ships in 1988 which is the first example in domestic. In 1992, Sunrui used chlorine electrolysis system in the electric power industry in the first place. After quick development of many years, Sunrui has reached the international first-class level in the field of chlorine electrolysis (sodium hypochlorite generator) technology and equipment manufacture and get approval and praise by the vast number of customers.



Processing workshop

### Industrialization construction

In order to further improve and promote the technical level and international status of Chinese chlorine electrolysis industry, the National Development and Reform Commission had approval of the joint construction project of "The high-tech industrialization demonstration project of sodium hypochlorite technology by electrolysis seawater" by Sunrui and local government on September 9, 2005.

Through construction of the project, Sunrui has further improved and enhanced the industrial and large-scale level of chlorine electrolysis industry since it has built chlorine electrolysis industry base, including assembly workshop, electrolytic cell workshop, electrode workshop, office and living areas and so on.

## Chlorine Electrolysis Industry



Assembly workshop

### R & D Strength

Sunrui has depended on State Key Laboratory for Marine Corrosion and Protection with its four marine experiment stations of Qingdao, Xiamen, Sanya and Deep-sea to do experiments and research. Sunrui has set up research and development department in charge of developing new products, new technologies and achievements. Sunrui has independent intellectual property rights of major technologies and products to promote the development of chlorine electrolysis industry with providing technology reserve and support.

### Production Capacity

Sunrui has modern workshops of 26000 square meters of, highly qualified and skilled workers, advanced production technology, dozens of producing and testing equipment, standardized management system and first-class testing conditions. Because of using the method of "production and inspection", Sunrui could improve the acceptability of products and provide guarantee for the quality of products. The annual production capacity of electrolytic chlorine system is 8000KG/H chlorine.



## Chlorine Electrolysis Technology

Compared with liquid chlorine and sodium hypochlorite products on the market, the directly generating fresh and highly active sodium hypochlorite technology by electrolyzing seawater or brine without diaphragm not only has the advantages of low running cost and more efficient chlorine sterilization capacity, but also avoid the second pollution to the environment and the shortcoming of tending to hurt operators in the procedure of shipping, storage and application. At present, with the environment protection awareness of citizens becoming more and more strengthened, the technology of chlorine electrolysis has been more and more popular quickly and extensively.

Sunrui has been engaged in research and development of electrolytic chlorine Industry for 30 years. It has established national standards such as “The Design and Installation of Ship Anti-fouling Equipment of Electrolyzing Seawater” and “The Technology of Sodium Hypochlorite Generator of Electrolyzing Seawater”. Electrolytic chlorine technology and products of Sunrui has been exported more than 10 countries and regions such as India, Malaysia, Indonesia, Turkey, and Sudan.

Sunrui has successively undertaken electrolytic chlorine engineering dozens of nuclear power stations such as Ling’ao nuclear power plant, Tianwan nuclear power plant, and Hongyanhe nuclear power plant, and hundreds of thermal power station, chemical plants, ships, offshore platforms and LNG. In almost two years, Sunrui actively explores the international markets, and has got several important electrolytic chlorine projects from BV, Alstom and other international well-known contracting company.



The largest electrolysis chlorine project of Sunrui –Hongyanhe nuclear power plant

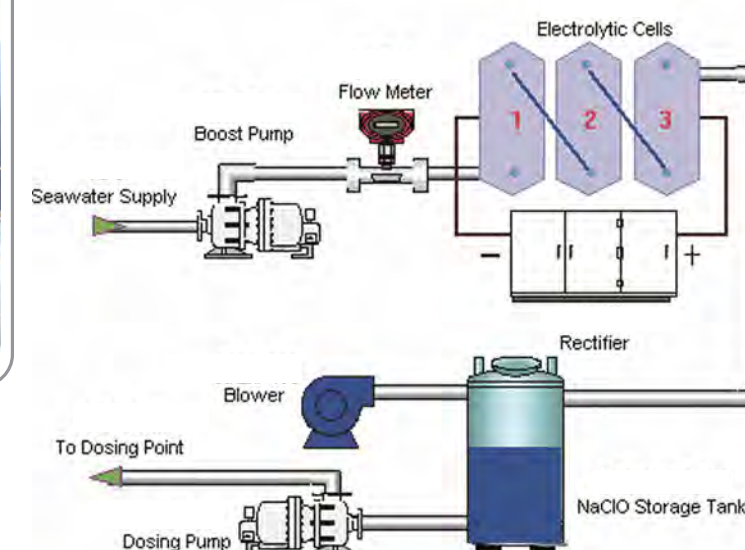


The electrolysis chlorine project of Lingdong nuclear power plant

## Chlorine Electrolysis Industry



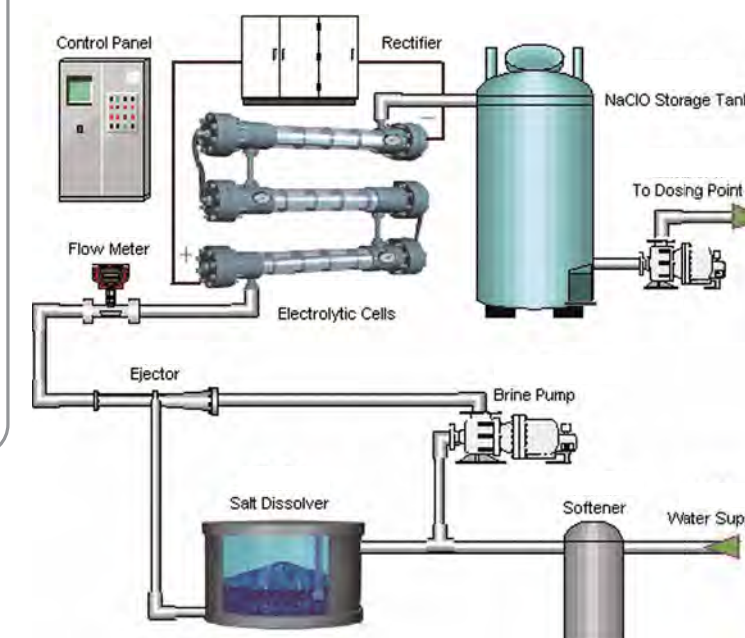
Electrolytic cells of electrolysis seawater system



Flow diagram of electrolysis seawater system



Electrolytic cells of electrolysis brine system



Flow diagram of electrolysis brine system



## Technology Characteristics

### Optimization Design

- One time electrolysis process, this can lower the complexity and investment of circling electrolytic equipment
- Product serialization, this can satisfy the various productions requirement of chlorine for customers
- Modularization design of the equipment, this can lower the workload of installation and maintenance for customers

### High efficiency and Energy saving

- DSA anode is a kind of anodes applied in 95% of the chlorination in the world
- Special structure of electrolytic cell, this is convenient for customers to manage
- Hastelloy alloy cathode, this is hard to get embrittlement and can save power in comparison with Ti alloy cathode

### High Safety and Reliability

- No chlorine gas leaking
- PLC control, no staff on duty
- Various safe structures of hydrogen removal

### Service

- Design and planning of electrolytic chlorine system
- Manufacturing and marketing of electrolytic chlorine system
- Installation and commissioning of electrolytic chlorine system
- Technical training, guidance and service

### Quality Assurance

- DSA anode, which has a continuously running life of over 5 years
- Hastelloy alloy cathode, which has a life assurance of over 40 years
- Stable electricity controller with special design

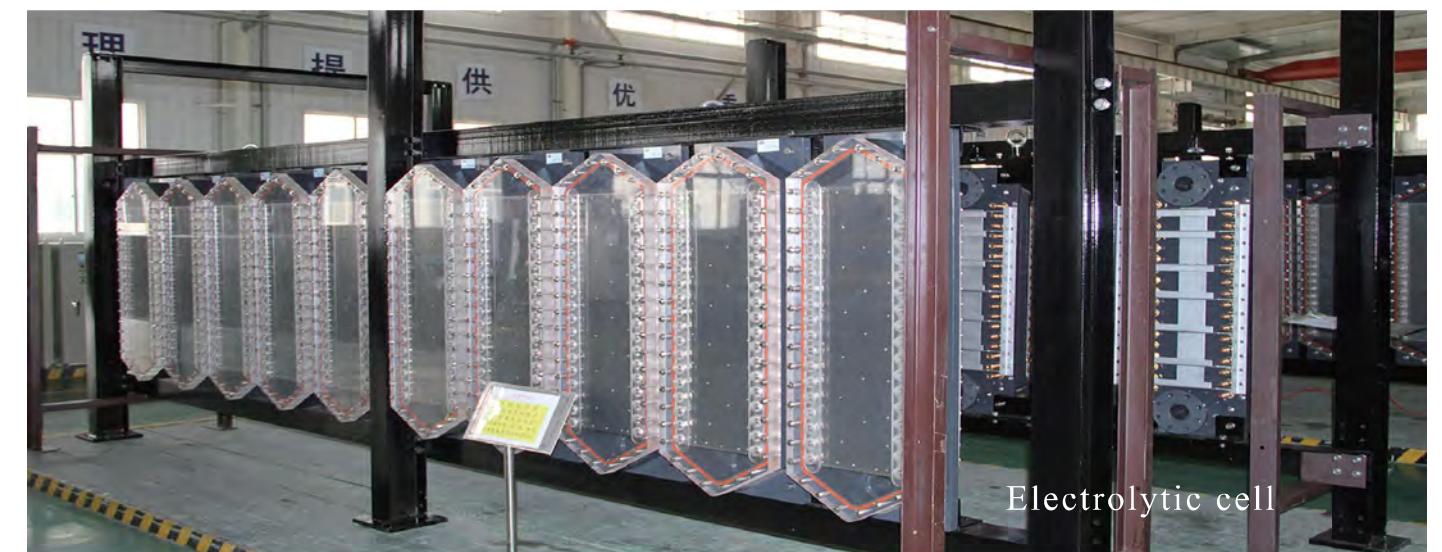
### Application

- Cooling water treatment
  - Nuclear power plant
  - Thermal power plant
  - Petrochemical enterprise
  - Chemical enterprise
  - Ship
  - Offshore Installation
  - Air Conditioning system
- Swimming Pool Sterilization
- Living Sewage Treatment
- Drinking Water Disposal
- Bleaching and Dyeing Wastewater Treatment
- Wastewater Treatment
- Killing the Virus in Recycle-water of Oil Field
- Hospital Sewage Treatment
- Food Industry Sterilization
- Industrial wastewater treatment

Sunrui has full abilities of designing, producing, assembling and commissioning in electrolysis chlorine system. According to customers' requirements and actual conditions, it can provide the systems of active chlorine production with 0.1kg/h ~ 1000kg/h by electrolysis sea water or electrolysis brine.

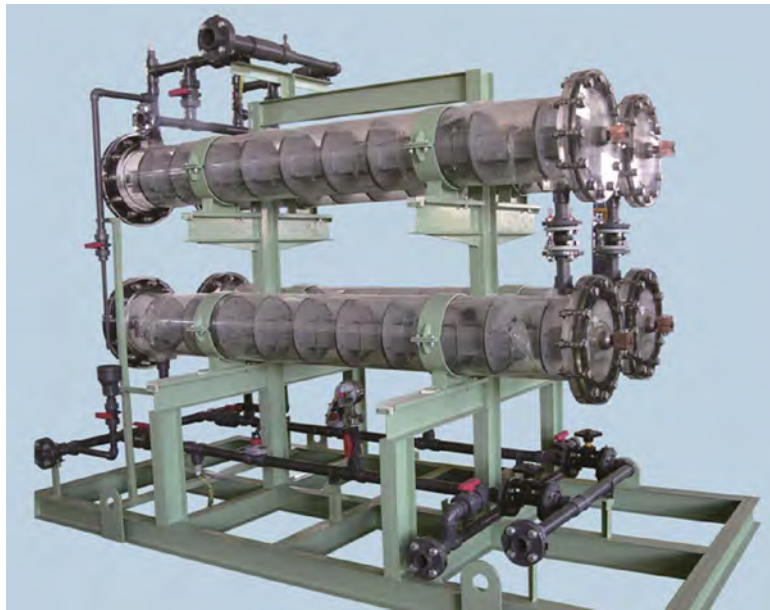
### Main equipment

- Machinery equipment
- Operating device
- Electrical equipment
- Electrolytic cell





Types and parameters of electrolytic cell



Tubular brine electrolyzer



Tubular seawater electrolyzer



Mesh seawater electrolyzer

Table1 Typical mesh brine electrolyzers

SRSP	Model	Electrolyzer assembly	Production of chlorine kg/h	Flux of NaCl solution L/h	Salt consumed kg / h	Power consumed KWh	Concentration of sodium hypochlorite ppm
1	SRBN-12	1*12	0.5	59	1.75	2.25	8000
2	SRBN-24	1*24	1	117	3.5	4.5	8000
3	SRBN-48	2*24	2	234	7	9	8000
4	SRBN-60	1*60	2.5	293	8.75	11.25	8000
5	SRBN-120	2*60	5	585	17.5	22.5	8000

Table2 Typical plate brine electrolyzers

SRSP	Model	Electrolyzer assembly	Production of chlorine kg/h	Flux of NaCl solution L/h	Salt consumed kg / h	Power consumed KWh	Concentration of sodium hypochlorite ppm
1	SRBT-120	1*120	5	585	17.5	22.5	8000
2	SRBT-180	1*180	8	940	28	36	8000
3	SRBT-240	1*240	10	1170	35	45	8000
4	SRBT-360	2*180	16	1870	56	72	8000
5	SRBT-480	2*240	20	2340	70	90	8000
6	SRBT-720	360+360	32	3740	112	144	8000
7	SRBT-960	480+480	40	4680	140	180	8000
8	SRBT-1200	600+600	50	5850	175	225	8000

Table3 Typical tubular brine electrolyzers

SRSP	Model	Electrolyzer assembly	Production of chlorine kg/h	Flux of NaCl solution L/h	Salt consumed kg / h	Power consumed KWh	Concentration of sodium hypochlorite ppm
1	SRT—6	1*6	120	16	0.48	0.6	7000~8000
2	SRT—12	2*6	240	32	0.96	1.2	7000~8000
3	SRT-24	3*6	360	48	1.44	7.2	7000~8000

Table4 Typical mesh seawater electrolyzers

Electrolyzer model design capacity	Six-cell					Three-cell			One-Cell				
	SRSM-30/6	SRSM-60/6	SRSM-120/6	SRSM-240/6	SRSM-320/6	SRSM-300/3	SRSM-360/3	SRSM-75/1	SRSM-150/1	SRSM-300/1	SRSM-330/1	SRSM-400/1	SRSM-
Available CL <sub>2</sub> production (kg/h)	0.57	1.13	2.27	4.54	6.05	5.67	6.80	1.42	2.84	5.67	6.24	7.56	
H <sub>2</sub> production (m <sup>3</sup> /h)	0.2	0.4	0.7	1.4	1.9	1.8	2.1	0.4	0.9	1.8	2.0	2.4	
Sodium hypochlorite concentration(ppm)	60	120	170	170	180	210	200	160	210	210	230	220	
Amperage (A)	100	185	365	730	960	1800	2160	1375	2750	5500	6050	7200	
Volts(V)	27	27	27	27	27	13.5	13.5	4.5	4.5	4.5	4.5	4.5	
Dimensions Length(mm)	1270	1270	1270	1270	1270	1270	1270	1270	1270	1270	1270	1270	
Width (mm)	403	403	403	403	403	403	403	403	403	403	403	403	
Height (mm)	203	204	217	248	219	248	219	204	218	255	255	270	
Dry weight (kg)	81	81	86	115	128	119	128	81	86	115	119	128	
Operating Weight(kg)	88	88	100	132	151	138	151	88	100	132	138	151	
Volume (l)	3.5	3.5	6.1	10.9	14.4	12.1	14.4	3.5	6.1	10.9	12.1	14.4	
Temperature increase ( C )	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Electrolytic tank pressure (Mpa)	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	
Max operating pressure(Pa)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
Seawater flowrate (m <sup>3</sup> /h)	9	9	14	27	34	27	34	9	14	27	27	34	

Chlorine Electrolysis Industry

Table5 Typical plate seawater electrolyzers

SRSP-	Seawater condition 5℃ < T < 10℃ TDS30—36g/l		Seawater condition 10℃ < T < 15℃ TDS36—40g/l		Seawater condition 15℃ < T < 34℃ TDS38—48g/l		Concentration of sodium hypochlorite	
	Production of chlorine kg/h		Production of chlorine kg/h		Production of chlorine kg/h		ppm	
Model	Min	Max	Min	Max	Min	Max	Min	Max
3H4050	2	4	5	7	8	11	500	750
4H4050	3	6	6	10	11	14	500	1000
3H6050	3	6	7	11	12	16	500	1000
4H6050	4	8	10	14	16	22	1000	1500
3H8100	8	17	19	29	32	43	1000	1500
3HX100	10	21	24	36	40	54	1500	2000
3H8150	12	25	29	43	49	65	1500	2000
3HX150	15	31	36	54	61	81	1500	2000
3HX200	21	41	48	71	81	108	1500	2000
4HX200	28	55	64	95	108	14	1500	2000
4HX250			79	119	135	180	1500	2000
4HX320			102	152	173	230	1500	2000
4HX375			119	179	202	270	1500	2000
3VX650					263	351	1500	2000
4VX650					351	468	1500	2000
3VX875					354	472	1500	2000
4VX875					472	630	1500	2000
4VX1300					702	936	1500	2000

Table6 Type I & Type II tubular seawater electrolyzers

Model	Production of chlorine kg/h	Flux of seawater m <sup>3</sup> /h	Electrolysis current A	Electrolysis volt V	Power KW	Production of hydrogen SCFM
SRST—45	0.19-0.45	5.68	200	14	6	0.08
SRST—90	0.47-0.91	5.68	200	28	12	0.17
SRST—135	0.93-1.36	5.68	200	42	17	0.26
SRST—180	1.38-1.81	5.68	200	56	23	0.34
SRST—225	1.83-2.29	5.68	200	70	29	0.42
SRST—250	2.29-2.72	5.68	200	80	34	0.52
SRST— II	0.45	5.7—6.0	200	9	Total length: 1400mm	



## Engineering Examples



For Daya Bay nuclear power station



For Lingdong nuclear power station



For Fuqing nuclear power station

### Engineering Achievements for Nuclear Power Station

The market share of Sunrui is up to 90% in the field of electrolysis chlorine for nuclear power station. It is the only domestic manufacturers with operation performance of electrolysis seawater chlorine project in nuclear power station. The company has reliable products, mature technology, and could meet the demanding requirements of nuclear power equipment with providing well security.



For Tianwan nuclear power station

### Performance of major projects

The main nuclear power stations using Sunrui equipment are Ling'ao, Dayawan, Tianwan (1th and 2th phase), Lingdong, Hongyanhe, Yangjiang (1th and 3th phase), Ningde, Shidaowan, Fuqing (1th and 2th phase), Haiyang, Sanmen, Changjiang and so on.

### Engineering Achievements for Thermal Power Station Inland

The electrolysis chlorine technology and products of Sunrui are widely used in the thermal power field, with up to 70% market share.

### Performance of major projects

#### *Projects of 600MW and above power plant*

Fujian Ningde, Guangxi qinzhou, Qingdao huangdao, Ningbo beilun, Zheneng Yueqing, Huangneng Rizhao, Guangxi Fangcheng, Shangdong Penglai, Huangneng Haikou, Fujian Hongshan, Datang Wushashan, Hainan Dongfang, Fujian Nanpu 2th, Fujian Jiangyin, Zhejiang Liuheng etc.

#### *Projects of below 600MW power plant*

Shandong Rizhao, Beihai power plant, Huaneng Dalian, Huaneng Yingkou, Fujian Nanpu, Nanshan Group, Donghai thermo electricity, Dagushan power plant, Huaneng Weihai, Zhanjiang power plant etc.

## Chlorine Electrolysis Industry

For Fujian Hongshan 2th power plant



For Zhejiang Liuheng power plant



For Fujian Nanpu power plant



For Dalian Huaneng power plant





## Engineering Examples

### Engineering Achievements for Thermal Power Station Abroad

Sunrui has independently undertaken large-scale capability and rich experience of carrying out and managing foreign electrolysis chlorine engineering.



Power plant project in Philippines Marie Vance



For Zhongli Linhuan Power station in Huaibei

### Engineering Achievements for Thermal power station (electrolysis brine)

Sunrui has undertaken more than 40 electrolytic brine projects to produce sodium hypochlorite in thermal power field. The company has abilities to supply total sets of electrolysis brine equipment and has engineering experience of project management. It can provide effective protection to the circulating water system of thermal power plants which are long away from marine.

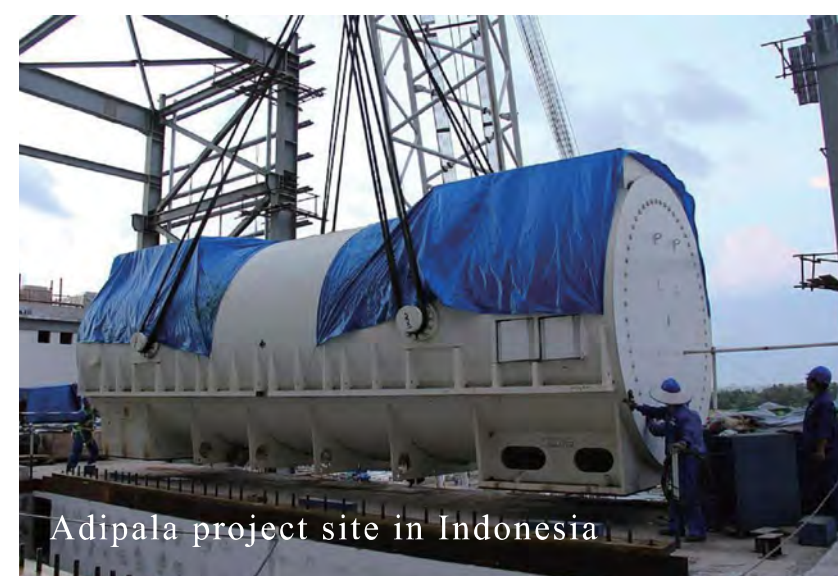
### Performance of major projects

#### Projects of 1000MW and above power plant

Turkey EREN, Turkey AYAS, Turkey BEKIRLI, Indian APL fourth period, Indonesia Adipala, India Cuddalore, Malaysia Manjung etc.

#### Projects of below 1000MW and above power plant

Java, Labuk Bay, Ba Qi Dan, Longwan, Away, Indramayu, Fenggang, East Kalimantan and Bali Island in Indonesia. Sri Lanka power station, Turkey BIGA, Turkey steel works, Pakistan bin Jia Sheng, Sihanouk, Philippines Maliwansi power station etc.



Adipala project site in Indonesia



For Datang Power in Luoyang

### Performance of major projects

The main power stations are Huarun, Datang Luoyang, Henan Xinli, India Jharsugudat, Huaibei Linhuan Zhongli Corporation, India WPCPL, India Jhajar power plant, Iraq Fahrenheit de, Indonesia West Kalimantan, Laos red sand plant etc. Other oil production plant projects are Zhongyuan oil field, Shengli oil field etc.



Malaysia MANJUNG project



BIGA power plant project in Turkey



For WPCPL power station in India



For Jhajar power station in India



## Engineering Examples



Electrolysis chlorine project for Dalian Yisheng

## Engineering Achievements for Ocean Engineering and Petrochemical Industry

Sunrui has actively explored the electrolytic antifouling marine engineering and petroleum chemical industry. Seizing the increase investment opportunities of the country in LNG, offshore oil and gas and other new energy industry, the company has won all the six projects of LNG and CNOOC marine engineering projects. Sunrui has opened up new market in electrolysis chlorine industry.

## Performance of major projects

The projects in petrochemical field are Dalian Yisheng, Hainan yisheng, Xiamen Xianglu and Dalian Hengli and so on. The projects in LNG field are Qingdao LNG of Sinopec, Jiangsu LNG of Petro China, Tangshan LNG and Zhuhai LNG of CNOOC and so on. The projects in offshore platform field are BZ34-1 , PY30-1, PY34-1, LF7-2, Lishui 36-1, Yuedong offshore platform etc.



Electrolysis chlorine project for Qingdao LNG of Sinopec



Electrolysis chlorine project for Zhuhai



Electrolysis chlorine project for Xianglu



## Sewage Treatment Technology

### Introduction of the technology and products

Electrolytic sewage treatment equipment of Sunrui is the second in the world, and the first in China, which uses electrolytic technology to purify sewage of ships and offshore platforms. The company has been committed to research and develop the new generation of electrolytic sewage treatment equipment after IMO new standard of sewage treatment implementation. The prototype has gained type approval of China classification society (CCS) on January 11, 2013.

The electrolytic sewage treatment equipment is officially approved to be applied in ship and on offshore platforms. Recently this technology and products has sufficient conditions for industrialization. The company has won the sewage treatment project contract of Oriental 1-1 gas field which belongs to CNOOC (China) Co., Ltd. This marks that the new generation products of electrolytic sewage treatment equipment of Sunrui officially have been put into market.

#### Application

- Ship
- Offshore platform
- FPSO ship
- Ocean vessel
- Seashore facility

#### Service

- Design and manufacture of electrolytic sewage treatment equipment
- Installation and commissioning of electrolytic sewage treatment equipment
- Technical training, guidance and service



The new generation sewage treatment equipment of Sunrui



Sewage treatment project for the 1th phase of Oriental 1-1 gas field

## Electrolytic Anti-fouling Technology



### Introduction of the technology and products

Sunrui have mainly used the technology of electrolytic chlorine, electrolytic Cu-Al anodes, and combining the both for antifouling and anticorrosion. The latter was originated by Sunrui. This combining technology utilizes the available chlorine produced by DSA anodes to form a coordinating effect with  $\text{Cu}_2\text{O}$  and  $\text{Al}(\text{OH})_3$ , which can control the adhesion and growth of marine life more effectively. The corresponding equipment has no pollution to the environment and the antifouling performance of it is remarkable. So it has been applied extensively in fields of ships and offshore platforms.

#### Application

- Ship
- Ocean vessel
- Naval ship
- FPSO ship
- Offshore platform

#### Antifouling Products

- Cu, Al, Cu-Al anodes of various specifications
- Anodes of various specifications
- Cl-Cu-Al antifouling equipment
- Electrolytic seawater chlorine antifouling equipment
- Other antifouling equipment in accordance with customer's requirements and different engineering conditions.



## Seawater Desalination Industry Introduction



The first seawater desalination project of Sunrui is for Indonesia Awar-awar power station

Sunrui is a consulting firm specializing in designing and engineering contracting of seawater desalination projects, mostly using the reverse osmosis (RO) treatment technology. It has obtained two projects, one of which is signed a contract in 2008 for Indonesia Awar-awar power plant, and the other for China Sanmen nuclear power station in 2011.

Seawater desalination is desalting the seawater and turning it to freshwater, for industrial consumption and potable water. Nowadays, the main technologies of seawater desalination are distillation, refrigeration and (RO). Sunrui has mainly used the RO technology before and is developing the multi-effect distillation (MED) technology and products to expand the industry field.

### Application

- Circulating water treatment of coastal power plants
- Seawater desalination to produce industrial water
- Seawater desalination to produce residential water

### Service

- Independent design and manufacture of seawater desalination equipment
- Providing seawater desalination solutions for customers and undertaking seawater desalination engineering
- Design, installation and engineering services of seawater desalination project
- Commissioning on-site service and technical training



### Technical features

- Optimum design
  - Products serialization – suitable for users with different water quantity and quality needs
  - Equipment modularization – convenient for equipment installation and maintenance
- High efficiency and energy saving
  - Adopting membrane module of DOW company – market share of membrane module is No. 1 in the world
  - Adopting energy recovery device – improving energy utilization of concentrated water
- Quality assurance
  - Make sure that the sustainable operation life could last for more than 3 years
  - Stable electronic control equipment with optimized design

### Industry advantage

#### • Market base

- Has the long-term stable partnership with ship industry, thermal power plants and nuclear power station
- Establish and maintain good relations with cooperation enterprises and supplier

#### • Corresponding guarantee

- Now production capacity of desalination equipment to make freshwater is 20000 tons/day
- The production capacity will be 200000 tons/day after the 4th industry base has been built



## Engineering Examples

On March 17, 2013, the first seawater desalination project of Sunrui for Indonesia T.J. Awar-awar power station project (signed in 2008) successfully produced freshwater. After examination, the water yield and water quality of the freshwater are up to the standard of the project completely. This marked that the ability of Sunrui to undertake large-scale seawater desalination projects independently.



Seawater desalination workshop of the Awar-awar project

Fresh water production of the Awar-awar project is successful in 2013



Seawater desalination device for Sanmen nuclear station

On May 14, 2011, Sunrui obtained the seawater desalination project of Sanmen Nuclear Power Co., Ltd. This project is the first AP1000 nuclear power project in the world. And the seawater desalination system of the project has the largest single capacity to produce freshwater using the RO technology at that time. Now the design and manufacture of the project have been completed.



The seawater desalination project for Sanmen nuclear station