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Application of Pure Water Process in Chemical Industry

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***Abstract*--**The effluent quality of fine chemical pure water equipment is related to people's production and life. Fine chemical has very high requirements. Water for chemical industry refers to chemical reagents, fertilizers and fine chemicals, cosmetics, electric locks, battery manufacturing processes, pure water, textile printing and dyeing processes. These all need softened water and desalinated pure water. This paper reviews the use of pure water technology in the chemical industry, and analyzes the advantages of these processes.

1. Introduction

In industry, according to the different requirements of water, its purity can be classified into demineralized water, pure water, high-purity water, theoretical water, desalinated water, etc. Softened water is to reduce the calcium and magnesium ions in the water to a certain concentration and soften water is widely used in low-pressure industrial boiler water[1]. The softening method is the ion exchange method and the agent softening method. Pure water is to remove the strong electrolyte in the water by physical and chemical methods, and reduce the silicic acid in the water to a certain extent. The methods for preparing pure water include ion exchange, sterilization, and membrane separation[2]. High-purity water is also called ultra-pure water, which completely removes the conductive medium in the water, and reduces the non-dissociative colloidal substances and gaseous organic substances in the water[3]. Theoretical water is water that does not contain any impurities, but such water does not exist. Demineralized water refers to physical and chemical methods to remove strong electrolytes in water to obtain a certain degree of water. In the process of desalination, some mechanical impurities and organic substances are also removed[4]. Commonly used desalination methods include steaming, membrane separation, Ion exchange or a combination of several of these methods.

The pure water used by Huading has been developed for a long time. In the past, the steaming method was used, and now it is a new technology that combines ion exchange and reverse osmosis with EDI[5]. With the increasingly stricter requirements of the chemical industry for pure water, the pure water equipment enters the booster pump to increase a certain pressure from the raw water. In the pretreatment system, the pretreatment can remove rust, impurities and other contaminants in the water, and the thousand softened water system can remove calcium and magnesium ions in the water. In order to achieve the standard of demineralized water, and finally passed the ultraviolet sterilizer and microporous filter to sterilize and remove odor, qualified pure water was obtained. For the treatment of raw water in chemical pure water equipment, the water quality of the pure water must meet the prescribed standards. The electrical resistivity of the chemical pure water equipment is greater than 15 trillion; the conductivity is greater than 0.5 microseconds; the ammonia in pure water should be less than 0.3 micrograms per milliliter, and the heavy metals per milliliter Less than 0.5 micrograms.

The chemical pure water equipment itself is unique. The overall use of stainless steel material can prevent corrosion. The overall structure of the equipment is easy to disassemble and install. It is easy to update and clean the parts. The equipment is fully automatic, efficient, energy-saving and simple to operate. The equipment is environmentally friendly, does not produce waste acid, the water quality of the produced water is relatively high, and it meets the pure water standard of the Ministry of Industry[6]. The quality of chemical pure water equipment has a great relationship with the quality of the drugs used, which directly affects the quality of pure water.

Today, with the rapid development of science and technology, the accuracy of the operation of the industry is also very high. For the electronics, pharmaceutical, food, chemical, light, aerospace, and metallurgical industries, the quality of pure water is very good for these industries. The great role, especially in the production process of the fine chemical industry, pure water equipment is indispensable, and the pure water process is also particularly important, so efforts should be made to study the pure water process.

2. Pure water process

2.1. Membrane materials for water purification

Purifying water using today's technology is expensive and energy-intensive; there is a pressing need for new research to identify novel approaches to purify water at lower cost, using less energy, and—importantly—minimizing the impact on the environment. Membrane technologies, in particular, have proven viable in water purification with decades of productive use. Membrane processes have distinct advantages, including high water quality with easy maintenance, stationary parts with compact modular construction, low chemical sludge effluent, and excellent separation efficiency. With recent innovation of both analytical and fabrication tools, more advanced membrane technologies are surfacing in a multitude of water purification applications.

A membrane is a thin physical interface that moderates certain species to pass through depending on their physical and/or chemical properties. In general, there are two classes of membranes (often defined as cross-section): isotropic and anisotropic membranes as shown in Fig. 1[7].

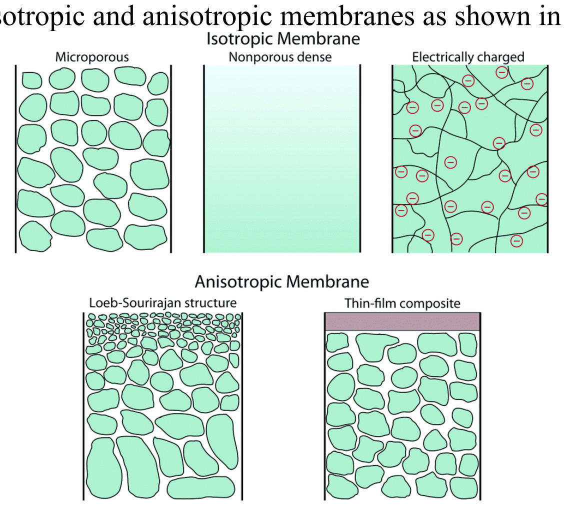

Fig. 1 Schematic illustration of various classes of membranes. Isotropic membranes have chemically homogenous composition whereas anisotropic membranes are heterogeneous both chemically and structurally.

Isotropic membranes are chemically homogenous in composition. Examples include microporous membranes, nonporous dense films, and electrically charged membranes. Porous membranes generally separate solutes based on the size of particulate and the size of pore[5]. Microporous membranes are similar to a conventional filter, but the pore diameter typically ranges from 0.1–5 μm (conventional filters are used for particles larger than 1–10 μm in size, so their pore diameter is typically larger than 5 μm).

There are two main types of anisotropic membranes: phase-separation membranes (Loeb–Sourirajan membranes) and composite membranes such as thin-film, coated films, and self-assembled structures. Loeb–Sourirajan membranes are homogenous in chemical composition similar to isotropic microporous membranes, but pore sizes and porosity (cf. 5.2) vary across the membrane thickness[8]. Development of such anisotropic membranes in the early 1960s represented a major breakthrough in the field of membrane technology. Composite membranes such as thin-film membranes are chemically and structurally heterogeneous. A thin surface layer is supported by a much thicker porous structure (functioning as a mechanical support), and these structures are traditionally made of different polymeric materials[7].

The following factors should be considered in order to design effective membranes: choice of membrane materials, high water flux, high solute rejection, module configuration, mechanical/chemical/thermal/temporal stability, system design including processibility at large scale, and operating conditions for cost-effectiveness. The performance of a membrane is mainly governed by the structure of its pores and the physical/chemical properties of the material. Intensive effort has been invested both in exploring new membrane materials/processes and in modifying traditionally used materials. Most commonly used commercial NF, UF, and MF membrane materials are synthetic polymers (such as polyvinylidene fluoride, polysulfone, polyacrylonitrile and poly(acrylonitrile)-poly(vinyl chloride) copolymers)[9].

UF and MF membranes are often prepared from the same materials, but preparation methods may be different to produce various pore sizes. Membranes can also be made from inorganic materials such as ceramics or zeolites[10]. However, large-scale applications of these inorganic materials are limited due to high operation cost and inherent mechanical fragility thus far. In the following sections, we survey recently developed membrane materials, their characteristics, synthesis/fabrication, and relevant analytical methods. Details of traditional membrane formation and operation processes can be found in the literature.

2.2. Inverter water cooling system pure water technology

The frequency converter is an electric energy control device that uses the power semiconductor device to turn the power frequency power supply into another frequency. It can optimize the motor operation, simplify the complicated speed control, and can play a role in increasing energy efficiency. During the working process of the inverter, the circuit components dissipate a lot of heat. In order to ensure their normal operation, heat dissipation is required. The cooling method of industrial large-capacity inverters is mostly water-cooled, and the circulating medium is pure water. The conductivity of the circulating water of the system is always kept at a low level, so it is necessary to purify the circulating pure water. When the pure water refined agent ages or fails, the pure water conductivity will rise rapidly, causing the inverter to alarm and trip, resulting in the device shut down.

Inverter water cooling system has the advantages of large thermal conductivity, small water flow, small vibration and noise, etc., which can effectively reduce the temperature of components and increase their life. In order to solve the problems of water purity, reliability, corrosion prevention and other problems in the water cooling system of the inverter, a purification branch that removes ions and oxygen dissolved in the water is used in the water circulation process, namely, a pure water refining unit. Through the pure water exquisite unit, the pollutants entering the pure water can be removed to ensure that the conductivity of the pure water is always kept within the range specified by the system during the circulation process. If the conductivity of pure water is higher than the specified value, it will cause the inverter to alarm[11]. If it is not handled in time, it will eventually cause a trip and cause the production device to shut down. In order to supplement the water loss caused by pump leakage and water electrolysis during operation, the device is also equipped with an automatic water replenishment system, which will make the entire system have excellent heat dissipation performance, high reliability, and environmentally friendly.

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According to the requirements of deionized water quality in the medium pressure inverter cooling water system, the Petrochemical Research Institute separately selected materials to remove trace organics, anions and cations, and silicon in pure water, and conducted compounding tests and pollutant removal effects12. Evaluation, development of pure water refined materials. Filling pure water refining materials in a layered manner, simulating the actual operating conditions, designing and making a pure water refining system, and conducting dynamic and stable operation evaluation of the developed pure water refining technology in the laboratory, the operation is in good condition. The working mode of the pure water refining unit of the water cooling system of the SIMOVERT-MV natural gas compressor medium pressure inverter produced by the German SIEMENS company is intermittent operation, that is, the pure water in the periodic purification circulation system is shown in Figure 2.

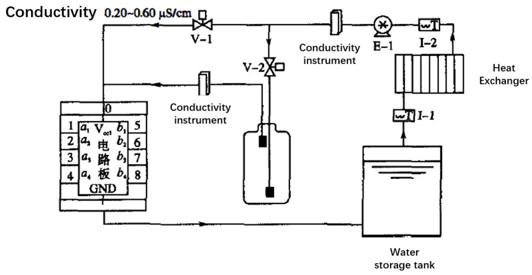

Fig.2 Process flow chart of water purification
in converter SIMOVERT-MV

3. Conclusion

Clean water scarcity is a massive and burgeoning challenge worldwide; advanced water purification technologies will be an indispensable pillar required to meet our future needs. Through innovative fabrication, processing methods, materials selection, and systematic studies for identifying key parameters (effect/influence of membrane structures, pores, surface roughness and charge, and understanding/predicting interactions between solutes and membrane), research on and development of membrane technology promises to play a key role in addressing this global water crisis.

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