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Trends in Wastewater Technologies in China: Water pollution is still a serious problem

- **11th Five-Year Plan focuses on water pollution prevention and control**
- **China is learning and adapting advanced foreign technology**
- **China has to improve the rules and regulations**

The enormous industrial growth in China has also caused tremendous environmental problems. In this context the commissioning and operation of advanced wastewater technologies play an important role in relieving the serious water pollution situation in China and improving the water environment. AchemAsia 2010, to be held in June 1 - 4 in Beijing, will focus on this important topic and offer solutions in technical terms.

Water Pollution Situation

According to the 2009 Report on the State of the Environment in China, surface water pollution in the People's Republic is still a serious issue. While the quality of surface water improved slightly in Southern China from 2000 to 2008, the quality in Northern China worsened over the same period of time. Of the 409 sections being monitored in the seven key river systems, 20.8 % were below grade V, the lowest grade in the Chinese National Standard for Water Quality. This water cannot be used, not even for irrigation purposes.

According to the statistics, the total wastewater discharge in 2008 was 57.2 billion tons, a 2.7% increase compared to 2007. Industrial wastewater discharge accounted for 24.2 billion tons or 42.3 % of the total with a 2.0% decrease compared to 2007. On the other hand, domestic sewage discharge increased by 6.4% to 33.0 billion tons (57.7 %).

While most of the industrial wastewater (92.4 %) is treated and a large part (83.8 %) even industrially reused, the treatment rate for urban sewage is at 70.2 % considerably lower. By the end of March 2008, 1321 sewage treatment facilities were in operation in China and 889 additional sewage treatment projects were under construction. The total treatment capacity of the sewage treatment plants reached 80,4 million m^3/day.

The 11th Five-Year Plan includes water pollution prevention and control planning for the most important river systems in China. 2712 pollution treatment projects are scheduled with an investment volume of RMB 160 billion, and an urban sewage treatment capacity of 12 million tons/day will be added.

New Wastewater Pollution Treatment Technologies

But improvements are not only necessary capacity-wise, but also with regard to treatment efficiency. In China, this is less than 60 %, while developed countries reach 80-90 %. The 11th Five-Year Plan sets a treatment efficiency of 70 % as a target until 2010.

Not least due to these plans, the annual growth rate of the waste water treatment industry is estimated at 15 %, reaching a market volume of 107 billion RMB in 2010. Overall, the investment in wastewater treatment in the 11th Five-Year Plan is set at 332 billion RMB. This offers interesting opportunities not only for domestic companies, but also for global players in the water industry.

Compared to developed Western countries, wastewater treatment in China has only recently become an issue. Starting about 25 years ago, the industry has developed fast during the 1990s, and the basic water treatment industry can be regarded as mature today. By adapting advanced foreign technology and experience, Chinese companies have introduced and developed many new wastewater treatment technologies based on national technology concepts. Some have even entered the international markets. The commissioning and operation of these technologies play an important role in relieving the serious water pollution situation in China and improving the water environment.

Today, more than 10,000 companies are active in the water treatment industry. Yet, the competition is mainly cost-driven with profit margins of less than 10 %. Most companies can handle only small projects, and research and innovation are hindered by lack of capital and human resources. Thus, besides large domestic companies like Beijing Capital C., Ltd, Shenzhen Water Group Co., Ltd, Beijing Enterprises Waster Industry Investment Co., Ltd and the Sound Group, global players like Veolia Environment, Sino French Water (Suez) or Dow Water Solutions have taken a large share of the Chinese water treatment market.

Urban Domestic Sewage

Currently, the conventional activated sludge process is the main urban sewage treatment method in China, combined with other technologies like the AB process, the anaerobic-aerobic activated sludge (A/O) process or the anaerobic-anoxic-aerobic activated sludge (A2/O) process. Over the last ten years, new technologies like the oxidation ditch process and the sequencing batch reactor (SBR) with several derivatives have come into use.

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Industrial Wastewater Treatment

A wide range of technological options are available for the treatment of industrial wastewater. Their improvement and new developments are continuously generating new fields of application.

Membrane Technology

The commonly used membrane separation technologies include micro-filtration, nano-filtration, ultra-filtration and reverse osmosis. As its functionality is mainly based on the separation of molecules by size and other parameters like polarity, it is often used in the treatment of water contaminated with large molecules, e.g. sewage from printing and dyeing facilities.

Magnetic Separation Technology

A comparatively new water treatment technology that has come up in recent years is magnetic separation. The method is based on using the magnetic properties of particles. By inoculation, non-magnetic or weakly magnetic particles can also be made accessible for this treatment method. There are three ways to apply the magnetic separation technology in wastewater treatment: direct magnetic separation, indirect magnetic separation and microorganism-magnetic separation. The magnetizing technology under research includes magnetic flocculation technology, ferrous co-precipitation technology, ferrous powder technology and ferrite technology among others. The typical magnetic separation equipment is a disc-type magnetic separator and a high gradient magnetic filter.

Currently, the magnetic separation technology is under library research and can't be applied in engineering practice yet.

Fenton and Fenton-like Oxidation

A typical Fenton reagent generates OH by catalyzing H_2O_2 with Fe^{2+} to induce oxidation degradation of the organics. Based on this reaction, the so-called OHP-process allows for the efficient removal of organic pollutants that are not biodegradable using a specially formulated hydrogen peroxide reagent and a complex catalyst. The process can be combined with other water treatment methods and offers an economic alternative to the combustion of complex sewage with a high C-load.

Ozone Oxidation

Ozone is a strong oxidant that is easy to use and doesn't cause secondary pollution. It can be used in sterilization, color removal, odor removal, and organic removal and COD

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reduction of sewage. Since ozone has a low solubility in water, a low generation efficiency and the generation requires large amounts of energy, increasing the water solubility of ozone, improving the utilization rate of ozone and developing an ozone generator with high efficiency and low energy consumption are the primary research targets. In order to improve the efficiency and cost-effectiveness of ozone oxidation, it is combined with other technologies such as UV/O_3, H_2O_2/O_3 and UV/H_2O_2/O_3 as advanced oxidation processes (AOP), widening the potential field of application.

Wet (Catalytic) Oxidation

Wet (catalytic) oxidation aims at oxidizing the dissolved or suspended organic or reduced inorganic pollutants by using O_2 or air as the oxidant using a catalyst at high temperature (150-350 ℃), high pressure (0.5-20 MPa). Wet air (catalytic) oxidation is applicable to the treatment of urban sludge, industrial wastewater from acrylonitrile and coking plants and dyeing and printing processes, and pesticide wastewater with phenol, chlorocarbon, organic phosphorus and organic sulfur compounds.

Plasma Wastewater Treatment Technology

The low temperature plasma wastewater treatment is economic and efficient in treating low concentration organics. The application of plasma technology in wastewater treatment in China is still under research and development.

Electrochemical (Catalytic) Oxidation

Through anodic reaction, electrochemical (catalytic) oxidation directly degrades the organics or generates oxidants such as the hydroxyl radical (OH) or ozone.

The most exciting technology in this field is the use of three-dimensional electrode systems. Three-dimensional electrodes are filled with granular electrode material, resulting in a large surface where every granule becomes a new microelectrode.

Three-dimensional electrodes combine large current strength with low current density. The particle distance is small, material transmission speed is high and spatial conversion is efficient, resulting in high current efficiency and a good treatment effect. The three-dimensional electrode can be used to treat organic wastewater hard to degrade (such as domestic sewage, pesticide, dye, pharmacy and wastewater with phenol), metal ion, garbage percolate, etc.

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Photochemical Catalytic Oxidation

Photochemical catalytic oxidation is a type of photochemical degradation employing catalysts like TiO_2, ZnO, WO_3, CdS, ZnS, SnO_2 and Fe_3O_4. With Fe^{2+}/Fe^{3+} and H_2O_2 as the medium, homogeneous catalytic degradation generates hydroxyl radicals; heterogeneous catalytic degradation uses light-sensitive semiconductor materials (e.g., TiO_2, ZnO) that generate free radicals (e.g., OH) with a strong oxidation capacity.

Ferric-Carbon Micro Electrolysis Technology

Ferric-carbon micro electrolysis technology is used for water treatment and pretreatment. Recovery of valuables is often one of the major targets when using this technology. This technology has many advantages such as wide application range, good treatment results, long service life, low cost and convenient operation and maintenance. Besides, it uses waste iron dust as the raw material and not electric power resource is consumed, so it "treats waste with waste". Currently, ferric-carbon micro electrolysis technology has been widely applied in treatment of wastewater generated in dyeing and printing, pesticide/pharmacy, heavy metal and petrochemical engineering and garbage percolate, and sound effect is achieved.

The Problems in Sewage Industry of China and the Solutions

Currently, the sewage treatment industry of China faces a range of problems and challenges. The system of relevant policies and regulations is not complete. The development of the sewage treatment industry is slow and the city and town sewage treatment is undergoing a transition phase of the administrative system, which hasn’t met the requirements. The responsibilities for the operation and supervision of some urban sewage treatment plants are unclear. The charge system for sewage treatment is not well implemented, and the investment and financing system needs improving. The construction of the supporting sewage collection pipelines is sometimes postponed, resulting in a low sewage collection rate. The water (effluent) quality of many city and town sewage treatment plants is far behind the design requirement. The monitoring and control system of industrial pollution discharge is incomplete and there is unqualified discharge and even unpermitted discharge in some enterprises. This affects wastewater quality and results often in wastewater quality that lowers municipal sewage treatment plants treatment efficiency. Local authorities are in general mostly judged by the economic performance of their region and are thus reluctant to support measures that might have a slowing effect on the local industry.

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Summary

But there is also some light at the end of the tunnel: Since 2000 (especially since the aniline device explosion at a bi-benzene plant of the Jilin Petrochemical Company in 2005), the Chinese government has paid more attention to and increased the investment in water pollution treatment. The construction of municipal sewage treatment facilities of large and medium-sized cities and towns has been sped up, and the urban sewage treatment rate reached 70.2 % in 2008. Discharge reduction is officially promoted especially for highly water-polluting industries such as paper mills, brewing and dyeing and printing. Rural sewage treatment is also actively promoted along with concepts to recycle and reuse water; these are included for example in the planning of rural construction projects and the development of modern agriculture. These measures have the potential to achieve a turn-around in the deterioration of water in spite of the booming economic development and they evidently improve the water environment.

If the right measures are taken, China will not only benefit from the advancement of sewage treatment technologies by being able to supply its population with clean water and reducing the negative consequences of water pollution within the country. Advanced water treatment technologies also meet the needs of a considerable international market, thus creating a potential win-win situation of a cleaner environment and sustainable economic growth.

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(This trend report was put together by a team of experts and international trade journalists on behalf of DECHEMA. DECHEMA does not accept any responsibility for incomplete or incorrect information.)

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