

INDUSTRIAL WASTEWATER-TYPES, AMOUNTS AND EFFECTS

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Summary

Industrial wastewater is one of the important pollution sources in the pollution of the water environment. During the last century a huge amount of industrial wastewater was discharged into rivers, lakes and coastal areas. This resulted in serious pollution problems in the water environment and caused negative effects to the eco-system and human's life.

There are many types of industrial wastewater based on different industries and contaminants; each sector produces its own particular combination of pollutants. Like the various characteristics of industrial wastewater, the treatment of industrial wastewater must be designed specifically for the particular type of effluent produced.

The amount of wastewater depends on the technical level of process in each industry sector and will be gradually reduced with the improvement of industrial technologies. The increasing rates of industrial wastewater in developing countries are thought to be much higher than those in developed countries. This fact predicts that industrial wastewater pollution, as a mean environment pollution problem, will move from developed countries to developing countries in the early 21st century.

1. Introduction

Until the mid 18th century, water pollution was essentially limited to small, localized areas. Then came the Industrial Revolution, the development of the internal combustion engine, and the petroleum-fuelled explosion of the chemical industry. With the rapid development of various industries, a huge amount of fresh water is used as a raw material, as a means of production (process water), and for cooling purposes. Many kinds of raw material, intermediate products and wastes are brought into the water when water passes through the industrial process. So in fact the wastewater is an "essential by-product" of modern industry, and it plays a major role as a pollution sources in the pollution of water

environment.

2. The types of industrial waste water

There are many types of industrial wastewater based on the different industries and the contaminants; each sector produces its own particular combination of pollutants (see Table 1).

Sector	Pollutant
Iron and steel	BOD, COD, oil, metals, acids, phenols, and cyanide
Textiles and leather	BOD, solids, sulfates and chromium
Pulp and paper	BOD, COD, solids, Chlorinated organic compounds
Petrochemicals and refineries	BOD, COD, mineral oils, phenols, and chromium
Chemicals	COD, organic chemicals, heavy metals, SS, and cyanide
Non-ferrous metals	Fluorine and SS
Microelectronics	COD and organic chemicals
Mining	SS, metals, acids and salts

Table 1: Water Pollutants by the Industrial Sector

The metal-working industries discharge chromium, nickel, zinc, cadmium, lead, iron and titanium compounds, among them the electroplating industry is an important pollution distributor. Photo processing shops produce silver, dry cleaning and car repair shops generate solvent waste, and printing plants release inks and dyes. The pulp and paper industry relies heavily on chlorine-based substances, and as a result, pulp and paper mill effluents contain chloride organics and dioxins, as well as suspended solids and organic wastes. The petrochemical industry discharges a lot of phenols and mineral oils. Also wastewater from food processing plants is high in suspended solids and organic material. Like the various characteristics of industrial wastewater, the treatment of industrial wastewater must be designed specifically for the particular type of effluent produced.

Generally, industrial wastewater can be divided into two types: inorganic industrial wastewater and organic industrial wastewater.

2.1 Inorganic industrial wastewater

Inorganic industrial wastewater is produced mainly in the coal and steel industry, in the nonmetallic minerals industry, and in commercial enterprises and industries for the surface processing of metals (iron picking works and electroplating plants). These wastewaters contain a large proportion of suspended matter, which can be eliminated by sedimentation, often together with chemical flocculation through the addition of iron or aluminum salts, flocculation agents and some kinds of organic polymers.

The purification of warm and dust-laden waste gases from blast furnaces, converters,

cupola furnaces, refuse and sludge incineration plants, and aluminum works results in wastewater containing mineral and inorganic substances in dissolved and undissolved form.

The pre-cooling and subsequent purification of blast-furnace gases requires up to 20 m³ water per t of pig iron. On its way into the gas cooler the water absorbs fine particles of ore, iron and coke, which do not easily settle. Gases dissolve in it, especially carbon dioxide and compounds of the alkali and alkaline earth metals, if they are water-soluble or if they are dissolved out of the solid substances by gases washed out along with them.

In the separation of coal from dead rock, the normal means of transport and separation is water, which then contains large amounts of coal and rock particles and is called coal-washing water. Coal-washing water is recycled after removal of the coal and rock particles through flotation and sedimentation processes.

Other wastewater from rolling mills contain mineral oil and require additional installations, such as scum boards and skim-off apparatus, for the retention and removal of mineral oils. Residues of emulsified oil remaining in the water also need chemical flocculation.

In many cases, wastewater is produced in addition to solid substances and oils, and also contains extremely harmful solutes. These include blast-furnace gas-washing wastewater containing cyanide, wastes from the metal processing industry containing acids or alkaline solutions (mostly containing non-ferrous metals and often cyanide or chromate), wastewater from eloxal works and from the waste gas purification of aluminum works, which in both cases contain fluoride. Small and medium sized non-metallic-minerals plants and metal processing plants are so situated that they discharge their wastewater into municipal wastewater systems and have to treat or purify their effluents before discharge, in compliance with local regulations.

2.2 Organic industrial wastewater

Organic industrial wastewater contains organic industrial waste flow from those chemical industries and large-scale chemical works, which mainly use organic substances for chemical reactions.

The effluents contain organic substances having various origins and properties. These can only be removed by special pretreatment of the wastewater, followed by biological treatment. Most organic industrial wastewaters are produced by the following industries and plants:

- The factories manufacturing pharmaceuticals, cosmetics, organic dye-stuffs, glue and adhesives, soaps, synthetic detergents, pesticides and herbicides;
- Tanneries and leather factories;
- Textile factories;
- Cellulose and paper manufacturing plants;
- Factories of the oil refining industry;
- Brewery and fermentation factories;

- Metal processing industry.

As examples, some special types of wastewater produced by the industries mentioned above are briefly introduced as follows.

Wastewater produced from the pharmaceutical industries

The quality of the wastes from the production of pharmaceuticals varies a great deal, owing to the variety of basic raw materials, working processes and waste products. It is a characteristic of the pharmaceutical industry that very many products as well as intermediate products are manufactured in the same plant. Thus different kinds of effluent with widely varying qualities flow from the different production areas.

For large chemical industries it is also usual to manufacture pharmaceutical products together with other chemical products. Some times waste substances include the extraction residues of natural and synthetic solvents, used nutrient solutions, specific poisonous substances, and many other organics.

The wastewater produced by the pharmaceutical industry has a very bad quality for wastewater treatment. Usually the concentration of COD is around 5000 – 15000 mg/L, the concentration of BOD₅ is relative low, and the ratio of BOD₅/COD is lower than 30% which means the wastewater has a poor biodegradability. Such wastewater has bad color and high (or low) pH value, and it needs a strong pretreatment method, followed by a biological treatment process with a long reaction time.

Wastewater produced by tannery plants

A tannery is one of the most water intensive plants, and its production process consists of several steps. The quality of water depends only to a slight degree on the type of hides and the mechanical and chemical methods used in tanning. In a tannery with chrome and bark tanning, the wastewater resulting from the different processes are as follows:

▪ Soaking and washing	22.5%
▪ Liming	17.5%
▪ Rinsing	5.5%
▪ Plumping and bating	19.0%
▪ Chrome tanning	2.0%
▪ Bark tanning	2.0%
▪ Washing and drumming	31.5%

In fact the wastewater flow is very uneven. The peak flow can be 250% of the hourly average flow rate.

The wastewater produced by a tannery (including preparation of the hides) has a fairly acid pH and high chloride content (up to 5 g Cl/L). It contains a high concentration of COD (about 1500 – 2500 mg/L), a high amount of settable substances (10 – 20 g/L) and emulsified fat, and tends to form foam. The dichromate content can reach a peak value of 2000 mg/L. So the tannery wastewater is a killer to the water environment if it is

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Bibliography

- Alicia Leung, Deepak Si
nha., (1998) *Brewery Industry China Hong Kong Management Case Study*
,Management Development Center of Hong Kong, Hong Kong. [This report shows the components of
wastewater produced by the brewery industry and its effects.]
- Bhaskaran, T. R, () *Tannery Wastes, Guidelines for the Control of Industrial Wastes*, WHO/WD/ 73.14
[This report presents the components of tannery wastewater and the control methods.]
- Czys W. and Schneider W., (1989)*Waste Water Technology: Origin, Collection, Treatment and Analysis
of Waste Water*, Springer-Verlag Berlin Heidelberg, New York, pp103-109 [This article show the
wastewater amounts produced by the different processes in a tannery with chrome and bark tanning.]
- Julie, Stauffer, (1998) *The Water Crisis: Constructing Solution to Freshwater Pollution*, Earthscan
Publications Limited, London UK. [This article show the major pollutants in wastewater produced by
different industrial sectors.]
- Modern Methods of Plant Analysis Vol. 20 Analysis of Plant Waste Materials*, Springer- Verlag, Berlin
Heidelberg, 1999, pp 41-42 [This article presents the characteristic of mixed brewery wastewater.]
- Meybeck M., Chapman V.D. and Helmer R., (1990) *Global Freshwater Quality (A First Assessment)*,
Published on behalf of the WHO and UNEP, Blackwell Ltd., USA. [This report presents the amounts of
industrial wastewater produced by different industrial sectors and the increasing trend in different areas of
the world.]

Biographical Sketch

Han-chang SHI is a professor of the Department of Environmental Science and Engineering, Tsinghua University and the director of State Key Joint Laboratory of Environment Simulation and Pollution Control in P. R. China. He graduated from the Department of Environmental Science and Engineering, Tsinghua University in 1984 and studied in Water Research Center in the U.K. and University of Michigan in the U.S.A. as a senior visiting scholar during 1989 and 1994. The major research fields of him are biological wastewater treatment, refractory and toxic organics treatment using anaerobic acidification process, modeling and simulation of aerobic biological wastewater treatment process, and low toxic wastewater treatment using photo-oxidation process.