SAVONIA

Treatment of Industrial Wastewater

Treatment of Printing and Dyeing Wastewater

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Abstract

In this paper, the main topic is the treatment of sewage which is coming from industry. It contains four basic methods of treatment and also introduces five types of sewage. The emphasis of the study is on disposing the printing and dyeing sewage. The target of this paper is to find a suitable way to make the quality of effluent meet the discharging standard. So the thesis describes an imaginary case of a printing and dyeing factory whose sewage must be disposed of. The quantity of the sewage is not so huge. Therefore, the paper aims at finding some right methods to design an appropriate work process by comparing the different treatment methods.

By considering several features of every kind of treatment technology, I finally chose the biochemical contact oxidation process. Because the method is economical and this process suits for small amount of inflow. In the whole work process, it includes adjusting tank, hydrolysis acidification pool, biochemical contact oxidation pool, vertical sedimentation tank, coagulation sedimentation tank, sludge concentrated tank and sludge dewatering room and some other devices.

In my personal opinion, in the future, in the development direction of sewage treatment, prevention should be considered first. For example, we could replace the materials by other new and environmental materials, or improve the consciousness of discharging sewage of all industrial enterprises.

Keywords

Sewage, biochemical contact oxidation, printing and dyeing sewage

Confidentially

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Abbreviations and symbols

BOF	Basic Oxygen Furnace
PAC	Poly Aluminium Chloride
COD	Chemical Oxygen Demand
COD_{cr}	Chemical Oxygen Demand by Using Potassium Dichromate
BOD_5	Five Day Biochemical Oxygen Demand
BOD	Biochemical Oxygen Demand
PH	Power of Hydrogen
SS	Suspended Solids
HF	Hydrogen Fluoride
F^-	Fluorine Ion
ASP	Activated Sludge Process
BCO	Biological Contact Oxidation

1 INTRODUCTION

1.1 **Background information**

Water plays a very important role in people's daily life; it is an indispensable substance of nature. All of the living-beings depend on it. It can be seen it has the same value with air and sunshine. Water can be used in many fields, people need to drink water to survive, crops need to be irrigated by water, and also the industrial factories need huge amounts of water during the productive process.

The world is facing a serious problem which is that fresh water is becoming less and less, how could we treat the wastewater to make it fit the general demand? It seems that most of us are living a kind of life which has enough water. The tap-water has changed our view of the shortage of water although it makes our life much more convenient. Unfortunately, people have not realized we are lacking of water when they open the tap and then the water comes out. With the rapid development of the world, there are so many factories like iron and steel factories, printers, electroplate factories etc. In recent years, the water pollution incidents have appeared becomes frequent. So many industrial factories discharge the wastewater into the river directly without any disposal in order to save money. This causes the pollution more seriously. Soil be polluted then the crops cannot grow.

Sewage has many types so that each kind of sewage has different elements in it. The sewage discharged by steel factories or electroplate-factories has quite many heavy metal elements. The sewage of printers might have huge amount of organic substances which are harmful. So because of this, when treating different type sewage, workers need to combine several methods together. Sewage can be discharged or cyclically used only after it is disposed. The aim of wastewater disposal will be achieved generally when a disposal system consists of more than 2 disposal means because the composition of sewage is complex. This thesis will focus on the common principle of physical process, chemical process, physic-chemical process and biological for industrial sewage disposal. It emphatically introduces some available technologies for handling printing sewage and resumes the research and development direction of water handling technology.

1.2 **The research purpose**

The problem with wastewater in Sweden started, like in all other countries, in the towns in the 18th century. To start with the problem was to handle the waste to avoid sanitary problems. During the second half of 19th century, building of the water supply system started. With the increasing use of water the need of sewage piping also increased but the development was slow.

Wastewater has been a problem since people moved to cities. In that time it was a question about health. The wastewater piping that was built only leads the water from the town to the closest watercourse. Later problems in the watercourse occurred. The fish died and the lakes became overgrown. It was necessary to treat the water before letting it out.

Today the rights of letting out wastewater are regulated. Sweden has been and still is successful in wastewater treatment and the rules are hardest in the world. But that does not mean that the problems are solved. Still more research is needed to figure out what kind of treatment the environment demands. The aim with this thesis is to describe wastewater pollution, and give some methods to purify the wastewater.

1.3 **Limitation of the study**

Main information sources are from Internet. The books are published in China and it is found from Internet. This thesis is about the sewage treatment of China, so there are not many books and little data of sewage could be found in the library in Savonia UAS. And the idea in this thesis is writer's personal opinion which is only utilized for this single research

1.4 **The structure of the thesis**

The introduction includes background information of industrial wastewater, purpose of this research, limitation for writing this thesis and the structure.

Chapter two introduces the damage of industrial wastewater pollution, both for human health and environment. And there will be the introduction for different kinds of sewage.

The chapter three is mainly about the printing and dyeing swage. Also, three methods of disposing the dyeing sewage are described.

In chapter four, there detailed analyses each process of the whole system and the result of effluent quality after every process. And last chapter is the conclusion.

In the conclusion part, there has some principals of handling sewage and also has some graphical charts which show the discharge of COD in China.

2 THE CLASSIFICATION OF INDUSTRIAL WASTEWATER AND MAINLY COMPOSITION OF DIFFERENT SEWAGES

Commonly, the industrial wastewater refers to the liquid that is generated or discharged during the industrial processes. It contains the materials that are washed away during the industrial processes, intermediate products and contaminants generated in the production process. With the development of industry, the type and quantity of wastewater have increased rapidly. It has made huge influence on the fresh-water; people are facing a serious challenge. Therefore, for the protection of environment, the industrial wastewater treatment is more important.

Figure 1: Wastewater [1]

2.1 **The Classification of Sewage**

Normally, the industrial wastewater can be divided into three types;

1）According to the chemical property of the contaminants in sewage, there are:

-wastewater that contains inorganic contaminants

-wastewater that contains organic contaminants

-wastewater that has both inorganic and organic contaminants (mixed water)

-heavy metal wastewater

-wastewater that contains radioactive substances

-cooling water

For example, electroplating wastewater and wastewater generated during the mineral process is inorganic wastewater, wastewater produced in printing and

dyeing factory is mixed wastewater. Wastewater from different industry has different composition.

2）On the basis of products or manufacturing objects, it has:

-Papermaking wastewater

-Textile wastewater

-Tannery wastewater

-Pesticide wastewater

-Metallurgical industrial wastewater

-Refinery wastewater, etc.

3）On the basis of composition of main contaminants, there are:

-Acid wastewater

-Alkaline wastewater

-wastewater containing chromium

-wastewater containing phosphorus

-wastewater containing radioactive substances, etc.

In fact, one kind of industry could discharge several kinds of wastewater which has different properties, and one kind of wastewater has different pollutants which could cause diverse pollution. So, the treatment of wastewater is a complicated problem, workers should detect the constituents of the wastewater, then to think about the feasible methods and its sequence.

2.2 **The Characristics of Industial Wastewater**

One of the features of sewage is that the quantity and quality would have very huge difference when the processing methods and manufanturing methods are not the same. Such as the electric power department and mining industry, the primary composition of contaminants is inorganic. But in papermaking and food indutry, the wastewater has high concentration of organics. Normally, the BOD5 over 2000mg/L, some also can reach to 3000mg/L. Even if in the same process, the quality of wastewater might have difference. For example,like BOF steelmaking process, in different stages of steel smelting in the same furnace, the pH value of wastewater is about 4-13, suspended solids is about 250-25000mg/L.

Another feature of industrial wastewater is, except the cooling water, most of the wastewater contains the raw material or substance related to the raw material.In addition, these substance always have disparate forms in wastewater. For example, in the glassmaking industrial sewage and electroplating sewage, the fluorine (F), generally exists as HF or F^-. This feature makes the sewage treatment more difficult and complicated.

The quantity of wastewater depends on the usage of water. In the metallurgy industry, papermaking factory,petrochemical industry and printing plant, the demands of water arelarge, so the amount of wastewater is large as well. For example in some steelmaking factories, there will be about 200 tons of water be used when 1 ton steel of comes out. But the practical quantity of discharged wastewater of a factory often relates to the circulatory usage rate. If steel factory has high rate of circulatory usage, the demand of water for 1 ton steel could be reduced to 2-10 tons.

2.2.1 **Treatment method**

Typically, the treatment method of sewage can be divided into four categories based on its principle, physical treatment, chemical treatment, physical-chemical treatment and biological treatment;

1）Physical treatment

It is a method that by using physical effect to separate and recycle the contaminant which is suspended and insoluble (including oil film and beads), commonly methods like gravity separation, centrifugation, and filtration are used.

2）Chemical treatment

It is handled by adding certain chemical substances, and using the chemical reactions to separate and recycle the contaminant. Such methods like, chemical precipitation, coagulation, neutralization, oxidation-reduction (including electrolysis).

When using chemical method, PAC flocculants are quite a good substance. As inorganic polymer flocculants, it militates by compressing double, adsorption to get the suspended solids together. Because of this property, flocculants are widely used in the field of wastewater treatment.

3）Physical-Chemical treatment

This kind method combines the physics and chemistry together to remove the contaminants, mainly using adsorption, ion exchange, membrane separation, extraction and so on.

4）Biological treatment

By using microbial metabolism to make the solution, colloids and suspended solids which exist in organic sewage transform into stable, harmless substances. It can be divided into aerobic biological treatment and anaerobic biological treatment.

When dealing with organic wastewater which has high concentration and hard to degrade, there are many ways to dispose, include chemical oxidation, extraction, adsorption, burning, catalytic oxidation method and biochemical process. But in practice, biochemistry is a popular method which is widely used in wastewater treatment, because by using this method, the equipment can be simple but can handle large amounts of wastewater. The cost is low as well. Usually, during the disposal period, using the traditional biochemical process, like A/O, A2/O or some kind of technology based on these two methods. Among biochemical method, activated sludge is the most commonly used technology when disposing of the organic sewage. It has merits of large superficial area, high activity and good quality; it is the most efficient manual way to dispose of sewage.

The purpose of wastewater treatment is to remove the contaminants of wastewater by using some methods, or to make it harmless and stable so that the sewage is clean. Normally, it needs to reach to the standard of fitting the different demands.

The treatment is a very complicated thing; the methods need to base on the quantity and quality of the sewage, the place where it would be discharged and the applications. Meanwhile, it is necessary to think about the sludge and residue could cause pollution again.

These methods mentioned above have its own application field, and it is almost impossible to use only one method to refine sewage. So, it is very important to think about every detail like the quantity and quality of sewage, the standard of discharging, and the value of recycling sewage, etc.

2.2.2 **Measurement method**

1) BOD Test

Biochemical oxygen demand (BOD) is a parameter or measure that illustrates the extent or amount of consumed oxygen happening in the process of wastewater treatment. The oxygen is consumed by microorganisms. It is an important index of wastewater. Normally, the higher level of BOD the water has, the more severe the pollution is. Therefore, the sewage with high level of BOD must be disposed before it can be discharged into rivers of other waters. (Source: The Biochemical Oxygen Demand)

The unit of BOD is mg/l. In fact, the total time needed for resolving the organic substances in wastewater is about 100 days, it is hard for workers to measure in practice. Therefore, in the case of this, normally, the BOD is measured under the situation of 20 degrees, total demand of oxygen. It is called five days biochemical oxygen demand (BOD5). The bigger value of BOD means the more seriously the water is polluted.

Self-purification aspects of rivers were given strong consideration when BOD standards were established for these water bodies. Waters having a BOD of less than 1 mg/L can be relatively unimpacted by humans and primary candidates for conservation. (Source: The Biochemical Demand)

Figure 2: Measurement tools: measuring cylinder (left) and triangular flask (right). [2]

2) COD Test

Chemical oxygen demand (COD) is a measure of the mass of consumed oxygen during the period of decomposing the organic substances by adding some inorganic chemical substances like potassium permanganate. COD measurements are normally measured on samples of sewage of natural waters contaminated by domestic or industrial wastes. It is also an important index of sewage, the high level of COD would make the heavy pollution of environment. (Source: http://camblab.info/wp/index.php/272/)

The unit of COD is mg/L as well; firstly it uses the chemical oxidant like potassium permanganate to resolve the oxidable substances (organic substances, nitrite and so on) in sewage, the mass of consumed oxygen then is calculated. It has the same sense as BOD, the smaller value the water has, the better quality the water is.

COD is used as an organic pollution index including phytoplankton growth. A COD of less than 1 mg/L is assumed not to be caused by anthropogenic influence. Water under this condition is suitable for conservation of the natural environment.

2.3 **Introduction of different kinds of sewage and solution for handling the sewage**

In fact, sewage has many different varieties, such as pesticide sewage, heavy metal sewage, phenol sewage and so on. It depends on what is involved in the sewage. When dealing with sewage treatment, it is needed to detect the composition of the sewage first. Then the designed process for dispose could be started.

2.3.1 **Pesticide wastewater**

The quality of the pesticide wastewater is complicated because of the wide varieties of pesticide. Its main traits are;

a) It has high concentration of contaminants, COD could even reach several tens of thousands milligram per liter.

b) High toxicity. The wastewater has not only pesticides and intermediates, but also phenols, arsenic, mercury and other toxic substances. Most of these substances are hard to degrade by microorganism

c) It smells bad, and it is harmful for human's respiratory tract and mucosa.

d) Unstable wastewater quality and quantity.

Therefore, pesticide wastewater really has bad influence on environment. The purpose of pesticide wastewater treatment is to reduce the concentration of the contaminant in wastewater, increase the recycle rate and finally to make the wastewater nontoxic. The main methods for disposing this kind of wastewater are active carbon adsorption, wet oxidation process, solvent extraction, distillation and activated sludge method. However, in order to reduce the pollution extent, it is necessary to develop some kinds of new pesticides with low toxicity, high efficiency. This should be the new development direction of pesticide. (Source: Sewage with pesticide)

2.3.2 **Heavy metal wastewater**

This kind of wastewater comes from these kinds of enterprises which are related to mines, smelting, electroplating, medicine, paint and so on. The categories, content and the forms are not same if the enterprise is different. Because the heavy metals are indecomposable, in order to remove the metal elements, things that can be done are to transfer their position and change their physical and chemical forms. For example, through chemical precipitation, heavy metal transfers to substances which cannot be dissolved by water from the ionic form. Therefore, when disposing the heavy metal wastewater, firstly, the basic principle is using heavy metal as little as possible or never uses it. Then, adopting suitable technology to dispose of it, and reducing the discharge. (Source: Sewage with heavy metal)

The treatment is generally divided into two categories; one is to make the metal ion transfer to water insoluble metallic compounds or simple substance (Neutralization precipitation, precipitation with sulphide, floatation separation and so on).

Another method is to separate or concentrate the heavy metal by not changing its chemical form (reverse osmosis, evaporation, ion exchange method).

2.3.3 **Printing and dyeing wastewate**r

The demand of water in the printing factory is very large, generally, printing and dyeing 1 ton of textile needs 100-200 tons of water. And nearly 90% of water is discharged as sewage. Commonly, there are two kinds of methods for handling this kind of sewage. One is to recycle and reuse the printing and dyeing sewage, another is to make the sewage nontoxic after disposal.

For recycling and reusing, it can be divided into three parts:

1) The sewage can be recycled and reused on the basic of its own feature, like the bleaching sewage. It can be applied for convection washing as well. In this way, the demand of wastewater will be cut down; the enterprise could also save money.

2) The lye can be recycled and used again. Usually, it is recycled by evaporation. If the quantity is large, the treatment method can be replaced by triple effect evaporation. On the contrary, if there is just a little amount of sewage, the thin film evaporation will be an appropriate way.

3) Dye's recycling. For example, some sort of dyes can be turned to colloids after acidizing. Then after precipitating, dyes will be collected through filtration.

For nontoxic treatment, it can be discussed from three aspects, physics, chemistry and biology.

1) If using the physical method, precipitation and adsorption will be good choice. Using precipitation to remove the suspended solids, and then by choosing adsorption, the dissolved substances will be eliminated and the colour also could fade.

2) The chemical method has neutralization, coagulation, and oxidation. The function of neutralization is to adjust the PH value of sewage, to decrease the chromaticity of sewage. Coagulation is used to eliminate the dispersive dyes and colloids of sewage. Oxidation is used to oxidize the reductive substances in the sewage, make sulphur dyes and reduced dyes precipitated.

3) For biological method, there are activated sludge, biological contact oxidation process and so on.

All the methods mentioned above are suitable for sewage treatment, but most of the time, it is difficult to handle sewage just by using one method. For the purpose of

improving the quality of effluent, most time, using one method is not enough. In other words, when facing to dispose of sewage, all the possible methods need to be combined together.

In this paper, the emphasis is to research this kind of sewage and find out the most suitable and economical treatment way.

2.3.4 **Wastewater with phenol**

The staple origin of this sewage is from coking plant, gashouse, petrochemical plant, or some industry like these, and it also produced in the manufacturing process of synthetic phenol, organic pesticide, and synthetic dyes and so on.

Sewage with phenol mainly contains phenolic compounds (such as phenols, cresol). Phenolic compounds are a kind of protoplasm poison; it can curdle the proteins. If the kind of sewage is discharged into river without any treatment, and the mass concentration reaches 0.1-0.2 mg/l, the fish cannot be eaten. If the concentration rises to 1 mg/l, fish's spawning will be influenced. If the concentration is 5-10 mg/l, fish will be killed directly. Drink water with phenol also has impact on human's health, even if there is just 0.002mg/l in the water; it will produce effluvium by adding chlorine. (Source: Sewage with phenol)

Normally, sewage of over 1000 mg/l is called high concentration sewage with phenol; this kind sewage must be dispose after recycling the phenol. Mass concentrations that are lower than 1000 mg/l are called low concentration sewage with phenol. Normally, treatment for handling this sewage is firstly reusing it and then condensing the phenol before disposal. There are quite lot of ways to recycle phenol such as solvent extraction, adsorption, closed loop method, etc. When the phenol's mass concentration is less than 300 mg/l, it is possible to use bio-oxidation, chemical oxidation and physical-chemistry oxidation to treat the sewage. (Source: Sewage with phenol)

2.3.5 **Wastewater with mercury**

The toxicity of different kinds of mercury compounds is not the same, basically, mercury element has no toxicity. In the inorganic mercury compounds, mercuric chloride ($HgCl_2$)

is an extremely toxic substance. For organic mercury compounds, phenyl mercury can be dissolved quickly. Methyl mercury can be absorbed easily by human body.

This kind of sewage mainly comes from nonferrous metal factory, chemical plant, pesticide factory, papermaking factory and dye factory. The methods for removing the inorganic mercury are sulphide precipitation method, metal reduction method, activated carbon absorption, ion exchange method, microorganism method, etc. The sulphide precipitation method could be used for disposing alkaline sewage; metal reduction could be used for acidic sewage. The organic mercury sewage is difficult to dispose, generally to change it to inorganic mercury by oxidation first. (Source: Sewage with mercury)

3 TREATMENT OF PRINTING ADN DYEING WASTEWATER

China is a country which produces large amounts of textiles every year, so the printing and dyeing sewage is a big part of total sewage. The treatment of this sewage has vital importance to the environment.

3.1 **Basic information of China's textile insudutry and sewage**

In 1995, Chinese textile exports all ranked first in the world. In 2003, the total output of cloth is 31.9 billion meters. 7.578 billion meters of cloths are for exporting. (Source: How the dyeing plants dispose of sewage).

Most contaminants of this sewage belong to organic substances, and the contaminants are changed with the fibers which are used in the production process. In general, the pH value of sewage is 6- 10, that is to say the sewage is almost alkaline liquid. COD is 400-1000 mg/l and BOD is 100-400 mg/l. SS is 100-200 mg/l, chromaticity is about 100-400. From technology aspect, dyeing sewage is a sort of complex sewage. First, the value of COD is so high that the possibility of disposing by biochemical method is low. Second, the chromaticity is high as well, the color of the sewage normally is much darker that normal water. Last but not least, the contaminants are quite different when making different cloths. The figure showed in next page is the main method of making textiles. And it states the material that is needed for each method, and what would be produced after every work phase.

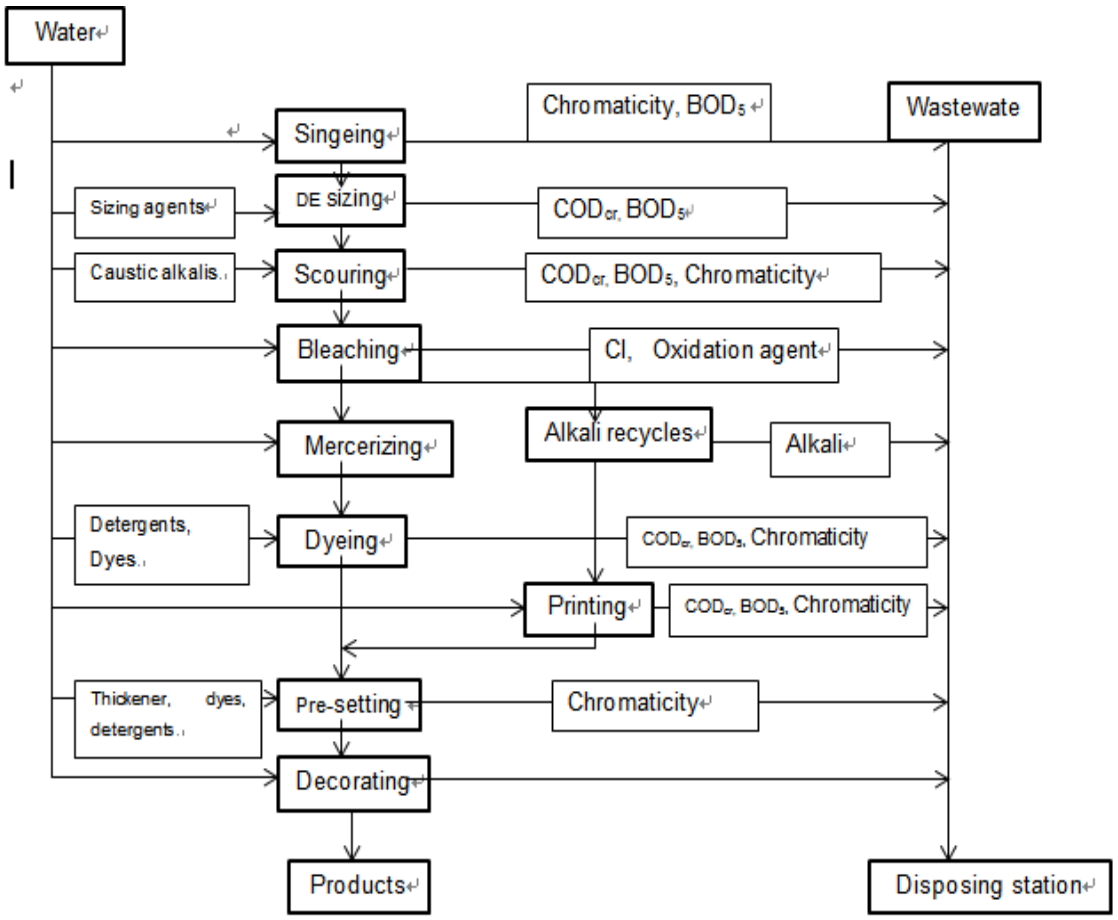

Figure 3: Main contaminants of dyeing sewage of every work phase.[3] P22

1) Singeing sewage

This stage is for burning the cilium on the surface of textiles to make the surface bright and clean. After singeing, the fire will be quenched by water. So, the burned substance and other materials will drop into the water. The COD_{cr} and BOD_5 concentration value exceeds the standard. Meanwhile, the sewage is colourful, too. (Source: Linsheng Zhang, Shenglin Zhang, Mingfang Xia, 2005, P22)

2) DE sizing sewage

The stage of DE sizing is to dissolve the sizing agent by using acid, alkali, and enzyme and oxidation agent. (Source: Linsheng Zhang, Shenglin Zhang, Mingfang Xia, 2005, P23)

3) Scouring sewage

Impurities on the textiles will be heated by detergent, sodium silicate and so on. The sizing agent remaining in the textile will be washed away by scouring. The feature of this sewage is strong alkalinity, high concentration of BOD_5 and COD_{cr}.

4) Bleaching sewage

There are many kinds of bleaching agents like sodium hypochlorite, hydrogen peroxide. Because of it, the property of sewage is different. The chromaticity is low and the BOD_5, COD_{cr} is not high as well. Therefore, the bleaching sewage can be discharged directly or recycled.

5) Mercerizing sewage

The textiles could get sheen after treating by sodium hydroxide. Because of this, almost all the textiles will be disposed by NaOH. As it is well-known, the NaOH is a sort of substance with strong alkalinity. When the concentration of BOD and COD is exceeding the standard, the sewage must be disposed.

6) Dyeing sewage

It is apparent that there are many types of dye. So, this sewage is complex, with high concentration of COD_{CR}, and high chromaticity. (Source: Linsheng Zhang, Shenglin Zhang, Mingfang Xia, 2005, P24)

7) Printing sewage

The printing sewage has the same properties as the dyeing sewage. In this stage, many kinds of dyes will be used, even more than dyeing stage.

8) Pre-setting sewage and decorating sewage

In the process of pre-setting, many chemical agents are needed and detergents to make the products soft or anti-water. Therefore, the sewage is also complex and needs to dispose of.

For decorating sewage, it contains chromium. Because of this, it is important to gather the sewage and handle it alone.

3.2 **The harm of printing and dyeing sewage**

The sewage has large amount of organic substances. When it is put into rivers or lakes without disposal, the oxygen in the water will be consumed so that the fish and plants in the water will be influenced. The nature balance will be broken. Due to the chromaticity of sewage, the appearance of water will be changed.

If the sewage is discharged into cropland, the land will be salinized. In some situations, it even could produce sulphides. The soil will be destroyed.

3.3 **One case of disposing printing and dyeing sewage**

In this part, there will be a presumptive case for treating printing and dyeing sewage. And all the data and the designs represent the author's personal opinion.

Assuming that the total amount of water is 2000 m^3/d, and the sewage is produced by a fabled factory of China.

Table 1,

The table below shows the quality of sewage before disposal; [10]

	Value	Unit
BOD_5	230	mg/L
COD_{cr}	1100	mg/L
SS	210	mg/L
Chromaticity	400	
pH	9-11	

Table 2,

The table below shows the quality of sewage after disposal. [10]

	Value	Unit
BOD_5	25	mg/L
COD_{cr}	100	mg/L
SS	70	mg/L
Chromaticity	40	
pH	6-9	

In order to get the target, it is important to collect information and select the method for handling the sewage. Therefore, next task is to gather the available ways and then compare to each other, and finally, to find out the best way to treat the sewage.

3.4 **Introduction and selection of treatment method**

There are three types of methods taht could be used to treat the sewage in writer's opinion. They are traditional activated sludge process, oxidation ditch process and biological contact oxidation process.

3.4.1 **Traditional activated process**

This is the typical way of treating sewage by the activated sludge process. The trait of this process is, the aerobes exist at the aeration tank is the form of activated sludge, and the oxygen is provided by air blower. The aerobes would reproduce and resolve the organic substances in the sewage. After precipitating, the mixed liquor (containing the sludge and sewage) would be separated, and then the sludge would flow into the aeration tank. Precipitation time is 4-6H. (Source: Shouyin Tang, Youzhi Dai, 2004, P326)

The advantages of this process are:

a) It is suitable for huge amounts of sewage.

b) Reliable and the quality of sewage is stable.

c) The effect for treating sewage is good.

d) The history of this process is long; there is much data and information about this technology. Enough management experience.

The disadvantages are:

a) High operating cost due to the waste.

b) High basic construction cost. Occupying large area. In China, the land resources are limited by the reason of large population.

c) Low adaptability.

d) Due to the short precipitation time, the removal rate is not satisfactory.

3.4.2 **Oxidation ditch process**

The oxidation ditch process was invented by Holland's public engineering research institute in 1950. The aeration tank is the shape of closed channel. The sewage and the

activated sludge is constantly flowing in the system. The structure of this system is diverse like a ring, oval or horseshoe- shaped basin. (Source: Oxidation ditch process)
The oxygen and flowing energy is offered by the aeration equipment. The depth of the ditch is shallow and flow path is long, so it can be designed as, anaerobic treatment at the place where has no aeration machine and aerobic treatment at the place where has aeration machine. The duration of stay is longer than the traditional activated sludge process; the time is about 15h. (Source: Qingliang Zhao, Yu Liu, 2006, P17)

Advantages:

a) The flow rate is large so that the sewage can be diluted by the circulating water. It has good ability to stand the impact.

b) The effect of treatment is stable.

c) The suspended solids and the organic substance can be degraded much more exhaustive because of the time of stay.

d) Little amount of sludge.

e) Good quality of sewage.

Disadvantages:

a) The management cost is high

b) Area is large

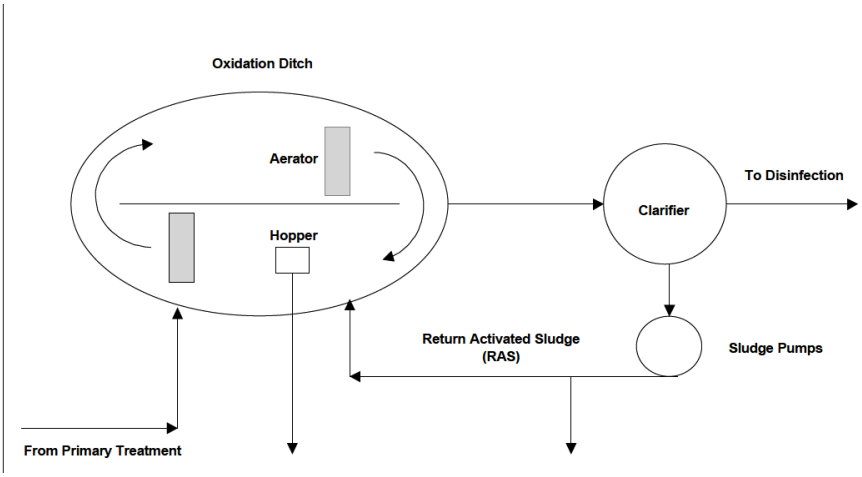

Figure 4: Typical oxidation ditch activated sludge system [4]

3.4.3 **Biological contact oxidation process**

The process is one kind of technology that is based on the activated sludge process and biological filter. The conception of this process is, putting the biofilm in the pool and the oxygen is released at the bottom of the pool so that the sewage can stay flowing in the pool. It can ensure that the sewage can contact that biofilm sufficiently. Through the oxidation, the organic substance can be degraded. It is widely applied in the dyeing industry.

Advantages:

a) Treatment duration is short.

b) The equipment could be smaller than in other two processes. The area is smaller in than other two processes.

c) High efficiency. The unit amount of microorganisms is more than in traditional activated process.

d) Suitable for low concentration sewage

e) Less remaining sludge

f) It is easy and convenient for maintenance and management.

Disadvantages:

a) The quantity of biofilms depends on the BOD.

b) The biofilm will drop into the pool.

3.4.4 **Selection**

After comparing these three types of treatment processes. It is apparent that the biochemical contact oxidation process is much more suitable. The BCO is based on the activated sludge process, so it has the features of ASP. The area is not so large. And

most important is, the quality of disposed sewage is good. Therefore, the final selection is the BCO process.

4 DESIGN FOR THE PROJECT

The picture below is the flow chart of sewage treatment process;

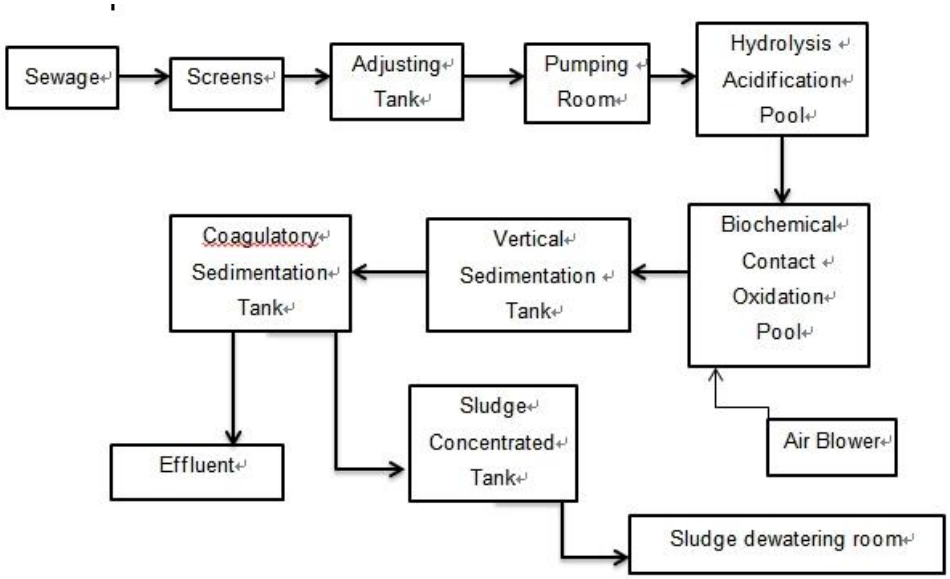

Figure5: Flow chart of treatment process of design

4.1 **Screens**

Screen is a sort of physical structure consisting of a group of parallel metal strips. Normally, it is installed at the entrance of sewage pump. The function of screens is to intercept the big suspended solids in sewage before they flow into adjusting tank. And screens also could reduce the load of next treatment structures.

The contaminants be intercepted could be cleaned manually or by machine. Usually, in large sewage treatment plants, the contaminants are cleaned by machine. On contrary, the manual way is used in small plant.

For the dyeing sewage, the distance between two metal strips is 10-20mm. The contaminants be intercepted are about 60%-70% of all contaminants. Moisture content is about 70%-80%. Density is 750 kg/m^3. (Source: Linsheng Zhang, Shenglin Zhang, Mingfang Xia, 2005, P58)

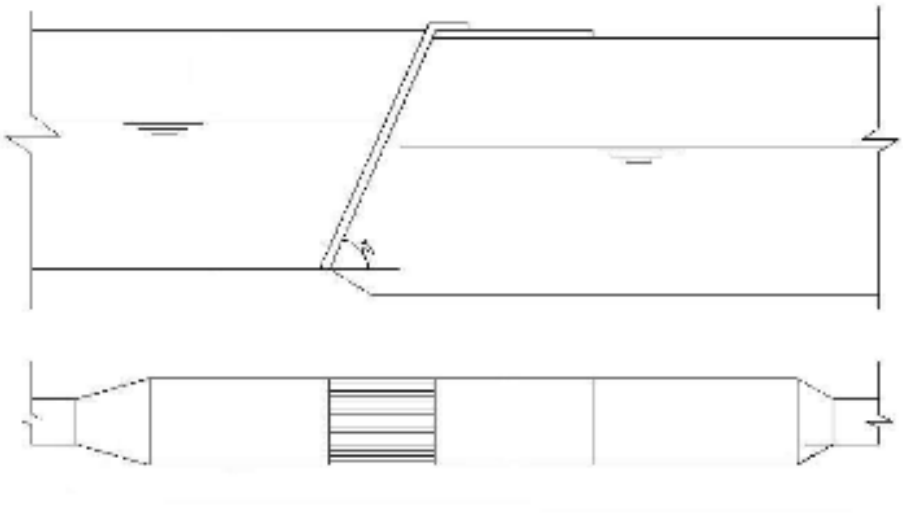

Figure6. Screen [3] P58

Because the flow rate is small, the manual method is a suitable way of cleaning contaminants.

4.2 **Adjusting tank**

The quality and quantity of sewage is changeable. Therefore, when disposing of sewage, it is needed to adjust the sewage first. The effect is not good when the quality and quantity of sewage changes a lot. Even the whole process will be broken.

If it is just used to adjust the quantity of sewage, normal tank could be the selection. If it is used to adjust both quality and quantity, it can use stir and mixture method. The shape of this sort of tank commonly is rectangle. The dosage of air is 4-6m^3, the effective depth is 3-5m. (Source: Linsheng Zhang, Shenglin Zhang, Mingfang Xia, 2005, P62)

Parameters

1) Designed flow rate: Q= 2000m^3/d = 83m^3/h= 0.023m^3/s

2) Stay duration: T= 10h

3) Depth: h=4m

4) Air consumption: q=8m^3/(m^3h)

Table 3,

Quality of effluent after adjusting;

	BOD_5(mg/l)	COD_{cr}(mg/l)	SS(mg/l)	Chromaticity	pH
Inflow	230	1100	210	400	9-11
Outflow	230	1000	190	400	8-10

4.3 **Hydrolytic acidification pool**

The shape of this pool is generally rectangular or circular. When it is combined with other processes, the efficiency can be improved and cost will be decreased. This is the process of transferring the contaminants from undissolved and un-biodegradable to dissolved and biodegradable. The biodegradability will be enhanced.

One of the key conditions that affect the pool's operation is the enough contact between sludge and sewage. So the distribution water system at the bottom of pool should be uniform. It is necessary to set several entrances for water.

Normally, the height of sludge in the pool increases, and the quality will also be improved. But when the height exceeds a certain value, the sludge will also be discharged from the pool. Therefore, when the height is high enough, the sludge needs to be cleaned immediately. Commonly, the height is 4-6m. In addition, there should be a board at the effluent position like screen to intercept the dross. Most of the dross is activated sludge.

Parameters:

1) Height: 5m

2) Stay duration: 4h

3) Flow rate: Q=83m^3/h

Table 4,

Quality after this process:

	BOD_5(mg/l)	COD_{cr}(mg/l)	SS(mg/l)	Chromaticity	pH
Inflow	230	1000	190	400	8-10
Outflow	200	450	150	350	6-9

4.4 **Biochemical contact oxidation pool**

The shape is mostly square, circular and rectangular. Normally the height is 4.5-5m. Filler's height is 3-3.5m. The aeration height at the bottom is 0.6m. Top water height is 0.5-0.6m, and the quantity of this pool is not less than two.

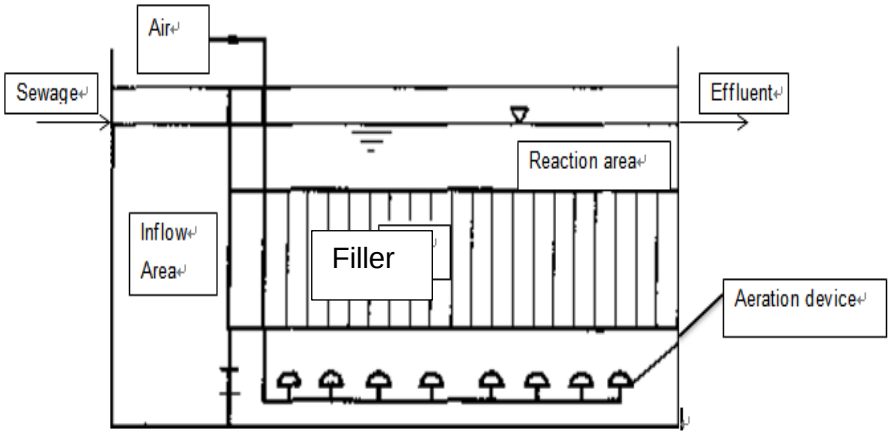

Figure7: Structure of biochemical contact oxidation pool [3] P157

Parameters:

1) Flow rate: Q=83m^3/l

2) Height: H=5m

3) Filler height: h=3m

In addition, the type of filler is one significant point which might influence the treatment. The standard of choosing filler should be as follows: large surface and porosity, small flow resistance, strong strength, low cost and stable material. The filler could be divided into three types: hard filler, elastic filler and soft filler. The choice for this case is elastic filler. The reason for this choice is the elastic filler which has the feature of the standards mentioned above. (Source: Linsheng Zhang, Shenglin Zhang, Mingfang Xia, 2005, P186)

Table 5,

Quality of effluent:

	BOD_5(mg/l)	COD_{cr}(mg/l)	SS(mg/l)	Chromaticity	pH
Inflow	200	450	150	350	6-9
Outflow	45	170	150	300	6-9

4.5 **Vertical sedimentation tank**

Primary sedimentation pool is the main structure of sewage treatment plant; it can remove the suspended solids in sewage. Meanwhile, it also could remove a part of BOD_5. There has three types sedimentation tank: horizontal flow sedimentation tank, radical sedimentation tank and vertical sedimentation tank. Due to the small flow rate of sewage, the choice is the vertical sedimentation tank.

The following picture illustrates the structure of the tank.

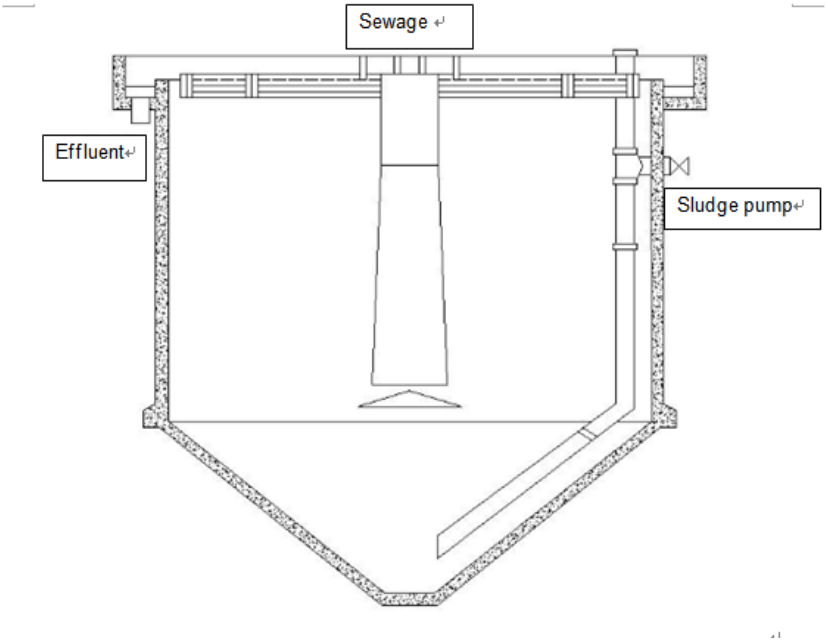

Figure8: Vertical sedimentation tank [3] P65

Parameters:

1) Flow rate: Q=83m^3/h

2) Stay duration t=2h

Table 6,

Quality of effluent:

	BOD_5(mg/l)	COD_{cr}(mg/l)	SS(mg/l)	Chromaticity	pH
Inflow	45	170	150	350	6-9
Outflow	45	170	95	250	6-9

4.6 **Coagulation sedimentation tank**

Coagulation is an important process of whole treatment processes for dyeing sewage. By using this process, the hydrophobic substances can be eliminated. It can be used after the bio-treatment to remove the dyes so that the chromaticity can be reduced. The process also can remove several kinds of macromolecular substances, colloidal organic substance and the heavy metals. According to the effluent quality after last process, it is apparently that the chromaticity and concentration of suspended solid is still high. So, it is necessary to use coagulation to solve this problem.

Mixture and reaction are the two processes of coagulation; mixture means the mix between coagulation agent and sewage. The period should be short and fast. Then the coagulation agent will react with the sewage. This duration depends on many conditions. (Source: Linsheng Zhang, Shenglin Zhang, Mingfang Xia, 2005, P113)

Parameters:

1) Flow rate: Q=83m^3/h

2) Coagulation time: reaction time t=30min. H=3.5m

Table 7,

Effluent quality:

	BOD_5(mg/l)	COD_{cr}(mg/l)	SS(mg/l)	Chromaticity	pH
Inflow	45	170	95	250	6-9
Outflow	20	90	20	40	6-9

4.7 **Sludge concentrated tank and sludge dewatering room**

The two processes are for disposing the sludge after treatment. The sludge produced by the whole system is a sort of substance with high moisture content; meanwhile, the volume of sludge is also large. It is not convenient for transportation, dispose. By using the concentrated tank, the volume of sludge could be decreased by several times comparing with the original state.

There are three ways to concentrate sludge, gravity concentration, and air floatation and centrifugation concentration. In China, the frequently-used method is gravity concentration. So, in this design, the concentrated tank is the type of gravity concentration.

Sludge dewatering is the last method of the whole system; the sludge finally will be transported to the refuse landfill. The dewatering can be accomplished by nature withering, machine and burning. In this design, the choice is machine.

4.8 **Assisting devices**

1) Pumping system

Due to the design of BCO process, the system is simple so that there just need one lifting process that is when the sewage is coming out from the adjusting tank. The sewage will be lifted into the hydrolysis acidification pool, and then the sewage passes the sedimentation pool and other pools natural.

Figure9: Lifting pump [5]

2) Air blower

The air blower is used to provide the oxygen the for the biological contact oxidation pool.

Figure 10: C20-1.5 Air blower [6]

5 CONCLUSION

There are many factors that might influence the result of disposing of what such as the temperature, structure and velocity of flow. Although the whole system seems simple, in fact, we can find that when dealing with the treatment, there are so many things need to be considered. Before treating, we need to measure what kind of contaminant is included in the sewage. After measurement, we need to think about and choose the suitable process for the sewage. In this period, a lot of complicated calculations are involved. In addition, the cost also should be included.

The emphasis of the research is the printing and dyeing swage. The reason for researching it is this sort of sewage as the main part of sewages, and firstly it has huge bad influence to the environment. Secondly, China ranks the first of making textile products; hence the quantity of dyeing sewage is very huge. This terrible situation must be solved before it has bad consequences. Lastly but most important, water is an essential thing for human beings and the social activities.

In theory, the sewage must be disposed before discharging. But the best way to dispose sewage in my personal opinion is reducing and preventing. With the rapid development of worldwide industry, the pollution of environment is getting worse. The sewage is one of the serious compositions of it. Most of time, people are in the wrong region, they just come up with some methods to treat sewage after it is being produced. In the process of manufacturing and production, so many substances are used even if the substances are harmful to the environment. Maybe, it is the time for us to think about other approaches to handle it. That is reducing and preventing. Substitutes could be the choice. The idea is to invent a new substance with low toxicity to replace the original substance. Also, the manufacturer could reduce the dosage of material or improve the efficiency of material.

Here are the ideas of mine for handling sewage. In my opinion, the principles should be as following:

1) Choose the harmless and advanced technology in manufacturing process, or reduce the usage of toxicity substance as little as possible.

2) Supervise the production strictly, reducing the run off of harmful substance. Use the reasonable treatment process and equipment.

3) The sewage with low pollution level and large quantity should be recycled. And it should not be discharge to the sewer. Because it would cause high pressure to the sewer.

4) The sewage with toxicity such as containing heavy metal, radioactive substance and cyanogen needs to be separated with other kinds of sewage
.

5) Some sorts of organic sewage that is similar with the urban sewage could be discharged in to sewer. And the biodegradable sewage should be disposed first, and then discharged after getting the permission. For the sewage cannot be degraded, it cannot be discharged into the sewer.

In short, it has to be said both the governments and the enterprises should enhance the awareness of protection for environment. In China, there are quite a lot of people who lack of the awareness of protecting environment. It is necessary to let people know what has taken place on our Earth. Treatment is not a good way for protecting environment, but the prevention is.

In conclusion, looking to the future, we are confronting with many serious issues which are related to the environment. But I have enough confidence that we could control it and make the environment better on the base of the advanced technology. One day, we will find a suitable way to make the Earth clean.

Graphical trends

Table 8,

The sewage and concentration of COD from 1998 to 2001 [7]

Year	Sewage (100 million tom)			COD emission (10000t)		
	Total	Industry	Domestic	Total	Industry	Domestic
1998	395.3	200.5	194.8	1495.6	800.6	695
1999	401.1	197.3	203.8	1388.9	691.7	697.2
2000	415.2	194.2	220.9	1445	704.5	740.5
2001	433	202.6	230.3	1404.8	607.5	797.3
Change (%)	4.3	4.3	4.3	-2.9	-13.8	7.7

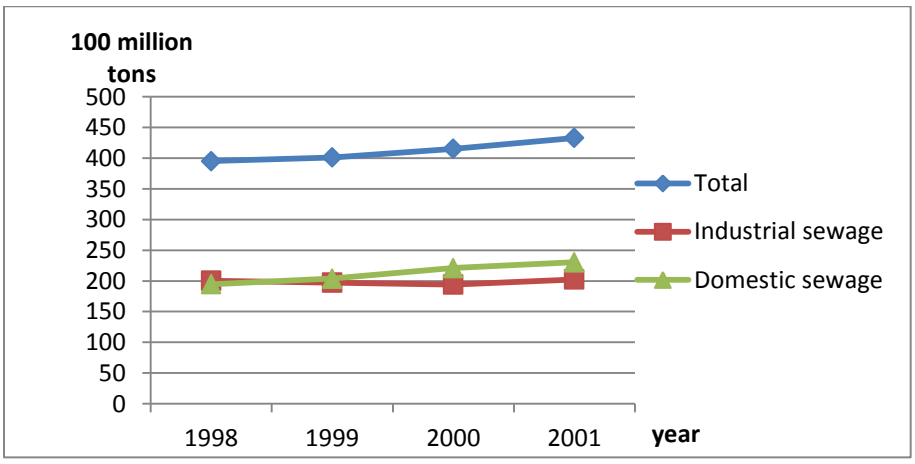

Figure11. Discharge value of sewage from 1998 to 2001

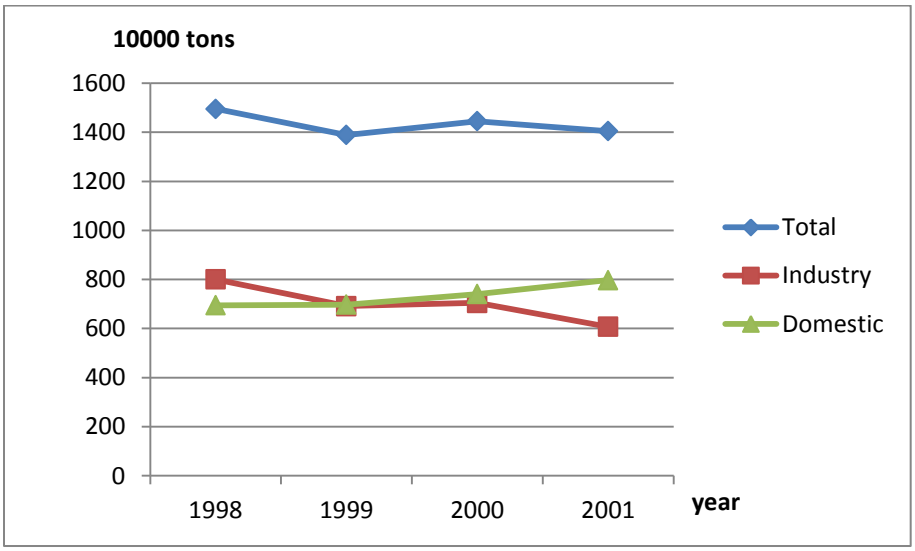

Figure12. Discharge value of COD from 1998 to 2001

The chart above shows the change of sewage's quantity from 1998 to 2001 in China, it describes that although the total sewage quantity is increasing huge; the concentration of COD is declining year by year. For industrial sewage, the COD is decreasing while the domestic' COD is rising. It illustrates that China paid more attention and money on treating industrial sewage in these four years.

Table 9,

The sewage and concentration of COD from 2001to 2002 [8]

Year	Discharging value (100 million tons)			Discharging value of COD (10000 tons)			Discharging value of ammonia nitrogen (10000t)		
	total	industry	domestic	total	industry	domestic	total	industry	domestic
2001	433	202.7	230.3	1404.8	607.5	797.3	125.2	41.3	83.9
2002	439.5	207.2	232.3	1366.9	584	782.9	128.8	42.1	86.7
2003	460	212.4	247.6	1333.6	511.9	821.7	129.7	40.4	89.3
2004	482.4	221.1	261.3	1339.2	509.7	829.5	133	42.2	90.8
2005	524.5	243.1	281.4	1414.2	554.7	859.4	149.8	52.5	97.3
2006	536.8	240.2	296.6	1428.2	542.3	885.9	141.3	42.5	98.8
2007	556.8	246.6	310.2	1381.8	511	870.8	132.4	34.1	98.3
2008	571.7	241.7	330	1320.7	457.6	863.1	127	29.7	97.3
2009	589.7	234.5	355.2	1277.5	439.7	837.8	122.6	27.3	95.3
2010	617.3	237.5	379.8	1238.1	434.8	803.3	120.3	27.3	93
Growth rate (%)	4.7	1.3	6.9	-3.1	-1.1	-4.1	-1.9	0	-2.4

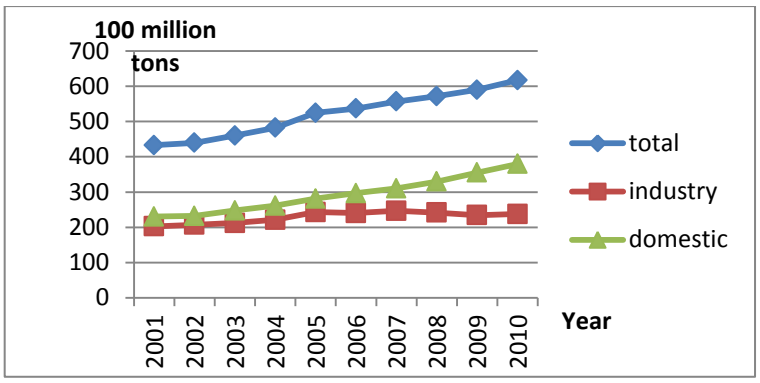

Figure13. Discharge value of sewage from 2001 to 2010

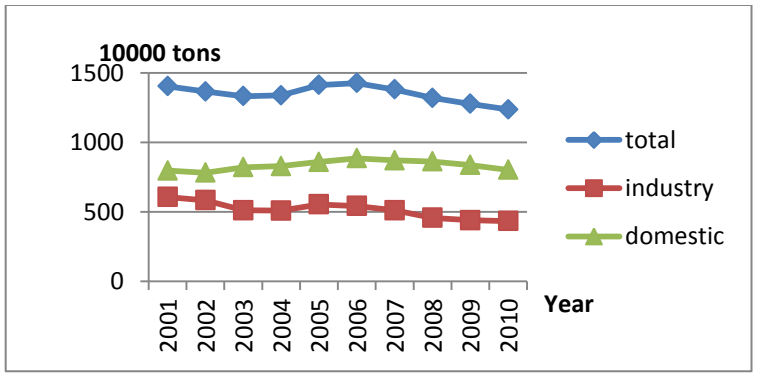

Figure14. Discharge value of COD from 2001 to 2010

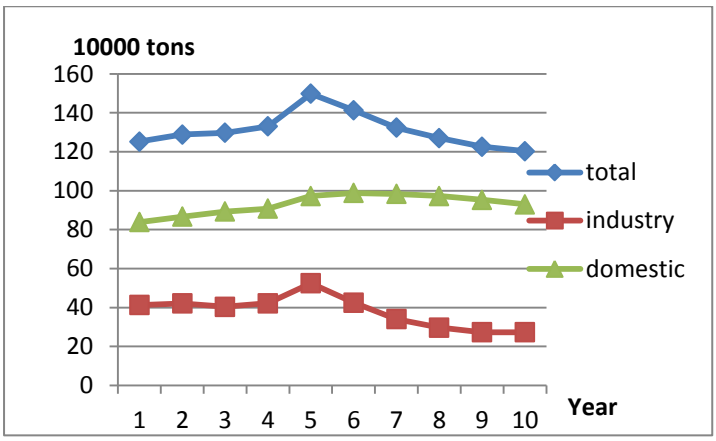

Figure15. Discharge value of ammonia nitrogen from 2001 to 2010

The pictures presented above demonstrate the change of total sewage quantity, concentration of COD and discharge value of ammonia nitrogen from 2001 to 2010. Apparently, with the growth of total sewage, the COD concentration and ammonia nitrogen value in industry field is decreasing.

Table 10,

Discharge value of heavy metals and other contaminants [9]

Year	Petroleum	Volatile phenol	Cyanide	Mercury	Cadmium	Cr(+6)	Total Cr	Lead	Arsenic	Unit
2011	20589.1	2410.5	215.4	1.2	35.1	106.2	290.3	150.8	145.2	Tons
2012	17327.2	1481.4	171.8	1.1	26.7	70.4	188.6	97.1	127.7	Tons
Change %	-15.8	-38.5	-20.2	-8.3	-23.9	-33.7	-35	-35.6	-12.1	

The table above shows the discharge value of heavy metal and other contaminants is on a declining curve.

In a short, according to the tables and figures above, the situation of sewage treatment in China is optimistic. Both the concentration of COD and other contaminants reduced every year. In the future, with the new technology appeared, the pollution status will much better than recent year's condition.

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