

1.10 Water Pollution Monitory Assessment and Control - A Case Study for Solving Water Pollution in a Petrochemical Industrial Area

Wang Ju-Si
Chinese Academy of Sciences, Beijing, China

Water pollution is a most serious environmental problem in China. The amount of wastewater is increasing year by year and reached 36.8 billion M³ in 1988. Water treatment techniques and facilities have lagged far behind the growth of industrial development and city construction. Only 25% of industrial wastewater and less than 3% of domestic sewage was treated. Even for factories in which wastewater treatment facilities have been built, drainage may still not reach the standard of wastewater discharge. This situation often happens in those industries such as chemical, petrochemical and pesticide production, coal gasification, dyeing and printing, etc.

This paper considers how to solve water pollution problems in a petrochemical industrial area.

Problems Arising

A petrochemical corporation located in the southwest of Beijing was built in 1967 and gradually extended to become one of the biggest enterprises in China. The corporation has one refinery, four chemical factories, a rubber plant, a chemical fibre carpet plant and two power stations. About 120,000 M³ of wastewater is produced each day, 75% from industrial waste and 25% from domestic waste. Three wastewater treatment plants were built during the 1970s and these accept and treat highly contaminated industrial wastewater (30% of total industrial wastewater in this area). These treatment plants have played an important role in water pollution control, but the situation has deteriorated since the early 1980s. Treatment efficiency decreased year by year, the outlet water of the plants still had high CODs and a high level of pollutants and was over the national standards of wastewater discharge. Water pollution became serious in this area. Surface water and ground water became polluted in different degrees, even the water reservoir which accepted water from the three wastewater treatment plants became a heavily contaminated water pond. Crops and vegetables which were irrigated with the water from the reservoir were polluted and could not be used as food. In order to solve the pollution problems, the corporation invited many experts from research institutes and universities to discuss and study ways of improving the environment in this area, and a number of projects were introduced between 1985 and 1988.

Here as an example we show how to improve the effect of one wastewater treatment plant which accepts and treats the wastewater from four factories. The projects followed the following procedure: investigation, assessment, proposal, design and practice.

Investigation, Research and Proposal

1. Sources of pollution were investigated and major sources identified. Measures for pollution control and suitable techniques for wastewater treatment from pollution sources were studied. Some special techniques were developed depending on the chemical properties of the pollutants in the wastewater so as to be very effective and economical.
2. Based on a diagram of the wastewater drainage system, the degree of pollution in each drainage line was assessed and major pollutant points needing control were identified.
3. The factor which had the most effect on the running of the wastewater treatment plant was the lack of any pretreatment inside the production factories. Sometimes as a result of an emergency in the production system, a large quantity of chemicals was discharged into the wastewater system. This caused a high concentration of chemicals to build up in the entrance to the wastewater treatment plant giving the plant a big 'shock'. So the wastewater system became overloaded and could not be restored for a long time.

It was suggested that pretreatment measures and facilities, such as oil separation tanks, wastewater storage tanks, etc. must be built inside the production factories.

4. Wastewater characterisation and analysis, pollutant identification and quantitative determinations were made. This was done for each pollution source, the effluent from each factory and the inlet and outlet of the wastewater treatment plant. More than a hundred organic pollutants were determined in wastewater. Major pollutants in the effluent of each factory were identified. Some of them had to be given more attention since they either appeared at very high concentration or were very toxic.
5. The biodegradation properties of wastewater and major pollutants discharged from each factory were studied. They could be described by their BOD curves and judged by the ratio of BOD to COD. Biodegradation studies of some major pollutants appearing in wastewater such as phenol, m-cresol, terephthalic acid, acetic acid, etc. were also undertaken. A ratio of BOD/COD of less than 0.2 usually means the compound is undegradable by aeration, higher than 0.4 means it is easily degraded. The ratio can vary with concentration of pollutant. The relation of biodegradation with concentration was obtained for each compound.

Based on the results of wastewater analysis, the biodegradation study of wastewater and major pollutants and the amount of wastewater discharged from each factory, the permitted concentration of pollutants in the effluent from each factory was decided and a standard for the entrance water of the wastewater treatment plant was set. This regulation protected the plant from 'shock' due to high pollutant concentration of entrance water and was very important in maintaining good running of the treatment plant.

6. A survey of the working status of the wastewater treatment plant and the investigation of problems in management and operation indicated some shortcomings in treatment facilities and management. A plan of renovation and extension of the plant was suggested. It was also suggested that a fair amount of domestic sewage should be introduced into the wastewater treatment plant to modify the entrance water quality and to supply enough nitrogen and phosphorus nutrition for the aeration treatment tank.
7. Strengthening management and emphasising education was important for water pollution control. The administration of environmental protection should be further improved and a set of regulations should be perfected. Reward and penalty is necessary for the unit or persons doing good or bad work for environmental protection.

Increasing environmental awareness is the basic guarantee of environmental protection. Strengthening education is vital, not only for the leaders and cadres responsible for environmental protection work, but also for every employee.

Practice

Based on the investigation and research work, a series of projects were put into practice:

1. Treatment facilities were built at pollution sources, and high concentrations of wastewater was thus controlled.
2. Pretreatment facilities, oil separators, wastewater storage tanks and neutralisation equipment were built in some production factories. The concentration, amount and pH value of wastewater discharged from each factory became stable so that the entrance water of the treatment plant also stabilised.
3. The engineering of the renovation and extension of the wastewater treatment plant was completed in 1987. New aeration and sedimentation tanks were constructed, filtration tanks were extended so that the capacity of the treatment plant was increased from 1200 M³/hr to 1800 M³/hr, domestic sewage was introduced so that it constituted about 45% of the total entrance water quantity. In addition a set of facilities for sludge digestion and concentration, mechanical dewatering of concentrated sludge as well as a sludge combustor were all built. Meanwhile, management and regulation was strengthened and the operation of the treatment plant was greatly improved.

As a result of the whole work described above and carried out in the 1980s, the water pollution situation has greatly improved. The quality of the outlet water of the treatment plant improved and the water reservoir became clean and fish could live happily.

Conclusion

Water pollution control is a hard task and needs the contribution of the whole society. Control and treatment at the source of pollution is the first thing. Solving water pollution problems needs science and technology as well as policy, law, regulation and management, etc. However, chemistry plays an important role and environmental protection cannot be done without it.

The Author

1964 graduated from Department of Chemistry Beijing University, 1964-75 Research Assistant, Institute of Chemistry, Chinese Academy of Sciences, 1975-86 Research Assistant Institute of Environmental Chemistry, Chinese Academy of Sciences, 1986 - Associate Professor, Research Centre for Environmental Sciences, Chinese Academy of Sciences. 1981-82 Visiting Scholar, Department of Chemistry, Queens College of the City University of New York, 1982-83 Visiting Scholar of Department of Pharmaceutical Chemistry, University of California. Research activities in industrial wastewater treatment and water reuse, biology for wastewater treatment, analysis and identification of environmental pollutants and their degradation products.