1. Project Name

1.4.4 Experimentation of the reclaimed use of steel factory wastewater
1974 (S49)~1975 (S50)

2. Objectives

The steel industry is a manufacturer consuming an approximately 100 to 150m^3 of water per ton of crude steel produced. Industrial water usage reached 24% of the entire industrial water ratio at the time of this project. Within the steel industry at the time, treatment technology for pickling wastewater, cold-rolled oil-bearing wastewater and coke oven wastewater was at the center of research due to the refinement of wastewater regulations. However, because the prior two were developed at a positive pace, the primary topic of this development research was the coke oven wastewater treatment methods. Although this type of wastewater was conventionally biologically treated after dilution, the development of the high quality treatment technology was done due to the flaws with SS, COD, Ammonia, and chromaticity that required revision, along with the demand for non-diluted water use savings.

3. Contents

Treatment Flow : Source Water→Coke filter → ammonia stripping→Active Sludge Treatment→Coagulating sedimentation →Sand Filtration→Ozone oxidation →Activated Carbon Absorption→Treated Water

Amount of Treated Water : 48~2.4m^3/day(smaller scale as the stage is subsequent)

Device Summary and operational conditions :

Coke filter (Tar removal) : Diameter 1m, Height 1m, Coke particle size 25mm, 40mm

Deammoniation tower : Diameter 1m, Height 5.5m, Liquid Temperature 85℃, pH9~10, Gas-liquid ratio 1000~4500

Gas cleansing tower : Diameter 1m, Height 5.5m, Circulating Liquid pH 1~3, Gas-liquid ratio 300~650

Active Sludge Device : Aeration Tank 31m^3, BOD Work Load 0.15~ 0.25kg/kg MLSS day

Coagulating sedimentation device : Diameter 830mm, Height 3m, Ferrous sulfate 2000~8000mg/L injection

Sand Filtration Device : Diameter 130mm, Anthracite 1~2mm, Sand 0.3~0.8mm, linear Velocity 10~20m/h

Ozone oxidation system : Reaction Tank Diameter 150mm, Height 4.5m, injection amount 20~160mg/L

Active Carbon Absorption Device : Tower Diameter 150mm, Height 1m, Flow Speed 2.8~5.6m/h

Corrosion in the gas cleansing tower was a concern, due to the ammonia removal device requiring a harsh pH and temperature setting. Data was collected for after the installment of a corrosion test piece covering 6 different types of materials within the tower.

4. Results

The characteristics in this project are in the experiments done with the treatment of gas liquids without dilution, also aiming for the objective product water quality. As a result of the experiment, although a water quality very close to the objective level was achieved, also with the obtainment of data required for the planning of other practical plants, issues requiring resolution emerged as well. The results and the emerged issues are stated here.

【 Results 】

(1) The treatment conditions in order to produce the objective water quality were made clear. With most of the water quality categories, the treatment conditions in order to bring the level below the objective level were revealed, although the set objectives were severe due to the consideration of reuse.

(2) Conditions in order to active sludge process without dilution were made clear. Because raw wastewaters contain biological components that are difficult to remove, especially when at a high concentration, active sludge treatment is usually done after the dilution of up to 5 times, using industrial waters. With this project, the attempt to no dilution active sludge treatment of liquids containing high concentrations of substances such as phenol was done. The possibility of treatment was observed if ammonia is decently removed.

(3) The active carbon absorption treatment is effective when in the process of further removing COD after the active sludge treatment. Although the active sludge absorption method is regularly used for the COD removal with wastewaters, it was proven that the method is useful even with this type of wastewater. Characteristically with this type of wastewater when in use of the active carbon absorption method, the COD absorption rate is significantly high, calculated by the difference of before treatment and the resulting level. The absorption observed in each of the towers was also very large in amount.

Example of the results of water analysis

Category	Source Water Quality	Objective product water quality	Product water quality
pH (-)	9.1~9.5	6.5~8.0	7.3
SS (mg/L)	160~ 940	Below 20	5
COD (mg/L)	2,100~4,200	Below 50	22
Phenol (mg/L)	400~ 900	Below 1	ND
Totalcyanide (mg/L)	100~ 160	Below 0.5	0.3~8.2
Ammonia (mg/L)	4,500~4,900	Below 100	200~570
Color	Brown	Colorless	Colorless to Tan

(4) Treatment Costs

Based on the results, the costs in the scenario of both no-dilution and 4 times dilution when treatment an amount of 1000m^3/day was calculated. The overall costs for the no-dilution plan resulted in an 11% increase in costs as the construction costs increased significantly, with a small decrease in operational costs.

【 Challenge 】

(1) Active Sludge Treatment

Reconsideration is needed due to the conditional space being found to be too small in order to stably process by the active sludge method. Although the active sludge treatment was possible without dilution, operational conditions became overly restricted with requirements for the BOD load to be small, for the stable operation. There is a possibility of affecting the factory as a whole in terms of environmental precautions in the case of this wastewater decreasing in quality due to problems in the treatment system. However, generally this type of wastewater changes in quality significantly, largely affecting the active sludge treatment. It is necessary to have a plan such as the installment of a precipitation tank in order to absorb the changes in water quality.

(2) Ammonia Removal

Although the objective ammonia removal level was 100mg/L, resulting water satisfying this level was rather uncommon. This is due to the planning mistakes and problems with corrosion within the ammonia removal device. When designing the practical use plant with an objective of 100mg/L, it is necessary to have enough margin in ability, and have enough consideration in the prevention of corrosion. It is required to reconsider the economic aspects as well as the device ability and treatment water quality due to the ammonia removal device being the most costly system in terms of construction and operational costs out of the entire system. It is also necessary to consider the effective use of the removed ammonia.

(3) Cyanide removal

The navy blue method was used for the small amount cyanide removal method. As a result, all levels of cyanide was observed to become approximately below 1mg/L when 4,000mg/L (as $FeSO_4 \cdot 7H_2O$) of ferrous sulfate was supplemented as a coagulant. Due to the above results, the problem is in the aftermath treatment of the sludge and the economic costs of using an excessive load of coagulant.

(4) The necessity for ozone oxidation treatment

The ozone oxidation was found to increase cyanide levels although it showed signs of COD removal as well. Due to this reason, the reconsideration of whether the ozone oxidation device is needed or not, is required.

5. Reference

Japan Keirin Association (JKA) Outsourcing Project

Cooperative Organizations：The Japan Iron and Steel Federation, Kobe Steel, Ltd.