Feasibility Analysis of "Zero Waste Water Discharge" of Coal Chemical Projects

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Abstract: Due to the inconsistent distribution of coal and water resources in China, the allocation of water for industrial development is very challenging. Due to the capacity constraint of regional surface water bodies, a mitigation measure called "zero waste water discharge" is proposed in the EIA statements of some coal chemical projects in order to deal with the problem on wastewater. This paper discusses some concerned issues such as technical feasibility, environmental impact, planning and management.

Key words: coal chemical, wastewater treatment, zero waste water discharge

Introduction

Coal chemical is an industry that converted coal to petroleum substitute products through chemical process. It is encouraged to translate the coal resource into the chemical substance and energy on site, considering the transportation problem of raw materials and the development of regional economic in china. Studies have shown that coal chemical industry is high water consumption industries (Lin 2010), therefore the main limiting factors for industrial development are coal and water resources (Yang 2012). Due to the inconsistent distribution of coal and water resources in China, the allocation of water for industrial development is very challenging (Cao 2011). Due to the capacity constraint of regional surface water bodies, a mitigation measure called "zero waste water discharge" is proposed in the EIA statements of some coal chemical projects in order to deal with the problem of wastewater.

Methodology

The methods of data collection, case study and survey are used in this study, mainly analyzed 13 demonstration projects of "zero waste water discharge" in coal chemical industry. A detailed list of the analytical projects was presented in Table 1.

Table1. List of the analytical projects

The type of the analytical projects	The number of the analytical projects
Coal-alcohol ether	5
Coal-natural gas	4
Coal-oil	2
Coal-olefins	2
Total	13

Case study showed that the feasible designs in "zero waste water discharge" of the coal chemical projects mainly included the evaporation pond disposal, the electro-dialysis desalination,

the brine concentration-crystallization, the multi-effect evaporation of the brine, the multi-effect evaporation-incineration, and the coal field humidification in the present. Industry surveys showed mostly of "zero waste water discharge" of coal chemical projects still remained in the design or test run stages. There are only one coal-oil project has carried out the "zero waste water discharge" operation practice, still with many challenges.

Results and discussions

Case studies showed that "zero waste water discharge" was difficult to achieve. Because it is heavily relied on the stability of the main production process, the integration of water treatment process and the scheduling of recycled water. The key problems of "zero waste water discharge" of coal chemical projects in practice are the following:

1. The water quality varies widely in disorderly operation conditions

The micro-organisms need to domesticate by the sewage treatment plant which would take 3 to 6 months. During this period the drain usually could not reach the design value. Whereas, we still haven't got appropriate disposal methods to deal with the large amount of wastewater during this period. Furthermore, in the present, most of the modern coal chemical industry still remains at the engineering demonstration stage. The unstablematerial consumption, reaction temperature as well as the reaction pressure, etc. lead to the significant changes in wastewater quantity and quality. Consequently, the closed loop water recycle design has been challenged greatly.

2. Lack of effective ways to reuse all the recycled water leading to the water unbalance in coal chemical projects

The deep treatment and the wastewater reuse are the important factors to achieve "zero waste water discharge". Recently, most of the coal chemical plants have carried out wastewater reuse. The biologically treated wastewater and deep treated wastewater have been discharged into the circulating water system as the supplementary water. In order to further improve the capacity of wastewater reuse, several coal chemical plants have tried to put the treated gasification wastewater into the "circulating sewage" system as the supplementary water. But in the case practice, it is still hard to keep the water balance absolutely for the unsteady operation of main equipment as well as the significantly changed demands of the circulating water.

3. Additional steam consumption increases the energy consumption

The key in wastewater treatment of coal chemical projects is the gasification wastewater treatment process. Respectively, the wastewater discharged from the low/medium temperature lignite gasification unit is highly concentrated, toxic, and difficult to be bio-degraded. In the present, using low-quality coal with high-sulfur and high-ash, such as the lignite, as raw material in coal chemical industry is very often in china. The lignite was gasified mainly with the pulverized coal pressurized gasification (solid slag) technique and BGL gasification (slag tapping) technique. Due to toxic pollutants, primly coal tar and phenol, were highly concentrated in the lignite gasification wastewater, steam stripping technique was used to remove those difficult-biodegradable materials. After all, the trouble of significant increase in energy consumption of enterprises was lay ahead.

4. Deep wastewater treatment might produce the secondary pollution

In "zero waste water discharge" designs, we usually recycled the treated wastewater into the circulating wastewater system to improve the wastewater reuse capacity. However, it would cause trouble to the follow-up treatment of circulating discharged wastewater. Currently, the high

efficient reverse osmosis (HERO) technique has been tested to treat the circulating discharged wastewater in several coal chemical plants to improve the water reuse rate. But the risk of this technology was the disposal of large amount of sludge, which was discharged from the sewage treatment unit, since substantial water-softening agents were added to meet the waterquality requirements of ultra-filtration-reverse osmosis (UF-RO) unit.

5. The evaporation pond still has many problems

Because solid-evaporation-crystallization technique consumed too much energy, natural evaporation pond technique is widely adopted to deal with the brine wastewater in coal chemical projects. However, up to now, the evaporation pond technique is still immature, with many unresolved engineering issues. There haven't been suitable regulations to be followed yet in the evaporation pond design. The drainage usually exceeded the design value of the evaporation pond in practice. Consequently, it was showed that "zero waste water discharge" was difficult to achieve in case studies.

Moreover, continuative attentions should be paid to the problems of evaporation pond technique. Firstly, the large-scale evaporation pond would occupy substantial amounts of land and over-burden the resources. Secondly, the brine containing a lot of industrial pollutants increases the groundwater pollution risk. Besides these, there are risks of volatile pollutants and dam failure. Furthermore, the crystal-salt solid waste in evaporation pond has to be properly disposed to avoid the potential secondary pollution.

Recommendations

Above all, the recommendations on environmental management is that a scientific and rational plan of coal chemical industry should be made at the early stages, including industrial distribution, technologic selection and environmental management requirements. In the mean time, the strategic environmental impact assessment of planning should be carried out by the local government. Particularly, in order to achieve the rational water resource usage and the efficient environmental protection, we should plan the cascading utilization of the water resource from three levels: the region, the industrial park, the plant.

In addition, the important suggestion on wastewater treatment technology is that wastewater reuse designs should be changed from "sentinel reuse "to "multi-reuse", as well as the wastewater reuse approaches should be expanded to further reduce the environmental risks of water treatment, and minimize the discharge of the wastewater.

Suggestions of "zero waste water discharge" in coal chemical industry are as follows:

1. The EIA statement of "zero waste water discharge" should be strictly reviewed, and the pilot plant of "zero waste water discharge" should be carried out prudently.

2. In order to improve the capability of the terminal wastewater treatment service support, more attention should be paid on the water scheduling capability of industrial park.

3. The advanced wastewater treatment technology, such as membrane technique and high efficient reverse osmosis (HERO) technique should be further studied to improve the efficiency of wastewater treatment and minimize the discharge of wastewater.

Conclusions

Considering the problems of recycle water balance, high energy consumption, potential secondary pollution transfer, strictly "zero discharge of wastewater" of coal chemical projects is

difficult to achieve. In order to minimize the environmental impacts of wastewater discharge, it was proposed to improve the operational stability of main production process, expand wastewater reuse approaches, add wastewater reuse points, and practice strict environmental management of "zero waste water discharge" in coal chemical industry.

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