Design and Improvement of Wastewater Treatment Flowsheet Experiment

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This work is aimed to improve the teaching effect of the practice link of Water Pollution Control Engineering course. We added three new sections into the traditional wastewater treatment experiments, named as observation of laboratory wastewater treatment process, observation of tertiary treatment device and filtration backwash experiments. Via practice, the reform was proved to be successful in increasing students' ability of solving practical problems as well as their engineering consciousness.

Keywords: Wastewater Treatment Flowsheet; Comprehensive Experiment; Adsorption Performance; Teaching Reform

1. Introduction

In order to cultivate and bring up a group of engineering technical talents of strong creativity and strong social adaptation ability, the Education Department initiated the “outstanding engineer’s education training plan” in 2010. The plan is expected to play a conductive role in the development of Chinese new industrialization and the building of an innovative country, which means engineering specialties, should restructure the talent cultivation mode to meet the new requirements [1-4].

Water pollution control engineering is the core course of environmental engineering specialty in North China Electric Power University. However, in the early times of our teaching process, excess attention was put in the input of theories knowledge resulting in the divorce between theory and practice. Therefore, the reform of this course is of great importance. From 2008, we have stressed the comprehensive experiments and design experiments in the practice link in order to improve students’ practical and innovative ability [5-7].

On the basis of the reform practice in recent years, we further added a new wastewater treatment flowsheet experiment in “2013 talent cultivation plans”. The experimental device is of the same structure as the device used in practical engineering. This new experiment is aimed at strengthening students’ understanding of environmental equipments and the ability of solving practical problems, as well as their engineering consciousness. The total experimental
process is divided into three sections named as observation of laboratory wastewater treatment process, observation of tertiary treatment device and filtration-backwash experiments.

2. Observation of Laboratory Wastewater Treatment Process

The laboratory wastewater treatment process is displayed in Fig. 1. The observation process is divided into teacher explanation, students questioning, discussion and conclusion. The whole treatment process is automatically controlled.

At first, all the laboratory wastewater was collected into the underground wastewater pond and subsequently pumped into the pH adjusting reactor. Appropriate amount of acids were added in order to adjust water pH to 3.6. After that, the wastewater entered the reduction reactor and was mixed with appropriate amount of ferrous sulfate. Various metal ions were reduced from high valence to low valence in this reactor such as Cr6+ to Cr3+ and Mn7+ to Mn2+. After reduced, the water flowed into the neutralization reactor and these metal ions precipitated via increasing water pH. At last, the resulting mixture was pumped into aeration pond to filter out the precipitate and some soluble impurities. The packing medium in the aeration pond is appropriate amount of active carbon and quartz sand.

Via this section, students could deeply understand the way we treated the laboratory wastewater and the role of each step in the whole process. Also, they would know the composition of the wastewater and the method to remove specific pollutants. As this section is lack of practical operation, we added the “filtration-backwash experiments” to let students further master the filtration process.

Figure 1. Schematic diagram of laboratory wastewater treatment process.
3. Observation of Tertiary Treatment Device

The model of actual water tertiary treatment process is displayed in Fig. 2. The processing capacity is 5-18 L/h and the process flow is as follows.

The water was collected in the wastewater pond at first and then entered the iron/carbon electrolytic tank to remove organic pollutants from water. There is an aerating device equipped in the tank. This process is suitable for pretreatment of highly concentrated waste water. Subsequently, the water overflowed into coagulation tank to be mixed with flocculant and coagulant aid. After complete agitation under aeration, colloids in water formed alum grains and were removed in the vertical flow sedimentation tank. Then, the wastewater overflowed into the biologic aeration tank to react with activated sludge. Bio organic pollutants in water were adsorbed onto the sludge and removed via the inclined plank precipitator, which is included in the biologic aeration tank. To further purify the water, quartz sand filtration and activated carbon adsorption were set following the biological process. At last, ozone bactericidal technique was used to remove the germs and residual pollutants.

This section gave students a comprehensive cognition of the actual water tertiary treatment process and an opportunity for them to apply theory to reality. In this section, students could clearly observe the phenomenon of aeration, overflow launder and filtration-backwash, except for the specific treatment effect. Therefore, the “filtration-backwash experiments” was added to fill that gap.

Figure 2. Schematic diagram of tertiary treatment process.
4. Filtration-Backwash Experiments

The device used in the filtration-backwash experiments is displayed in Fig. 3. The whole process is divided into two periods, filtration and backwash. At first, the simulated wastewater was poured into the water tank and subsequently pumped into the filtration column. In the filtration period, valve 1 and 4 were on, while valve 2 and 3 were off. The water flowed from the top downwards and the pollutants were adsorbed onto the surface of packing medium. Via measuring the effluent quality, students could know the efficiency of the filtration column and whether it is deactivated. In the backwash period, valve 2 and 3 were on, while valve 1 and 4 were off. Clean water flowed from the bottom upwards and continuously washed the packing medium. Also by measuring the effluent quality, we can know whether the filtration column has been recovered.

In this section, student could explore the effect of filter medium (active carbon, quartz sand) and filter height on the removal efficiency of suspension particles and dyes. Also the practical operation of filtration and backwash is projected to deepen their understanding of filtration mechanism and process.

Figure 3. Schematic diagram of filtration-backwash device.

5. Conclusions

Via the reform of the practice link of water pollution control engineering course, students could experience the actual operation process of wastewater treatment, therefore developing their engineering consciousness and the ability of solving
practical problems. Moreover, graduates in recent years gained more appreciation from the employer units.

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References