Design of a Plant for the Removal of Phenol from Industrial Wastewater Using Super-Critical CO₂

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ABSTRACT

Phenolic compounds are common water pollutants and include a wide variety of organic chemicals. They are known to cause a lot of harmful effects on environment specially to human, animals and plants. Therefore, industrial drainage water containing phenol must be treated before entering the water resources. Wastewater containing phenol is generated in many of the steel industry’s coking facilities. A typical concentration for phenol in the effluent water is 6.8 wt%. Before this water can be released to the environment, the phenol concentration must be reduced to (or less than) 39 ppb which is the standard concentration required prior to disposal.

One of the method for removal of phenol from wastewater is extraction using supercritical CO₂. Recent research works found this method to be economically competitive with the alternatives. These alternatives include incineration, wet air oxidation (supercritical water oxidation), and biological processes.

In this project, a plant for the removal of phenol from industrial wastewater using supercritical CO₂ is modeled, simulated and designed using the chemical process simulator "Design II" Version 12. The software is a product of WinSim® Inc. The plant was designed to remove phenol from wastewater of a nominal quantity of 10,000 kg/h (543 kmol/h). The concentration of phenol in the wastewater is set at 6.8 wt% which is the average concentration of phenol in steel industries wastewater. The objective of the whole plant is to reduce the phenol concentration and bring it to (or less than) 39 ppb. Technically, the simulation results showed that the plant could be designed for this purpose. Economically, the results showed that the reuse of the phenol recovered from wastewater can bring considerable monetary saving in the cost of phenol as a raw material for many of the chemical process industries. This benefit was indicated by the return back (payback) period of the capital investment on the plant installation and operation. For this project the total capital cost was estimated at $52,290,000 while the amount of monetary saving on the cost of phenol is estimated at 13,012,000 $/yr. As a result of these costs, the payback period was found to be about 4 years which means a great encouragement investing in such projects. Environmentally, such treatment plants are of great importance and benefits since they are directly related to saving humans, animals and plants lives which are extremely valuable than monetary saving.