BACKGROUND

For the past three years, BP has been planning a $3.7 billion upgrade to its Whiting refinery to process Canadian heavy crudes. This upgrade will allow the refinery to process 90% Canadian heavy crude instead of mixing it with a minimum of 70% light crude, primarily from the Middle East. Not only will this result in reduced demand for crude oil coming from politically unstable regions, but it will also allow the plant to increase its gasoline and diesel production by 15%.

Canadian heavy crudes pose processing challenges because they contain significant amounts of nitrogen and sulfur than conventional crudes; these impurities must be removed to meet the increasingly stringent standards for gasoline and diesel products. In order to move forward with the expansion, BP filed for a new permit with the State of Indiana and the Environmental Protection Agency to increase its ammonia and TSS waste. The newly proposed levels of the permit would still lie bellow the federal limits.

Once word of the permit reached the media, however, there was public outcry against any increase in the disposal of waste in Lake Michigan. Because of this, BP decided that they would not implement it implement its design for the Whiting expansion until an acceptable design modification could be found for the wastewater treatment plant so that the amount of ammonia and total suspended solid, TSS, being dumped into Lake Michigan would not increase.

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IPRO 346

BP Whiting Refinery Expansion:

Developing Lake Michigan Wastewater Cleanup Options

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OBJECTIVE

The objective of IPRO 346 was to plan and design different models for possible upgrades to BP's Whiting refinery wastewater treatment plant to reduce the levels of ammonia and total suspended solids (TSS). To accomplish this objective, suitable technical options had to be investigated and several intermediate goals and environmental consideration were needed to be met.

TEAM FRAMEWORK

The team leader designates tasks and ensures that everyone is on track. The senior Chemical Engineering students fill this role in a sub-group. A collaborative session of all groups presents its work to the full group. The entire group was divided into the following teams:

- Ammonia Air Stripping Units
- Biological Aerated Filters (BAFs)
- Brine Treatment
- Equalization Tank
- Integrated Fixed Film Activated Sludge (IFAS)
- Membrane Modeling
- Moving Bed Bio-Film Reactor
- Refining
- Regulatory
- Sour Water Stripping
- Tar Sands
- Wastewater

CURRENT WASTEWATER TREATMENT

BP's wastewater treatment plant is currently discharging a monthly average of 1,030 lbs/day of Ammonia and 3,636 lbs/day of total suspended solids (TSS) into the Great Lakes. BP's refinery process wastewater enters a bar screen and grit chamber to enable collection and removal of large solid debris and then enter an API separator. The wastewater enters the API separator to separate oil, which goes to a surge tank, and solids from the wastewater. The wastewater goes to an equalization tank to lower the concentration of TSS and then through a dissolve air flotation (DAF) that clarifies the wastewater. Aeration Tanks are used to lower the concentration of ammonia, where the effluent stream is sent to secondary clarifiers and a tertiary filtration for the final process.

Located just south of Gary, Ind., the Whiting refinery is the second largest of BP's five U.S. refining operations.

BP'S PROPOSED TREATMENT PLANT

BP in Whiting, IN which wants to use its refinery to process higher capacity heave crude oil from Canada is researching ways to update its wastewater treatment process in an effort to pollution in Lake Michigan. To keep its promise not to exceed limits on its old water permit, BP will need to find more ways not to strip ammonia and suspended solids from its wastewater. BP is proposing a new wastewater treatment plant, which includes a sour water stripping, brine treatment, equalization and tertiary filtration.

MEMBRANE MODELING

A suggested technical option for BP's expansion due to reducing the limits for TSS and ammonia is a membrane process. A membrane module reduces the number of unit processes in treatment systems. Therefore, formation of secondary chemical by-products does not occur and less sludge production is expected. But membrane has a low life time, low selectivity and is costly.

These systems can be installed above or below the ground. The system shown in this picture shows how several units are assembled so additional capacity can be added as needed.

OTHER TECHNICAL OPTIONS

Other technical options that have been suggested to BP are the following:

- Integrated Fixed Film Activated Sludge (IFAS) – increases treatment capacity by introducing media inside the aeration takes
- Moving Bed Biofilm Reactor (MMBR) - enhances the removal of TSS as well as ammonia by inducing growth of additional microorganisms
- Biological Aerated Filters (BAFs) – enhance ammonia and TSS removal by filtration
- Ammonia Air Stripping Units – removes ammonia from the wastewater and return it to the crude oil processes