Extending the run time of Canadian Natural's Kirby Evaporators

Canadian Natural is always looking for ways to increase operational efficiency. Enhancing vapour washers in one of our SAGD facilities is a great example of improving business value while reducing our impact on the environment.

At Canadian Natural's thermal operations, we use the Steam-Assisted Gravity Drainage (SAGD) process: a process that uses recycled water to produce the steam necessary for bitumen recovery. Over time, the evaporators that produce the water for the steam in the process build up scale and foulants and must be taken out of service and cleaned about once per year.

By using a Computational Fluid Dynamics (CFD) model, Canadian Natural identified one of the causes of build up and modified the vapour washers to effectively double their run time. This change has extended the time between cleanings which has reduced costs, and is ensuring high efficiency performance for longer. We are now applying this solution for all other evaporators of the same model.

Business Benefits

- Reduced costs by increasing the amount of time between evaporator cleanings.
- Increased high efficiency performance for longer.

Identifying the Issue

As part of regular operations at our Kirby thermal facility, emulsion from well pads is processed to separate the oil and water, then constituents of concern in the produced water are removed through an evaporator process. The evaporators produce boiler feed water for the steam generators and this equipment is cleaned yearly due to fouling.

There are two main types of fouling in the evaporators — tube scaling and vapour washer mist eliminator plugging. These issues reduce the overall rate of the evaporator — tube scaling reduces heat transfer and vapour washer plugging can break through into the boiler feed water. Vapour washer plugging is usually what drives the need for an evaporator cleaning.

In the evaporator, a portion of the produced water is evaporated in the exchanger tubes. The steam and brine (concentrated produced water) are separated in the sump of the evaporator and the steam is drawn through the vapour washer into a compressor. The steam is then compressed and sent to the shell of the exchanger; it condenses there as boiler feed water and provides the driving force for evaporation on the tube side.

The purpose of the vapour washer is to ensure that no brine is carried through the compressor and into the boiler feed water (anything carried through risks fouling in the steam generators). The vapour washer mist elimination is done by a vane pack and de-mister. They slowly plug up over time due to salts, solids and oil in the brine.

The plugging results in high velocity that carries brine through to the compressor. If the cause of the fouling can be determined and reduced at the source, the runtime of the evaporators can be extended. Canadian Natural explored this through simulation and field work shown on the following page.

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Research Findings and Improvements

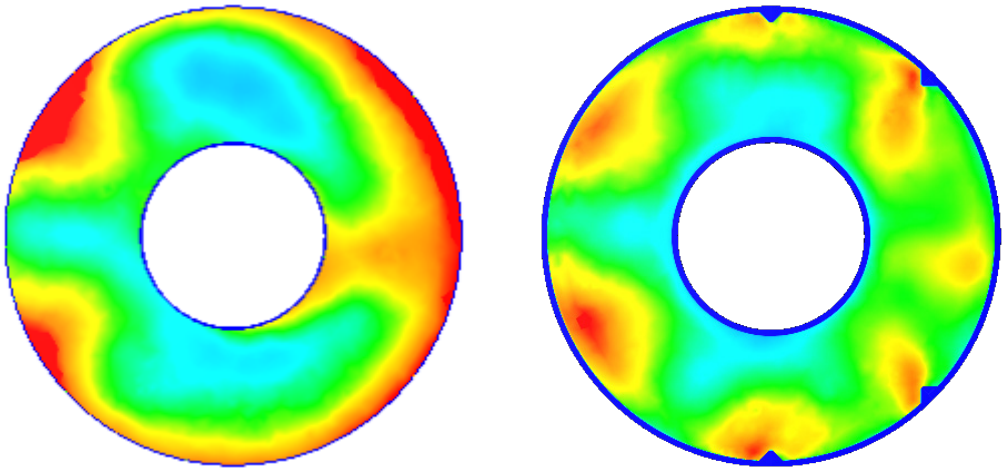
Due to non-uniform fouling observed during cleaning of evaporators, we hypothesized that poor flow distribution was causing the high velocities that resulted in overall poor vapour liquid disengagement and accelerated fouling. In theory, better flow distribution would solve the problem and ultimately result in extended run times.

A Plexiglas model of the upper section of the vapour washer was made to improve brine removal and reduce plugging, but the model was found to have poor repeatability. The vapour washer was then modelled using Computational Fluid Dynamics (CFD). This confirmed uneven steam loading — the high loading areas of the vane pack are where the worst plugging occurred during evaporator cleaning.

Following multiple iterations to the CFD model, we determined two vapour washer modifications could yield better flow distribution:

- Baffles installed on the inside of the exterior wall of the upper section of the vapour washer, between the vane pack and upper sump floor.
- A 40% open area backing plate installed to the entire vane pack.

Following the baffles installation, the team saw a significant reduction in carryover through the mist eliminator at evaporator start-up. Preliminary estimates show the run time of these evaporators has been doubled and this solution will be used for all other evaporators on the same model.



Original vapour washer flow distribution (left). Red is high velocity, blue is low velocity (flow left to right).