Mitigating fouling in the High Temperature Paraffinic Froth Treatment process through science and serendipity

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High Temperature (70 to 90ºC) Paraffinic Froth Treatment (HT-PFT) process will be used by ExxonMobil in the Kearl commercial project (300,000 bbl/D) to clean the froth resulting from water-extraction of mined oil sands in Alberta, Canada. In this process, a paraffinic solvent (pentane-isopentane blend) is added to the froth—consisting of bitumen, solid fines (inorganics), water and air—in a proportion to precipitate out a small fraction of the asphaltenes from the bitumen. The asphaltenes precipitation enhances the removal of solid fines and water from the froth, but increases the fouling risk. Concerned with the significant fouling of the inner walls and the launder areas of the froth treatment vessels (Figs. 1 and 2) in a pilot testing of the HT-PFT process, a research program had been conducted to mitigate the fouling risk in the commercial project. This presentation will highlight the application of science and serendipity during execution of the program that led to the understanding of the HT-PFT fouling and three novel solutions in preventing fouling, cleaning fouled vessels, and reducing foulant carry-over, culminating in three Canadian patents.

Assisted by a team of scientists from Imperial Oil and ExxonMobil, the research has significantly reduced the fouling risk by:

- applying fouling science (ExxonMobil's Fouling Analysis Strategy Tool) in identifying the nature of the foulant and postulating a fouling mechanism
- monitoring foulant build-up using gamma-ray densitometer and physical measurements
- inventing the fouling prevention solution by serendipity (patent CA 2594205) and demonstrating it in pilot tests
- inventing a simple method for cleaning fouled vessels through out-of-the-box thinking (patent CA 2592725) and demonstrating it in pilot tests
- inventing a new method of reducing foulant carry-over using results from "failed tests" (patent CA 2595336).

The following conclusions are made from the research program:

- foulant builds up to a certain thickness in the vertical section of the vessel and remains at that thickness for the remainder of the pilot operation
- foulant consists of inorganics held together by asphaltenes
- a fluorocarbon polymer coating (FPC) with no additives and with a narrow water contact angle distribution prevents fouling (Figs. 1 and 2) and, out of thirteen materials evaluated, is the only successful anti-fouling material
- liquid jetting is more effective for removing the loosely bonded foulant than chemical cleaning
- foulant carry-over to downstream pipes and equipment may be reduced by placing foulant collectors—made of materials that failed in preventing fouling—inside the froth separation units
- fouling in HT-PFT is a manageable risk with the implementation of the solutions identified in this research and proactive engineering design.

Fig. 1. Carbon steel vessel and coupons collect foulant; FPC coupon (white) remains clean

Fig. 2. Carbon steel vessel collects foulant; FPC liner (white) prevents fouling