An efficient approach for techno-economic evaluations of membrane technologies in SAGD Central Processing Facilities

Oil sands operators are continuously investigating ways to reduce operating cost, energy use, and associated GHG emissions through process optimization and the development of innovative technologies. Steam Assisted Gravity Drainage (SAGD) is a thermal bitumen production technology widely used in Northern Alberta's oil sands. A SAGD process consists of bitumen production from subsurface reservoirs and bitumen and water treating in a surface facility.

The Canadian Oil Sands Innovation Alliance (COSIA) Water Performance Goals are focused on reducing fresh water use intensity in the oil sands and their published "aspiration" is to "be world leaders in water management, producing Canadian energy with no adverse impact on water." One of the technologies that has been under consideration for some time is the use of membrane technology to replace the lime softening/ion exchange systems typically found at these facilities. This article reports on a high-level evaluation of membrane technology as applied to a typical SAGD central processing facility (CPF) and the implications of such a technology change for key indicators such as make-up water use, regulatory compliance, steam generation and GHG emissions. We describe how COSIA's InsituSIM online software can be used to perform these evaluations efficiently.

For comparison purposes we describe first the CPF base case that involves a CPF with the following characteristics and is illustrated with the InsituSIM process flow diagram in Figure 1:

- 33,000 bpd bitumen production
- SOR: 3
- Brackish make-up water
- Mechanical lift (emulsion temperature 170 C)
- Warm lime softening and ion exchange (WAC) water treatment
- Once-through steam generators

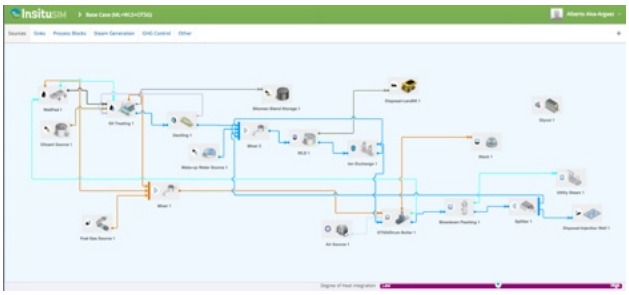

Figure 1. Base Case.

In order to compare the base case with the membrane option, some modifications to the flowsheet would be required.

In consultation with industry experts it was determined that two membrane systems would be installed to perform the produced water de-oiling step and another (reverse osmosis operating at 85 C assumed for this case) for Silica, TDS and hardness removal. As illustrated in the modified process flow diagram in Figure 2, in addition to the membrane blocks, a new disposal water treatment (DWT) block has to be included to treat the membrane reject streams and remove the silica before disposal of the wastewater. Performance parameters for the selected membrane blocks were obtained from the technical literature.[1] Different membrane specifications would lead to different conclusions, however InsituSIM enables users to enter their own performance and economic parameters.

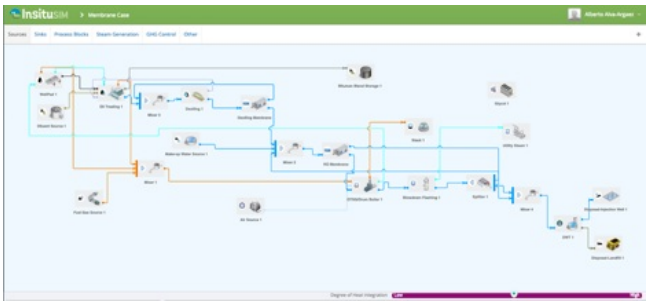

Figure 2. Membrane Case.

The main results of this comparison are presented in the following table:

Parameter name	Unit	Base case	Case with membrane
OTSG Steam Quality	%	77	90
D81 Disposal Limit	%	16.2	16.0
D81 Actual Disposal	%	9.1	12.9
Make up water use	m3/d	5,760	4,519
BFW TDS	ppm	4,408	1,085
Direct GHG Intensity (Bitumen Basis)	kg/bbl	65.1	61.4
Natural Gas use	MMSCFD	36.1	34.0

Some of the key outcomes from this comparison include the implications of this technology change on regulatory compliance. In particular InsituSIM evaluates the performance of the flowsheet with respect to AER Directive 081 which establishes limits on the wastewater disposal and water recycling rates. Although

the disposal limit does not change much and the make-up water is reduced, it can be observed that the volume of reject water from the membrane operations is significant and although the CPF remains compliant, performance has worsened.

Given the improved quality of the treated water, it has been assumed that the steam quality at the OTSG could be increased to 90% which would result in reduced natural gas consumption and an associated reduction in GHG emissions.

Conclusion

Membrane technologies are a promising option to improve the economic and environmental performance of in situ oil sands operations, while technology development is ongoing and better materials are identified the ability to study the impact on the CPF of technology changes on key performance indicators provides valuable information to operators and technology developers. The InsituSIM platform provides a framework to conduct these engineering analyses efficiently and using a consistent approach. COSIA has made this tool available openly and it can be accessed by visiting www.insitusim.com and registering for an account.

References

[1] M. Salerno, “Piloting New Technologies for SAGD Produced Water Deoiling”. International Water Conference, 71st Annual Meeting, October 2010.