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# Investigation of Solvent and Surfactant Additives on the Efficiency of Steam Assisted Bitumen Recovery Processes

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## Summary

**In steam assisted gravity drainage (SAGD) processes injection of light hydrocarbons (15 to 100 % mass of bitumen) with steam has been studied with limited commercial success. The purpose of solvent addition is to reduce bitumen viscosity and promote relative permeability of bitumen in the reservoir. At our laboratory, we are investigated the effect of bitumen-water interfacial tension on SAGD process by injecting Biodiesel as a surfactant additive with steam under 2g/kg bitumen dosages.**

**In the present study steam assisted bitumen recovery tests were performed at typical reservoir pressure conditions, 200 $^{o}$C and 1.4 MPa pressure, to evaluate the performance of solvent (pentane) and biodiesel as additives with steam on bitumen recovery efficiency. The results show that bitumen recovery efficiency may decrease with the addition of solvent such as pentane and increase with biodiesel addition suggesting that bitumen/water interfacial tension may be an important factor for bitumen recovery in SAGD.**

## Introduction

In Alberta, Canada bitumen is commercially produced by the steam assisted gravity drainage (SAGD) process in excess of 350,000 bbl/d capacity;[1] economics and efficiency of the SAGD process would be improved by reducing the steam to bitumen ratio.[2] For this purpose addition of light hydrocarbon solvents into steam as a solvent to reduce bitumen viscosity has been studied;[3] however, several decades of research effort has resulted in only limited commercial success. More recently, as an alternative to solvent addition, use of biodiesel (fatty acid methyl esters) with steam as a surfactant additive reducing bitumen-water interfacial tension was proposed and studied experimentally.[4,5]

## Theory and/or Method

The experiment was a pressure cooker type test shown in Figure1. Oil sands cores were steamed at reservoir conditions (200°C, 1.4 MPa) with either pentane or biodiesel additives. The produced and residual bitumen were determined and used to calculate recovery efficiencies.

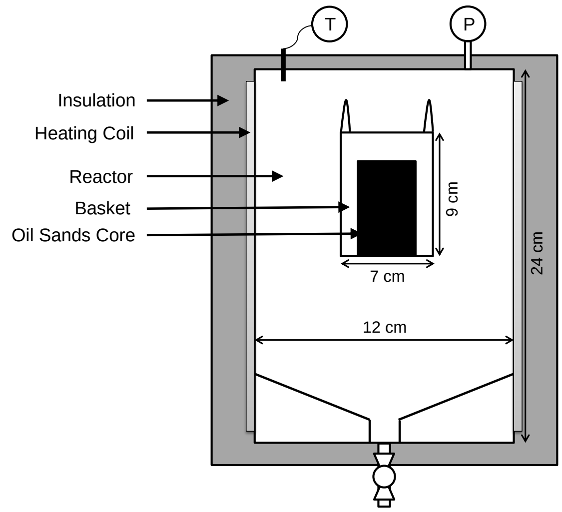


Figure 1: Reactor assembly design for pressure cooker tests

## Examples

Bitumen recovery was determined from the pressure cooker experiment, as shown in Table 1. The extracted bitumen was compared to the total bitumen in the sample (determined by mass balance).

Table 1: Bitumen Recoveries from Pressure Cooker Test

| Method | Additive | Extracted | Residue | Total Bitumen | Bitumen Recovery |
|---|---|---|---|---|---|
| | % (w/w) | $g_{bitumen}$ | | | % |
| Control 1 | 0 | 11.94 | 32.81 | 44.76 | 26.7 |
| Control 2 | 0 | 12.9 | 31.7 | 44.6 | 28.9 |
| Control 3 | 0 | 10.61 | 37.94 | 48.55 | 21.9 |
| Control Avg | | | | | 25.8 |
| Biodiesel 1 | 0.21 | 14.09 | 34.14 | 48.23 | 29.2 |
| BD 2 | 0.20 | 12.26 | 38.47 | 50.73 | 24.2 |
| BD Avg | | | | | 26.7 |
| 5% Pentane 1 | 5.0 | 9.54 | 40.46 | 50.01 | 19.1 |
| 5% Pentane 2 | 5.1 | 6.87 | 39.55 | 46.42 | 14.8 |
| 5% Pentane Avg | | | | | 16.9 |
| 15% Pentane 1 | 15.4 | 2.68 | 46.03 | 48.71 | 5.5 |
| 15% Pentane 2 | 14.8 | 7.9 | 40.85 | 48.75 | 16.2 |
| 15% Pentane Avg | | | | | 10.8 |

## Conclusions

In the presented experiment, bitumen recovery efficiency decreased with the addition of hydrocarbon solvent, tested at 5% and 15% of bitumen mass dosages, whereas biodiesel addition under 2-g/kg-bitumen dosage showed a small increase in bitumen recovery efficiency. These results suggest that surfactants may be superior to solvents as additive in SAGD.

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