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osum

Evaluation of Recovery Technology for the Grosmont Carbonate Reservoir

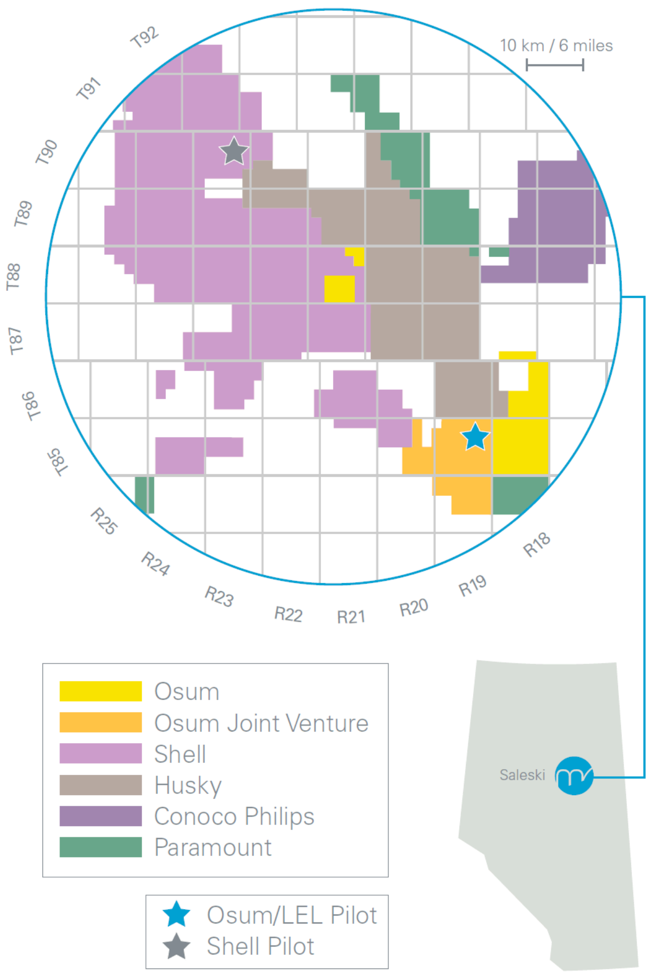
Qi Jiang
Jian-Yang Yuan
Jen Russel-Houston
Bruce Thornton
Andrew Squires

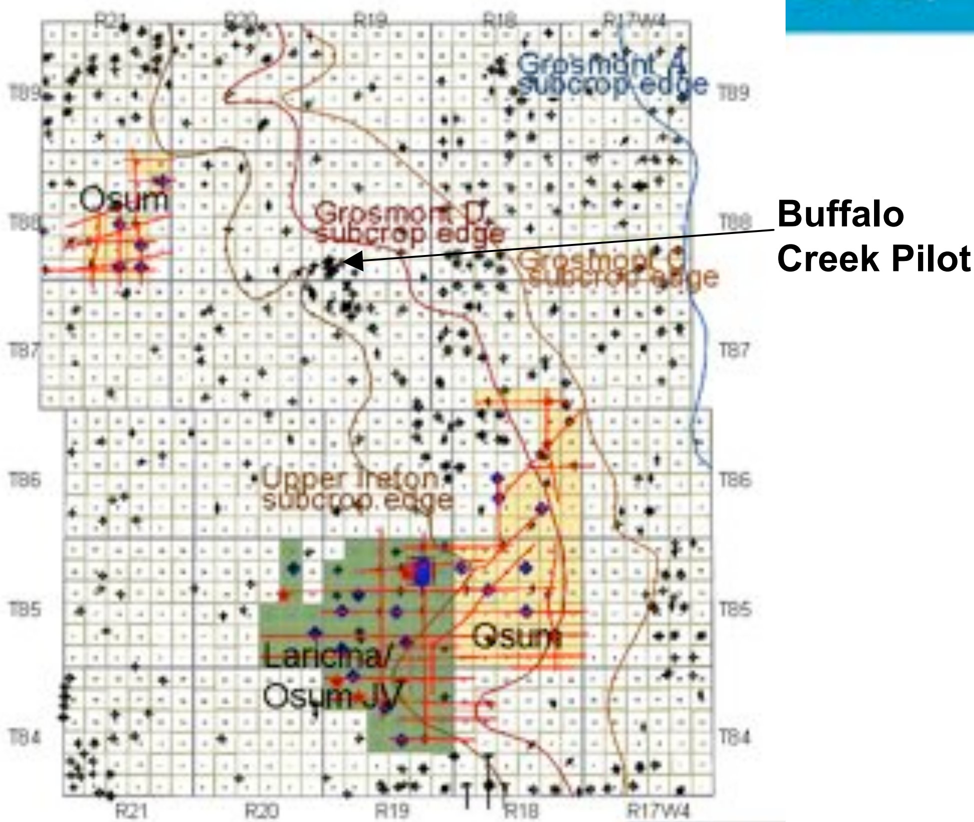
Osum Oil Sands Corp.

Outline

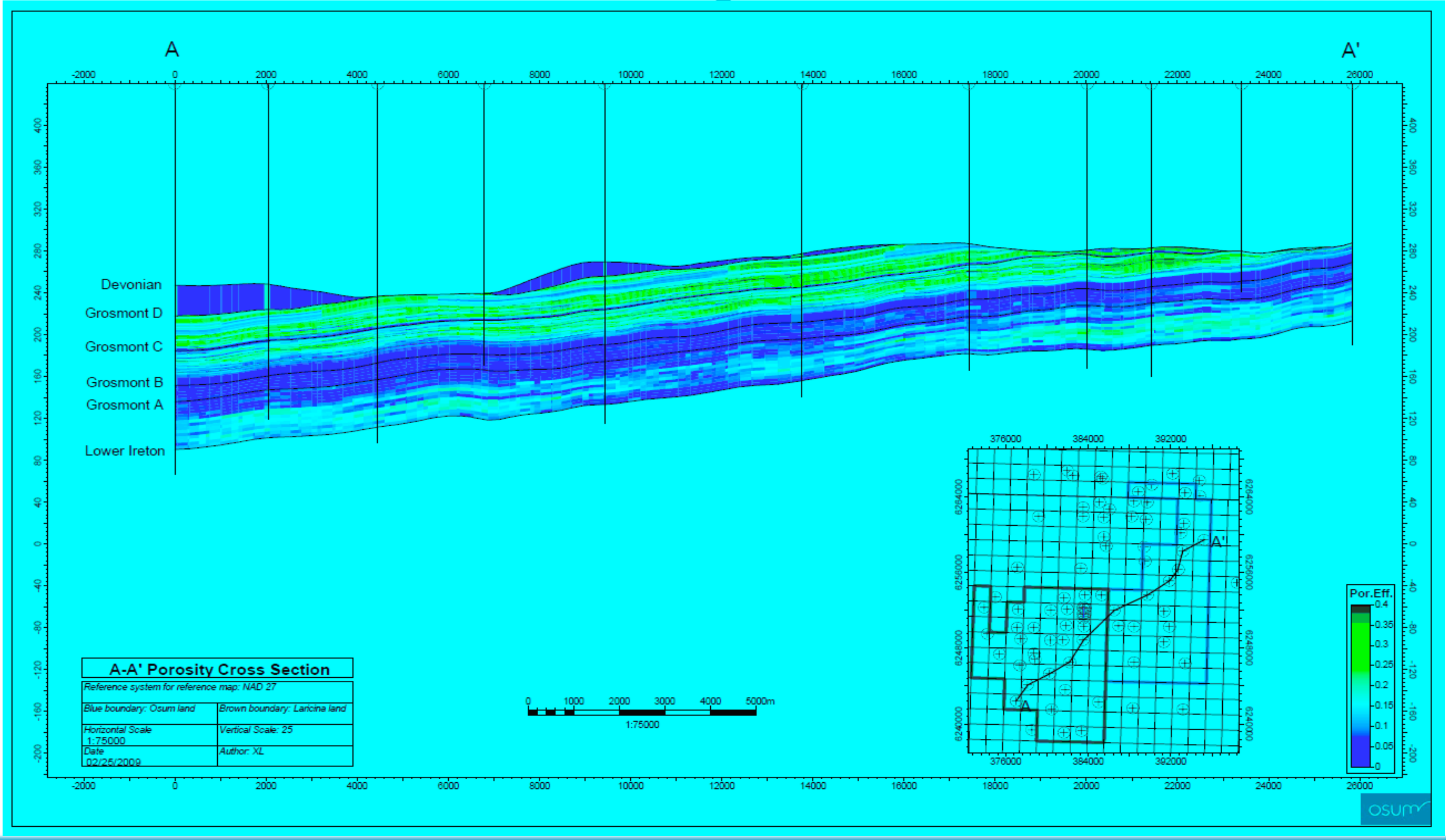
- Geology in Osum's Saleski area
- CSS Test at Buffalo Creek
- Analog to the McMurray Formation
- Laboratory Tests of Solvent Process
- Commercial Prospective
- Conclusions

Osum’s Saleski/Liege Project Area

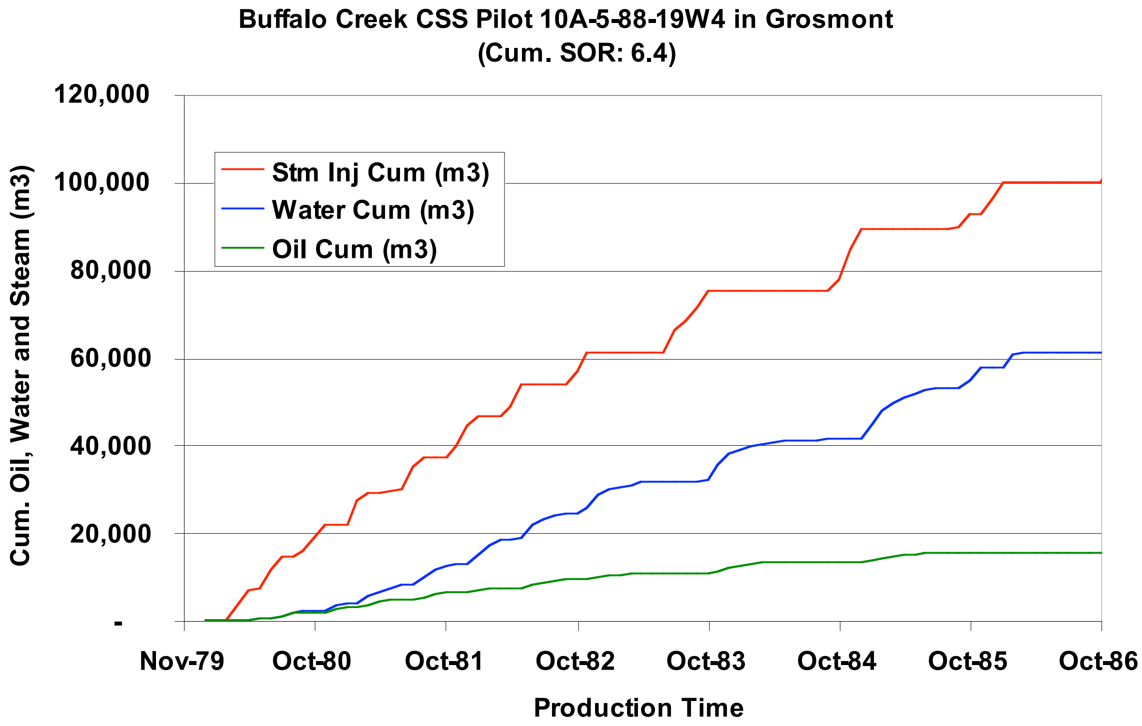




Cross-Section through Saleski Area



Pilot Test in Buffalo Creek



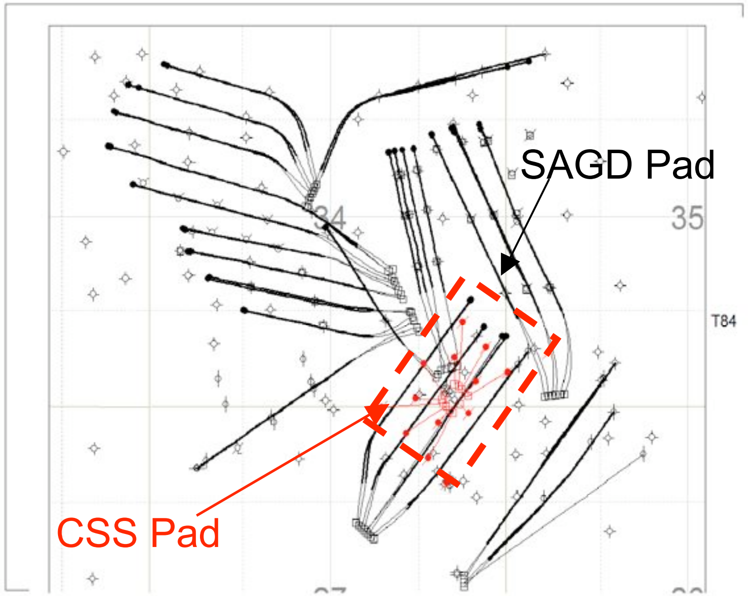
- Peak oil rate close to 500 Bbl/d (80 m3/d)
- High Steam Injectivity
- Best cycle SOR was 4.0
- Low produced water to injected steam ratio (<0.7)

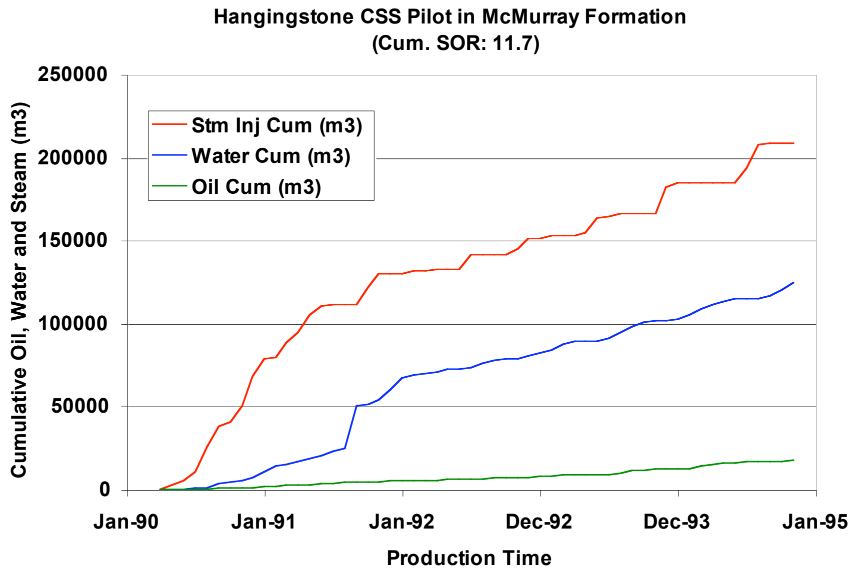
Challenges for CSS in Grosmont Formation

- Low mobility of bitumen
  - Bitumen becomes immobile when temperature falls below critical value
- Lack of solution gas drive
  - Low solution GOR in the bitumen (<5.0 m3/m3)
- Low compaction drive
  - Reservoirs buried in shallow formations (100 to 500 m) and partially pressure depleted
- Reservoir containment

Less Favorable Conditions for CSS

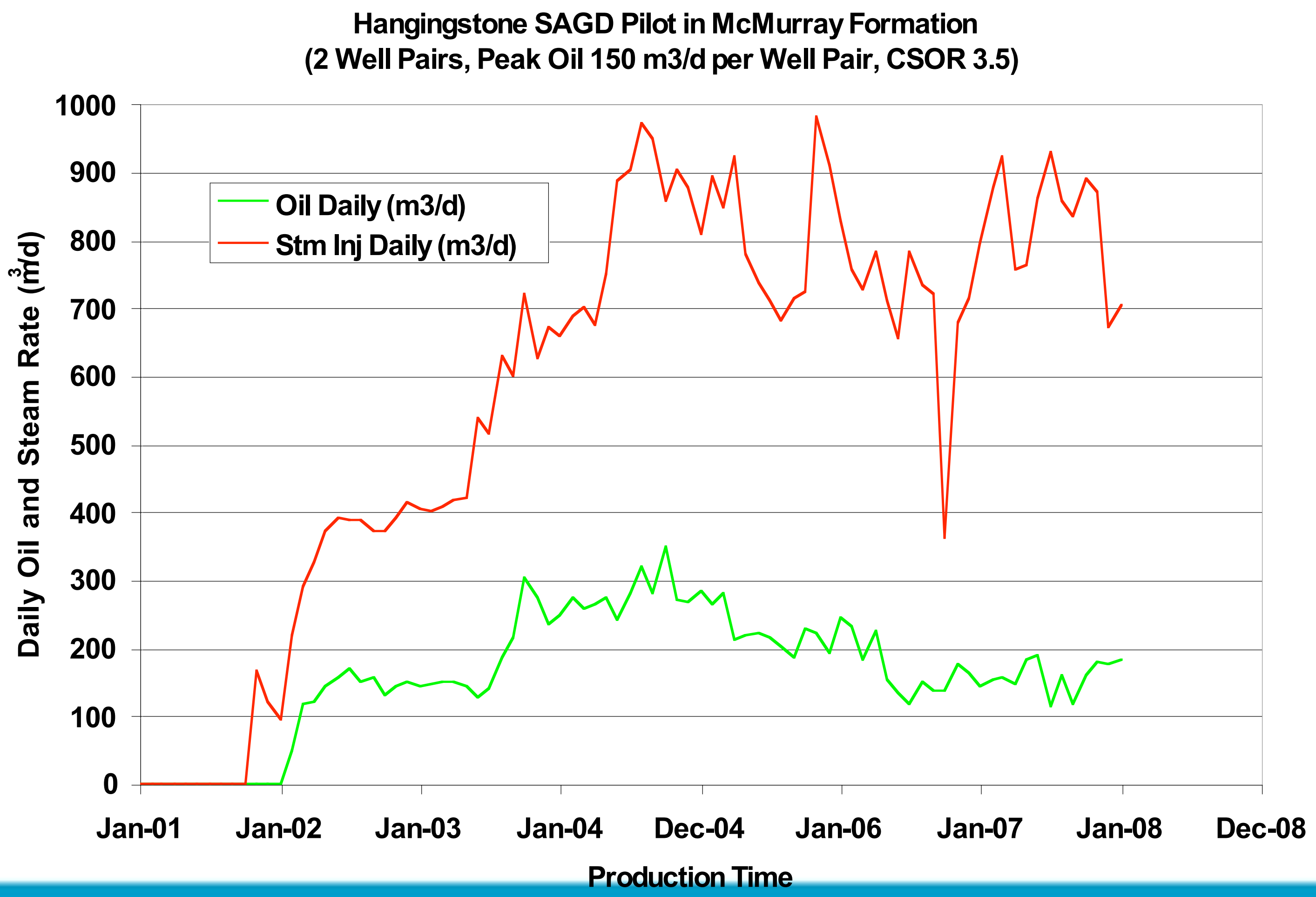
CSS in McMurray Formation at JACOS Hangingstone





Higher SOR and Lower Productivity than Buffalo Creek Pilot

SAGD in McMurray Formation at JACOS Hangingstone



Comparison of CSS and SAGD at Hangingstone Pilot Area

Process	Peak Rate (m3/d/Well)	CSOR (m3/m3)
CSS	20	11.7
SAGD	150	3.5
Ratio between SAGD & CSS	7.5	0.3

Step Change in McMurray Performance with SAGD

Estimate of SAGD Rates in Grosmont

Parameters	McMurray	Grosmont
Φ (fraction)	0.33	0.22
k_v (Darcies)	5	10
ΔS_o	0.7	0.7
h (m)	20	30
Productivity ratio	1.0	1.4

$$q = 2L\sqrt{\frac{1.3 k g \alpha \phi \Delta S_o h}{m \upsilon_s}}$$

Grosmont could achieve higher SAGD productivity than McMurray

Laboratory Studies

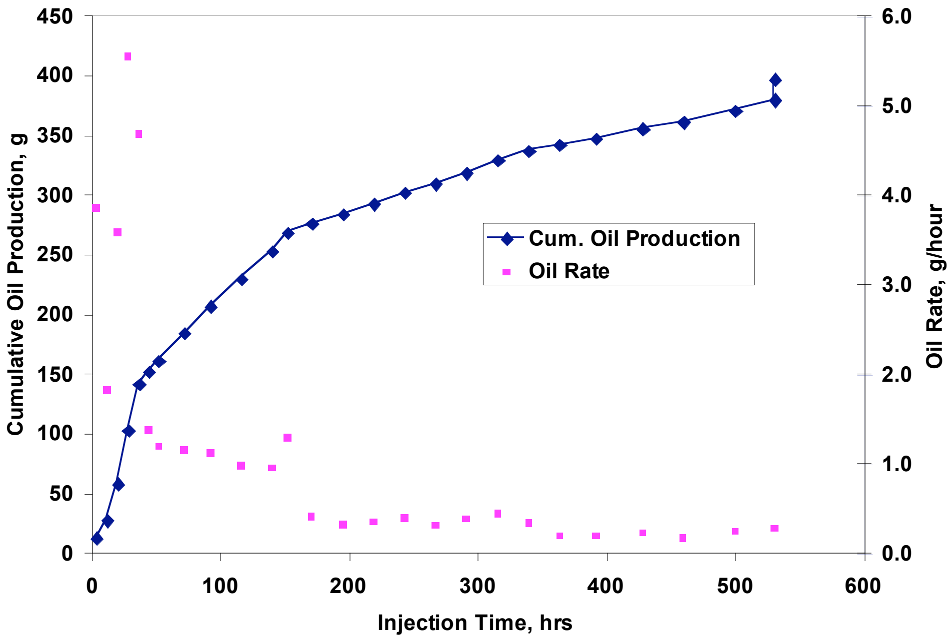
- Gravity Drainage process
  - Steam
  - Cold Solvent
  - Warm Solvent

Laboratory Test Apparatus

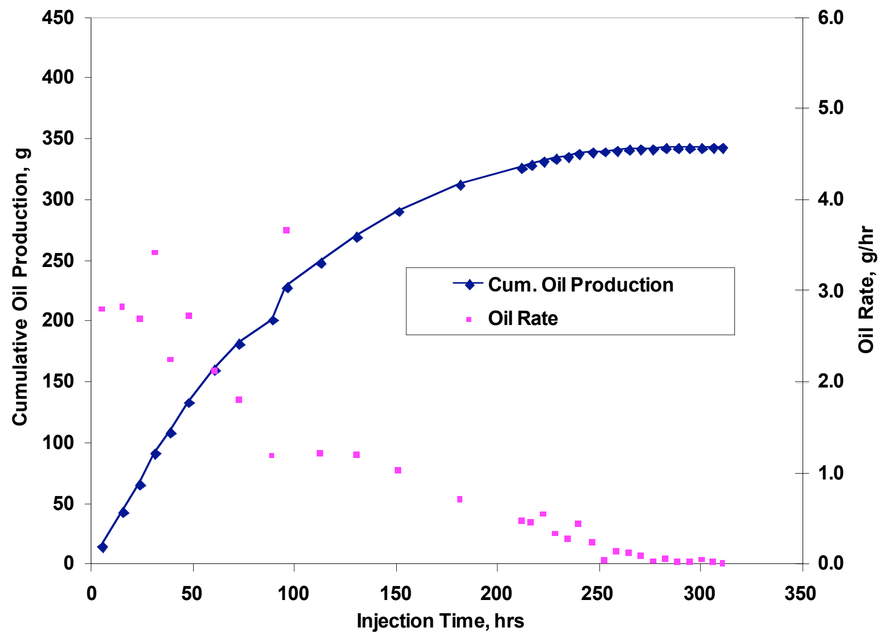
(Picture showing test apparatus at TIPM Lab. at University of Calgary)

- Full diameter Grosmont core
- Injected solvent is vaporized and maintained at constant pressure and temperature
- Diluted bitumen drains by gravity
- Production is collected from bottom and analyzed with NMR (Nuclear Magnetic Resonance)
- Core is CT scanned before and after test to visualize fluid distribution
- Residual oil is confirmed using Dean Stark

Laboratory Test of Solvent Process



Warm Solvent @ 50 C

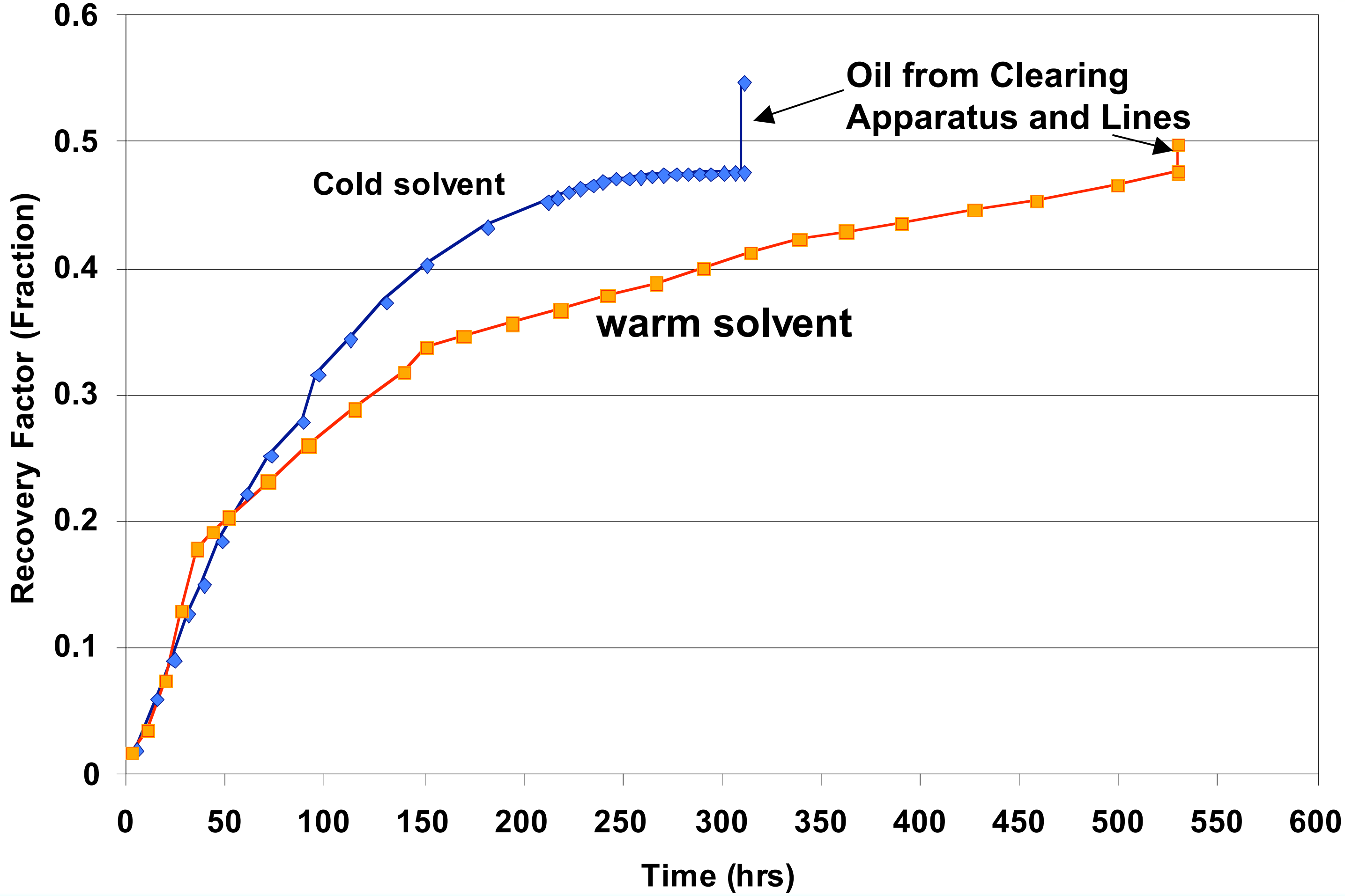


Cold Solvent

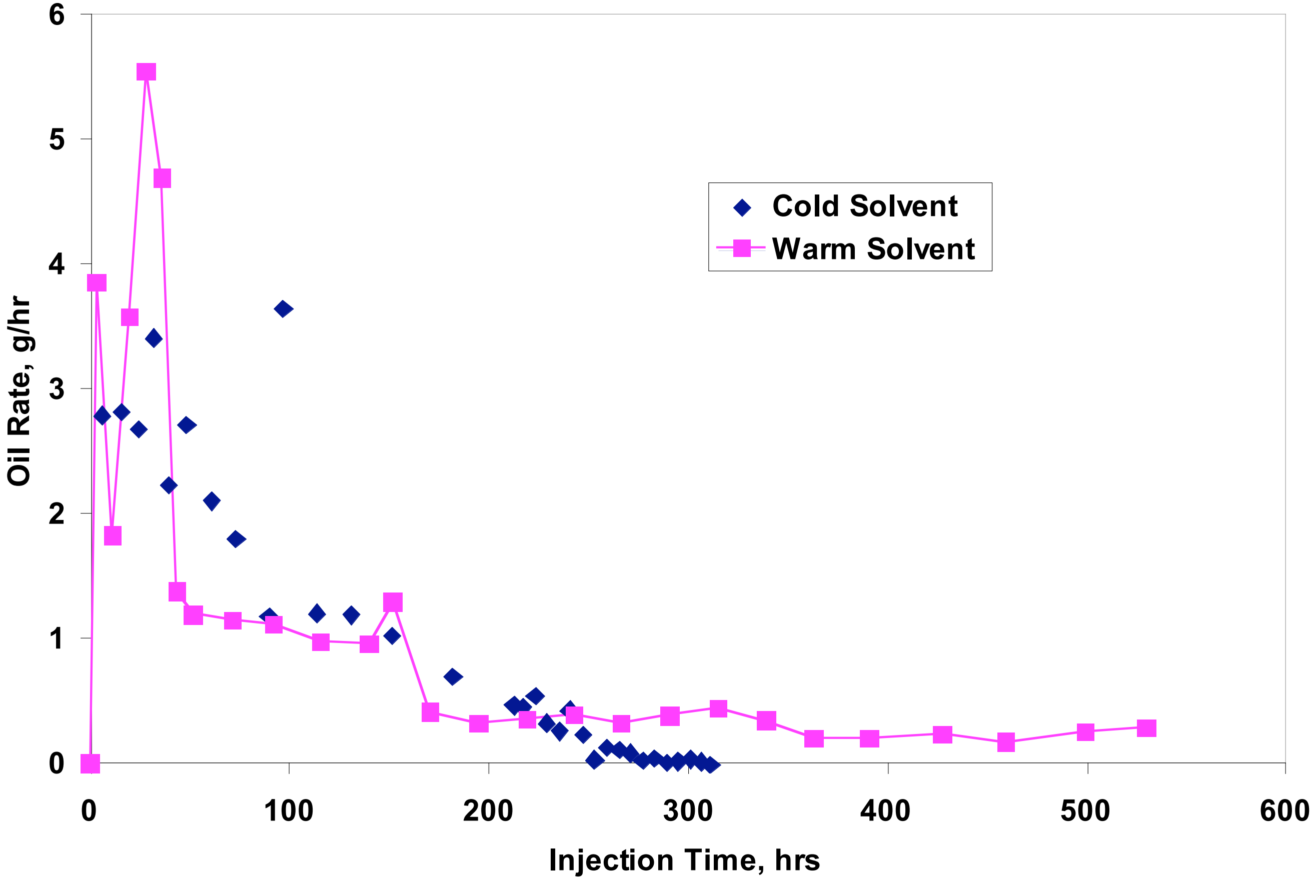
(From Edmunds et al CIPC Paper 2008-154)

Two separate tests using core samples from different wells

Over 50% RF Achieved from Both Cold and Warm Solvent Tests



Effect of Temperature on Oil Rate



Temperature Increases Initial Process Rate

Drainage Patterns

- High initial rate following by reduced rates
  - Initial high oil rate is most likely due to drainage from fractures
  - Slower drainage rates in late stages could be the combination of flow from both matrix and fracture
- Drainage from both fracture and matrix is confirmed from CT Scan

High Residual Oil in Core (>40%)

- Less drainage head (0.9 m) in the core than in the field (20 to 60 meters)
- Less drainage time (days) in the core than in the field (years)
- Higher percentage of the liquid hold-up by capillary pressure in the core than in the field

Interpretation of Lab. Test Results

- Scaling Factor
  - Geometrical Similarity
    - H_{field}= 27.0 m; H_{model}=0.9 m
  - Permeability
    - K_{field}=10 D; K_{model}=300 D
  - Time Similarity
    - T_{field}=10 Yrs; T_{model}=4.0 Days

$$\frac{K_m}{K_f} = \frac{\left(\frac{h}{N\Delta S_o}\right)_{field}}{\left(\frac{h}{N\Delta S_o}\right)_{model}}$$

$$\frac{t_m}{t_f} = \frac{\left(h^2\right)_{model}}{\left(h^2\right)_{field}}$$

$$N = \int_{\partial C}^{C_e} \frac{(1-C)\Delta\rho}{D_s\mu}\frac{dC}{C}$$

Limitation for an Unscaled Test

- Recovery efficiency in actual reservoir could be higher than that from unscaled laboratory test
  - Residual oil in the model is higher than that in actual reservoir

$$S_{or} = \frac{(b-1)}{b}\left(\frac{\nu_s \phi h}{kgt}\right)^{1/(b-1)}$$

  - Impact of capillary pressure in the model is higher than that in actual reservoir

$$H = \frac{\sigma \Delta J}{\Delta \rho g}\sqrt{\frac{\phi}{k}}$$

Evaluation of Commercial Prospect

- Scaled experiments
  - Very challenging for multiple porosity medium
- Field-scale reservoir simulation
  - PVT, transport and interfacial properties in porous medium
  - History match of laboratory and field tests
- Field test towards commercial development
  - Promising results have been obtained from initial solvent tests at Laricina-Osum JV property (From Edmunds et al CIPC paper 2008-154)
  - Large-scale pilot tests are planned

Conclusions

- CSS pilot test at Buffalo Creek demonstrated high injectivity and high productivity in Grosmont Formation.
- Both cold and warm solvent soak tests achieved over 50% recovery from a Grosmont core.
- Drainage of oil occurred also from the low porosity (<10%) section of the Grosmont core.
- Warm solvent test achieved higher oil drainage rates than cold solvent test especially during the initial production stage.

Conclusions (Cont'd)

- Solvent process could be more efficient in the field than the unscaled core test.
- Scaled physical modeling and field pilot testing are required to evaluate the commercial potential for future Grosmont development.
- Gravity drainage process applied to Grosmont reservoirs appears to hold great promise.
- Optimization of the recovery process for the Grosmont reservoir should be focused on a combination of solvent and thermal processes.

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