Insulated Tubulars for use with Thermal Oil Recovery Processes

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Agenda

• SAGD basics
• Value propositions of insulated tubulars
• Development of insulated tubulars
  – Objectives
  – Insulation strategy
  – Design
  – Development milestones
• Field trial
• Initial results
• Thermal modelling
• Summary
SAGD basics

• In situ recovery of bitumen from oil sands
• Two parallel wells constructed in the reservoir
  – Steam Injection line
  – Production line
• Steam is injected under HP/HT (200°C +) into the well directly above the production line
• Steam heats up the reservoir causing the very thick/viscous bitumen to ‘drain’ downwards by gravity
• Production line draws bitumen from reservoir for eventual upgrading into oil
• Steam to Oil Ratio (S.O.R) is key measure of process efficiency
Insulated tubulars for SAGD

Insulated region

Steam injection well
Value propositions of insulated tubulars

- Decrease the well start-up period, reducing the time required to begin bitumen production
- Improve the steam quality delivered to the reservoir
- Reduction in cumulative steam to oil ratio (CSOR)
- Reduce the effects of heat exposure or thermal fatigue to the casing cement, lessening the chances of cement failure
- Lowering overall steam requirements and potentially allowing for either reduced Capex or using an increased number of pads for an existing infrastructure
- Realized savings on carbon taxes due to reduced natural gas consumption
Development

Objectives

• Co-development program with major Oil Sands producer
• Adaptable to the larger size casings/tubes used in SAGD wells
• Provide thermal insulation to all of the steam injected into the well
• Use customer supplied tubes
• Durable, stable insulation performance for life of well
• Customizable to operators size and insulation thickness requirements
• Locally produced
Insulation strategy
(Concentric completions)

Current practice

*Injected steam volumes being insulated

New concept

Heel string

Toe string

~70-80%

~20-30%

100%
“HT-ThermoShield” insulated tubular design

- Rugged ‘pipe-in-pipe’ design
- Heat resistant insulation material
- Customer specific tubes and couplings
- Proprietary end closure system
Development milestones

- Development and lab-scale processing trials of insulation materials - 2011
- Prototype production (10ft & 30ft samples) - 2011
- Testing program:
  - Heat aging,
  - Mechanical properties,
  - Insulation performance
- Field handling trial – 2012
- Second iteration design – 2013 to 2014
- Production of tubulars for well trial - 2014
- Live well installation with SAGD operator– July, 2014
- Start of steam injection (circulation) – September, 2014
- Thermal modelling study - In progress
Field trial

- Steam injected at 230°C (2800 KPa)
- Insulated tubulars:
  - 10.75” x 8” assembly
  - 1” of thermal insulation
- 33 tubes (~450m) of HT-ThermoShield installed: July 2014
- 4 bare tubes installed at bottom of well
- Distributed Temperature Sensing (DTS) fiber attached to OD of insulated tubes
- 6-point thermocouple temperature sensors installed on ID of 4.5” tubing
- Start of steam injection: September, 2014
- Startup and performance to be compared to adjacent non-insulated wells, along with data collected from P/T sensors and test separator
Insulated steam injection well

10 ¾”OD Insulated tubular with 1” thick insulation (450m)

DTS Fiber clamped to outside of 10 ¾” tubular

4.5” Injection tubing (toe string)

6 Point thermocouples
Installation
Tube handling
Tube makeup
Securing the DTS fiber
Initial results

Avg. external temp. of insulated HT-ThermoShield tube (10.75" OD) to 450m depth: 85°C

145°C decrease in heat loss (63%)

Inlet Steam Injection Temperature +230°C

Uninsulated Pipe at 225°C
Thermal modelling

Insulated tubing analysis
- Field data interpretation
- Insulation performance vs. well start up time
- Sensitivity studies
Summary

• Co-developed 10.75”x 8” insulated tubulars for use on heel string of concentric well completion
• Tubes installed in SAGD steam injection well in July of 2014
• Started steam injection for circulation (warm up) phase in September 2014
• Preliminary results indicate a significant temperature reduction on external surface of tubulars by 63% from the wellhead injection temperature
• Insulation system can be scaled to a variety of tubular sizes and thicknesses
• Additional monitoring planned to assess effects on well startup time, steam quality, and cumulative steam oil ratio (cSOR)
• Ongoing development work underway to target higher temperatures (300°C+)