

Overview Presentation

"We Bring Low Cost Barrels"

www.salamandersolutions.com



Salamander Heaters: A Technology Whose Time has Arrived

Challenges

Heavy Oil:

- How to increase oil production in long horizontal wells?
- How to reduce water consumption in SAGD wells?

Subsea:

- How to prevent deepwater flowlines from plugging and clear plugged lines?
- How to extend the productive life of a field?
- How to reach stranded resource and add reserves at low cost?

Solution

For each of these challenges, the solution is heat. Heating provides many benefits but until now, a very long, reliable heater did not exist.



Salamander heaters:

- are rugged and reliable
- are available in long length (up to 10 km)
- deliver high power (up to 1.5 kW/m)
- have been extensively tested



Salamander Heaters: Unmatched in Power, Length and Reliability

- Only heater capable of high power delivery at long length with minimal splices leading to superior reliability
- Order of magnitude improvement over competing technology in the areas of heat delivery in harsh environments
- Unique, patent protected manufacturing process
- Well-suited to Subsea flowline environment







Salamander Heaters: Competitive Advantage

Capabilities ►		Heat Injection				Operating Environment				Deployment Length				Toughness			
		Mediun @ Medi	n Power um Temp	High I @ Higl	Power h Temp	High O Temp	perating erature	High Pı Cap	essure able	Long- Without or Con	Length t Splices nections	Very Lor Circuit (Low	ng Single Length Power)	High Pul	l Strength	Crus Impac	h and t Proof
		(>500 W/r	n @ 150C)	(>1,000 W/	m @ 400C)	(>3	00C)	(>35	0 bar)	(>1	l km)	(~3	0 km)	(>2	5 kN)		
		MI	Polymer	MI	Polymer	MI	Polymer	MI	Polymer	MI	Polymer	MI	Polymer	MI	Polymer	MI	Polymer
S	alamander Solutions		na		na		na		na		na		na		na		na
Co	mpetitor #1		×	×	×		×	\checkmark	×	×	×	×	\checkmark	×	×	\checkmark	×
Co	mpetitor #2	×		×	×		×	×	×	×		X		×	×	×	×
Co	ompetitor #3	V	×	×	×		×	V	×	×	\checkmark	×	×	×	×	\checkmark	×
Co	mpetitor #4		×		×		×		×	×		X	×	×	×		X
Co	empetitor #5 (China)		na	×	na		na	×	na	×	na	×	na	×	na	×	na

Salamander MI heaters easily outperform the MI and Polymer heater competition:

- Salamander heaters are built to last. The Salamander's manufacturing process enables long lengths between splices (2 km) and operating voltages of up to 8.7 kV enabling high heating rates (>1,000 W/m) for in-well deployments.
- High voltages allow designs of very long single circuit lengths (~30 km) for low power subsea applications.
- Salamander heaters are tough enough to be installed in harsh environments and can operate for years at high pressures and temperatures with no special mechanical protection.
- Salamander professionals can provide integrated solutions for many oil & gas, pipeline, and other novel heating applications.



Salamander Heating Applications

Heavy Oil Heavy Oil Applications

- BoostWell Increases production by viscosity reduction in cold production wells
- LinkWell Improves performance in SAGD wells

Subsea Applications

- Subsea Enable Eliminates hydrate/wax plugging enabling optimized field development
- Subsea Extend Eliminates hydrate/wax plugging reducing chemical costs and extending field life
- Subsea Recover Removes hydrate/wax plugs from existing lines allowing *recovery* of production

Novel Applications

- StreamWell Provides flow assurance, increases uptime and reduces expenses in high wax/hydrate producing wells
- Foundry Enables recovery of oil from massive kerogen and extra heavy oil deposits via the patented *In situ* Conversion process (ICP) or *In situ* Upgrading Process (IUP)
- Other Provide high-value solutions for Liquid Rich Shales, Product/Sulfur Pipelines, Industrial Heating, Special Applications …



Subsea

Novel

BoostWell – Increases Production in Cold Production Wells

BoostWell[™] heaters in long, horizontal cold producers:

- evenly heats the near wellbore reducing oil viscosity and increasing effective wellbore diameter
- increases drawdown (particularly in toe section) significantly increasing incremental recovery
- increases oil production by a factor of 5 or higher





Increases production rates (up to 5x) and improves recovery Longer effective well length and reduced skin

Increases the life expectancy of pump systems

Lower viscosity, stable flow rates, and precipitation control

Reduces water cut

Balanced mobility contrast results in less water coning

Easy implementation

Designed for use in new or existing wells

Produces low cost barrels with fast payout

Incremental barrels are produced at \$10 - \$15/bbl and payout can be achieved in less than 12 months.



BoostWell – Alberta Case Study

A BoostWell heater was installed in a half-length test well in late 2016 and energized in April 2017. Heater performance has been excellent and the 4.5x production increase of the lateral has been in close agreement with the CMG STARS reservoir model. A full length heater would have resulted in a production increase of 7.5x.





LinkWell – Improves SAGD and CSS Performance

LinkWell[™] heaters in a SAGD well pair for the first 6 - 9 months improve lifetime performance:

- Faster first oil due to accelerated initial heating (no early steam breakthrough)
- Increased oil production and SAGD efficiency fore pattern life due to improved steam conformance (initial heat applied uniformly sets up the pattern for success)



Accelerates Steam Assisted Gravity Drainage Connection

Faster/more early oil in SAGD applications. Can be applied to individual wells before commissioning steam injection facilities.

Improves Production

Oil production is increased by better steam conformance allowing greater steam penetration and higher recovery efficiency

Optimizes Energy and Water Usage

Increased recovery efficiency results in lower costs, lower water usage and lower CO_2 emissions per barrel

Better <u>CSS</u> Performance

LinkWell[™] heaters also complements CSS performance by increasing steam conformance allowing more uniform steam injection in the important early cycles setting up the reservoir for better performance (lower SOR, longer production cycles)



Subsea – Summary of Benefits

Salamander heating of flowlines and subsea systems enables ...

New flow assurance strategies

Longer offsets and new architectures

More volumes, better hub loading, lower risk

- Increases certainty of flow: no hydrate or wax plugging; recovery from plugged flowlines
- Lowers development and drilling capex (less-deviated wells)
- Simplifies host: less equipment and chemicals, lower opex, improves HSE
- Enables reach of stranded reserves



Subsea – New Flow Assurance Strategies

- Salamander heaters provide a major step change in electrical properties (8.7 kV vs. 600/2000 V, current up to 275A) allowing flow assurance on very long flowlines (up to 40 miles (64 km) for a single electrical circuit depending on insulation)
- Salamander heaters are built to last with no deepwater pressure or temperature constraints, no degradation for long service life
- Salamander heaters are strong, self-supporting to ~5000 ft (1500 m) water depth



Illustration: Two 3-phase circuits, 8" flowline



Subsea – Salamander Beats the Competition

- Salamander heaters can be installed inside or outside of new or existing flowlines
- Salamander heaters can be used to for plug removal without loss of pressure containment

	Installation >	New Flo	wlines	Existing Flowlines				
		Outside	Inside	Outside	Inside	Plug Remediation		
1	Salamander Solutions							
	Direct Electric Heating (DEH)	\checkmark	×	×	×	×		
	Electric Heat Trace w/Pipe in Pipe		X	X	X	×		
	Electric Heat Trace w/Single Pipe		×	×	×	×		

- Facilities Benefits
 Salamander saves 20-40% in subsea capex, lowers power costs, and simplifies topsides
- Drilling Benefits Salamander enables a simpler, less-deviated well layout and may enable reaching stranded reserves





StreamWell – Improves Flow Assurance

StreamWell[™] heaters can be installed in vertical or horizontal sections of producing wells to enable precise control of wellbore temperatures to prevent precipitation of solids such as wax, sulfur, and hydrates.



Eliminates wax and hydrates

Consistently maintains wellbore above the temperature where solids can precipitate and cause a problem

Improves flow

Prevents solids from compromising artificial lift

Easy implementation

Designed for new or existing horizontal or vertical wells

Increases profits

Can pay out in less than 12 months by increasing well up-time and decreasing the need for costly chemical injection and mechanical interventions



Foundry Application – Play Opening Technology

Foundry[™] applications use closely-spaced heaters to heat the entire reservoir to 300°C to recover conventional oil and gas from solid kerogen (In Situ Conversion) or very heavy oil (In Situ Upgrading). The process generates its own reservoir drive resulting in high recovery efficiencies. Coke and other low value heavy products are left in the reservoir.



Enables Play Opening Technology

Salamander heaters are at the heart of the patented ICP/IUP process that can unlock many billion barrels of resource

High Recovery Factor

Results in recovery factors between 50% (ICP) and 75% (IUP) with energy ratios of up to 10

Reduces or Eliminates Diluent Purchasing

Produces API gravity between 16°–50°

Limits Environmental Impact

Often uses existing infrastructure, by-products remain subsurface



Salamander Heaters

Novel

- Are unmatched in reliability, power, temperature and length
- Can dramatically increase heavy oil cold production at a cost of \$10 - \$15/bbl with payouts of one year
- Can accelerate first oil and increase recovery in SAGD and CSS fields
- Provide a lower cost alternative with increased capabilities in onshore and offshore flow assurance
- Can resolve flowline plugs
- Can simplify subsea field developments unlocking stranded reserves



Subsea







Thank You!

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