SAGD STEAM HEADER OPTIMIZATION

Maximize steam production, prioritize injection and automatically balance steam header pressure.

Control Challenge

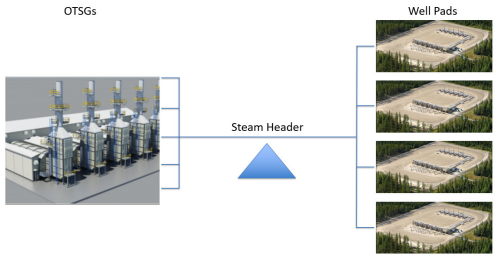

Figure 1: OTSGs vs. Well Pads

Steam-assisted gravity drainage (SAGD) facility operators have the difficult challenge of balancing the steam header pressure under variable process conditions. Depending on the size of the site, steam generation is typically managed by several (5-15) steam generators while steam demand is created by dozens or up to hundreds of steam injection wells. The generators and injectors are connected by several kilometers of piping which we refer to as the steam header. Under steady operation, the steam header pressure is typically controlled using one or more steam generators in which loading is adjusted based on steam demand. This is referred to as a swing-boiler control strategy.

Challenges

There are several challenges with the use of swing boilers in thermal oil sands steam systems:

1. Steam production is purposely limited by the control strategy to maintain the steam header pressure within operating limits. The figure below shows an once-through steam generator (OTSG) operating at rates lower than 100% of steam generation capacity in order to manage header pressure.
2. Slow steam generator process dynamics cause high header pressure variability under normal operation and can cause the steam system to be unstable under upset conditions such as a well pad or boiler trips.
3. Allocation of the steam from the generators and to the injectors is handled manually by operators under upset conditions using 'cut-sheets' provided by production engineering.

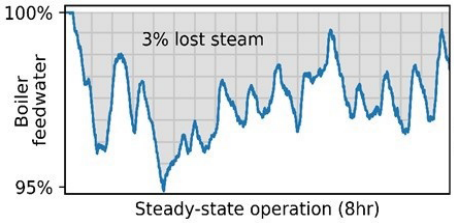

Figure 2: Lost steam capacity as a result of common control practice in thermal steam systems

Note that during upsets, it is extremely difficult for operators to manually manage hundreds of control loops on both the steam generators and injection wells. It can in fact take several hours to return production to normal operations after a pad trip or OTSG trip in these operations.

To avoid costly trips, the header pressure is typically controlled conservatively, running as much as 1,000 kPa below the header pressure safety valve limits. Consequently, lower header pressures can limit steam from reaching the most distant wells as the steam systems expand with infill projects. Steam velocity and erosion problems can also be a consequence of not being able to hold the header pressure tightly at its designed limit.

The challenges described here ultimately lead to both suboptimal steam injection and production for the producer if they remain unmanaged.

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Solution

The SpartanPRO™ SAGD Steam Header Optimization Solution utilizes optimization strategy which helps producers increase steam production by up to 3% if the facility is steam short, and up to 8% if the combustion air fan is speed limited. The header pressure can be raised to 200 to 300 kPa of the pressure safety valve (PSV) limits, allowing steam to be delivered to more distant injectors. The key components of the solution include:

1. Fully automated steam header pressure control which utilizes prioritized steam injection and boiler feedwater rates as manipulated variables
2. High speed automated steam load allocation from the generators and to all injection wells

The graphics below compare header pressure, steam production rates and boiler feedwater (BFW) flows before and after the implementation of the SpartanPRO™ SAGD Steam Header Optimization Solution for a SAGD plant in Fort McMurray. The top left graph shows the performance difference during a well pad trip using conventional control methods. The top right graph shows that the SpartanPRO™ Solution stabilized the steam header within 10 minutes after a well pad trip and only a fraction of a tonne of steam was lost.

The bottom left graph is an example in which an OTSG was brought into the steam header manually. In this example, the operations ramped up BFW over 30 increments and the field operator rebalanced injection rates in tandem. Conversely, as shown in the bottom right graph, neither operator made any changes once the SpartanPRO™ SAGD Steam Header Optimization Solution was commissioned.

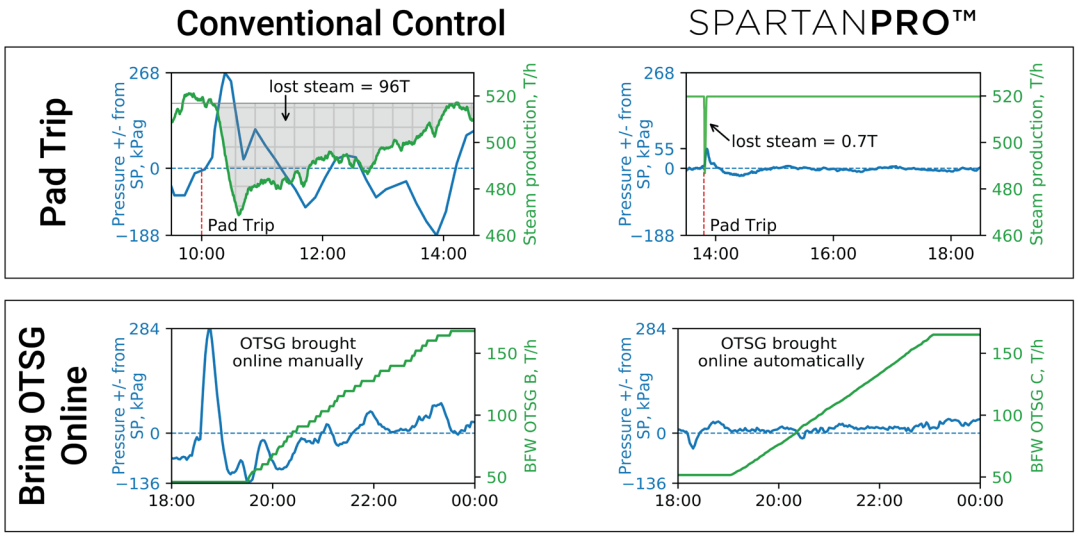

Figure 3: A comparison of pad trip and OTSG examples using conventional control methods and the SpartanPRO™ Solution

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Summary of Features

- Automates optimal injection of steam based on engineering-set priorities and constraints
- Maximizes production rates by utilizing steam injection for steam header pressure control and allowing steam generation to run at stable maximum loads
- Provides fast and repeatable ramping of OTSGs into steam header to bring steam on faster
- Responds immediately and precisely to upset conditions, allowing for higher header pressure operation
- Improves OTSG stability leading to less unplanned downtime
- Maximizes of steam production when air fan speed is limited

Return on Investment (ROI)

SpartanPRO™ SAGD Steam Header Optimization Solution significantly increases plant production by maximizing the utilization of the steam plant. In addition, injections rates stay on optimal targets during steady-state and upset conditions allowing for improved chamber growth and steam: oil ratios. The approximate measurable benefits are:

- +3% increased production if steam short
- +8% increased production if air fan speed is limited
- +500 kPa increased steam header pressure

For a typical SAGD producer, these improvements significantly outweigh the cost of implementation.

For further information, contact your local Spartan representative.

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