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Pushing the Boundaries of Artificial Lift Applications: SAGD ESP Installations in Canada

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Abstract

The need for high-temperature electric submersible pump (ESP) systems is growing as the oil industry matures. Canada's nonconventional oil reserves are estimated at just over 1 trillion barrels and Suncor's heavy oil reserves in northern Alberta, Canada, are estimated to have a potential production of 14 billion barrels of crude oil, but traditional mining methods of recovery do not make them all economically reachable. It is estimated that less than one-fifth of the oil sands resource is mineable. To deal with this, Suncor has turned to in-situ steam-assisted gravity drainage (SAGD) operations as a key part of its plans to increase bitumen supply to its upgraders.

The SAGD approach uses a pair of horizontal wells drilled parallel to each other and separated vertically by a distance of approximately 5 m. Steam injected through the uppermost well penetrates the surrounding formation, heats the heavy-oil sands, and creates a high-temperature region above the injector known as the steam chamber. Heat transferred to the oil sands reduces oil and bitumen viscosity. Gravity forces the oil, bitumen, and condensed steam downward, where these fluids, consisting of about 25–80% water, are produced into the lower well.

Suncor uses SAGD technology to recover 8 to 9 degree API bitumen and heavy oil from unconsolidated sands in the Firebag field. Wells in these fields experience bottomhole pressures of 2000 to 3000 kPa and bottomhole producing temperatures of 180°C to 209°C. Whereas standard ESP strings are rated to 149 °C, bottomhole operating conditions (BOC), key components of the SAGD system featured in this paper, especially its motor, power cables, pump, and advanced protector, are built to withstand bottomhole temperatures up to 218 °C.

Suncor has installed 21 of these ESP systems, which have enabled a reduction in downhole pressures to improve the steam/oil ratio (SOR). This is a direct reduction in operating and lifting costs, which provides several million dollars in savings by reducing the amount of water that needs to be treated and the amount of fuel burned to generate the steam. Suncor's line of ESP systems has achieved a runlife of more than 500 days.

World Oil Reserves and Demand

There are several sources of information that continually evaluate and discuss world oil reserves. The numbers may differ slightly from source to source, but almost all of them agree on a similar distribution of fossil fuel reserves as shown in **Figs. 1 and 2**. According to this, the world has twice as much heavy oil and bitumen than conventional oil. It is estimated that there are approximately 8 to 9 trillion barrels of heavy oil and bitumen in place worldwide, of which potentially 900 billion barrels of oil are commercially exploitable with today's technology.

As for oil demand, the International Energy Agency (IEA) projects that global primary energy demand will increase by 1.7 to 2% per year from 2000 to 2030, which is equivalent to two-thirds of the current demand. On the other hand, the supply from relatively cheap conventional sources is declining, and reserves are not being replaced with new discoveries. A conservative 3% of natural decline in production from existing reserves is estimated. While non-conventional oil is emerging as a new major source of oil, even an aggressive worldwide development scenario can only capture 10 to 15% of the required new oil supply in the next 20 years. In addition, nonconventional oil by itself cannot make up for the decline in the world conventional oil production (Isaacs, 2006).

Heavy Oil and Oil sands Resources in Canada

The situation in Canada differs significantly from the rest of the world in terms of oil reserves and demand. Certainly, the Canadian petroleum industry is facing dwindling light crude oil reserves. However, at the same time, an abundance of established heavy oil and bitumen deposits remain significantly untapped. According to government statistics, Canada's oil sands contain nearly 175 billion barrels of crude oil reserves that can be processed with today's technology, thus putting the oil sands second only to Saudi Arabia in crude