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Steam Assisted Gravity Drainage (SAGD): A New Oil Producton Technology for Heavy Oil and Bitumens

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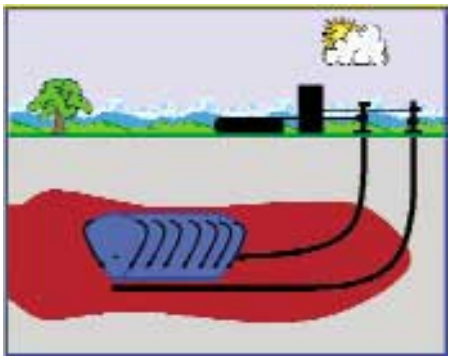

Introduction

The capacity of world heavy oil and oil sands has been estimated to be as much as that of the world's total discovered light and medium crude oils in place. Over 90% of the world's heavy oil and oil sands are deposited in Canada and Venezuela. Up to 90% of Canada's estimated reserves could be recovered by in-situ operations and 10% by surface mining. As the resources available for conventional crude in Canada continue to decline, further development of heavy oil and oil sands recovery technologies is critical in meeting Canada's present and future energy requirements.

Most recently, advances made in directional drilling and measuring while drilling (MWD) technologies have facilitated development of new in-situ production technologies such as Steam Assisted Gravity Drainage (SAGD) and combined SAGD-solvent processes. These processes have significantly improved well-bore reservoir contact and sweep efficiencies as well as reduced production costs.

SAGD Oil Recovery Technology

Western Canada has large reserves of heavy crude oil and bitumen. However, most of these reserves cannot be produced by conventional recovery methods. Specialized techniques are therefore required to produce these heavy oils. Recent thermal oil recovery technology developments at the Alberta Research Council (ARC) have focused on SAGD and SAGD-solvent r techno processes.

The most promising thermal recovery technology is the SAGD process. In this process, two horizontal wells separated by a vertical distance are placed near the bottom of the formation. The top horizontal well is used to inject steam, which rises forming a large steam chamber above the well, and the bottom well is used to collect the produced liquids (formation water, condensate, and oil). The rising steam condenses on the boundary of the chamber, heating and entraining the oil to the production well. The process leads to a high recovery and high oil rate at economic oil-to-steam ratios (OSR).

The Underground Test Facility (UTF-Phase A) at Fort McMurray, Alberta, Canada was constructed in 1985 by the Alberta Oil Sands Technology and Research Authority (AOSTRA) to test the concept of SAGD. The process was tested from December 1987 to mid-1990. The UTF-Phase A project was the first successful field demonstration of the SAGD process. In addition to proving the concept of SAGD, it also provided operational know-how, which is critical to its successful commercial application.

Following the success of the UTF Phase A project, 500 m long horizontal wells have been used in subsequent phases to further test the commercial viability of the SAGD process. In addition, a number of field pilots are in progress in other heavy oil reservoirs in western Canada (Alberta and Saskatchewan), and around the world. These pilots tested the use of surface-accessed horizontal wells and extended SAGD applications to problem reservoirs. These reservoirs often have lower permeabilities, are deeper, have bottom water transition zones, with initial gas-saturated "live" oil and top water / gas caps. In Alberta, the success of these pilots has led to a number of commercial SAGD projects currently underway.

Current developments of the SAGD process at ARC are aimed at improving oil rates, OSR, reducing energy and minimizing water disposal requirements. In addition to SAGD, progress has been made in the development of combined steam-solvent injection processes, a novel approach for combining the benefits of steam and solvents in the recovery of heavy oil and bitumen has been undertaken. A newly patented Expanding Solvent-SAGD "ES-SAGD" process has been successfully field-tested and has resulted in improved oil rates, OSR and lower energy and water requirements as compared to conventional SAGD. *R*

Tawfik N. Nasr is a leader of the thermal gravity oil recovery strategic area in the Heavy Oil and Oil Sands business unit at the Alberta Research Council (ARC). Dr. Nasr holds B.Sc. and M.Sc. degrees in engineering and a Ph.D. degree in physics from the University of Alexandria, Egypt and the University of Manitoba, Canada. Dr. Nasr's interests include thermal in-situ oil recovery processes particularly development and implementation of the steam assisted gravity drainage (SAGD), steam-solvent processes, horizontal well applications, fluids flow in porous media and heat transfer. He has authored and co-authored more than sixty technical papers and holds five patents in the area of in-situ oil recovery. He is a member of the Petroleum Society of CIM, the Society of Petroleum Engineers (SPE) and the Canadian Heavy Oil Association (CHOA).