Preface

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Developing global conventional and unconventional oil and gas resources in high-cost, fragile, and harsh environment continues to be a challenge, but progress has been made through the adaptation of innovative technologies in resource characterisation, quantification and delineation, such as multi-lateral wells for production of heavy oil. These technologies are being employed successfully throughout the world. In order to keep economically viable oil and gas production, producers must continue pursuing cost reductions. This can be accomplished in two primary ways: developing and applying advanced technologies, and improving the ability to comply with essential and necessary regulations in a more streamlined and less costly manner.

Overall strategy for the development of unconventional fossil energy resources should include an understanding of:

- magnitude of the potential resource
- current state-of-the-art
- the research and development efforts that are needed to address the technical, economical and environmental challenges.

The petroleum industry has enjoyed a huge success since its inception in the mid 18th century. However, diminishing light oil supplies have posed great challenges in recent years. Hence, the oil industry has already started to look for alternate supplies. The abundantly available heavy oil resources around the world present a viable and promising solution. The total resources are estimated to be around 4 to 6 trillion barrels (Besson, 2005). Also, conventional natural gas deposits have been the most practical, and easiest, deposits to produce. However, as technology and geological knowledge advances, unconventional natural gas deposits are beginning to make up an increasingly larger percent of the supply picture. The economics of extraction will play a major role in determining whether or not a particular deposit may be unconventional, or simply to costly to extract. Essentially, however, there are six main categories of unconventional natural gas. These are deep gas, tight gas, gas-containing shales, coalbed methane, geopressurised zones, and Arctic and sub-sea hydrates.

The articles selected for this special issue with a theme of 'Production of technically challenged oil and gas resources', primarily focus on recovery of heavy oil; bitumen; and hydrocarbons in harsh environments such as the Arctic and deep offshore or ultra deep water.

The first article deals with arctic environments, where wellbore heat losses are significant and limit the applicability of thermal recovery. Our study focuses primarily on the problem of wells penetrating permafrost. The authors use experimental approach to determine thermal conductivity versus temperature of nanomaterial insulators (aerogels), fibreglass, thermoelastic insulation, and carbon fibres. A comparator thermal conductivity apparatus as well as direct measurements using heat flux sensors were developed. Authors also compare their experimental results with semi-analytical and numerical models created to design a super insulated well. The models incorporate various composite insulations. Well failure/stability is inferred from the rate of thaw-front propagation. A key parameter is the insulation thermal conductivity versus temperature that is measured directly. The measured conductivity data agrees well with the literature values at ambient temperature. The wellbore heat loss and thaw front propagation model indicates that aerogels alone or aerogels in a composite with more conductive insulation may meet the requirements to avoid well failure, even for very high temperature fluids and over long time.

Next article explores a novel concept of harnessing geothermal energy from heavy oil fields that have undergone steam flooding and thus accumulated substantial heat from steam injection. Once the steam flooding process reaches economic cut-off resulting from high water cut and/or high steam-to-oil ratio, the reservoir would be abandoned, leaving behind stored energy in the form of heat. From this point, the reservoir could be regarded as an artificial geothermal system and its intrinsic heat from the steam flooding stage recovered by water circulation. The authors use a synthetic case to show that the average produced energy rate during the water injection phase is approximately 11 MMBTU/day for 3,800 days, after which the operations stop. At that time, a cumulative net energy production of 3.02 × 104 MMBTU is recovered.

Pressure-volume-temperature (PVT) properties play a critical role in all reservoir engineering calculations. Over the years researchers have proposed variety of approaches for predicting PVT properties based on empirical correlations, statistical regression and artificial neural networks. Unfortunately, the developed correlations are often limited and global correlations are usually less accurate compared to local correlations. In this paper, authors use a genetic-neuro-fuzzy inference system (GANFIS) for crude oil PVT properties prediction. Simulation experiments show that the proposed technique outperforms up to date methods.

In recent years, Vapex has been successfully used in laboratories and in the field. In this paper, the authors investigate the effect of the packed medium permeability on concentration-dependent dispersion coefficient of propane in heavy oil during Vapex process. Their experimental results show that propane concentration-dependent dispersion coefficient is a unimodal function. The dispersion coefficient of propane (at all concentrations) as well as its solubility in heavy oil increases with the decrease of the packed medium permeability. The properties determined in this work would enable engineers to optimise oil recovery, and perform more accurate simulations and implementations.

Several gas condensate and volatile reservoirs have been discovered in recent years and have received a lot of attention. It is important to optimise the gas condensate recovery during asset development. Authors use reservoir simulation approach to come up with development strategy and PVT characterisation of the liquefied petroleum gas as well as quantification of LPG production under primary depletion and gas injection.

References

Besson, C. (2005) 'Resources to reserves: oil and gas technologies for the energy markets of the future', *A Report prepared for the International Energy Agency*.