Unconventional Oil & Gas Production

HIGHLIGHTS

■ **PROCESSES AND TECHNOLOGY STATUS –** The unconventional oil and gas resources include: ■ **Extra heavy oil** (oil with high viscosity and API gravity of less than 10°.); ■ **Oil sand** (sand containing bitumen); ■ **Oil shale** (sedimentary rock containing kerogen); ■ **Tight gas** (natural gas with low permeability); ■ **Coal bed methane** (CBM, natural gas associated with coal); ■ **Shale gas** (nat. gas associated with shale oil); and ■ **Natural gas hydrates** (structures of water ice trapping natural gas). The Orinoco belt in Venezuela has a production capacity at 570 kb/d of extra heavy oil. Canada is the only country with commercial extraction of oil sand. The oil sand production was 1.3 mb/d in 2008. Oil shale is currently exploited in Brazil, China, Germany and Israel. In 2005, the worldwide oil shale production was 5 mb. North America is the continent with largest production of unconventional gas. The US production in 2006 was 161 bcm of tight gas, 51 bcm of CBM and 31 bcm of shale gas. Currently, there is no commercial production of gas hydrates. Development and production of unconventional oil and natural gas resources requires processes and technologies that differ considerably from those used for conventional resources in terms of energy input, cost and environmental impact. Because of the high viscosity, extra heavy oil does not flow easily at reservoir conditions. There are several techniques to decrease viscosity and facilitate extraction using steam injections, horizontal wells and multilateral technologies. Oil is extracted by surface mining or by in-depth in-situ mining (without physical extraction). In in-depth mining, the extra heavy oil is extracted from drilled wells where, for example, steam is injected to allow the bitumen to flow to the well head. Oil shale can be combusted directly or converted to oil by heating rocks in the absence of oxygen (retorting). Oil shale mining also includes basically two options, the surface mining (most common) and in-situ retorting using, for example, underground heating systems. Tight gas, CBM and shale gas extraction technologies include hydraulic fracturing and horizontal wells to allow the fluids to flow more easily through a well. As natural gas hydrates exist a high pressure and low temperature, gas production methods are based on thermal and inhibitor injection, and depressurisation.

■ **PERFORMANCE AND COSTS –** Production of unconventional oil is an energy intensive process that requires significant amounts of heat. The energy used as a percentage of the energy produced is about 20 -25 % for extra heavy oil, 30 % for oil sand and 30 % for oil shale, as compared to 6 % for conventional oil and gas. The ratio between energy used to energy produced is relatively small for tight gas, CBM and shale gas. The associated emissions depend on the energy used in the production process. Natural gas is the most common fuel used for heating purposes during production. Associated CO_2 emissions range from 9.3 to 15.8 g/MJ for oil sand and extra heavy oil, and from 13 to 50 g/MJ for oil shale. Production of tight gas, CBM and shale gas involves lower emissions compared to unconventional oil due to lower energy requirement. The production cost of extra heavy oil and oil from sand ranges from $6.6 to $13.1/GJ. Oil from oil shale is more costly and ranges from $8.2 to $19.7/GJ. As a comparison, the cost of conventional oil ranges typically between $1.6 to $6.6/GJ, with some exceptions. Production costs of unconventional natural gas range from $2.6 to $7.6/GJ for tight gas, from $3.8 to $7.6/GJ for CBM and from $3,8 to $8.6/GJ for shale gas. The estimated production cost of natural gas from hydrates is between $4.4 and $8.6/GJ, but little or no practical experience exists. For comparison, the production costs of new conventional natural gas resources range from $0.5/GJ to $5.7/GJ, with some exceptions. In general, production costs of unconventional resources are projected to decline in relative terms as well as the extraction technologies improve

■ **POTENTIAL AND BARRIERS –** At the end of 2005, estimated unconventional resources were: 2484 BBL of extra heavy oil; 3272 BBL of oil sand; 2826 BBL of oil shale; 210 tcm of tight gas, 256 tcm of CBM, 456 tcm of shale gas and between 1000 and 5000 tcm of natural gas from hydrates. The Orinoco belt in Venezuela have the largest extra heavy oil deposits with about 2 200 BBL and a production capacity at 570 kb/d. The largest oil sand deposits are located in the Western Canada. The United States have the largest oil shale resources. Asia pacific is the region with largest estimates of tight gas and shale gas, while the Former Soviet Union has the largest CBM resources. Estimates of unconventional resources availability and prospects for production vary significantly in the literature. The role of unconventional resources in the future depends on developments in production technologies, on future market demand, and on the development of other energy sources. According to Mohr and Evans (2010), the peak production for unconventional oil would range between 49 mb/d in 2076 and 88 mb/d in 2084. Oil shale is estimated to offer the largest potential followed by oil sands and extra heavy oil. At present, unconventional gas resources are mainly produced in North America and in this region the production is expected to increase towards 2030.

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