Conventional Oil and Gas Technologies

HIGHLIGHTS

- **PROCESS AND TECHNOLOGY STATUS –** Oil and gas technologies include the exploration and development of oil and gas fields, and production processes. Over the past decades, dramatic improvements in all oil and gas technologies have led to important discoveries of new fields and a significant increase in the recovery factor, i.e. the percentage of hydrocarbons that is economically recoverable from a given reservoir. These developments have made meeting the growing global demand for hydrocarbons possible in spite of the unavoidable decline in new giant reservoirs. From 1970 to 2008 global oil production has increased by 70% and natural gas by 200%. In 2008, global oil production was about 82 million barrels per day (mb/d). The major producers were Saudi Arabia, Russia and the United States with 10.8, 9.9 and 6.7 mb/d, respectively. In the same year, global natural gas production was 3066 billion cubic meters (bm^3), with Russia, the United States and Canada being the major producers - 602, 583 and 175 bm^3. A number of oil and gas fields are currently under development or renewal. The three biggest development projects are Kashagan in Kazakhstan, and Sakhalin 2 and Shtokman in Russia. The estimated capacity of Kashagan is 0.82 mb/d.
- **PERFORMANCE AND COSTS –** The **recovery factor** is a key performance in oil and gas production. In oil fields it normally ranges from 30-50%, while in natural gas fields it is usually much higher, ranging from 70-80%. In 2005 the **energy consumption** per unit of production was between 0.8 to 2.3 GJ per toe, depending on location (about 2-5% of the output). The energy needed for oil and gas production is often obtained from locally produced gas, which is burned in gas turbines. In the production process, **energy losses** may occur because of gas flaring and venting. Gas flaring occurs when natural gas is associated to the oil production and there is neither a local market nor any infrastructure to sell/use natural gas. The World Bank Global Gas Flaring Reduction Initiative estimates that 150 bm^3 of gas were flared or vented in 2005. Carbon dioxide (CO_2) is the largest gaseous **emission** occurring either from flaring or fuel combustion in energy production. Methane (CH_4) is the second largest gaseous release, basically coming from venting and from incomplete combustion of hydrocarbons. Europe is the region with the lowest emissions per unit of production: 65 tCO_2/1000 toe, 0.2 tCH_4/1000 toe and 0.2 tNO_x/1000 toe. Africa has the highest CO_2 emissions (274 tCO_2/1000 toe), Australasia has the highest CH_4 emissions (1.9 tCH_4/1000 toe) and America has the highest NO_x emissions (0.5 tNO_x/1000 toe). In 2006, the highest **production cost** was recorded in Canada at US$ 8.3/boe and the lowest cost (US$3.2/boe) in the so-called *Other Western Hemisphere* area (Central and South America and the Caribbean). The production cost (in US $ per barrel of oil equivalent, $/boe) accounts for operating and maintaining wells and related equipment, after the hydrocarbons have been found and developed for production. The **exploration cost** is the cost of adding proved reserves of oil and natural gas through exploration and development activities. In the period 2004-2006, the US offshore explorations recorded the highest exploration cost ($63.7/boe) with the Middle East having the lowest one ($5.3/boe). The estimated development cost of the Kashagan field is US$ 54,000 million.
- **POTENTIAL AND BARRIERS –** Over the last few years, exploration costs have increased in all regions because of the general decline of new discoveries, and the growing cost of field development. Exploration and production costs tend to grow because of the increasingly remote locations and depth of the new discoveries, the rising costs of materials and equipment, and also for geo-political reasons. Key technology advances such as 3D seismic and horizontal drilling have led to important achievements in both exploration and production at more affordable costs. Further cost reduction, increasing recovery factors and production are expected from new technologies (e.g. low-cost wells, deepwater techniques, and enhanced recovery).

PROCESS AND TECHNOLOGY STATUS – Oil and gas technologies include exploration, development and production processes. National organisations of oil and gas producing countries (e.g. the Norwegian Petroleum Directorate [18]), and national oil companies provide oil and gas production data. Other sources provide production data using national and private sources (e.g. Oil and Gas Journal, British Petroleum (BP), Organisation of Petroleum Exporting Countries (OPEC)). Oil and natural gas production over the past decades are shown in tables 1 and 2. From 1970 to 2008, worldwide oil production has increased by 70% and natural gas production has increased by 200%. In 2008, global oil production was about 82 mb/d. Saudi Arabia was the first producing country (10.8 mb/d) followed by Russia (9.9 mb/d) and the United States (6.7 mb/d). The proven oil reserves were 1258 billion barrels [2] and the reserves to production (R/P) ratio was 43 years. In the same year, the global natural gas production totalled 3066 bm^3, with Russia, the United States and Canada being the largest producing countries (602 bm^3, 583 bm^3, and 175 bm^3, respectively). The proven natural gas reserves were 185 trillion m^3 [2] and the R/P ratio was 60 years. While the R/P ratio provides information on reserves availability, it is not the right parameter to use to discover how long the reserves will last because oil and gas production vary over time according to demand, and new resources are found by exploration. The recovery factor (i.e. the percentage of hydrocarbons in place that is economically recoverable from a given reservoir) also varies over time due to advancement in technology. Over the past decades, important technology advances such as 3D seismics and horizontal drilling has meant substantial improvements in exploration, development and production technologies. Further improvements in developing low-

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