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**USE of CO<sub>2</sub> for ENHANCED OIL RECOVERY and STORAGE**

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CCS technologies are recognised to be a key element in CO<sub>2</sub> emission reduction strategy. Different solutions can be used for storing CO<sub>2</sub>, the most promising ones considering storage capacity, safety and geographical distribution are certainly deep saline aquifers and depleted oil and gas reservoirs.

Besides CO<sub>2</sub> storage in depleted oil and gas reservoirs, enhanced oil recovery (EOR) through CO<sub>2</sub> flooding has captured attention because of the potential economic gain from incremental oil production. Various miscible agents, among them CO<sub>2</sub>, have been used for enhanced (tertiary) oil recovery to further increase recovery. The experiences gained from CO<sub>2</sub>-flood EOR operations indicate an incremental oil recovery ranging from 7 to 23% of the original oil in place.

The opportunities offered by enhanced oil recovery (EOR) have therefore increased interest in CO<sub>2</sub> storage in the very recent years. As they are not designed for CO<sub>2</sub> storage (CO<sub>2</sub> EOR processes are typically designed to obtain maximum oil production while injecting minimum CO<sub>2</sub>), CO<sub>2</sub>-EOR projects demonstrate to some degree the associated storage of CO<sub>2</sub>. The lack of comprehensive monitoring of EOR projects (other than for the Weyburn Monitoring Project) makes it difficult to quantify how much is stored.

In the United States, there are around 70 CO<sub>2</sub>-EOR operations under way that, in total, inject between 20 to 30 Mt CO<sub>2</sub> per year, most of which comes from natural CO<sub>2</sub> accumulations. The three largest CO<sub>2</sub>-EOR projects in the United States are the Sacroc and the Wasson-Denver project in Texas, and the Rangely Weber project in Colorado. CO<sub>2</sub> is also used as part of the gas injection project at Prudhoe Bay. Smaller CO<sub>2</sub>-EOR projects are also currently under way in Argentina, Trinidad, Turkey, Brazil, and Canada.

The majority of these CO<sub>2</sub>-EOR projects use low cost CO<sub>2</sub> sources (such as natural accumulations) and have good economic returns in term of high gas utilisation factors (160-220 sm<sup>3</sup> CO<sub>2</sub>/ STB oil). It is considered that up to 60% of injected CO<sub>2</sub> can finally be retained in the reservoir at CO<sub>2</sub> breakthrough if reinjection is not considered.

When considering CO<sub>2</sub> geological storage, the situations are more complex and several issues must be addressed such as:

- Economic conditions for anthropogenic CO<sub>2</sub> sources (generally high costs).
- Greenhouse gas balance of the whole process including CO<sub>2</sub> recycling, but also secondary emissions related to energy used to recompress CO<sub>2</sub>.
- Optimization of oil production versus maximisation of CO<sub>2</sub> stored.

- Discrepancy between CO<sub>2</sub> flow rate dictated by the industrial emitting process, and the optimal flow rate for a good oil recovery in a given field.
- Size of oil reservoirs compare to size of CO<sub>2</sub> emissions for typical industrial emitters (generally several million tons of CO<sub>2</sub> per year).
- Time span of CO<sub>2</sub> emissions (30-40 years) for an emitting installation vs. field requirement.
- Time window: availability of CO<sub>2</sub> source vs. availability of reservoir.
- Presence of old wells that may compromise the trap.

Several topics will be illustrated and discussed in the presentation:

- CO<sub>2</sub> storage potential in oil reservoirs using EOR, comparison with other types of geological storage.
- Mechanisms involved in CO<sub>2</sub>-EOR.
- Mechanisms involved in long-term storage of CO<sub>2</sub> in reservoirs.
- Clean oil recovery concept, optimizing both oil production and anthropogenic CO<sub>2</sub> safe storage.
- Outline of some specific CO<sub>2</sub>-EOR / storage projects (e.g. ENCANNA-Weyburn, BP-Hydrogen Energy in California and Australia, Petrobras - Reconcavo Basin, Masdar project in Abu Dhabi)