

## **Potential for Increasing Recovery in mature Fields Onshore & Offshore Trinidad using Carbon Dioxide**

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### **Abstract**

Trinidad and Tobago has been producing oil commercially since 1908. Cumulative production from that time to end 2014 is over 3.5 billion barrels of oil (BBO). Most of this oil (estimated 3.0 BBO) has been produced by primary means.

A concerted if relatively small effort has been made at EOR using steam in shallow heavy oilfields onshore. Cumulative to date 200 million barrels oil (MMBO). Some minor water-flooding has been done but without much success. The oilfields in the East Coast Marine Area (ECMA) have natural water drives resulting in higher recoveries than one would expect from primary recovery. In one field in the North ECMA gas has been re-injected to increase recovery percentages.

Of the total produced approximately 2.5 BBO has been produced from land and Gulf of Paria (GOP) fields, over 2.25 BBO by primary means. A concerted if relatively small effort has been made at EOR using steam in shallow heavy oilfields onshore. Estimates based on a recovery factor of 20%, are that around 7.75 BBO remain in place in these fields onshore and in the GOP.

The land and GOP fields are producing oil of a range of API gravities from 12 degrees to 30 degrees, with one or two as high as 55 degrees. Generally, but with a few exceptions, the shallow oils are heavier. Production from these fields range from very shallow (less than a thousand feet) to relatively deep (around 12,000 feet). All reservoirs are sandstones, with the shallower ones often unconsolidated.

Relatively recent experiences (since 1975 or so) from small pilot projects in Trinidad and even more recently, from large projects worldwide, mainly in the USA but also in Canada show that carbon dioxide (CO<sub>2</sub>) is a viable economical means of improving the percentage of oil recovered. This has found to be of the order of 20-35% of original oil in place (OOIP), the recovery factor being mainly dependent on reservoir depth and parameters and the viscosity and API gravity of the reservoir oils. Currently CO<sub>2</sub> Enhanced Oil Recovery (CO<sub>2</sub>/EOR) accounts for about 300,000 bopd worldwide, CO<sub>2</sub> consumption (including re-injected CO<sub>2</sub>) being about 3-4 BCFD.

Trinidad and Tobago has a large industrial base comprising mostly petrochemical and gas based plants which, excluding 2.4 bcfgd used for LNG, consume about 1.6 bcfgd. These include seven world scale ammonia plants which collectively vent about 250-300 MMCFD of virtually pure CO<sub>2</sub> into the atmosphere. All of these plants are located in the large Point Lisas Industrial Estate (PLIPDECO) onshore the west coast of Trinidad abutting the GOP.

It is believed that CO<sub>2</sub> can be used to significantly increase percentage of oil recovery in T&T oilfields, both by huffnpuff and by flooding. It has also been recognised that flooding can include other fluids like water in either a water alternating gas (WAG) process or in a squeeze with CO<sub>2</sub> being injected in updip wells simultaneously with water in downdip wells.

Currently there are no active CO<sub>2</sub> projects in Trinidad, except for a very huffnpuff small pilot onshore (by the author's company K. Persad and Associates Ltd....KPAL)

Initially focus is on the onshore and GOP fields because of their relative proximity to PLIPDECO. The National Gas Company of T&T (NGC) has been mandated by the Minister of Energy and Energy Affairs to investigate the commercial feasibility of building a CO<sub>2</sub> pipeline system to supply CO<sub>2</sub> to oilfields onshore Trinidad. NGC reportedly has been in discussions with the State Oil Company of T&T the Petroleum Company of Trinidad and Tobago (Petrotrin) to supply them with 30 MMCFD of CO<sub>2</sub> for Petrotrin to use in a CO<sub>2</sub>/EOR project in the area where initial pilots were successful.

This paper examines the use of CO<sub>2</sub> for EOR worldwide, briefly describes the oilfields which are potentially suitable for CO<sub>2</sub>/EOR onshore Trinidad and in the GOP and discusses the feasibility of using CO<sub>2</sub> for EOR in these fields. It also outlines plans by the author to expand a pilot project in a small onshore field leased to KPAL into a flood.