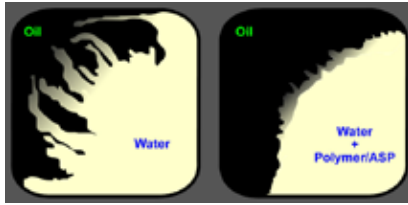




Enhanced Oil Recovery

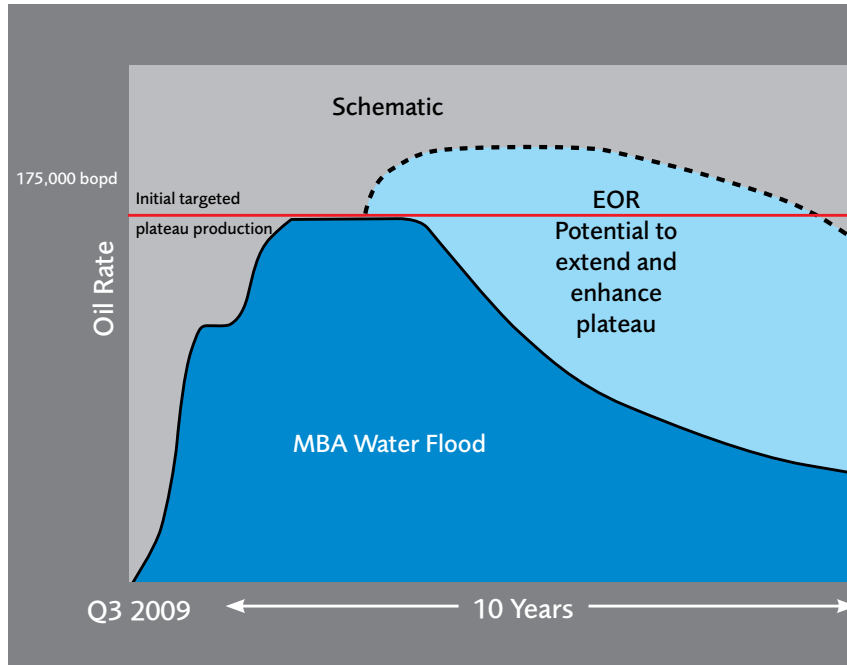
Chemical flooding

Enhanced Oil Recovery (EOR) is a term for special techniques to increase the amount of crude oil that can be extracted from a field, over and above conventional primary depletion or basic waterflooding which typically will recover 20% to 40% of the stock tank oil initially in place (STOIIP). Using typical EOR methods, an additional 10% to 20% of STOIIP can be extracted from a field. For example, polymers can be used to increase the viscosity of injected water, forcing it to move into regions of the reservoir that would not be contacted by plain water, resulting in a more efficient flood and sweeping more oil to the producers. In addition, small amounts of detergent-like surfactants can also be injected with the

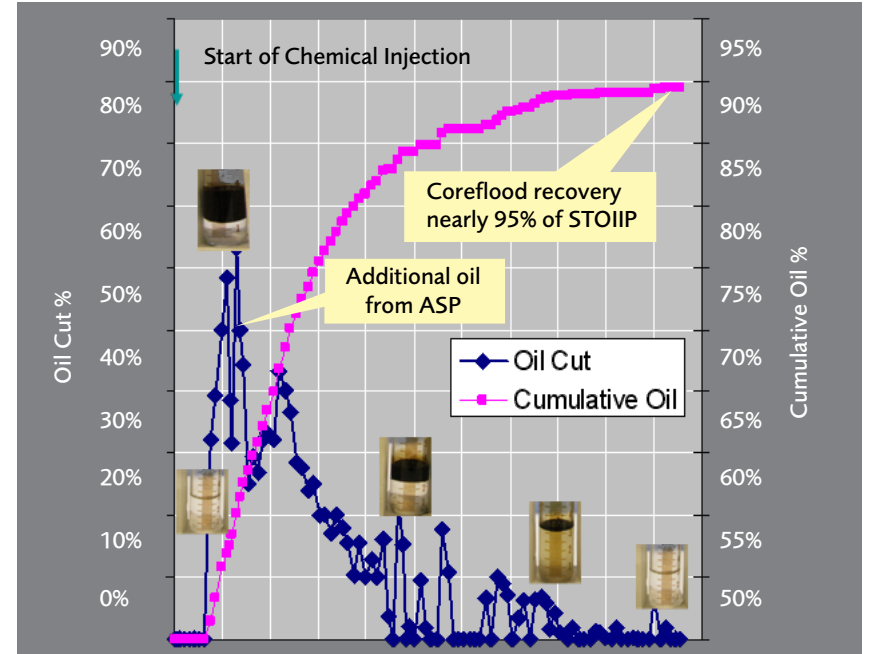


Left: Water "fingers" through the oil at it moves from injection (I) to production (P) well due to adverse viscosity effects. Right: with polymer or ASP little or no "fingering" is evident as viscosities are similar, improving sweep efficiency and oil recovery.

water and polymer; these "soaps" help "scrub" more oil out of the rock wherever the water goes, further enhancing oil recovery.



EOR Opportunity in Rajasthan



Mangala coreflood result along with pictures of produced effluent (Post waterflood result displayed)

The importance of EOR for the Mangala field (and subsequently for Bhagyam and Aishwariya) was realized soon after its discovery in 2004. The field is expected to produce around 35% of STOIIP over thirty years of conventional waterflood operations. In part due to its moderate oil viscosity, this oil production will be accompanied by large volumes of associated water production, as the less viscous injected water tends to "finger" or channel through the oil, arriving at the production wells prematurely. Because of this, under conventional waterflooding, the field can be expected to show moderate to steep oil production decline once it comes off its maximum production plateau. EOR screening studies by

reputable international consultants suggested that aqueous-based chemical flooding EOR processes are the most suitable based on the Mangala rock and fluid characteristics. These chemical processes are aimed at improving the sweep and oil displacement efficiency in the fields. That is, by adding oilfield polymer chemicals, it is possible to make injection water just as viscous as the oil, doing away with the tendency to "finger" through the oil. Thus, more oil will be contacted by the injected water resulting in increased sweep efficiency. Through the use of alkali and surfactant chemicals, injected water acts almost as a soap, helping to wash more oil off the reservoir rock surface resulting in increased

displacement efficiency. Depending on the combination of chemicals used, these processes are called Polymer Flooding or Alkaline Surfactant Polymer (ASP) Flooding.

Successful application of these processes should result in significantly increased oil reserves, an extended oil production plateau period, and even less water production as premature arrival of water at production wells is curtailed. All of this is intended to optimise and maximise oil production. Expected impact of successful EOR implementation is schematically depicted in the figure titled "EOR Opportunity in Rajasthan".

LABORATORY WORK

Beginning in 2006 and continuing to date, detailed laboratory studies have been conducted at Surtek laboratories (USA) and at the Petroleum Engineering

Department of The University of Texas (Austin, Texas, USA), to quantify the potential of the various chemical flood processes.

The laboratory programmes were developed to evaluate the potential of chemical flood processes for Mangala. Their main objectives were to screen and select chemicals that are suitable for application in Mangala and then to use the best of them in reservoir corefloods to understand process mechanisms, quantify incremental gains over waterflood and recommend a chemical formulation for pilot testing of the process in the field. Another important objective was to generate parameters specifically required by commercial chemical flood simulators.

Results confirm that these processes could significantly increase Mangala's

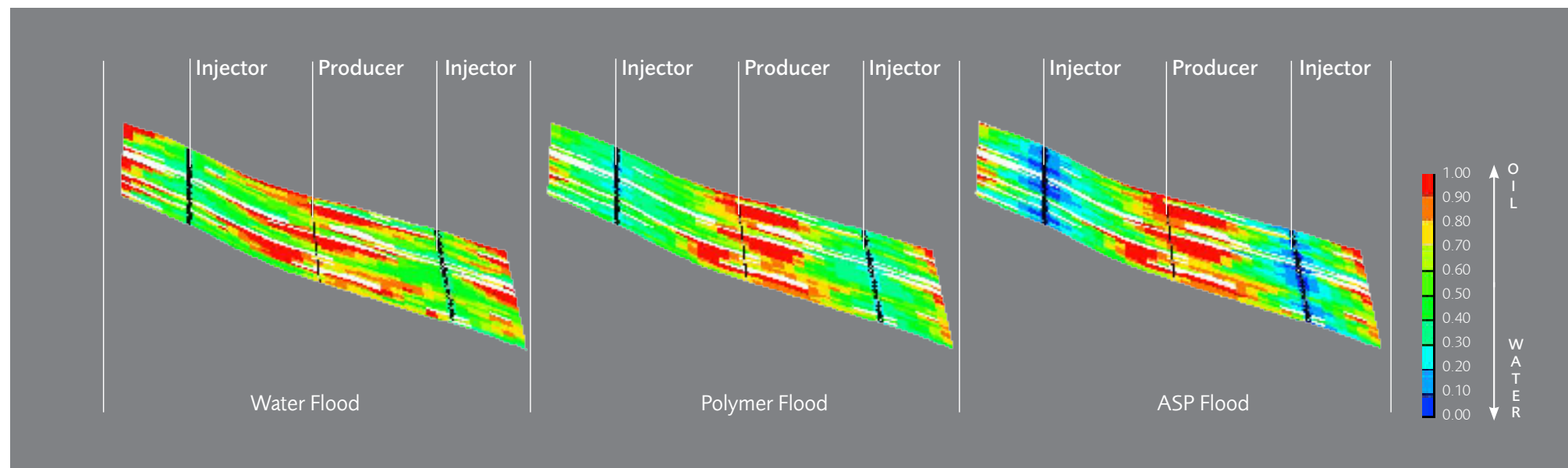
oil reserves. In the laboratory, recovery of an additional 15% of the STOIP was achieved under polymer flooding. With application of ASP, recoveries were increased by over 30% of the STOIP! Of course, due to the more heterogeneous nature of the whole field as compared to the smaller samples tested in the laboratories, recoveries in full-field application can be expected to be somewhat lower. Results of a Mangala coreflood performed at University of Texas are shown where almost 95% of the total oil in core was recovered.

RESERVOIR SIMULATION OF CHEMICAL FLOODING

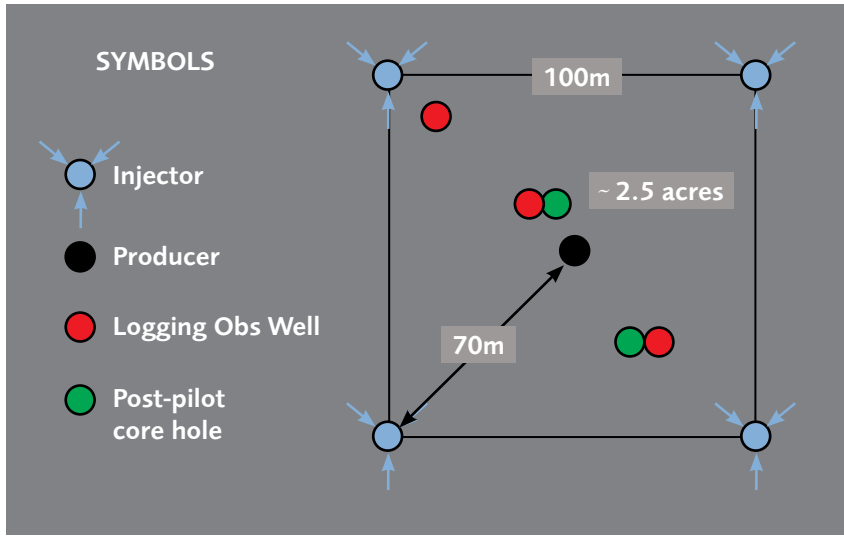
Detailed reservoir simulation of the chemical flood processes using an advanced commercial compositional simulator has been performed to understand the process mechanisms

as well as to assist in the design of an appropriate EOR strategy. Small-scale coreflood simulations reproducing laboratory results provided significant insights into the chemical flood process mechanisms and eliminated many uncertainties. Chemical flood parameters fine-tuned during the coreflood simulations have been used in field-scale simulations to evaluate expected performance and to aid in design of a field-scale pilot project.

Simulation results clearly confirmed an improvement in both sweep and displacement efficiency as a result of chemical flooding. A cross-sectional profile of a Mangala sector simulation model is shown in the figure below comparing the performance of waterflood, polymer flood and ASP floods (figure shows a central producer surrounded by two injectors). Results



Simulation Model - Oil /Water Saturation Display



EOR Pilot Schematic

show an improvement in the vertical sweep efficiency in the polymer flood case as well as a displacement efficiency improvement in the ASP flood case. Injection water does not break through easily in the producer and oil in the upper layers are also swept. Additionally in the ASP case, the oil saturation close to injectors is reduced to values much lower than was seen in the water and polymer flood cases. Extensive field-scale simulations have been used to design an appropriate chemical flood implementation strategy. These works indicate potential field-scale incremental recoveries over waterflooding of ~7% STOIIIP for polymer and ~15% STOIIIP for ASP floods respectively.

EOR PILOT

The next step in the evaluation process will be a closely spaced polymer-ASP

pilot to test the process under field-scale conditions. The simulation phase was instrumental in helping to design the pilot, the preparations for which are at an advanced stage.

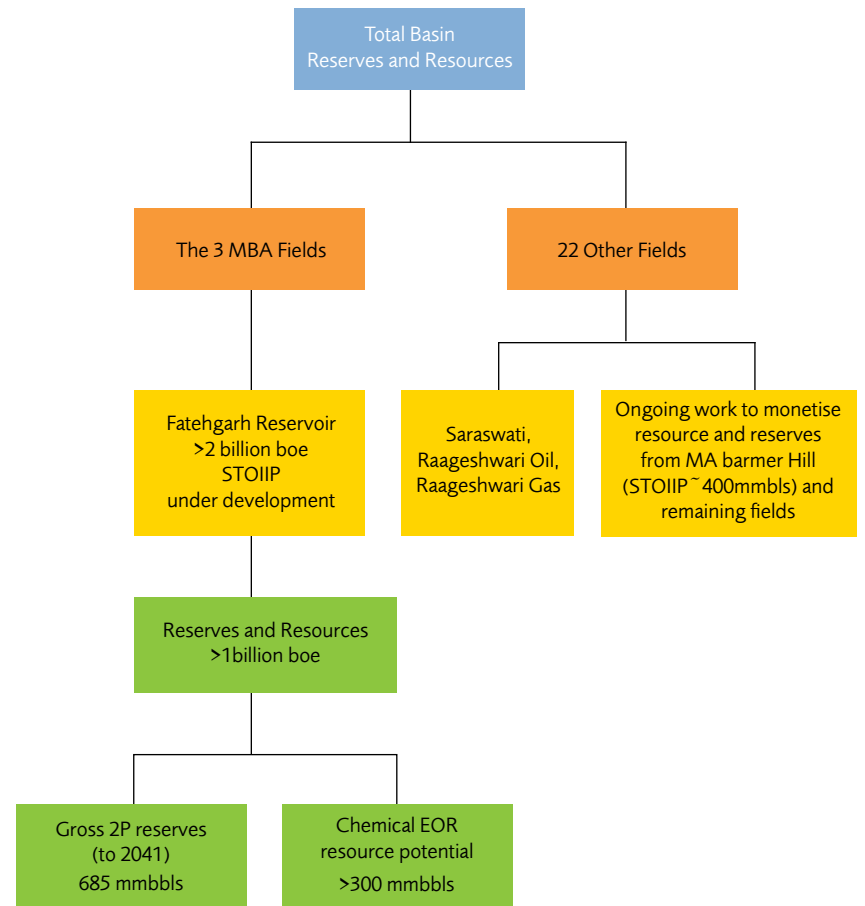
A normal "5-spot" pilot has been conceptualised for field testing of the ASP process. Extensive simulation was done to generate pilot forecast and optimise the design. The target zone for the pilot is uppermost unit of the Mangala reservoir which contains around 45% of the total STOIIIP.

The pilot is planned on a close well spacing with injector-to-injector spacing of 100m (injector-to-producer ~70m) to expedite timely results while allowing all pilot objectives to be met. The plan is to first inject water to establish baseline production trends, after which

ASP chemicals will be injected followed by chase water injection. Logging observation wells inside the pilot area will continuously measure changes in oil saturation as a result of chemical injection, and post-pilot coreholes drilled close to logging observation wells will tie core saturations to the logging observation results. It is expected that such a production-observation pilot

will give sufficient information in 18-24 months time to enable a decision on appropriate field wide implementation of a chemical flood process(es). The timely pilot results will allow field-wide chemical flood implementation before the field goes on waterflood decline. The figure below shows the significant potential for EOR in the MBA fields.

EOR PILOT



CAIRN INDIA LIMITED

Cairn India is one of the largest independent oil and gas exploration and production companies in India. It is headquartered in Gurgaon near Delhi and has material exploration and production positions in 10 blocks in India and one in Sri Lanka. Cairn produces oil and gas from three blocks in India: Ravva in Andhra Pradesh, CB-OS/2 in the Cambay Basin in Gujarat and RJ-ON-90/1 in Rajasthan where it works in partnership with ONGC. In 2007, Cairn India was listed on the National and Bombay Stock Exchanges.

Cairn has been operating in India for 15 years and has played an active role in developing the oil and gas resources in the country. The Mangala field, discovered in January 2004 near Barmer, Rajasthan and dedicated to the nation in August 2009 by the Prime Minister, the Hon'ble Dr. Manmohan Singh, is the largest onshore oil discovery in India in more than 20 years. The Mangala, Bhagyam and Aishwariya fields have recoverable oil reserves and resources of approximately 1 billion barrels.

In total there have been 25 discoveries on the Rajasthan block and the company is focused on exploiting the full potential.

Cairn India will account for more than 20 percent of India's domestic crude oil production when the Rajasthan fields reach the current approved plateau production rate of 175,000 barrels of oil per day in 2011.

Health, safety and the environment are integral to Cairn India's business management and the company is committed to working with all stakeholders to deliver material growth.