ITF Call for Proposals

EOR Technologies

(Output from ITF Technology Challenge Workshop)

A Collaborative Approach to Investment in Technology

The Industry Technology Facilitator (ITF) is a not for profit organisation owned by, and with access to funds from major oil and gas operating and service companies that comprise its membership. ITF has an impressive track record in delivering finance to help develop new initiatives for oil and gas technologies from early stage joint industry projects (JIPs) through to field trials and commercialisation. Since 1999, ITF has supported more than 150 projects worth in excess of £45 million in funding. ITF's key objectives are to identify technology needs, foster innovation and facilitate the development and implementation of new technologies.

A fundamental element of ITF's role as an internationally recognised champion for facilitating research, development and deployment of technology innovation within the upstream oil and gas industry is to engage with key industry sources. ITF uses a proven process, working in collaborative participation with both its Members and industry to identify technology needs and potential solutions.

The ITF process, illustrated below as a step-by-step course of actions, endeavours to bridge the gap between the industry's large global players and development community with the ultimate aim of implementing new technology solutions:

STEP 1 - Understand and Identify Technology Needs
STEP 2 - Engage the Development Community / Invite Proposals
STEP 3 - Evaluate Proposal Submissions
STEP 4 - Secure Funding
STEP 5 - Assist the Launch of JIPs
STEP 6 - Facilitate the Implementation of Technologies

ITF has contractual confidentiality arrangements with all its Members and will enter into a parallel agreement with all developers submitting proposal applications. Proposals will be submitted to our Members only for the purpose for which they are provided, i.e. assessment for funding support and implementation.

Proposals submitted under this Technology Challenge Program will be reviewed for financial sponsorship by **all ITF Members** therefore this is an excellent opportunity to gain access to a global audience in seeking support for your technology. The focus of all ITF themes is to identify technologies which bring clear benefits to sponsors but which require assistance in **research, development, and / or field trial.**

For details of ITF's full Portfolio of Members, please visit our Website - www.oil-itf.com

Background to the Theme

This Call for Proposals is the collective output of an ITF "EOR Technology" workshop held in Amsterdam on the 17th of March 2010 in recognition that technology in relation to EOR needs to be developed further to help overcome the specific problems associated with different methods.

All the events included intensive, facilitated workshops which brought together ITF Members, Operators, Service Companies, Small and Medium-sized Enterprises and research and academic players. The output of these discussions has formed the basis of this Call for Proposals.

Program Timeline

Each ITF Theme follows a nine month timeline from the Technology Challenge Workshop to Program Completion. The following list of tasks describes the key milestones and their associated date:

Technology Challenge Workshop	Mar 2010
Call for Proposals Issued	May 2010
Deadline for Receipt of Proposals	***5th Jul 2010***
Publish to Members for Review	Aug 2010
Member Review and Voting	Aug 2010
Technical Clarification Meeting	Sep 2010
Members finalise commitment to sponsor	Dec 2010
Program Complete	Dec 2010

An Open Invitation to Global Technology Developers

This document aims to stimulate high quality proposals from global development expertise which meet the specific requirements for EOR Technologies. ITF and its Members will jointly assess all submitted proposals and our Members will potentially fund those proposals of greatest interest.

ITF and its Members will not prescribe specific technology solutions, but instead use the output gathered from the Technology Challenge Workshop to stimulate innovative proposals that offer potential solutions to identified needs. Key technology drivers, as identified by ITF Members, are the desire to produce fields in a more cost effective and efficient manner.

This is an open invitation to any organisation seeking sponsorship for innovative technologies in the oil and gas industry to submit proposals for research, development, and / or field trial in the following areas, associated with the identified needs of the ITF EOR Technology Challenge Program:

- **Chemical EOR**
- **Miscible and Immiscible Gas Injection**
- **Thermal recovery (including In Situ Combustion)**
- **Microbial EOR**
- **Modelling**
- **Other**

It is recognised that much work is being undertaken in these areas and that many valuable developments are being worked on around the world. The purpose of this call is to add to this body of work by challenging the development community to think beyond the current limits and propose projects which will significantly improve the industry's ability on EOR Technologies.

The list of detailed technology challenges are identified within each area that are of explicit interest to ITF Members in the 'Specific Technology Requirements' below. This information highlights key elements required but allows for innovation and flexibility in interpreting the most appropriate technical solutions.

The method for submitting a proposal is described later in this document but you can also learn how to submit a proposal by going to our website www.oil-itf.com

Specific Technology Requirements

(Any submitted proposal **must** address one or more of the following identified requirements)

CHEMICAL EOR

Background:

Chemical EOR is a well-established technology that provides incremental oil recovery but its current applications are usually limited to sandstone reservoirs of moderate temperature and salinity.

Although much is known about Chemical EOR methods, the current contribution to worldwide production is very limited; the potential in heavy oil development is just unfolding.

Requirements:

- *Chemical efficiency.* There is a need to make the existing chemicals more efficient as well as to introduce new ones. There are a few challenges in different areas that need to be taken into account to optimize the economics of chemical EOR both onshore and offshore.
    - HSE. There is a need for chemicals that are registrable and that follow in place Fire/Explosion HSE regulations and could be easily disposed of. Also to take into account is the nature of the installations (manned/unmanned) when dealing with the risks associated with the handling and use of chemicals (asphyxiation, toxicity, irritants, disposal)
    - Volumes. Transportation, mixing and storage of the different phases (liquid, powder) is still a challenge when managing high volumes (egg. large water injection).
    - Process Plant Operation. Incompatibility for different chemicals in terms of transportation, storage and mixing in the processing plant is a challenge that needs to be addressed.
    - Cost. There is a need to deal with the impact that the incompatibility with existing chemicals, the existing processes and equipment and process upsets (Oil deferment) have on export product quality and value.

- *EOR Chemicals for carbonates*. There is a specific need to develop cost-effective chemicals (surfactants and polymers) for Carbonate rocks. Most of the applications to date are for sandstones with limestones being neglected as they are considered more difficult. Carbonate rocks can pose an added challenge due to the low permeability, fracture density and their calcium content. The chemical make-up of the rock can affect the wettabilitty and thus the oil displacement which is critical to the eventual recovery. There is a need to understand the effect of brine on the natural components of the rock.

- *EOR Chemicals for High Temperature and High salinity.* There are limits on current polymers and surfactants so there is a need to develop chemicals that will remain stable at high temperature (200 – 240 deg F) and high salinity (100 – 220 Kppm)

- *Advanced surfactants*. There is a need to create viscoelastic surfactants (VES) that combine viscosity with surfactancy, one molecule that can shear the system and can re-form. There is also the need for non-alkaline surfactants that will be insensitive to reservoir conditions and will avoid the absorption effects of the reservoir rock.

- *Cost reduction by re-use.* There is a need to reduce the cost of this technology which could be achieved by chemical recycling or developing easily separable chemicals.

- *Compatibility with plants and environments.* An increasing regulation to manage the environmental issues associated with the handling of produced chemicals requires a better system modeling to understand and deal with environmental issues during production.

- *Chemical placement.* This requirement is associated with the need for a better well design to deliver chemicals where they are needed and a better conformance and chemical design to deal with heterogeneity. Still a challenge is the lack of subsurface control on flow of chemicals and the placement of blocking agents.

- *Better chemical modeling*. It is recognized that the modeling limitations and the lack of sufficient modeling tools reduces the confidence in the chemical modeling. There is a specific need to upgrade an ageous reactive flow modeling, to improve simulation that will take into account permeability modifiers and non-Newtonian fluids.

- *Process intensification.* There is a need for a scaleable customized chemical production process.

- *Viscosity control reduction.* Polymers are needed to reduce the oil viscosity and therefore increase the mobility together with new chemicals to reduce viscosity of viscous oil.

- *Near wellbore/through reservoir.* The expansion of the treatment beyond the near-wellbore is still identified as a challenge.

MISCIBLE & IMMISCIBLE GAS INJECTION

Background

Miscible and immiscible gas injection are widely accepted and implemented technologies being the miscible gas injection the most commonly used approach to enhanced oil recovery.

This method can be both difficult and expensive and still constitutes a challenge when economics are against.

The safety issues associated with this method are of paramount importance as gases are being injected at very high pressures and fail-safe mechanisms need to be in place.

Requirements:

- *Modeling Gas injection processes.* The challenges and limitations associated with reactive reservoir modeling (sandstones and Carbonates) for H2S/CO_2 injection need to be addressed.

- *Using Gas resources effectively.* There is a need to integrate the reservoir/surface issues with the modeling of the process and use the excess of hydrocarbon gas available to produce positive results (e.g. WAG)

- *Improving the miscibility.* As part of this requirement additives to improve miscibility are requested. Also a challenge is how to use CO_2 EOR in High Pressure/High Temperature reservoirs.

- *Link CCS CO_2 Flooding*. There is need for a better understanding of CO_2 processes for Carbon Capture and the injection strategies using low cost sources of CO_2 as well as the reinjection of flue gas.

- *Reservoir and Production monitoring.* The monitoring key has been identified as in-situ real time composition monitoring (seismic?), routine compositional analysis in each producer (sensors?) and intra-reservoir tracking of EOR flood.

    - Injector to producer. In-situ real time fluid combustion measuring for chemicals and microbial composition of producing intervals is needed as well as a novel real time geophysical reservoir saturation monitoring and profiling. Thermal profiling is also needed between injector and producer as well as novel tracers (e.g. Nanoparticles)

    - Producer to surface. Asphaltene precipitation measurement in-situ is very important as well as the accurate measurement of gas lift injection in dual well completion.

- *Improve 3 Phase Understanding*. There is a need to experiment on measurements of 3 Phase and analogue database to develop accurate three-phase capillary pressure and relative permeability functions to understand the physical principles of the processes taking place in the porous media.

- *CO_2 tolerant kit.* Reliability of CO_2 compression and generation equipment/machinery is needed as well as additives to mitigate corrosion impact of CO_2 injection.

THERMAL RECOVERY METHODS (Including In Situ Combustion)

Background

New technologies are requires to continue improving the project economics and to reduce environmental impact from thermal oil recovery operations.

Requirements:

- *Innovative thermal additives.* One of the main challenges is the heat retention in reservoirs due to the steam heat loss. There is a need for development of a High temperature stable foam and boundary layer additives.
- *More efficient steam generation*. There are commercial and environmental challenges associated with this requirement. There is a need for a cost effective more efficient heat generation and deployment offshore together with the need to tackle the issues associated with the emissions created by the power generation for steam production.
- *Improve reservoir modeling.* There is a need for an improved understanding of the steam front growth over time as well as effectiveness and trends of the applied steam pressure.
- *New methods of generating heat.* New heating methods are needed (inductive heating?) as well as rheological downhole modifications methods (ultrasonics?)
- *Impact of heat on geomechanics*. This specific challenge has been identified for in-situ combustion and it is to understand the impact of heat on geomechanics and vice versa.
- *Understand and simulate In situ Combustion.* There is a need to control and understand the in situ process.

MICROBIAL EOR

Background

Although this biological based technology has had decades of research and successful applications is not as commonly used as the other recovery mechanisms.

There are many claimed advantages in the use of this technology such as the low energy input requirement for microbes to produce MEOR agents and it being more efficient than other methods when applied to carbonates but the advantages are overshadowed by the lack of published evidence and unknown environmental impact.

Requirements:

- *Develop awareness for oil industry*. There is a need to understand the basis processes of MEOR as there is a very high interest on this technology but a low level of knowledge.
- *Microbial modeling.* Reactive flow modeling and simulation are being identified by our members as specific challenges for this biological technology.
- *Commercial recovery mechanisms.* There are a number of challenges that need to be overcome to make this recovery method commercial and those are:
  - How to control microbial placement and growth?
  - Finding a suitable nutrition for microbial
  - How to deal with High Temperature microbial. Can this be controlled?
- *Bug tolerant kit.* This name was given to describe the requirement to deal with the challenge associated with the produced fluids and the compatibility of the facilities design.

MODELLING

Background

There is a strong need to simulate the combination of processes. COUPLING AND UNDERSTANDING PROCESS INTERACTION.

Requirements:

- *Prototype simulator.* The development of a simulator (a prototype) that combines commercial proprietary tools is required, a project that is able to validate available data and to quantify uncertainty. This cannot be done in isolation and Universities and service providers are encouraged to work together to develop the interface between existing commercial codes (plug-in apps).

  There is a need to use the simulator (prototype) to cover the-What Ifs? and also to become much more user friendly with flexible simulation tools (modules) that can work simultaneously and that address different areas:

  - Multiphase flow
  - Thermal
  - Geothermal
  - Feedbacks/Interactions
  - Bugs
  - Crosscaling

OTHER

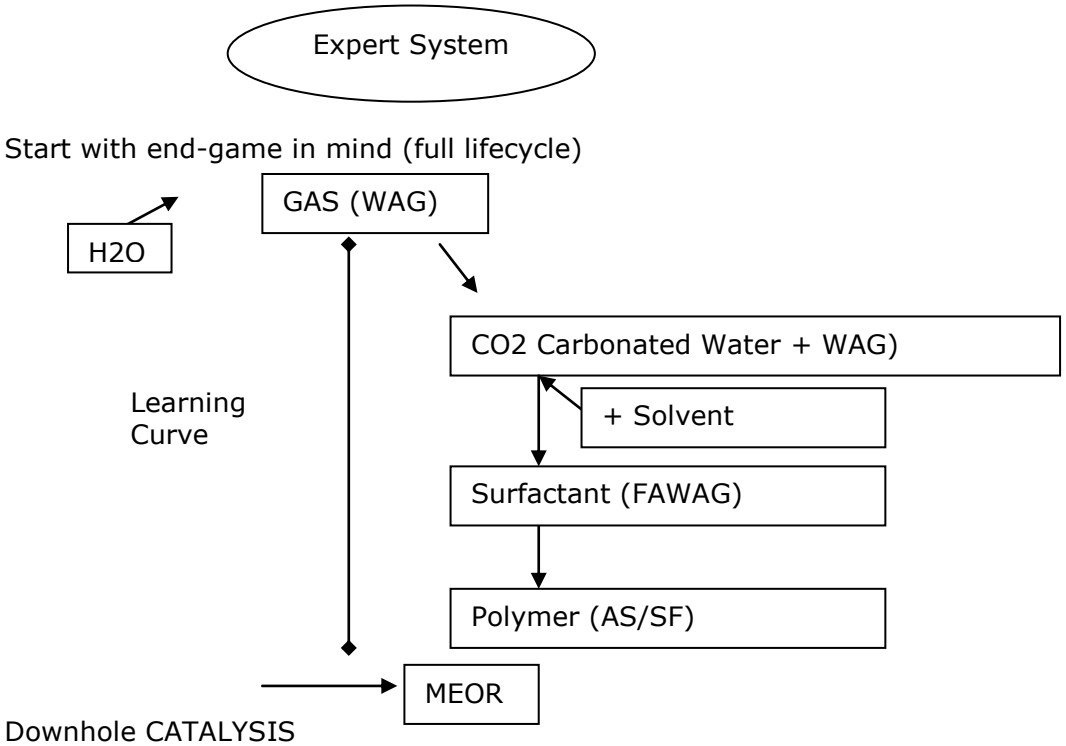
This covers different challenges that were identified during the Technology Challenge Workshop but were not thought to belong to any of the previous categories.

They were identified to be discussed separately and they include:

- *Combined EOR.* There is a specific need to develop an "expert system" that allows to build the whole cycle for EOR (any possible combination), a system that will include all kind of reservoir fluids, a matrix of what it is possible and what it is not possible. The system would have different run scenarios (compare costs + availability of gas, CO_2, Chemicals, etc...)

  - Full life cycle production optimization
  - Hybrid EOR
  - Multi stage reactive EOR Bio⇔Chemical

  There is a need for a full cycle prediction from the start which will become a learning curve and de-risk the more expensive EOR. There are some challenges such as how to get the surfactant down and the order of application of EOR techniques that need to be resolved. There is also a need to understand heterogeneities and know where they are together with the location of low viscosity and low permeability areas. The reservoirs need to be looked at in an individual basis.



- *Non thermal Heavy oil EOR.* There are a large number of heavy oil reservoirs that due to being too thin of offshore are not suitable for steam injection. These reservoirs have been identified as a challenge and there is a need to better develop chemical of physical recovery methods as an alternative to thermal methods which are generally non-environmentally friendly.
    - Alkaline Flooding.
    - Natural Surfactant utilization.
    - CO_2 Foam Injection.
    - Viscosity altering chemicals/polymers.
- *EOR Tolerant kit.* The injection –production system for is still a challenge as well as the material selection for EOR
- *Big picture modeling.* There is a need for modeling the field scale aspects of EOR processes.
- *Augmented water flooding.*
- *Cross fertilization.* There is a need to look outside the traditional oil industry. EOR requires integrated decision based organization and crosses academia-upstream and downstream sectors.
- *Well density and location.* Better management of multilaterals in production (Recovery) is needed.

Process for Submitting a Proposal

1. **Register Interest with ITF**
   Register your interest as early as possible by sending an email to Cristina Puig at c.puig@oil-itf.com

2. **Visit the ITF Website -** www.oil-itf.com
   On the ITF Home page, click on the "How to Submit a Proposal" button or follow this link to access all the information required to submit a proposal.

3. **Read the 'Project Application Guidance' Document**
   This document is available to view or download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website. Reading this document prior to submitting a proposal is essential. If you require further clarification or are unsure if your proposal is suitable for submission, please call ITF (ITF Contact Information appears later).

4. **Download and Complete the 'Project Application Form'**
   This form is available to download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website.

5. **Download and Complete the 'Project Presentation Template'**
   This template is available to download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website.

6. **Email the Completed 'Project Application Form' and 'Project Presentation Template' to ITF**
   Email the Completed 'Project Application Form' in Microsoft Word format (not PDF) and the 'Project Presentation Template' in Microsoft PowerPoint format (not PDF) to Cristina Puig at c.puig@oil-itf.com by **no later than 5th July 2010**. Proposals received after this date may not be processed.

Qualifying Technologies

In order to qualify for potential sponsorship, technologies submitted in response to this Call for Proposals must:

- be applicable to at least one of the identified requirements
- be novel or innovative
- demonstrate a clear business case for support
- have a clear and demonstrable path to commercialisation and implementation

Note: Proposals submitted to any other ITF Call in the past nine months or any previously unsuccessful applications should not be resubmitted without first consulting ITF (contact information provided later in this document).

Qualifying Organisations

Proposals are invited from any organisation including SME's, academia, research institutions, large organisations, consortiums or alliances. Proposals may be submitted by a national or international organisation, and equal opportunities will be extended to all proposers. Please keep in mind however that should your proposal be taken forward, you will be required to participate in meetings and make presentations to interested parties in the UK and in the English language (teleconference and video conference are acceptable).

ITF Contact Information

If you would like to discuss any matters related to this call or any other issue related to ITF, please contact any of the following people:

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