

ANNEX I TO THE AGREEMENT
BETWEEN
THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA
AND THE
NORWEGIAN MINISTRY OF PETROLEUM AND ENERGY
IN FOSSIL ENERGY RESEARCH AND DEVELOPMENT
IN THE AREA OF
ADSORPTION OF CHEMICALS ON RESERVOIR ROCK

WHEREAS, in the furtherance of their mutual interest the United States Department of Energy (DOE) and the Norwegian Ministry of Petroleum and Energy (MOPE) entered into the agreement in the field of Fossil Energy Research and Development signed April 22, 1987 (hereinafter referred to as the Energy R&D Agreement) which is set forth in the Appendix;

WHEREAS, MOPE has designated Rogaland Research Institute (RRI) to act on its behalf for purposes of this Annex I;

WHEREAS, DOE and RRI (hereinafter referred to as the Parties) desire to cooperate in the field of fossil energy research and development;

WHEREAS, the Parties have a mutual interest in technology exchange on the application of surfactants for the recovery of petroleum;

WHEREAS, the Parties have a mutual interest in developing cost effective chemical flooding systems for the recovery of petroleum from offshore petroleum reservoirs;

WHEREAS, Norway's Continental Shelf is known to be a prolific petroleum producing area, and therefore a prime candidate for evaluation, selection and petroleum recovery studies of chemical flooding including micellar/polymer, surfactant-enhanced alkaline and low concentration surfactant flooding processes;

IT IS AGREED AS FOLLOWS:

Article I - Scope of Work

The Parties shall cooperate in tasks in the area of adsorption of chemicals on reservoir rock as related to chemical flooding for enhanced oil recovery in onshore and offshore petroleum reservoirs as set forth in Article II of the Annex and in accordance with the terms and conditions of the Energy R&D Agreement.

Article II - Responsibilities of the Parties

The Parties shall carry out a series of tasks over the period of this Annex I as described below:

A. Technical Information Exchange

The Parties shall provide annual summaries of chemical flooding research and field testing activities in their respective countries.

B. Experimental Tasks Performed by RRI

Approximately 3 staff-years of RRI personnel effort shall be devoted to:

- Task 1. (a) Relate adsorption studies on reservoir cores from the North Sea at reservoir temperature to geological properties and the type and amount of clay minerals, i.e. kaolinite.
- (b) Perform long term adsorption studies using mixtures of ethoxylated sulfonates and the corresponding alcohols. The adsorption fractions related to the high permeable pores and the low permeable/blind pores, i.e. the micro-pores associated with the clays shall be determined. A simple kinetic model describing the nonequilibrium or diffusion controlled adsorption shall be tested.
- Task 2. (a) Determine adsorption behavior of mixtures of anionic surfactants and medium-chain alcohols on solid surfaces. Characterize bonding mechanisms and adsorption behavior.
- (b) Determine adsorption of mixtures of anionic and nonionic surfactants on solid surfaces. Characterize bonding mechanisms and adsorption behavior.
- (c) Determine adsorption of mixture of double- and triple-chain anionic surfactants on solid surfaces. Characterize bonding mechanisms and adsorption behavior.
- (d) Evaluate dynamic adsorption behavior of subparagraphs (a) through (c).

C. Experimental Tasks Performed by DOE

Approximately 3 staff-years of DOE personnel effort in total shall be devoted to:

- Task 1. (a) Determine thermodynamic properties of adsorption for surfactants and sacrificial agents to identify systems that are potentially applicable for chemical flooding.
- (b) Select and evaluate candidate surfactants and sacrificial agents for the study. Adsorption isotherms and enthalpies of adsorption shall be measured to determine the

preferential adsorption behavior of the formulations. Calorimetry, bottle tests, and dynamic flow adsorption tests in both columns and cores shall be performed.

- Task 2. (a) Determine the effects of composition of formulations containing nonionic and anionic surfactants on adsorption.
- (b) Evaluate a series of surfactant formulations containing nonionic and anionic surfactants to determine the effects of composition on adsorption. Adsorption/desorption isotherms shall be measured to determine compositions at which surfactant retention is minimized.
- Task 3. (a) Evaluate oil recovery efficiency of surfactant systems with favorable adsorption properties.
- (b) Evaluate the oil recovery efficiency of selected surfactant formulations that have been shown by Tasks 1 and 2 to have minimal adsorption. Oil displacement tests shall be conducted with core samples saturated with reservoir crude oil.

Article III - Management

The National Institute for Petroleum and Energy Research (NIPER) and Columbia University shall carry out DOE's technical responsibilities under Paragraph C of Article II of this Annex I.

RRI may designate the University of Bergen to carry out some of the technical responsibilities under Paragraph B of Article II of this Annex.

Each Party shall designate a Project Manager for this Annex I. These Project Managers shall provide technical management and coordination of the tasks described in this Annex I.

The status of activities performed under this Annex I shall be reported to the Joint DOE/MOPE Coordinating Committee as described in Article IV of the Energy R&D Agreement.

Article IV - Funding

All costs resulting from cooperation under this Annex I shall be borne by the Party that incurs them, except as otherwise agreed in writing, and as provided in Article V. It is understood that the ability of each Party to carry out its obligations under this and agreed Annex I is subject to the availability of appropriated funds.

Article V - Exchange of Samples

Shipping costs for any samples required by either Party shall be the responsibility of the Party providing the samples. Inventions resulting

from such exchange shall be owned by the inventing party in its territory and third countries and by the other party in its territory.

Article VI - Intellectual Property Rights

Article IX of the Energy R&D Agreement is hereby incorporated by reference (see Appendix).

Article VII - Invention or Discovery

Article X of the Energy R&D Agreement is hereby incorporated by reference (See Appendix).

Article VIII - General Provisions

Collaboration under this Annex I shall be in accordance with the laws and regulations of the respective Parties. All questions related to the Annex arising during its term shall be settled by the Parties by mutual agreement.

Article IX - Duration

This Annex I shall enter into force upon the later date of signature and shall remain in force for a period of 18 months. This Annex may be amended or extended only by mutual written agreement of the Parties.

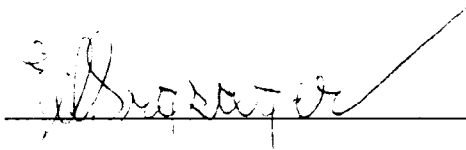
This Annex I may be terminated at any time at the discretion of either Party, upon six months advance notification in writing by the Party seeking to terminate. Such termination shall be without prejudice to the rights which may have accrued under this Annex to either Party up to the date of such termination.

FOR THE DEPARTMENT OF ENERGY
OF THE UNITED STATES OF AMERICA



Robert H. Gentile
Assistant Secretary
Fossil Energy

ROGALAND RESEARCH INSTITUTE
OF PETROLEUM AND ENERGY ON BEHALF
OF THE NORWEGIAN MINISTRY OF
PETROLEUM AND ENERGY



6/14/90
Date

Aug. 2, 1990
Date