CHARACTERISTICS AND POTENTIAL OF ANTRIM SHALE
FOR IN SITU ENERGY PRODUCTION

BY
MOHAMMED SAID ABUBAKR

A DISSERTATION

Submitted To
Michigan State University
In Partial Fulfillment Of The Requirements
For The Degree Of

DOCTOR OF PHILOSOPHY

Department of Chemical Engineering

1982
ABSTRACT

CHARACTERISTICS AND POTENTIAL OF ANTRIM SHALE
FOR IN SITU ENERGY PRODUCTION

By
Mohammed Said Abubakr

Antrim shale contains energy more than 1000 times the annual petroleum production of the United States.

Recovery of this energy involves heating the shale to 900°F at which temperature combustible material is evolved. This may be accomplished either aboveground after mining or underground. At 1500 feet depth, mining would be expensive, and true in situ processing would be advantageous if economically feasible.

A mathematical model was studied based on heat conduction into the formation from a hot well fueled by effluent gas and air. The model showed that the net energy production does not justify the process economically. Improvements on this model by higher temperature driving force for conduction, and by making a larger surface area accessible to combustion zone were investigated. Another mechanism considered was diffusion or forcing of air into the rock, followed by combustion of residual carbon deposited within the spent shale.

Laboratory experiments simulating in situ energy production under a variety of conditions were performed to investigate these possibilities.

Experiments showed that when shale is heated to about 1800°F glazing occurs blocking gas flow in or out of the rock.
The compressibility of retorted shale, containing porosity of 20%, was only 1.6%. Thus the porosity formed is of little use in producing space or fractures.

The opening of horizontal cracks during retorting under atmospheric pressure provided an important mechanism for the release of organic matter and the penetration of air into them. This was evident by the disappearance of carbonaceous residue along the cracks' surface. However, experiments performed under simulated overburden pressure showed no cracks and, therefore, this mechanism would be eliminated for true in situ energy production from Antrim.

In situ energy production from Antrim utilizing heat transfer is therefore not economically feasible. To make it feasible, an entirely different mechanism has to be found.

In situ energy production from other richer shales may be economically feasible if they occur at shallow depths, and produce more porous and compressible spent shale.