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CONVERSION OF ASSOCIATED NATURAL GAS TO LIQUID HYDROCARBONS. FINAL REPORT, JUNE 1, 1995--JANUARY 31, 1997

ENERGY INTERNATIONAL CORP., PITTSBURGH, PA (UNITED STATES)

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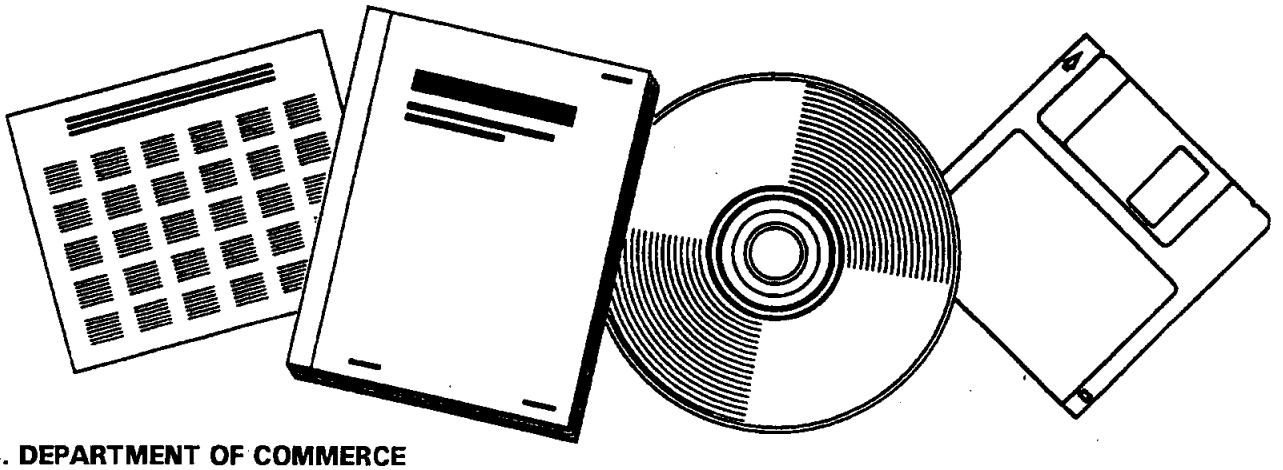

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Conversion of Associated Natural Gas to Liquid Hydrocarbons

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CONVERSION OF ASSOCIATED NATURAL GAS TO LIQUID HYDROCARBONS

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

ACRONYMS DEFINED

bbl	42-gallon barrel
BPD	barrel per day
BTU	British Thermal Unit
capex	capital expense
DOE	Department of Energy
DOI	Department of Interior
DP	dynamic positioning
DWT	dead weight tonnage
EI	Energy International
FFTP	floating Fischer-Tropsch production system
FPSO	floating production, storage, off-loading vessel
FSO	floating storage-off-loading vessel
FSU	floating storage unit
F-T	Fischer-Tropsch
FTP	Fischer-Tropsch Processing
GOM	Gulf of Mexico
GOR	gas to oil ratio =(cf/d gas)/(bbl/d oil)
LNG	liquefied natural gas
MCF/D	one thousand cubic feet per day
MMCF/D	million cubic feet per day
MMS	Minerals Management Service (within DOI)
OME	order of magnitude estimate
opex	operating expense
TLP	tension leg platform
ULCC	ultra large crude carrier
VLCC	very large crude carrier

SUMMARY

The original concept envisioned for the use of Fischer-Tropsch processing (FTP) of United States associated natural gas in this study was to provide a way of utilizing gas which could not be brought to market because a pipeline was not available or for which there was no local use. It was postulated that such situations could arise in remote areas of the U.S. or in deep offshore waters. U.S. regulations prohibit unrestricted flaring of gas, and this could conceivably prevent production of the crude oil with which the gas is associated. However, a survey conducted as part of this study showed no areas in United States territory at this time where associated gas and oil are shut in due to regulations on flaring or due to the lack of a way to utilize the gas. On the other hand, it was found that there is a need for a more economical and/or a more rapid way of utilizing associated gas in the offshore Gulf of Mexico in the deep water provinces currently being actively explored and developed.

Conversion of gas by FTP could provide a means of utilizing offshore associated gas which would not require installation of a pipeline or re-injection. The premium quality F-T hydrocarbons produced by conversion of the gas can be transported in the same way as the crude oil or in combination (blended) with it, eliminating the need for a separate gas transport system. FTP will produce a synthetic crude oil, thus increasing the effective size of the resource.

The two conventional approaches currently used in U.S. territory for handling of natural gas associated with crude petroleum production are re-injection and pipelining. Re-injection is sometimes desirable to enhance crude production but in some cases, it reduces or hampers production. It costs on the order of $0.25/MCF, and can range up to $0.50/MCF. This cost can be significant at high gas to oil ratios, and it does not make use of the gas resource.

For significant potential production of onshore and "near-shore" gas, pipelining to market or to a use point is the other current approach. However, as distances from shore increase, so do water depths, and distances to tie-in points to existing pipelines. Offshore pipeline installation costs can range from $170,000/mile to over $1,000,000/mile. In addition, sea bottom conditions such as a potential for mud-slides, can make building a pipeline too risky or too expensive. A deep water pipeline project at best is complex and time consuming. Some of the considerations involved are discussed.

Conversion of natural gas to a liquid product which can be transported to shore by tanker can be accomplished by FTP to produce hydrocarbons, or by conversion to chemical products such as methanol or ammonia, or by cryogenic liquefaction (LNG). This study considers FTP and briefly compares it to methanol and LNG. The Energy International Corporation cobalt catalyst, ratio adjusted, slurry bubble column F-T process was used as the basis for the study and the comparisons. An offshore F-T plant can best be accommodated by an FPSO (Floating Production, Storage, Offloading vessel) based on a converted surplus tanker, such as have been frequently used around the world recently. Other structure types used in deep water (platforms) are more expensive and cannot handle the required load.

Two cases were considered. The first was installation on a 135,000 ton capacity Suezmax tanker based FPSO of a Fischer-Tropsch plant capable of handling 56,000,000 cf/d of wet associated gas derived from 22,400 bbl/d of crude, a GOR of 2,500. This plant would produce 6,000 bbl/d of synthetic crude. The second case, considered more likely, would handle 200,000,000 cf/d of gas from 75,000 bbl/d of crude, a GOR of 2,670. For this case, the FPSO would be a converted 200,000 ton capacity VLCC tanker costing $142 MM including $65 MM for synthetic line mooring and associated vessel facilities. The F-T plant would produce 20,000 bbl/d of premium quality synthetic crude, and would have a capital cost of $420 MM. The combination of an F-T plant with an FPSO is referred to as an FFTP (Floating Fischer-Tropsch Production system).

A major oil and gas company which is a developer of deepwater gas/oil projects and a deep water Gulf of Mexico tract leaseholder has participated in this study on an anonymous basis. The Developer postulated development of a major oil/gas prospect at 6,000 ft water depth and a distance of 350 miles from the nearest available pipeline tie-in to the existing offshore to onshore pipeline transportation system. In this scenario, the Developer compared investment cost to produce the field via FFTP/shuttle tanker versus investment cost to produce the field via a new but conventional pipeline system. It was found that the FFTP/shuttle tanker system would enjoy a half-billion dollar investment advantage compared to production of the field via pipeline. Also, the field is produced by the FFTP approximately one year earlier than first oil is achieved via the pipeline system.

The Developer concludes his assessment as follows:

"In summary, if the Fischer-Tropsch process field-scale application will perform somewhat similarly to the representations made by EI, it appears that commercial interest in the F-T process/shuttle tanker development methodology is merited."

Consideration of other scenarios such as field development and delineation or production of small fields shows that the FFTP may have merit in these also, partly due to being able to move the entire facility to a new location easily as compared to a pipeline which must be dedicated to a project location.

Compared to methanol, F-T products have a much larger market, and can be handled and processed by existing petroleum systems if desired. FFTP is probably more adaptable to the offshore than LNG, and will be practical at lower production rates.