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OLEFINS AND METHANOL: THE GAS PRODUCTS FOR SECURE EXPORT INVESTMENT

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Abstract

There are multiple selections for natural gas transportation and conversion methods. Due to various purchaser requirements and very different export paths to consumption markets, it is very important to be familiar with all of these selections. This will help to find the optimum exploitation method of this valuable source.

Its applications have become very important, due to the 21st century challenges (petroleum-derived fuels air pollution, energy conservation, reduction of CO_2 & green house effect gases emissions and petroleum substitution requirement).

On the other hand, natural gas applications problems (large specific volume, high transportation cost and high explosion tendency) have complicated its techno-economic consumption. This explains the difficulty of decision making on the type and amount of investment, for each of the aforementioned methods (gas resource amount, consumption market scale, their distance, product type expected, newer sources exploration probability, etc.).This article tries to discuss these aspects.

Keywords: Natural Gas; Non-conventional Gas; Olefins; DME; GTL.

1. Introduction

The confirmed global natural gas resource is about 140 Trillion m^3; the 30% of it is located in the Middle East zone. Despite these huge reserves, only 9% of the global gas products market belongs to the Middle East. Natural gas is a clean fuel and a suitable chemical industries charge, but its special characteristics make its transportation expensive and difficult to the consumption market, with respect to petroleum. For example, one LNG carrier ship carries about 33 million gallons of LNG, containing about 3 Trillion Btu heating value. But, one petroleum carrier ship (which is simpler and cheaper) will carry 2.2 million barrel of petroleum, containing 130 Trillion Btu heating value.

In other words, 3 Trillion Btu (LNG) transportation costs more than 130 Trillion Btu (petroleum).This is due to problems like lack of a safe and appropriate market, and facing expensive and complicated technologies for LNG transportation.

Another difficulty is the pricing discipline for natural gas. The historical desire of natural gas exporters has always been the equivalence of gas and petroleum prices, on the basis of their heating values. But, its realization has confronted with obstacles [2].

LNG as a natural gas export alternative - is faced with more production and transportation problems, such as environmental issues, expensive operating cost and safety aspects, in comparison with other alternatives, e.g., pipeline.

2. Non-conventional Gas Resources, Treat or Opportunity?

Few years before 2008, in which the gas distribution networks resources in Europe and the United States became almost depleted, European firms started extensive efforts to procure enough natural gas, via entering into contracts with African and Asian gas exporting countries. But, about 2011 it was announced that the United States had a huge reduction in its natural gas imports, using its own Non-conventional gas reservoirs [3-4]. As a result, the global gas price reduced considerably [1-2], whereas natural gas application has major environmental benefits, for consumers. Continuation of this situation can seriously question the huge investment feasibility, on the gas exporting technologies.

3. What Is the Non-conventional Gas?

The gas obtained from coal bed methane, gas shale, tight gas sands, methane entrained in geo-pressed aquifers and gas hydrates, is called the non-conventional gas [1, 4].

An alternate definition is:" Natural gas reservoirs, without the ability of an economic production, or lacking an economic rate of oil or gas production, without extended stimulation operation (e.g., hydraulic fracturing, horizontal well drilling, multi-directional wells, or special recovery processes like steam flooding), are called non-conventional gas reservoirs".

Sands, compressed (low permeability) carbonates, and ultra deep reservoirs (deeper than 5000 meters) are introduced as non-conventional gas reservoirs [5].The common compound among them is methane. The non-conventional gas reservoir production costs are much more than conventional ones. Since 2009, the United States started this type of gas production seriously, such that its gas production became higher than Russia. Therefore, the U.S. LNG imports decreased drastically (from 21.8 billion cubic meters in 2007 to 12.8 in 2009) [6].

Considering the reduced gas demand in Europe, the free market gas price decreased considerably. In 2010, the United States informed India and China that it agrees with the transfer of shale gas production technology to them. China intends to increase its non-conventional gas production to one third of its total natural gas production, up to the year 2020 [7].

Although the United States is known as the pioneer in the non-conventional gas production, but it encounters many technical and wells performances challenges in this field. To produce 180 billion cubic meters of sand natural gas, it became necessary to drill 13000 gas wells in 2008.It seems impractical to do so, for other countries.

4. What Should Be Done?

At the time being, there exist multiple alternates for storage, conversion and transmission of natural gas. The main criteria for the selection of each alternate are the amount of gas and the transmission distance. But, other factors like: the required first investment, the return of investment duration, the technology requirement and some limitations are other effective factors. Some of these alternates have high added values, and should be concerned, during "low gas price" periods of time.

5. The Gas Transmission or Conversion Alternates

There are many useful natural gas applications, to be considered by gas exporters. Some of them are more attractive and discussed here:

5.1. Power Generation (Gas-To-Wire)

This alternate is suitable for relatively small amounts of gas and relatively short distances (up to 3000 Km). During recent decades, High Voltage Direct Current type of power transmission has been developed to overcome the distance and quantity limitations of this alternate. About 43% of the natural gas energy is received by the consumer, in this method. Also, this way is the safest, the most durable, and the most environmental friendly alternate for gas transmission [8].

5.2. Pipeline

This method is for medium to high amounts of gas and relatively short distances (up to 3000 Km). Recently, some Russian companies have built long-large diameter (super giant) pipelines, for 8000 Km (or longer) distances (trans-Russia gas pipeline). This last alternate necessitates multi-countries long-term contracts, to be established.

5.3. Gas to Liquids (GTL)

This method is suitable for medium amounts of natural gas, and medium to long distance markets. Natural Gas conversion to Fischer-Tropsch fuels, Di-Methyl-Ether, Methanol, Oxo Alcohols, etc., is considered in this method. The main step of this method is the Syngas (CO & H_2) production, which has the major costs, and is continuously developed and modified, to become more economical. Small to medium gas reservoirs are considered as the feed sources of this alternate. Gradually tightening environmental regulations promote using this method, because of producing the healthiest fuels and fuel blending components. One of other benefits of this method is the considerable amount of water production, which can be used for agriculture, in dry countries.

Another product of this method-Methanol-has recently been considered as the fuel cells power source, Methanol to gasoline and Methanol to Light Olefins feed. Therefore, high capacity Methanol production units (Mega-Methanol) are economical ones, with a well growing consumption market. Moreover, Di-Methyl-Ether (DME) is another product, which is a very environmental friendly substitute for Diesel Fuel, Jet Fuel, or LPG (both as a heating fuel or a power generation one). It is also a good substitute for LNG production from small gas reservoirs. This can be produced via existing Methanol production units, with only minor modifications.

5.4. Compressed Natural Gas (CNG)

CNG is a substitute fossil fuel for gasoline, diesel fuel, or LPG/Propane. Although it produces CO_2 with a considerable greenhouse effect, it is a more environmentally friendly than them. If it leaks out in open air, it readily is dispersed and leaves the place, due to its lower density than air. It can be supplied from, or mixed with biogas from buried municipal wastes, or waste water treatment, which are renewable sources and do not increase the atmospheric CO_2 inventory. There are over 6 million vehicles running on CNG worldwide, and the number is growing at an annual rate of 30%. Its weight-wise energy density is near the same as LPG and diesel fuel. But, its volume-wise energy density is approximately 42% of LPG and some 25% of diesel fuel [4]. It has a more efficient combustion and a lower price. Also, it requires less engine maintenance. Carbon monoxide, volatile organic compounds and NOx, from CNG combustion are (at least) 70% less than gasoline.

Natural gas marine export has developed considerably, and its economic range has been expanded to about 2200 Km, by using the recently developed ships [10]. A very important advantage of this method is that no non-affordable cost is imposed on the exporter or importer countries (except the ship itself). Therefore, they have a good flexibility in contracts.

5.5. Olefins Production

Olefins are valuable petrochemical products with considerable economical benefits. They can be produced from Methanol or DME. Generally, there are two main processes for this purpose:

First, a mixed flow (fluidized bed) reactor, with good temperature control, but a highly non-uniform residence time for the molecules. Therefore, its polymerized product quality is not the best.

Second, plug flow type (fixed bed) reactor with uniform residence time and good polymerized product quality. Obviously, its temperature control system should perform well.

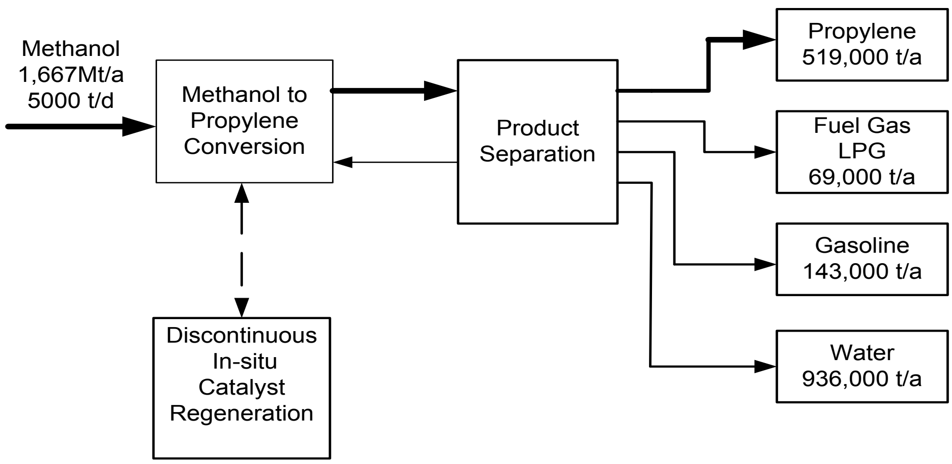

Fig. 1 Methanol to Propylene Conversion Path

The consumed catalyst is one of two main types:

First, the ZSM type catalysts, doped by metallic ions, such as: Manganese, Antimony, Magnesium or Barium.

The second one is of Silica-Alumina-Phosphate Molecular Sieves (SAPO), doped by Manganese, Nickel or Cobalt metallic ions [11].

There are some demonstration or industrial plants, constructed for this process.

One of the best choices for olefin production is the Methanol-To-Propylene process (MTP). LPG, gasoline and water are by-products of this process. About 58% of global Propylene consumption is in the form of Poly-propylene, and has the highest growth rate, among the propylene-derived products. This material is a good substitute of paper, steel and wood in many applications. Due to the very large and growing global consumption of Propylene with considerable benefit, its production is a good choice to invest on.

5.6. Fischer-Tropsch Products

This process-depending on the catalyst used-can produce different slates of naphtha, kerosene, and diesel fuel products.

The Iron-catalyst produces more naphtha and kerosene, whereas the Cobalt-catalyst enhances the diesel fuel production, as the major product (60%). The very high qualities of these products give a viable means of petroleum refinery products qualities modification [12].

Since the so-called "hard" sulfur compounds existing in petroleum-derived diesel fuels are very difficult to be eliminated by hydro-desulfurization refining, practically EURO-IV standards for diesel fuel sulfur content is almost not attainable. The practically viable method is to blend it with the Fischer-Tropsch diesel [9]. This has been a very strong reason for the Cobalt-type Fischer-Tropsch diesel production.

The reactors used can be of fixed bed, fluidized bed or slurry types.

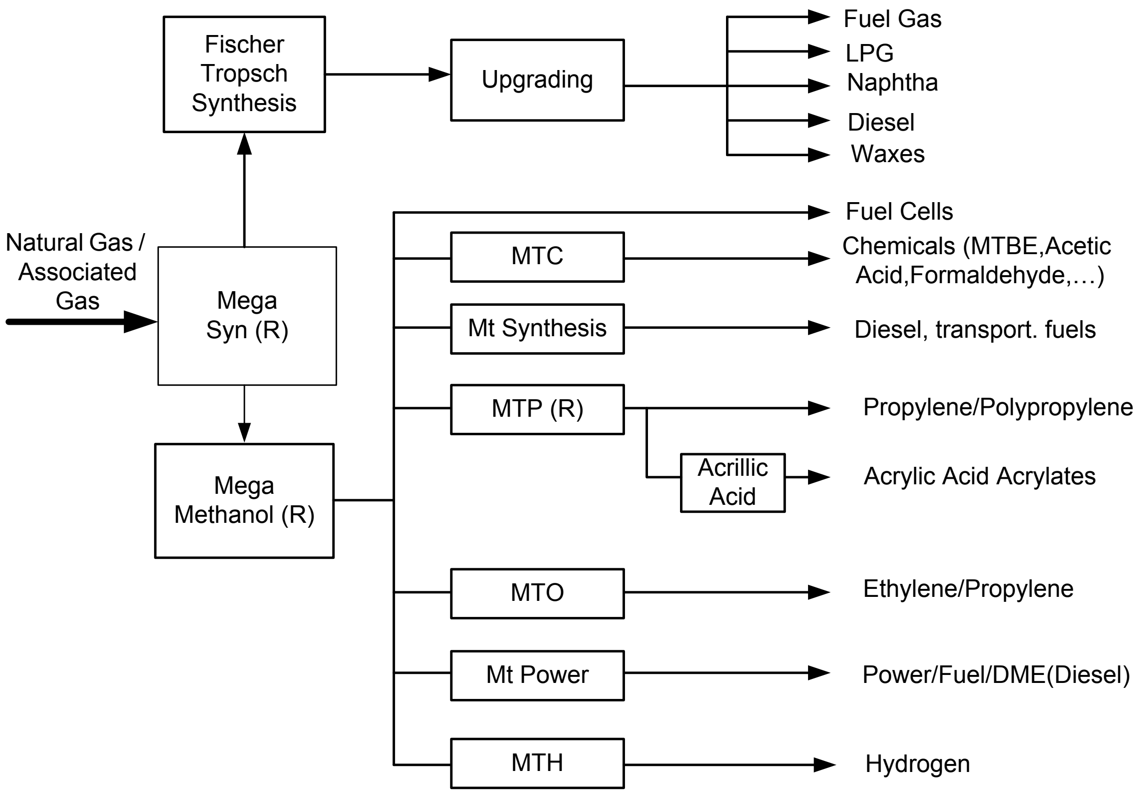

Fig.2 Gas Conversion to Chemicals Paths

6. Conclusions

There exist huge non-conventional gas reservoirs in the North-American region. Most of these reserves are facing with many techno-economical difficulties, to be exploited. Therefore, limited developments have been observed for them.

Except United States, there are no major existing threats for considerable investment on conventional gas reservoirs, but in long run, their economic feasibilities may be questionable.

Natural gas conversion processes seriously should be concerned, to have trustable and secure investment. Decreasing natural gas prices will only increase the marginal profits of these processes.

Olefins, DME, Methanol and Fischer-Tropsch products are suitable goods, with guaranteed markets, for this purpose.

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