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Towards the Production from Hydrate: Application of Methane Gas in Industrial Sectors.

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Abstract: *Methane gas originates from fermenting organic matter and also arises from distillation of coal and natural gas. The planet's heat and pressure disturb the biomass of dead plants, therefore its energy-rich carbon molecules become materials from which methane mining can occur. Methane is the core element of natural gas. The combustion of methane discharges energy, which is in the form of natural gas. This methane gas (natural gas) is applicable in many industrial sectors including chemicals industries, power, medicine, electronics, aerospace and food processor industries. In this research paper, the results show that, power sector in industrial sector consume much methane gas about 60%, than other industrial sectors. The future work has been suggested in this paper including methane gas availability and its transportation process.*

Keywords— methane gas, natural gas, industrial sectors, organic matter, coal, biomass, dead plants, hydrate

1. INTRODUCTION

As the amount of available petroleum declines, the need for substitute technologies to produce liquid fuels that could possibly help protract the liquid fuels culture and mitigate the upcoming effects of the shortage of transportation fuels is needed. More recently, conversion of bio renewable feedstock's to the liquid biofuels has become a promising method for the future [1-7]. As a gorgeous material, methane hydrate is plentiful on the earth, and when extracted, promises to potentially solve the world's energy needs for many centuries and in this case methane gas hydrates are progressively considered as potential energy resource [8].

Gases in the natural-gas hydrate sediment are principally methane molecules [9], in which methane hydrates are considered as a major potential source of hydrocarbon energy and could be important in meeting natural gas demand in the future [10]. Natural-gas hydrates are a vast potential, though not currently commercial source of additional natural gas and one of the most interesting aspects of this potential new gas source is that large deposits are located near the expected demand growth areas[11]. The growth of new, lower cost technologies and methods is required for economic production of methane gas from offshore hydrates. Low-cost production from gas hydrates will be incomplete by the rate of gas dissociation. Geothermal decomposition of gas hydrates provides the simplest, and lowest-cost, production technique. Decomposition reaction of gas hydrate is given by Eq 1:

$$CH_4.6H_2O_{(s)}=CH_{4(g)}+6H_2O_{(l)} \quad \text{(Eq.1)}$$

The production of natural gas from oceanic and permafrost sediments is presently being developed by such techniques as depressurization, thermal stimulation, and chemical injection of hydrate inhibitors. In the production process, it is significant to understand the physical properties of sediment in surveys of structural properties, such as permeability, hydrate saturation, and sediment porosity, since these properties are significant to the growth of natural gas production. The sediment porosity is principally significant for material flow in sediment, in this case many studies have been done on the relationship between sediment porosity and permeability [12-14]. Proposed approaches of gas production from hydrates generally deal with decomposing or melting in situ gas hydrates by increasing the reservoir temperature beyond the temperature of hydrate formation, or lowering the reservoir pressure below hydrate stability zone.

The depressurization method is based on lowering the pressure below hydrate stability zone inside the well and causing the methane hydrate to decompose and its objective is to reduce the pressure in the free-gas zone immediately beneath the hydrate stability zone, encouraging the hydrate at the base of the hydrate stability zone to dissociate [15], the same can be applied for the thermal stimulation technique which is applied to the hydrate stability zone to increase its temperature, encouraging the hydrate to dissociate. In this technique, a source of temperature provided directly from injected steam or another heated liquid, or indirectly through electric means, that makes methane hydrate to decompose and generates methane gas [16]. The chemical inhibition technique leads to shift the natural gas hydrate equilibrium condition beyond the hydrate stability zones thermo-dynamic conditions via injection of a liquid inhibitor chemical adjacent to the hydrate. Study by Davies[17], reveal thermal stimulation method and chemical inhibitor injection method to be expensive methods ,while the depressurization technique proved to be cheap in comparison to the two method and is more valuable to be applicable in more than one production.

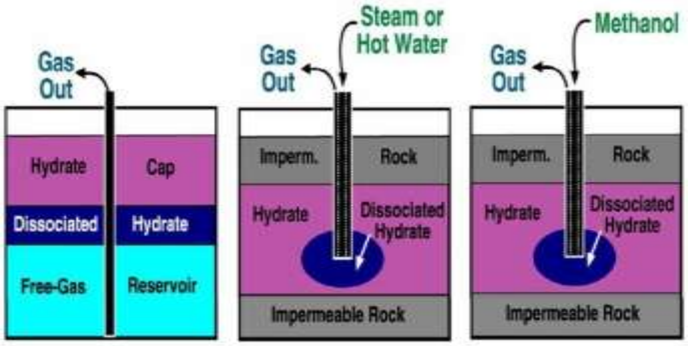

Figure 1: Methods of hydrate production such as depressurization, thermal stimulation and chemical inhibitors respectively[18].

In these three production methods, the combination of depressurization and thermal stimulation method appears to be the most useful for zones where free gas is trapped underneath the methane hydrates.

Towards the recovery of natural gas from hydrates, this natural gas plays a big a role in different industrial sectors and in doing so, it becomes a very important raw materials in many manufacturing industries, which makes it to be the potential source of energy for the present and future. Two examples states that, liquid fuels are better used as a raw materials for generation of petrochemicals in which it has been stated that, many power plants are being transformed from coal to natural gas, and fleets of cars have been transformed from petrol to natural gas fuel.

In this research paper, the author describes the major applications of natural gas in industrial sectors in terms of percentage ratio for each sector, the world energy consumption and also world sectors energy consumption.

2 BACKGROUND AND LITERATURE SURVEY

The authors in [19, 20], discussed the fundamental principles and significances of natural gas hydrates and the results revealed that, these natural gas hydrates were non-flowing crystalline solids that were denser than typical fluid hydrocarbons and that the gas molecules they contain were effectively compressed, give rise to numerous applications in the broad areas of energy and climate effects.

According to the authors in [21], the review paper on the present status of microalgae use for biodiesel production, counting their cultivation, harvesting, and processing were conducted and the results showed that, application obtained from microalgae products were includes biological sequestration of CO_2, wastewater treatment, in human health, as food additive, and for aquaculture.

Thomas *et* al [22],performed the review of methods to transport natural gas energy from countries that do not need the gas for domestic use and they found that, most of the applicable ways were including pipelines, liquefied natural gas , compressed natural gas, gas to solids, i.e. hydrates, gas to wire, i.e. electricity, gas to liquids, with a wide variety of potential products including clean fuels, plastic precursors or methanol and gas to commodity, such as aluminium, glass, cement.

Also Moridis *et* al [23], investigated the distribution of natural gas hydrate accumulations, the status of the primary international research and development programs, and the remaining science and technological challenges affecting the commercialization of production and they found that, the numerical-simulation capabilities were quite advanced and that the related gaps either were not significant or were being addressed and they determine that, there were consistent indications of a large production potential at high rates across long periods from a wide variety of hydrate deposits and finally they identified (a) characteristics, conditions, geology and methods which were desirable in potential production targets; (b) techniques to maximize production; and (c) conditions and features that render certain gas hydrate deposits undesirable for production.

Sharma and Ghoshal [24], studied the hydrogen as the future transportation fuel: from production to applications and the results showed that, hydrogen appears to be an ideal synthetic energy transporter due to its lightweight, exclusive abundance and environmentally benign oxidation product, although storage remains a big challenge.

According to the authors in [25], the study on Gas hydrates: significance and applications in petroleum exploration were conducted and the results showed that, in the first place, hydrate act as an efficient seal in which the significant gas columns can be trapped in some circumstances beneath the base and furthermore, as the stability of gas hydrates was effectively constrained by thermodynamic conditions, the bottom simulating reflector, if present, can be used as a direct hydrocarbon indicator.

Gudmundsson *et* al [26, 27], conducted the study on techniques for production of gas hydrates for transportation and storage and the results revealed that, there were two important method for hydrates production which were depressurization and thermal stimulation.

The authors in [28],performed the study of fundamental understanding of natural gas hydrates and on their study they came up with the conclusion that, the natural gas hydrates were solid crystalline inclusion compounds consisting of polyhedral water cavities which enclathrate small gas molecules and were significant industrially because the occurrence of these solids in subsea gas pipelines presents high economic loss and ecological risks, as well as potential safety hazards to exploration and transmission personnel.

Kvenvolden *et* al [29-32], discussed the possible effects of gas hydrate on human welfare and the result revealed that, the vulnerability of gas hydrate to temperature and sea level changes increases the instability of deep-water oceanic sediments, and hence lead to affect human activities and installations in this setting.

3 OBSERVATIONS AND DISCUSSIONS

Methane gas (natural gas) is significant for a variety of industries activities especially it is common fabric, plastic, anti-freeze and fertilizer ingredient and also in industrial natural gas users include companies which produce pulp and paper. Food processors, petroleum refineries sector,

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electronics, and companies which work with stone, clay and glass, use the energy it releases. It is also applicable in medicine industries, Aerospace and in electronics issues. Methane-based combustion supports businesses dry, melt and sanitize their products. The consumption of methane gas in commercial settings sometimes look like home uses.

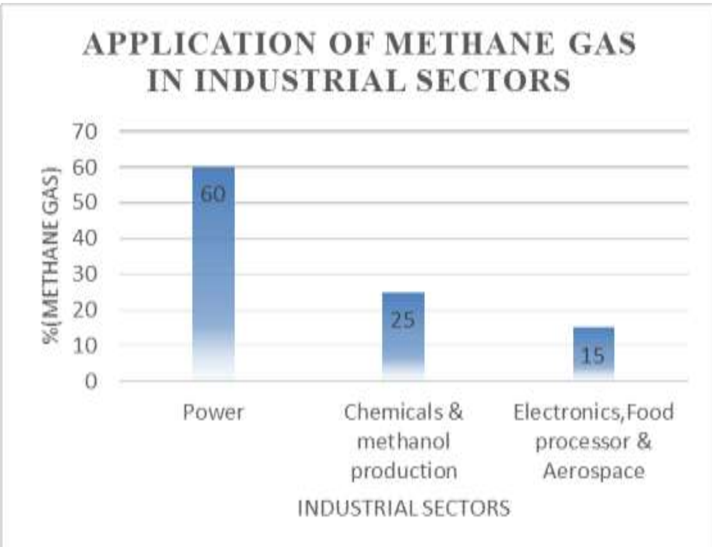

Figure 2: Application of methane gas in industrial sectors

Figure 2 shows the relationship between methane gas and industrial sectors in which power sector occupy maximum usage of methane gas in industrial sectors which is about 60% than other sectors such as chemicals and methanol production which occupy only 25% and both electronics, food processor and Aerospace occupies 15%. Then it is concluded that, power sector is the leading one in natural gas (methane gas) consumption, because it is used to support other sectors in industrial sectors.

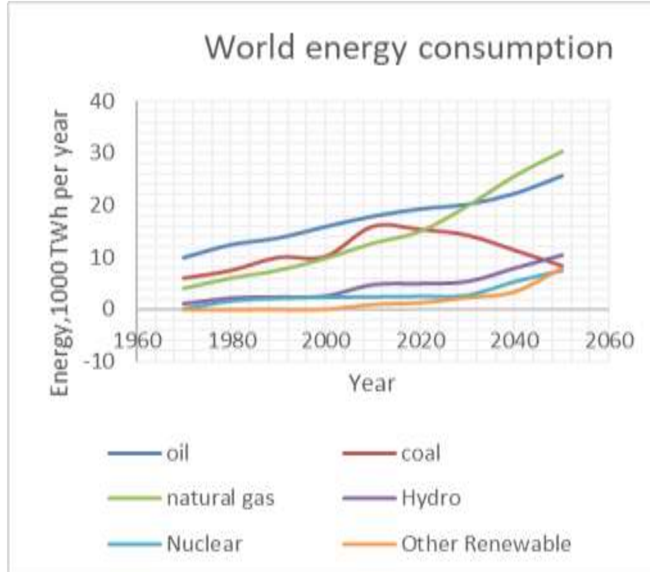

Figure 3: World energy consumption

Figure 3 describes the world energy consumption on different source of energy and it reveals that, as the time goes natural gas will take the lead as the potential source of energy in comparison to other source of energy because it is cleaner than other source of energy as it emits 50 percent less carbon dioxide than coal when you burn it. Moreover are considered as a fuel for power generation, heating systems and as transport fuel, although its availability is more complicated [33].

The world development is shifting on using other source of energy, so as to reduce the global greenhouse emission effect caused by other energy sources like oil and coal. In doing so, the optional on using natural gas as a source of energy, has been launched in many countries to support the policy of ozone layer protection.

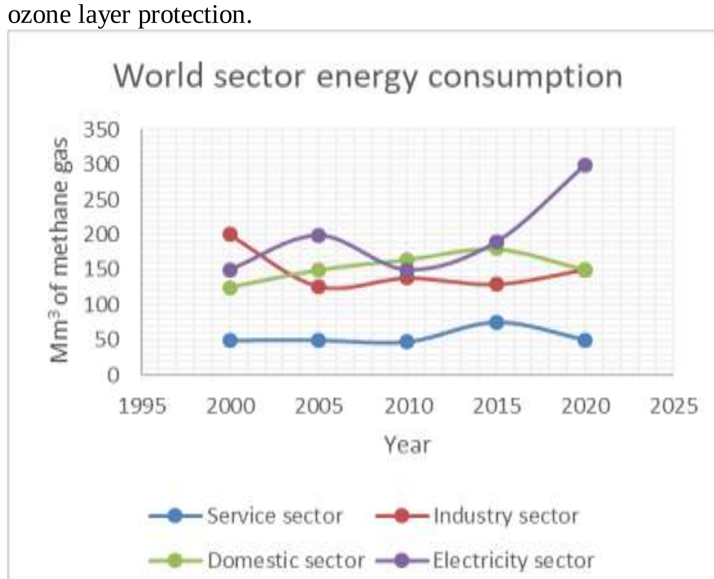

Figure 4: World sector energy consumption

Figure 4 shows the consumption of different world sectors and it reveals that, electricity generation sectors, as the time goes will depend much on methane gas as the feedstock's than other world sectors that signifies the potentiality of this kind of energy source, because lighting is the main use of energy in the industrial sector, that accounts for the tremendous electricity requirements of this sector.

It is believed that 90% of natural gas hydrate is methane hydrate and the greenhouse effect of methane is 20 times that of carbon dioxide. Therefore, along its applications in different industrial sectors, it pollute the environment in high concentration comparing to other gases.

4 CONCLUSION AND FUTURE WORK

In this paper the application of methane gas in industrial sector has been discussed in which methane gas development becomes more significant in different industrial sectors and mostly used as raw materials to some sectors, this signifies the advantage of this natural gas and being notified as the clean energy which make it to be potential for source of energy for the present and future. The results shows that in industrial sector, the power sector accounts maximum usage percentage of methane gas about 60% and the rest sectors consumes the remaining percentage out of 100%.

In world sector energy consumption, electricity generation sectors consumes maximum volume of methane gas as the source of energy, due to its applicability in industrial sectors to run some machine and lighting operations, all this describe the natural gas (methane gas) to continues to be potential source of energy for the future because it is clean than other kinds of source of energy.

In the future work, more research on this kind of natural gas, concerning its availability and proper ways of transportation to the industrial sectors, should be conducted to maximize its usage to different sectors.

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