IPE3 2022

ISBN: 978-604-76-2595-6

NOT FOR SALE

IPE3 2022

Hanoi University of Mining and Geology

Integrated Petroleum Engineering

IPE3

Hanoi, Octorber 6, 2022

ISNB: 978-604-76-2595-6

TRANSPORT PUBLISHING HOUSE

Available online at www.tapchi.humg.edu.vn

IPE 2022

IPE (2022) 097-106

International Conference on Integrated Petroleum Engineering (IPE-2022)

Potential for producing hydrogen from depleted gas fields with existing production facilities offshore Vietnam

Ngo Huu Hai[a,*], Nguyen The Vinh[b], Nguyen Trong Tai[c]

[a]Bien Dong Petroleum Operating Company (BD POC), Ho Chi Minh, Vietnam
[b]Hanoi University of Mining and Geology, Hanoi, Vietnam
[c]Zarubezhneft Vietnam E&P, Ho Chi Minh, Vietnam

Abstract

With the acceleration of the energy transition and drive to reduce carbon dioxide (CO_2) emissions, the emission of CO_2 from the burning of fossil fuels must be reduced. One effective route to reduce CO_2 output is to replace hydrocarbons with clean energy carriers, such as hydrogen. The energy source provided by hydrogen is now being used in all sectors of the economy including industry, agriculture, transportation, commerce and domestic. However, the production of hydrogen from water electrolysis, biomass or other methods has not yet achieved high efficiency. Therefore, producing hydrogen from oil & gas fields is a promising method for the future.

Currently, many of the existing offshore gas projects in Vietnam are reaching the end of field life. In accordance with the regulations issued by Vietnam Government, Plug and Abandonment activities (P&A) are required to be carried out with the abandonment of production wells and removal of all offshore facilities. However, with the estimated recovery factor for gas production fields in Vietnam at 50-60%, when gas fields are abandoned, they still contain significant volumes of hydrocarbon in the reservoir due to non-optimal production/depletion regime such as water breakthrough and formation damage.

Pilot projects in Brunei and Russia have indicated that production of hydrogen from gas fields achieved high efficiency, carbon dioxide emissions generated in the hydrogen production process can be stored in the reservoir which assists in meeting environmental standards. This paper firstly evaluates the potential of production of hydrogen from offshore gas fields in Vietnam which have entered the final stage of the field's life and to be abandoned in near future; in order to take advantage of available offshore facilities such as Xmas-tree, platform and pipelines. Thereby, there is the potential for these fields to produce hydrogen from the residual hydrocarbons stored in the reservoir which would prolong the life of the project, specifically to have a new concept for production and produce green energy in Vietnam.

Keywords: hydrogen production; methane steam reforming; offshore gas field, membranes;

1. Introduction

According to the statistics database, the usage and production of energy derived from fossil fuels emits about 75% of greenhouse gas emissions in Vietnam. Therefore, to comply with commitments in the COP 26 which required reduction of 45% CO_2 emissions by 2030 from emission rate of 2010 and cut down to zero by 2050. Vietnam could reduce its CO_2 output by 50% by shutting down coal power and switching to natural gas, but that would require a lot more exploration and development for hydrocarbons therefore the production of green energy and renewable energy should be encouraged because they are promising and developing sectors of energy generation. Meanwhile, a kind of clean energy which has a number of benefits as an energy source is hydrogen. Besides that, hydrogen is a valuable chemical product required for the refining industry and the production cycle of ammonia, methanol, and is a feedstock for multiple other chemical production processes.

Hydrogen can be generated in several different ways including reforming of fossil fuels, gasification of coal, electrolysis of water, and production of hydrogen from biomass. However, all these hydrogen production methods are energy consuming. In addition, energy usage for producing hydrogen is usually produced by burning hydrocarbons which is a cause of carbon dioxide emissions. Therefore, selection of methods through which

* Corresponding author

sustainable hydrogen production can be achieved without greenhouse gas emission or obtaining carbon capture and storage is a primary requirement in the future. Hydrogen is generated from fossil fuels using numerous technologies, the principal of which are pyrolysis and hydrocarbon reforming. These techniques are the most advanced and normally employed, recovering virtually all the hydrogen from the feedstock. About 48% of hydrogen is generated from natural gas, 18% from coal, and 30% from naphtha and heavy oils /bitumen. Currently, fossil fuels provide the source for the majority with 77% of world hydrogen production.

Currently production from upstream sector of oil & gas industry in Vietnam is in decline, there is a need to find a resolution for depleted offshore oil & gas projects. There are currently more than 15 oil & gas offshore projects producing in Vietnam, almost all of them are producing at plateau rates and have been maintained the production for 8-10 years, and some projects have entered the final stage of the field's life where are producing at a zero benefit rate, meaning income is lower than the operating expenditure (OPEX). Therefore, it is necessary to work out the forward scenarios for projects, to be abandoned or continue to sustain the production rate with drilling additional infill wells.

In accordance with the PSC contracts, the Operator is requested to complet the commitment work in the contract and when petroleum sharing contract (PSC) finish; ownership of Platform, pipelines, production facilities and other properties will be transferred to the Government.

With the current production rate, PetroVietnam and Operators are working on the forward plan for projects with scenarios as follows:

- *P&A*: Well(s) shall be abandoned in accordance with P&A regulations issued by the government and then the facilities in field shall be removed. All of the related expenditures to abandonment of field shall be paid by the P&A funds.
- *Development*: Continue to work on the development stage with the drilling of additional infill wells in other prospects to improve production rates and keep the project running.
- *R&D*: Working on R&D for application of new technologies to sustain the project's life and continue to obtain the benefit from new product.

Based on the proposed scenarios, there is the potential for the application of new technologies to produce hydrogen from depleted oil & gas offshore projects. However, the selection of suitable offshore project for application of new technologies needs to consider both the technical and commercial viability of the proposal.

2. Application concept for selection of offshore project in Vietnam

The production of Hydrogen using technology which would produce pure hydrogen with simultaneous CO_2 storage is considered for application in oil & gas fields in Vietnam based on the following criteria:

a. The project technical feasibility
b. Energy-efficient, and cost-effective
c. Commitment on greenhouse gas emissions

Projects to be evaluated based on the required criteria are given to select the potential depleted oil & gas projects for application of hydrogen production technology.

Using the Table 1 selection criteria, the evaluation indicated that gas fields have a greater potential for application of proposed hydrogen production technology in Vietnam. This technology could be a possible solution for low-emission hydrogen production due to simultaneous CO_2 storage; and it also can be implemented even in depleted or abandoned fields or fields in a late stage of production phase because there is an increase in the amount of gaseous components as a field reaches the end of normal production life. With existing facilities that could be used in hydrogen production, leading to a significant decrease in the produced hydrogen cost. On the other hand, the concept of transportation of complex gas including hydrogen mixing with natural gas from field to facilities onshore through existing pipeline systems need to be considered. A transportation simulation was performed to optimize the efficiency for Nord Stream indicated that the hydrogen could be transported using gas pipeline through mixing with natural gas in concentration (volume) from 20% even up to 70%.

Table 1. Project selection criteria

Descriptions	Depleted Oil Field	Depleted Gas Field
Capability for application of technologies	Yes – the generation hydrogen technologies could be applied for Oil field	Yes - the generation hydrogen technologies could be applied for Gas field
Capability of usage of existing facilities & equipment for hydrogen production	No - The offshore oil fields facilities were built included platforms construction, internal	Yes - The offshore gas fields facilities were built included platforms, internal pipelines, CPP

	pipelines and a FPSO, therefore it is necessary to build hydrogen tanks or a new pipeline system to shore for transportation of hydrogen	and a main pipelines system to transfer gas & condensate from offshore to facilities onshore. The pipelines systems could be usage for transportation of hydrogen
Capability of usage of downhole & surface equipment in the existing wells	No - The existing downhole & surface equipment system installed for oil wells were designed to meet the oil field standard which doesn't not meet technical requirement for hydrogen production	Yes - The existing downhole & surface equipment system installed for gas wells were designed to meet the gas field standard which may be re-run for hydrogen production with required additional equipment
Estimated Investment Expenditure impact for Project	High - The project implementation costs shall be increased because of costs for new pipeline systems from offshore to onshore facilities and downhole & surface equipment	Lower - The project implementation costs may be saved because of re-run pipeline systems and downhole & surface equipment with required additional equipment
Greenhouse gas emissions	Generate blue hydrogen with application of carbon capture and storage in the reservoir	Generate blue hydrogen with application of carbon capture and storage in the reservoir

3. Offshore Gas Projects & Properties

With some new gas fields which have been discovered in 2020 in the Song Hong basin, it is recognized that currently most gas fields in Vietnam are almost all located in Song Hong and Nam Con Son basin. In addition, there are also some big gas fields in Cuu Long basin. Currently, almost all gas projects in production phase are mainly concentrated in the Nam Con Son basin including Hai Thach - Moc Tinh, Lan Tay - Lan Do, Rong Doi - Rong Doi Tay and Su Tu Trang in Cuu Long basin.

Traditional concept design methods for production of natural gas from upcoming projects shall be applied for upcoming development phase works, therefore this paper only mentions gas projects which are in production phase or at the final stage of the field's life where there is potential to apply new hydrogen production technologies in the next phase of field life.

All of the natural gas production projects use a pipeline system to transport gas & condensate from the field to the processing center onshore. In particular, two (2) pipeline systems were built for gas projects in Nam Con Son basin including NCS 1 pipeline systems transporting natural gas from Hai Thach-Moc Tinh, Lan Tay-Lan Do, Rong Doi-Rong Doi Tay and Chim Sao / Dua fields; and NCS 2 pipeline system to transport gas & condensate from Sao Vang-Dai Nguyet, Dai Hung and Thien Ung fields. On the other hand, natural gas from Su Tu Trang field and associated gas from Bach Ho, Rang Dong and Su Tu Nau fields are transporting to shore through a dedicated pipeline system. Thai Binh gas field located in the North is being produced and natural gas transported by Thai Binh pipeline system. However, based on the evaluation of volume of gas remain in reservoir for Thai Binh prospect with total 44bscf, it is indicated that the estimated value is not efficient for application of new technology for hydrogen production.

Referring to the current database for gas projects in Nam Con Son and Cuu Long basin using pipelines systems for transportation gas from offshore to processing center, the primary technical information needs to be analyzed to evaluate the potential application of hydrogen production technologies for gas projects. Results of the analysis are given below.

Table 2. Estimated remain volume of gas & condensate in reservoir

Field	**GAS**	**CONDENSATE**

Name	Total GIIP 2P (bscf)	Estimated Gas Recovery Factor (%)	Remain in reservoir (bscf)	Total CIIP 2P (mmbbl)	Estimated Condensate Recovery Factor (%)	Remain in reservoir (mmbbl)
HT	1,259	54	579.0	142.2	27	103.8
MT	644	56	283.4	10.9	39	6.6
SV	650	59	266.5	36.7	35	23.8
DN	483	57	207.7	9.1	42	5.2
LT	2,380	71	690.2	22.86	68	5.3
LD	814	58	244.2	0.58	65	0.2
RD	730	60	306.6	24.9	40	15.0
RDT	367	60	146.8	12.5	40	7.5
STT	3,050	58	1,281	390	35	292
TOTAL			**3,858**			**454**

Note: The estimated volume of gas & reservoir in reservoir will be referred for primary project evaluation. It should be revised based on the updated data in specific project.

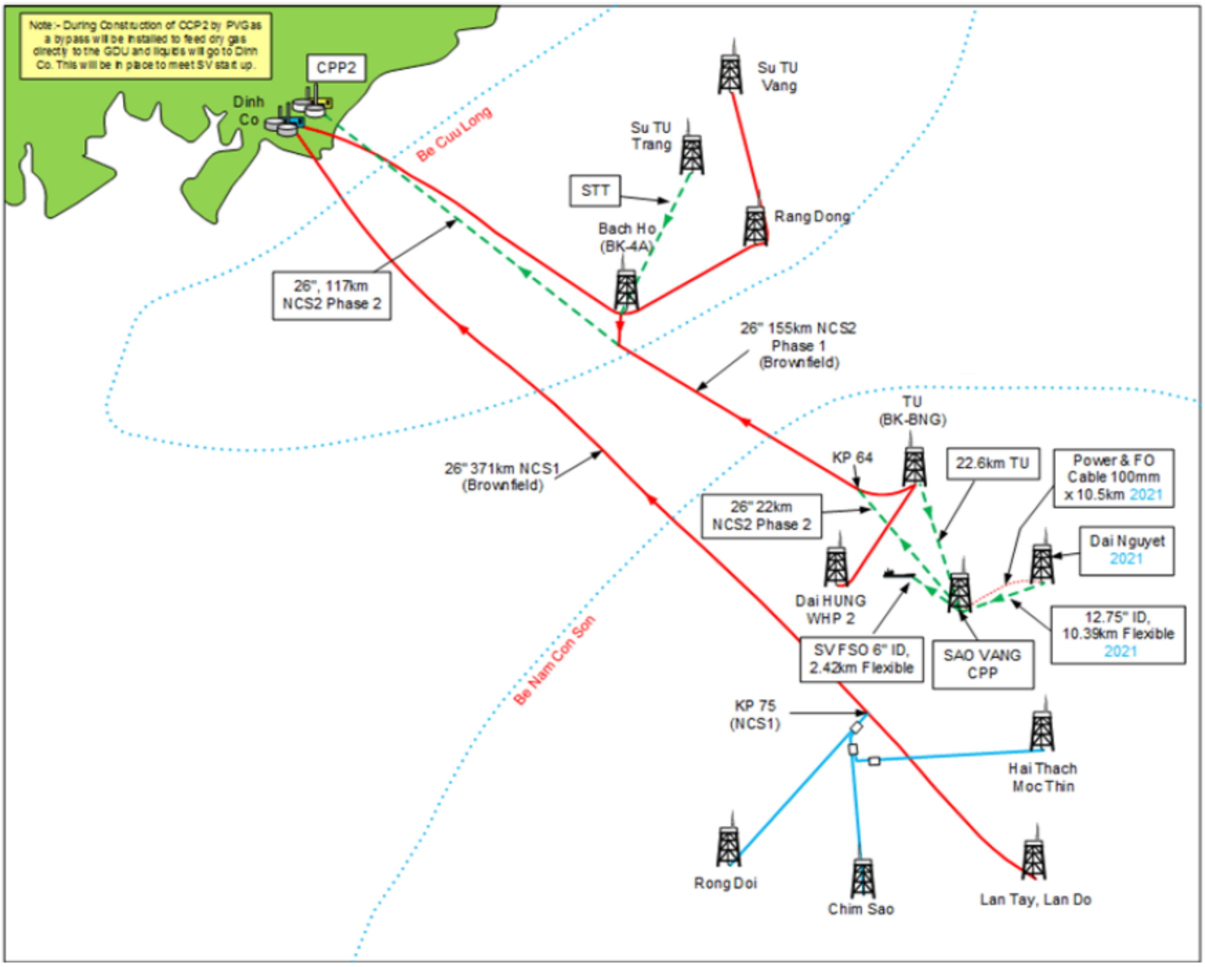

Fig. 1. NCS & BH Pipelines Layout Offshore Vietnam

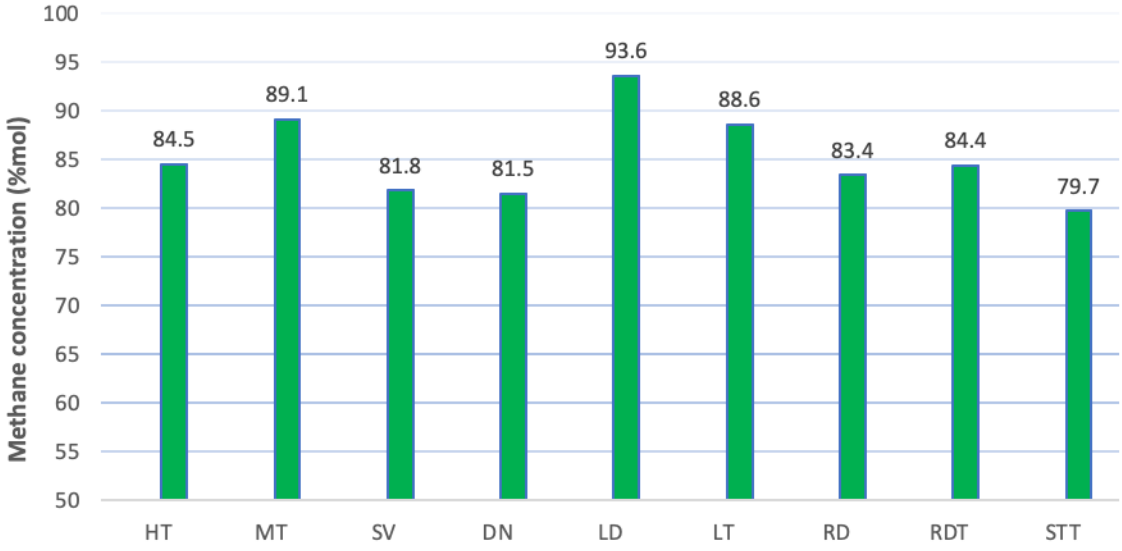

Fig. 2 – The concentration of methane in gas fields (% mol)

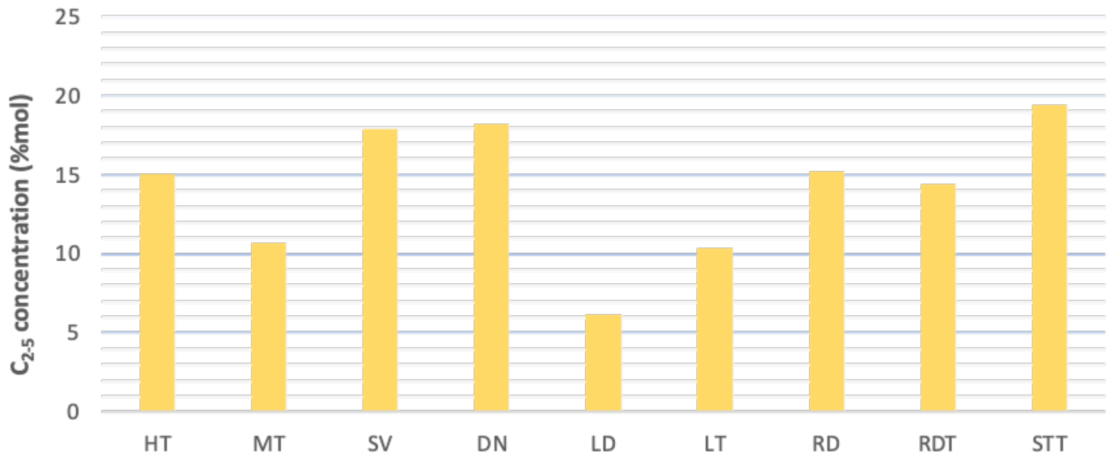

Fig. 3 – The concentration of C_{2-5} in gas fields (% mol)

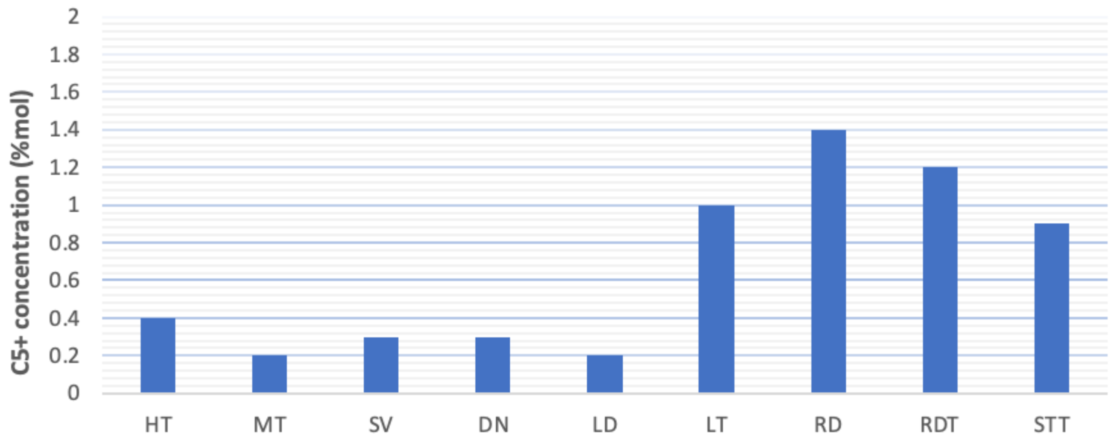

Fig. 4 – The concentration C_{5+} in gas fields (% mol)

4. Hydrogen production from Hydrocarbon

Hydrogen is the most prevalent element on the planet, it is chemically tied to the other elements and compounds in great quantities and has to be freed to from an extensive assortment of feedstock. Other than water, the source of hydrogen feedstock includes all hydrocarbon such as natural gas and oil. Hydrogen is generated from hydrocarbons using several different technologies, in principal they are hydrocarbon reforming and pyrolysis with presence of catalysts. The hydrogen production methods from hydrocarbon is given in the **Figure 5**

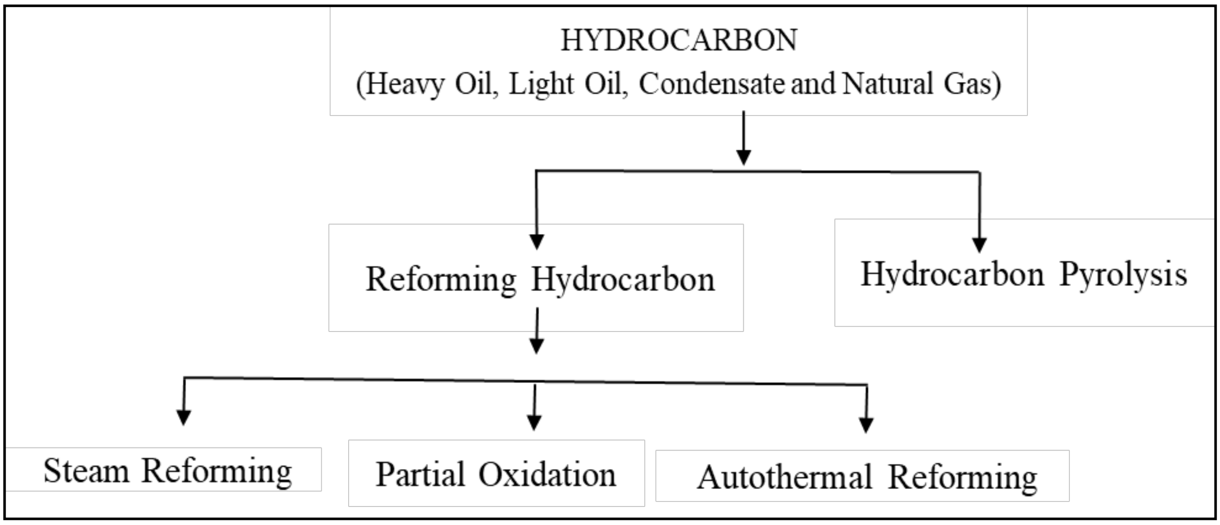

Fig. 5 - Hydrogen production methods from Hydrocarbon

The process by which the hydrocarbon fuel is changed to produce hydrogen via reforming systems is termed hydrocarbon reforming. During hydrocarbon reforming other components are employed along with the hydrocarbon. These include carbon dioxide and the system is termed as CO_2 or dry reforming. Moreover, steam may include as reactants in the reforming system of the hydrocarbon. This system is branded as steam reforming, both dry and steam reforming reactions are endothermic. Therefore, it necessary to furnish energy to produce the hydrogen. Reforming the hydrocarbon with oxygen is known as partial oxidation, and the reaction is exothermic. When steam and partial oxidation reactions are combined the system is called autothermal reforming.

4.1. Steam reforming of natural gas method

In the steam reforming process, the catalytic conversion of natural gas into hydrogen and carbon monoxide is carried out in the presence of steam in the feed. The chemical transformations occurring in the gas reservoir include mainly steam methane reforming, water-gas shift reaction, and methane cracking. Most feedstock contains natural gas consist of methane and a mixture of light hydrocarbons, which include propane, butane, ethane, pentane and other elements. The primary chemical reaction that occurs during the steam reforming is:

$$C_nH_m + nH_2O \rightarrow nCO_m + (m/2+n)\ H2 - Q\ kJ/mol \quad (1)$$

Reaction (1) is endothermic and occurs in the range of temperature between 300^{o}C - 1,100^{o}C.

For natural gas, the transforming occurring in the gas reservoir include mainly steam methane reforming (SRM), the reaction requires 206.2 kJ/gmol

$$CH_4 + H_2O \leftrightarrow CO + 3H_2 - 206\ kJ/mol \quad (2)$$

In additional, hydrogen generation is further enhanced by the water–gas shift reaction:

$$CO + H_2O \rightarrow CO_2 + H_2 + 41.1\ kJ/mol \quad (3)$$

This reaction is exothermic, generating about 41.1 kJ/g mol. According to reactions (2) and (3), the carbon in the fuel reduces water to produce hydrogen and carbon dioxide.

However, at the same time, side reactions take place that consume generated hydrogen. These reactions mostly include methanation reactions: reverse reactions (1) forward reaction:

$$2CO + 2H_2 \leftrightarrow CH_4 + CO_2 + 59.0\ kJ/mol \quad (4)$$

In case of hydrogen content in product gases is low due to reaction (4), the water with catalysts should be added, this action is aimed to shift the thermodynamic equilibrium of the system to the products, as water is one of the reagents and can possibly create additional mixing of gas components.

In selection of methods for hydrocarbon reforming which could be applied for hydrogen production technologies in situ gas reservoir, an experimental study was performed by a group was leaded by Pavel Popov for Promyslovskoye gas field [1] with a sandstones core, porosity of 29%, with the presence of Ni-based catalysts to measure performance of methane conversion into hydrogen. The results of methane conversion rate are given in the Figure 6.

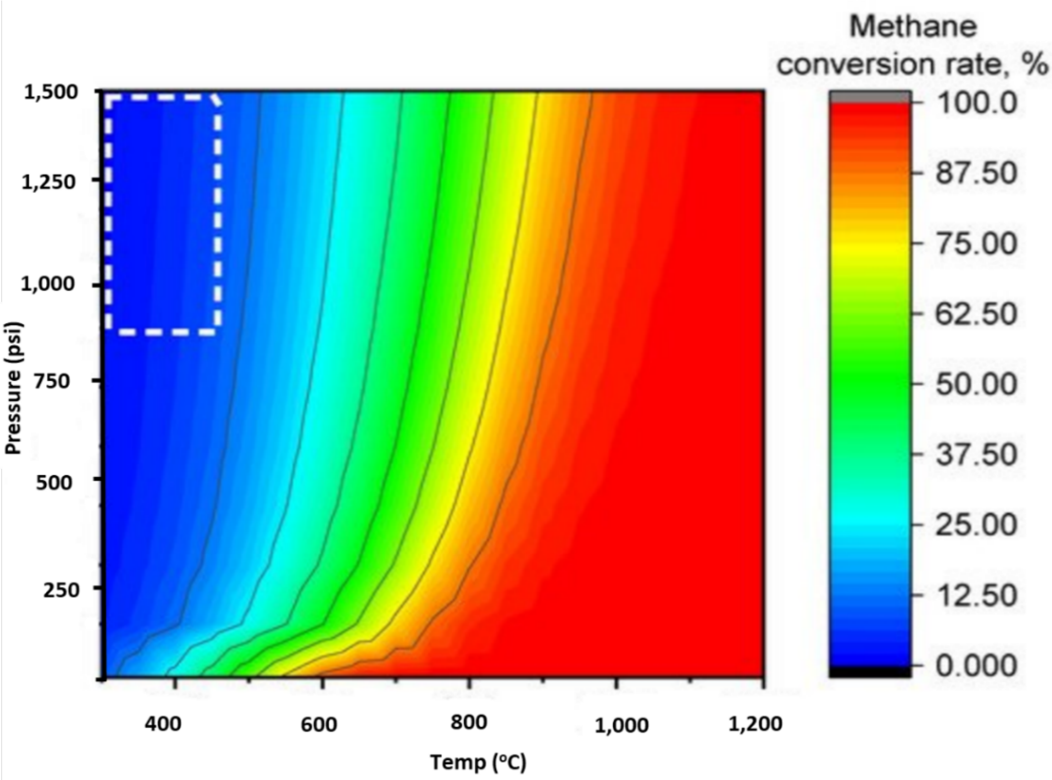

Fig. 6 – Methane conversion rate on Temperature & Pressure

In additional, the experiment also recorded the conversion rate of other elements in natural gas C_2-C4 is given in the Figure 7

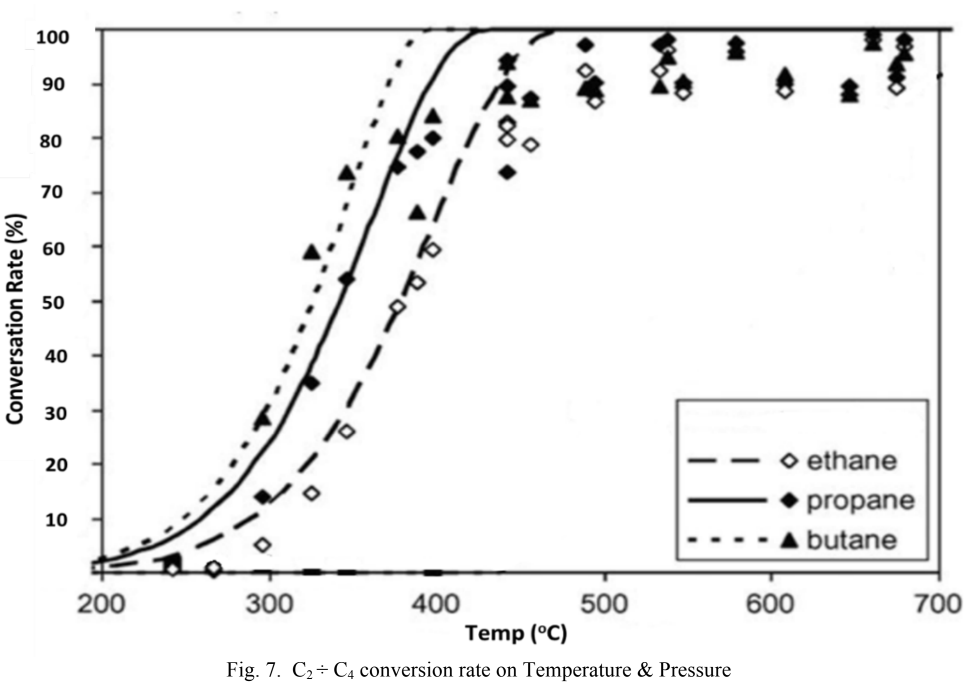

Fig. 7. $C_2 \div C_4$ conversion rate on Temperature & Pressure

With the range of temperature from 300 to 450°C, it was discovered the possibility of hydrogen generation from natural gas in situ during the experiments. The conversion rate of natural gas shall be reached to 85-95% at the temperature 600^{o}C approximately. Besides, the conversation rate is lower if reactions occur in higher pressure environments, therefore there is a need to perform experiments to measure the optimum conversion rate in the reservoir temperature, pressure and porosity conditions.

In accordance with reaction (2), (3) and (4) the SMR methods produced carbon monoxide and carbon dioxide. A resolution to remove CO_2 by swing adsorption and producing virtually pure hydrogen.

Usage of palladium-alloy membrane is a remarkable solution for the issue of the presence of CO_2, the palladium-based membrane has been used for decades in steam reforming processing with extracting a 99.9% pure stream of hydrogen in tests. The diagram of application of palladium-based membrane in removal of CO2 is given in the Figure

8.

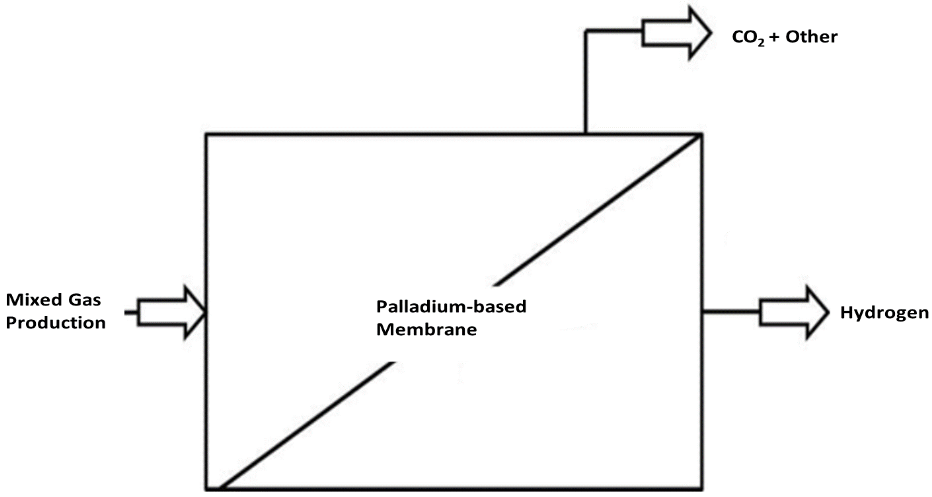

Fig. 8. Steam methane reforming unified-membrane process.

In principle, the most effective and commonly-used process utilizes steam reforming of natural gas with carbon capture and store (CCS) such as: steam reacts with methane at low temperature from 300^{o}C to 1,100^{o}C in the presence of catalyst to yield carbon monoxide and hydrogen (synthesis gas). Steam reforming typically employs an excess of water because additional hydrogen can be recovered from the steam via the water–gas shift reaction.

4.2. Partial oxidation method

Partial oxidation (POX) method chiefly comprises the reaction transformation of hydrocarbons, oxygen, and steam, to synthesis gas which consists of hydrogen, carbon monoxide, and carbon dioxide. Feedstocks starting from methane to naphtha are used in the catalytic process at the temperature about 950°C. In case of no-catalytic, the process operation takes place at 1,150–1,315°C. Oxygen is used to incompletely oxidize the hydrocarbon feedstock, after the elimination of sulfur content in the feed removal. The generated synthesis is additionally purified and separated in a similar way as the output gas of the steam reforming method. In the process dealing with catalyst, the heat is delivered through the monitored combustion.

The transformation process is given in the following reactions. Reforming hydrocarbon in the reaction (5) in the presence of a catalyst:

$$C_nH_m+12nO_2 \rightarrow 12mH_2+nCOC_nH_m+12nO_2 \rightarrow 12mH_2+nCO \quad (5)$$

while the chemical reactions of water gas shift and methanation are present as follows:

$$CO+H_2O \rightarrow H_2+CO_2CO+H_2O \rightarrow H_2+CO_2 \quad (6)$$
$$3H_2+CO \rightarrow H_2O+CH_43H_2+CO \rightarrow H_2O+CH_4 \quad (7)$$

The reaction transformation occurs at a high temperature 800 - 900^{o}C even with presence of catalysts and pure oxygen need to be provided. The formidable price of oxygen to supply the process and the extra expenses of desulphurization of hydrocarbon feedstock to perform the process result in this method being significantly expensive. Therefore, the partial oxidation method could be suitable for production of hydrogen from heavy oil and could be applied for onshore project.

4.3. Autothermal reforming method

In the process of autothermal reforming method (ATR), the endothermic steam reforming receives heat from the combined exothermic partial oxidation to promote the production of hydrogen. Fundamentally, steam, air, and oxygen are fed, starting the oxidation reactions as well as the reforming to happen simultaneously.

$$C_nH_m+12nH_2O+14nO_2 \rightarrow nCO+(12n+12m)H_2C_nH_m+12nH_2O+14nO_2 \rightarrow nCO+12n+12mH_2 \quad (8)$$

When methane is autothermally reformed at 700°C with the proper ratios of steam to carbon and oxygen to carbon. A small improvement is reported when the ATR reactor is combined with a Palladium-alloy membrane.

The authothermal reforming method is a combination of partial oxidation process. Therefore, it shall be suitable for production of hydrogen from heavy oil and could be applied for onshore project.

5. Existing downhole equipment in gas projects & Primary concept for application

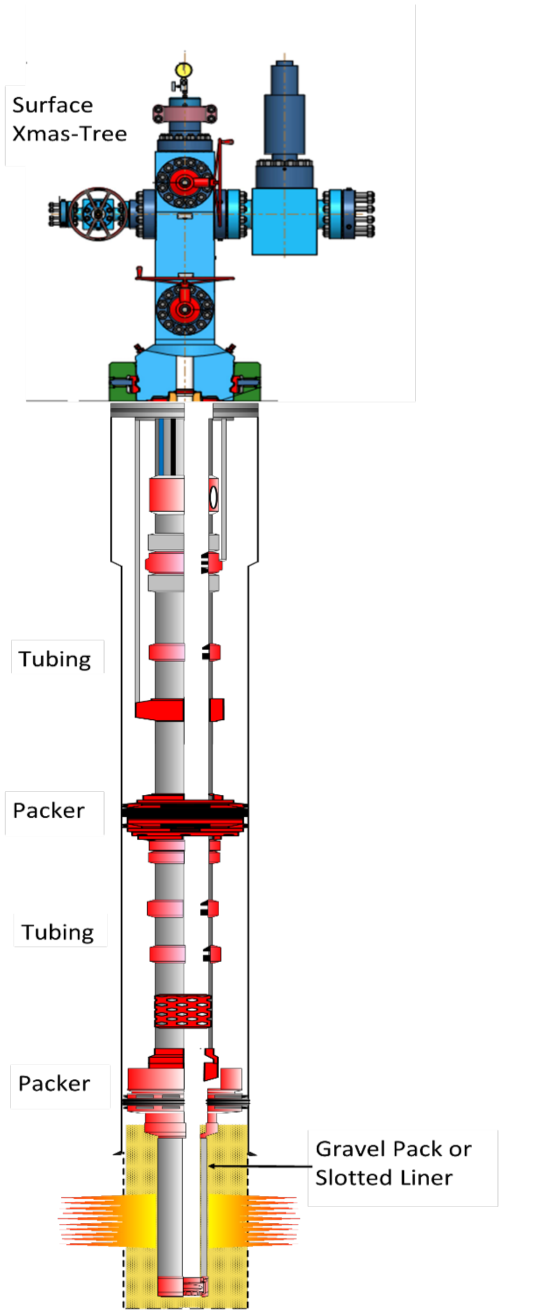

Figure 9 - *Downhole Completion Systems*

Gas production wells were designed with completion systems included lower & upper completion. All of installed downhole equipment are meet requirement technical standard for gas industry. A typical well schematic is given in the Figure 9.

Based on the gas fields information including depth of production reservoirs, temperature & pressure, existing downhole & surface equipment and pipelines system, recommend to apply the primary concept for hydrogen production project as follows:

Provide heating energy to reservoir using a downhole antenna in the reservoir to generate radio-frequency electromagnetic waves. This method results in thermolysis, which is the thermal decomposition of chemicals. During hydrogen production it is possible to use the generated heat to produce steam.

To produce pure hydrogen, gas separation is achieved by installing a palladium-alloy downhole membrane, which can separate hydrogen from undesirable greenhouse gases, such as carbon and nitrogen oxides, having a higher density than hydrogen, will sink to the bottom of the field under the influence of gravity. These gases are also more soluble in water, compared with hydrogen. In addition, carbon oxides also can react with rocks, forming insoluble compounds such as carbonates. So, greenhouse gases may not be produced at all during hydrogen production from the gas reservoir. They would remain underground, the process would not release greenhouse gasses to the atmosphere. In case of improve the production area, injection wells could be drilled for injection of a catalyst precursor (aqueous solution of Ni-containing salt) or an active catalyst (particles of Ni-based catalyst) into a hydrocarbon-containing zone on the first stage in the form of a water solution of the catalyst precursor, then obtained through chemical transformations directly at the reservoir. The second active catalyst that could be injected is the ex situ prepared catalyst which was nickel oxide particles supported on alumina. This catalyst can be delivered into the reservoir in the form of suspension together with steam or overheated water. The heating equipment also may be installed in the injection well to accelerate the steam reforming process.

6. Hydrogen Market and production demand in Vietnam

The hydrogen energy consumption is predicted to follow upward trend rapidly in near future because hydrogen is a green energy which does not generate greenhouse gas emissions which the hydrogen is burnt. According to the forecast in the Bloomberg hydrogen economy outlook (march 2020): By 2050, the hydrogen energy source supplied could meet 7-24% of total global energy demand depending on different scenarios. The hydrogen market could generate about $2.5 trillion in revenue and 30 million jobs in the world.

Currently, there is no published official data on the demand for hydrogen energy in Vietnam, however, as per Prime Minister commitments in the COP 26 which reduction of 45% CO_2 emissions by 2030 from rate of 2010 and cut down to zero by 2050, therefore the use of hydrogen is being developed for implementation in the near future. There are some green hydrogen production projects which have been built in Ben Tre province, which applied electrolysis of water using energy provided by electricity or wind energy, and some biogas projects are being built to serve domestic hydrogen consumption as well as export.

With the available advantages of technology and existing equipment in oil & gas field, producing hydrogen from oil and gas fields promises to bring great benefits to the environment in the future.

7. Conclusion

Recommendation for application of steam reforming methods with carbon capture store for depleted gas field or gas field have entered the final stage of the field's life offshore Vietnam for production “blue” hydrogen. The following technical & commercial issues need to be considered:

The need to perform experimental studies with the initial conditions the same as in the proposed gas field, to discover the maximize hydrogen generation in reservoir condition such as temperature, pressure with the effects of different forms of catalyst and steam/methane ratios on catalysts methane conversion (CMC). The obtained data can help conclude the expediency of the new stage of field exploration and manage the process of CMC to intensify and speed up of in situ hydrogen generation processes

The thermodynamic stimulation should be applied for overall of gas field to build a development plan including infill gas wells location, new hydrogen production wells and injection catalyst & heating wells

Thermodynamic/ corrosion stimulations need to be performed to measure the corrosion rate of existing pipelines systems for scenarios transportation of generated hydrogen and hydrogen mixing with natural gas. Costing plan needs to consider any potential issues.

Concept design for downhole equipment to be run for production wells, injection wells. The reservoir heating equipment, palladium-based membrane equipment and other downhole equipment in high temperature environment.

Perform market survey for demand of hydrogen in Vietnam and SEA to build an economic model for project prior to prepare the Outline Development Plan.

References

Pavel Afanasev Evgeny Popov, Alexey Cheremisin, Roman Berenblyum, Evgeny Mikitin, Eduard Sorokin, Alexey Borisenko, Viktor Darishchev, Konstantin Shchekoldin and Olga Slavkina, “*An Experimental Study of the Possibility of In Situ Hydrogen Generation within Gas Reservoirs*”, Energies 2021, 14, 5121. Available on website https://doi.org/10.3390/en14165121.

Ahmed Aidid Ibrahim, “*Advances In Hydrogen Generation Technologies”*, pp. 40 - 47, 2018.

Trent Jacobs “*Canadian Operator Works To Transform an Oil Field Into a Hydrogen Factory*” Journal of Petroleum Technology, March 1, 2021.

Perry Boeker “*Transforming Oil Wells Into Carbon Free Hydrogen Sources*” Proton website on Jul. 9, 2020.

IEA “*The future of Fuel: The Future of Hydrogen*” Available on website, 2019.

Punitkumar Kapadia, Michael Kallos, Ian Gates “*Potential for hydrogen generation from in situ combustion of Athabasca bitume*n” SPE EUROPEC/EAGE Annual Conference and Exhibition, Amsterdam, The Netherlands, 8–11 June 2009; pp. 1–14.

Yu, M., K. Wang, and H. Vredenburg *“Insights into low-carbon hydrogen production methods: Green, blue and aqua hydrogen”* International Journal of Hydrogen Energy, 2021 pp. 261-273

Eria, Bneri and Chiyoda Corporation (2020), “*Potential of Hydrogen Production*” ERIA Research Project Report FY2020 no.04 Jakarta: ERIA, pp.9-28.