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International Affairs

Methanol
Introduction, Applications Review of Iran's production status and Global Market Analysis, Production complexes and projects in Iran

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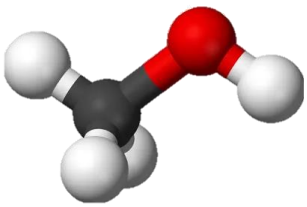
1. Introduction

Methanol, also known as Methyl Alcohol or Wood Alcohol, is the simplest type of alcohol with the chemical formula CH_3OH. It is a colorless, volatile, and toxic liquid with high flammability. As one of the fundamental petrochemical products, methanol plays a crucial role in the production of many chemical and industrial products.



2. Production Method

2.1. Methanol production using conventional methods

The methanol production process is a low-pressure process. Methanol is produced from natural gas, collected gases from refining processes, gas synthesis, coal and coke, or even biomass.

Methanol is industrially synthesized from coal or natural gas. The reforming step in methanol production is done in different ways. Among the types of reforming used in this process are:

- Steam reforming
- Intensive reforming
- Autothermal reforming
- Combined reforming
- Hot gas reforming

Steps such as compression and synthesis of methanol are performed after the reforming operation. Raw methanol is separated from water, ethanol and other compounds in the separation unit. These impurities are separated in a system consisting of two distillation columns. In the first column, light impurities such as ethers, esters, acetone as well as insoluble gases are removed, and in the second column, heavier water and alcohols and similar heavy organic matter will be removed from the stream.

Today, with the exception of China, which uses coal to produce methanol, other parts of the world use cheap natural gas as feed to produce methanol. Economically, it is different to choose either synthesis gas or coal technology to produce methanol. In China, due to the huge resources of coal, building units based on this technique is a priority.

There is also a worldwide tendency for offshore units to use natural gas extraction facilities to produce methanol from natural gas due to access to cheaper gas reservoirs. There are different methods for preparing and synthesizing methanol with natural gas. These methods are:

- Steam reforming
- Partial oxidation
- Partial catalytic oxidation
- Photochemical
- Photocatalytic method

Direct and indirect methods are used to convert natural gas to methanol. In the direct method, methane is converted directly to methanol at high temperature and pressure, which is limited in industry due to special operating conditions (high temperature and pressure).

The indirect method is done in three steps. In the first stage, methane first reacts with water to form carbon monoxide and hydrogen, which is reacted according to equation (1) and is called

synthesis gas production. Due to the importance of this stage and the fact that it is extremely hot and requires a lot of energy, about 60% of the total cost of the process is related to this stage.

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

In the second stage, the synthetic gas produced in the first stage is converted to methanol:

$$CO + 2H_2 \rightarrow CH_3OH$$

After the production of methanol, in the third stage, the methanol is separated from the system and the uncharged gases return to the system in the return stream to reproduce the methanol.

2.2. Production of methanol by modern methods (Green Methanol)

Methanol is one of the most widely used and basic chemical products that can be collected and produced using carbon dioxide. Methanol production unit is one of the important petrochemical units. In Iran, due to its rich gas reserves, it is one of the main producers of methanol. So far, 5 methanol units with a production capacity of 5 million tons per year have been created and about 12 units with a capacity of 19 million tons per year are being studied and commissioned.

The main reason for paying attention to the production of methanol with recovered carbon dioxide is the production of methanol from any source of carbon dioxide. This advantage has made it possible to use any source of carbon dioxide produced and enter it into the recovery cycle to reduce carbon dioxide as a greenhouse gas.

In this cycle, carbon dioxide is collected from any source and converted to methanol in response to hydrogen and recovered. In this cycle, the required hydrogen is produced completely independent of fossil fuels and using electrolysis.

In this cycle, methanol is renewable, so that in other processes, methanol is used to produce petroleum compounds such as ethylene, propylene, gasoline and other products that are part of oil and gas derivatives, and then as soon as combustion. These products re-produce carbon dioxide and are released into the air, which is recovered and collected and sent to the methanol production cycle. The conversion of carbon dioxide to organic compounds and the preparation of fuels are the most useful ways to reduce carbon dioxide.

3. Industrial Applications of Methanol

Methanol has a wide and diverse application in industry. Some of the applications of methanol include:

- Formaldehyde production for the production of MDF and plywood
- Melamine resin production for the production of various types of containers, switches and sockets and various types of industrial adhesives
- Acetic acid production for the production of VAM and cellulose acetate in the textile industry
- Producing polymethyl methacrylate PMAA for the production of various types of laminates
- Producing MTBE to improve the slow burning degree of gasoline
- Producing DME dimethyl ether to replace diesel fuel
- Blending with gasoline to fuel cars
- Producing ethylene and propylene as raw materials for the petrochemical industry

The following chart shows the application and distribution of methanol consumption in various industries around the world.

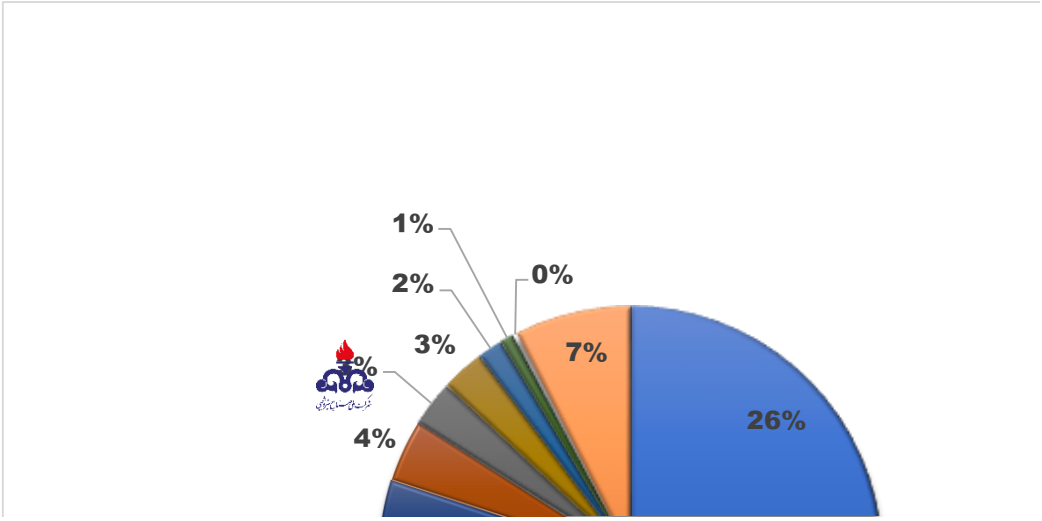


Figure1: Application and Distribution of Methanol consumption in various industries in the world.

4. Global Market Analysis and Industry Economics

4.1. Status of Global Methanol Capacity and Production:

As of 2022, the global methanol production capacity reached approximately 171.84 million metric tons. Actual production for the same year was estimated at over 111 million metric tons, marking a nearly four percent increase compared to the previous year. China plays a pivotal role in the methanol market, accounting for around 37% of the global supply in 2020, with the rest of Asia contributing an additional 40%.

4.2. Future Outlook for the Global Methanol Market:

The global methanol market was valued at over $37 billion in 2021 and is projected to experience continual growth in the coming years. This expansion is driven by methanol's versatility and its potential for reducing carbon emissions. The International Energy Agency (IEA) highlights methanol's potential as a motor fuel, which could offer significant economic and environmental benefits. In China, methanol demand is expected to increase in the coming years until the end of the decade, then decrease through 2050.

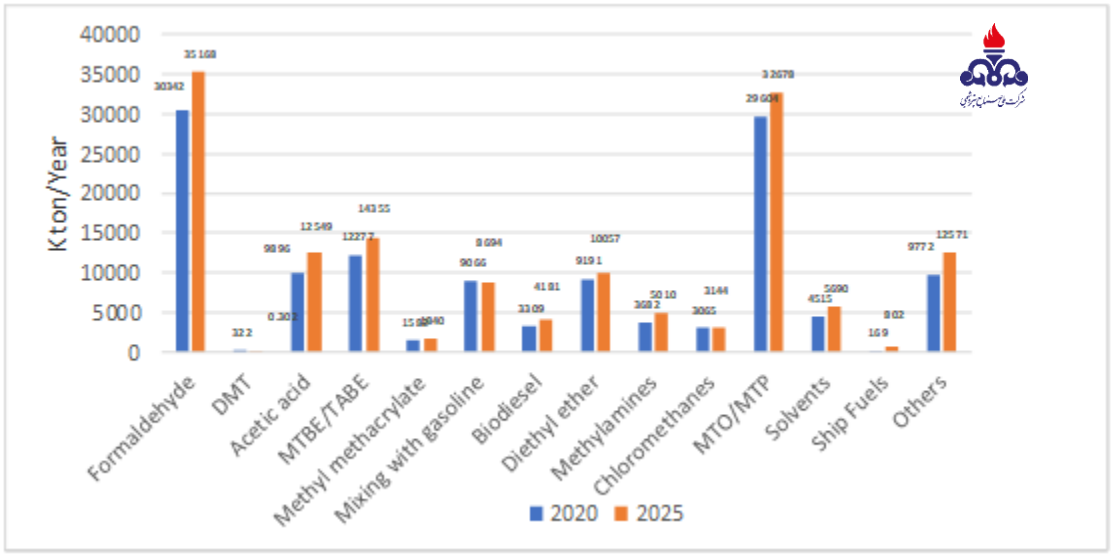


Figure2: Trends in methanol consumption in downstream units around the world in 2020 and 2025

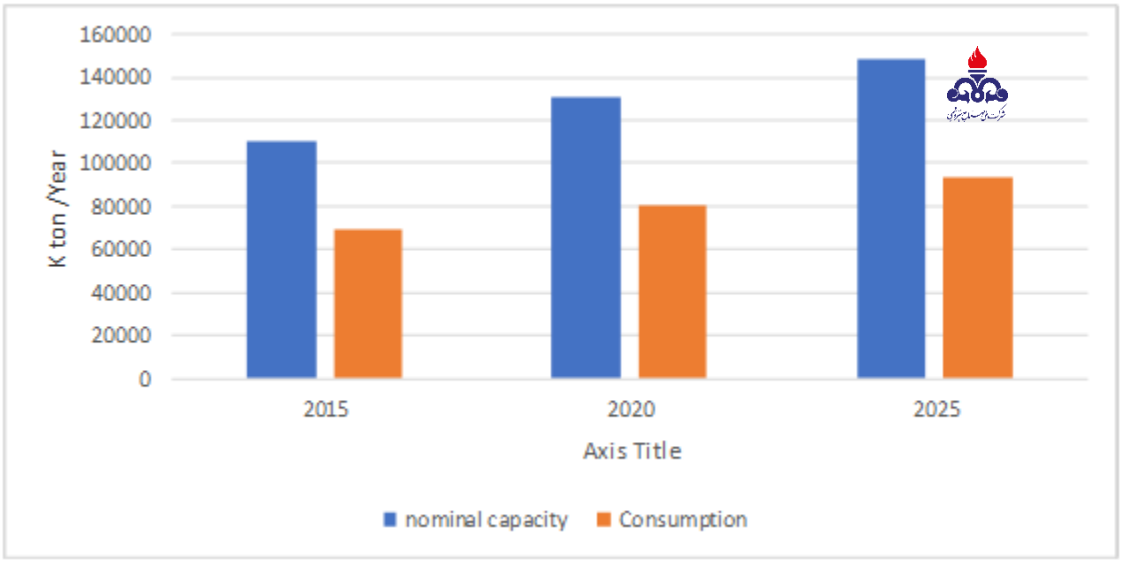


Figure 3: Trends in nominal capacity and methanol production in the world in 2015, 2020 and 2025

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5. Methanol production complexes and projects in Iran:

5.1. Methanol production complexes in Iran

By the beginning of 2025, Iran has eleven operating Methanol production plants with a total nominal capacity of 17.3 million tons. The major methanol-producing companies in Iran include:

No.	Logo	Petrochemical Complex	Production Capacity (KTons/Year)	License	Year of Operation	Web site
1		Zagros Petrochemical Company (ZPC)	1650	Lurgi (Italy)	2006	www.zpcir.com
2		Petro Kave Group	2310	Casale (Switzerland)	2018	www.petrokaveh.com
3		Marjan Petrochemical Company	1650	Haldor Topsoe (Denmark)	2018	www.mjpc.ir
4		Fanavaran Petrochemical Company	1000	Haldor Topsoe (Denmark)	1998	www.fnpetro.ir
5		Shiraz Petrochemical Company	84	lurgi (Germany)	1990	www.spc.co.ir
6		Bushehr Petrochemical Company	1650	Casale (Switzerland)	2019	www.bupc.ir
7		Kharg Petrochemical Company	660	Lurgi	1999	www.khargpetrochemical.ir

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8		Kimia Pars Middle East Petrochemical Company	1650	Haldor Topsoe (Denmark)	2020	www.mekpco.ir
9		Sabalan Petrochemical Company	1650	Haldor Topsoe (Denmark)	2021	www.sabalanpico.com
10		Arian Methanol Petrochemical Company	1650	Lurgi	2024	-
11		Arta Petrochemical Company	132	Uhde	2023	www.artagroup.com

5.2. Methanol production complexes in Iran

No.	Logo	Petrochemical Complex	Production Capacity (K Tons/Year)		Year of Operation	Web site
1		Siraf Energy Petrochemical Company)	1650	Tapsoe	2027	www.sirafco.com
2		Apadana Petrochemical Company	1650	CASALE	2025	www.pgapco.ir
3		Lavan Industrial Development	1000	Haldor Tapsoe	2027	www.lid-co.com
4		Soroush Energy Paydar GTO Methanol (Phase 1)	1650	Haldor Tapsoe	2027	-

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5		Sina Chemical Development industries Company	1650	SYN Energy Company	2026	www. sinachem.com
6		Badr Shargh	1650	Haldor Tapsoe	2028	-
7		Kimia sanaat mabna (GTPO-Train1)	1650	-	2028	-
8		Kimia sanaat mabna (GTPO-Train2)	1650	-	2027	-
9		Dena petrochemichal industries	1650	Haldor Tapsoe	2026	www.denapico.com
10		West Islamabad GTTP	660	Petrochemical Research and Technology company	2027	-