Methylamine Market Report

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1. Introduction

Methyl amine is an organic compound with CH_3NH_2 formula; it is one of the simplest amines and one of the derivatives of Methanol. It is a colorless gas, which is produced by reaction of ammonia and methanol, in which there is a methyl group instead of the hydrogen atom in an ammonia molecule. Methyl amine is soluble in methanol, ethanol, THF, and water. It is sold as a waterless gas in pressurized metal containers. In its industrial form, methyl amine is transferred in waterless form and in pressurized containers by train and tank trailer. Methyl amine has a strong smell like fish.

$$CH_3OH + NH_3 \rightarrow CH_3NH_2 + H_2O$$

Figure 1–Reaction of methanol and ammonia to produce methylamine

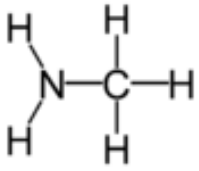

Figure 2- Methyl amine chemical structure

As it was mentioned earlier, methanol is the main material for producing methylamine. Methanol is one of three most important compounds in the world chemical industry, and lots of material are derived from it. Methanol is a strategic product and its use in different industries has made it a highly strategic compound. Therefore, its price fluctuations affect many production industries. The product chain of methanol is shown below.

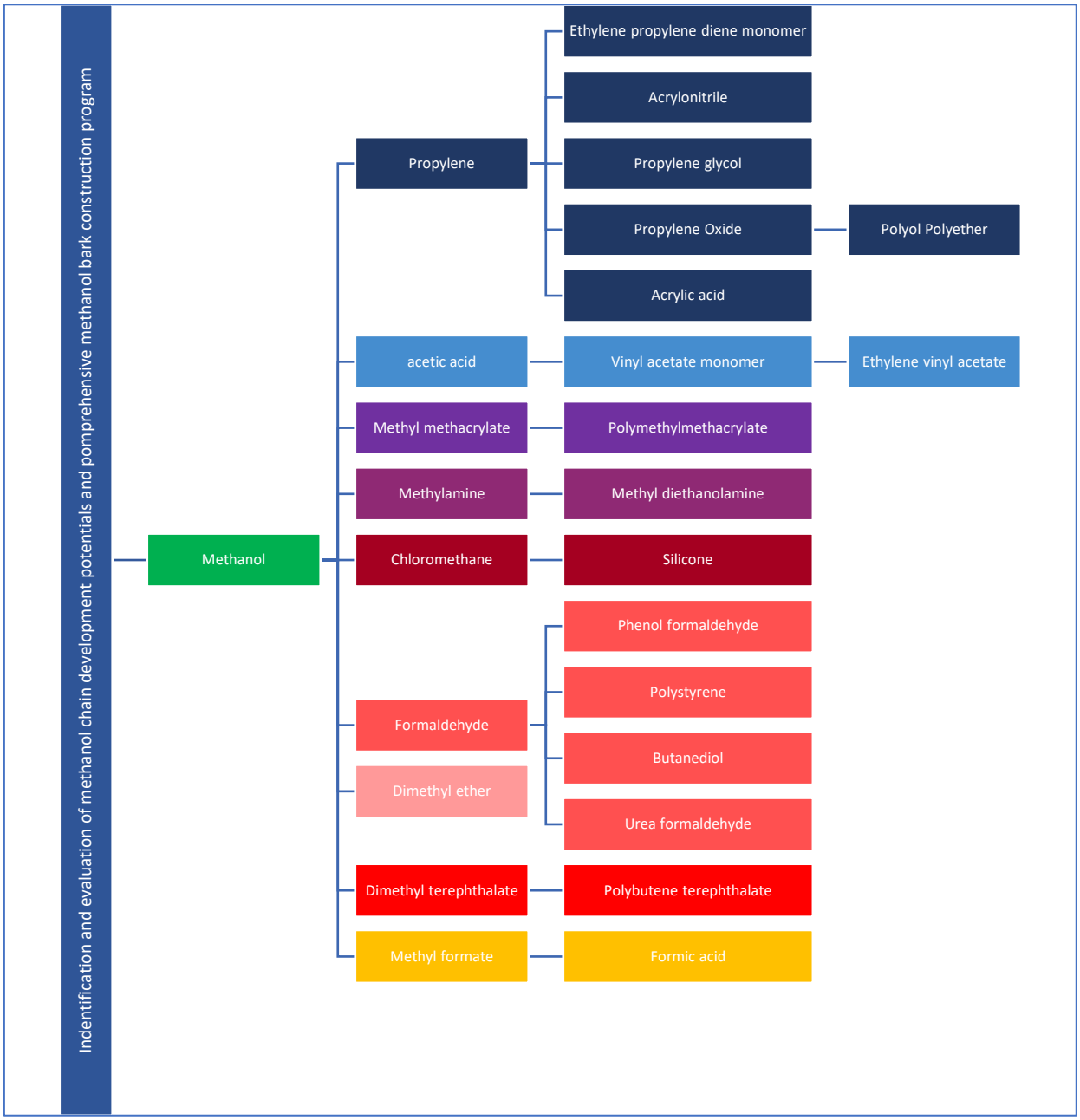

Figure 3- Methanol chain product

Monomethyl amine or methylamine is also known as methane amine and aminomethane. Dimethylamine is also known as methyl methane. These compounds are in gas form in the environment; smell like ammonia; are soluble in water, alcohol, and ether; and are highly flammable and toxic in their pure form. Therefore, they are presented as dissolved in water in pressurized containers and in specific weight percent, so that monomethyl amine, dimethylamine, and trimethylamine are available at 40% dissolved, 40% or 60% dissolved, and 40% dissolved in water, respectively. Monomethyl amine is the simplest member of the primary amine group; dimethylamine is the simplest member of the secondary amine group;

and trimethylamine is the simplest member of the tertiary amine group, all of which are colorless.

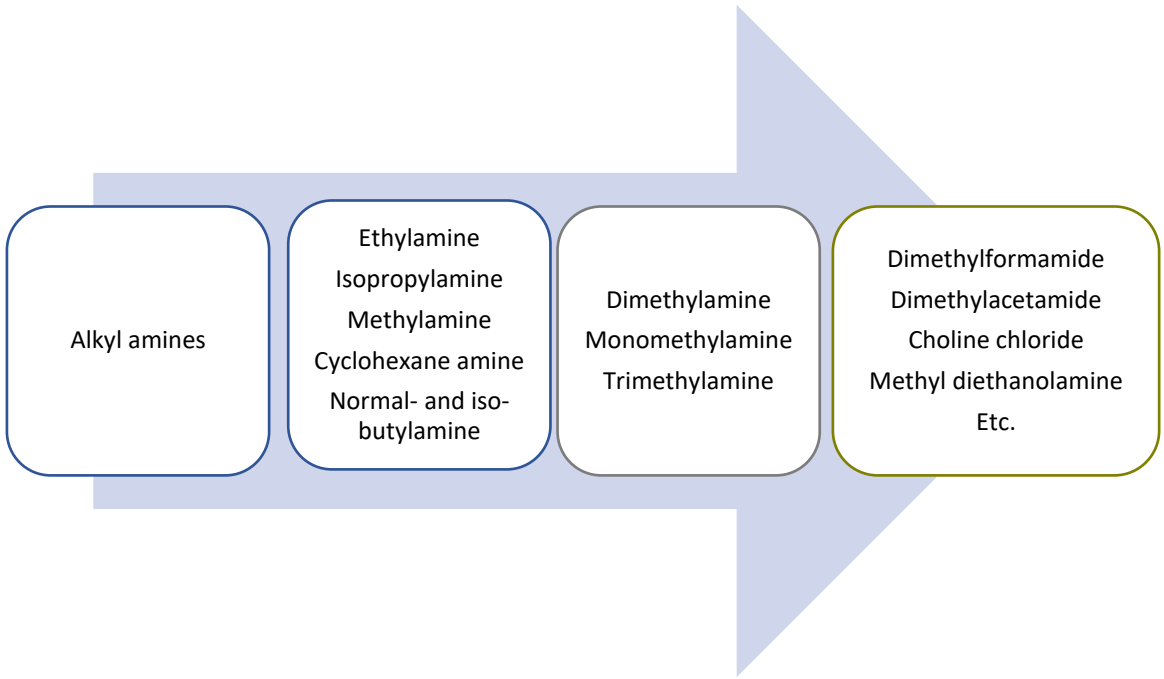

Figure 4- Product chain scheme

A summary of the physical and chemical properties of these products is given in table below.

Table 1- Physical and chemical properties of pure methylamines

Compound	Molecular Formula	Molecular Weight (g/mole)	Boiling Point (°K)	Melting Point (°K)	Density (kg/m^3)	Lower Level of Explosion (vol%)
Monomethylamine	CH_3NH_2	31.06	266.7	177	656	4.98
Dimethylamine	$(CH_3)_2NH$	45.08	279.9	181	650	2.8
Trimethylamine	$(CH_3)_3N$	59.11	275.9	156	627	2

As it was mentioned earlier, methylamines are sold as 40% and 60% dissolved in water. The physical and chemical properties of these products in the given percent is summarized in the table below.

Table 2- Physical and chemical properties of dissolved methylamines in water

Compound	Boiling Point (°K)	Melting Point (°K)	Density (kg/m^3)	Vapor Pressure (kPa)
Monomethylamine 40%	223.7	235.1	904	34
Dimethylamine 40%	324.6	245.1	898	27
Dimethylamine 60%	309.1	213.1	827	57
Trimethylamine 40%	303.9	274.8	880	61

2. Applications of the Product

2.1. Agriculture

Methylamine is used in production process of a great number of intermediate in agriculture. For instance, it is used for producing herbicides, fungicides, insecticides and etc. Agriculture is one of the most extensive field of methylamine consumption.

Figure 5- Application of methylamine in agriculture – herbicides and pesticides

2.2. Animal Nutrients

Choline chloride is one of the most important product of methylamines. The most extensive and important application of choline chloride is as a nutrient for birds and cattle food backup. The most extensive use of trimethylamine is to produce choline chloride, which is a vitamin B supplement in the food of animals like chicken, turkey and pig. This compound is produced from the reaction of trimethylamine, chloric acid, and ethylene oxide. Choline's function in the animals' body are:

- ✓ Choline is essential for construction and maintenance of cellular structure.
- ✓ It has an essential role in the metabolism of liver fat, so that it inhibits un-natural accumulation of fat in the liver by stimulating their displacement from the liver as cysteine or increasing the decomposition of fatty acids.
- ✓ It is necessary for construction of acetylcholine, which is an important material for neural message transmission.

Figure 6- Application of choline chloride, a product of methylamine, in the field of animal husbandry - animal nutrition supplement

2.3. Electronics

Some epoxy resins are used in the electronics industry. Epoxy resins are hard and brittle. Reaction of dimethylamine and benzene chloride yields in production of dimethylamine, which is used as a catalyzer in producing electronics equipment. Dimethylamine and trimethylamine are extensively used in the field of electronics.

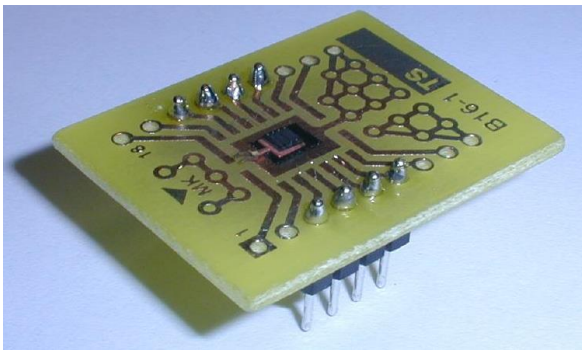

Figure 7- Application of methylamine in electronics

2.4. Explosives

Monomethyl nitrate is produced by reaction of monomethyl amine, formaldehyde and ammonium nitrate. Due to their ease and safety in handling, monomethyl nitrate is used in the production of explosives applicable in the mining industry.

2.5. Fuel additive

Fuel additives are used to improve engine performance in a variety of ways. MMA and chlorobenzene are reacted with copper as a catalyst to make n-methylaniline for aviation fuel. DMA hydrochloride is also used as an additive in aviation fuel as an antiknock compound.

MMA nitrate is a freezing point depressant in jet engines using ammonium nitrate-urea fuels. Mixtures of MMA, DMA, and TMA in water have been tested as coolants in some high-speed engines.

2.6. Solvents

Mono- and di-methylamine are used in production of polar solvents, namely dimethyl formaldehyde (DMF) and dimethyl acetamide (DMAc). DMF is produced from the reaction of dimethylamine and carbon monoxide or methylformate, and is used as urethane coating, rotary solvent, extraction solvent and process solvent. DMAc is produced by reaction of methylamine and acetic acid or acetic anhydride, and is used as rotary solvent and reaction solvent in manufacture of paints, medicines and vinyl polymers.

Figure 8- Dimethyl formaldehyde

2.7. Surfactants

Surfactants are used in the manufacture of soaps, shampoos, detergents, and other specialty wetting applications. Dimethylamine react with fatty tertiary amines with C10-C18 alkyl groups from alpha-olefins or fatty alcohols to make nonionic alkyldimethylamines. Non-ionic surfactants have weaker cleaning properties, but do not irritate the skin.

2.8. Water treatment

Dimethylamine is used as the primary material for producing compounds used for removing the water suspended solids in order to purify the water for municipal uses, drinking and wastewater treatment.

Figure 9- Application of dimethylamine in water treatment

2.9. Catalyst

Methylamines can be used either directly as a catalyst or as a primary material for producing catalyst. MDEA is produced from monomethyl amine, used as urethane catalyst. MDEA, produced from dimethylamine, is used as urethane catalyst to promote foam rise and gel strength for insulation applications, such as refrigerators.

2.10. Rubber chemicals

Dimethylamine oleate is used as emulsifier for synthesis of rubber products. Dimethylamine is directly used as modifier of butadiene gas phase polymerization and stabilizer of latex natural rubber (instead of ammonia).

2.11. Resin production

Methylamines are used for manufacturing reins used in water deionization. Cation exchange resins are produced from the reaction of trimethylamine and polystyrene-di vinyl benzene copolymer.

3. Middle East Market

The Middle East is located on the border of Asia and Africa, includes the most parts of Western Asia and Egypt. Due to having giant oil reservoirs, Middle East is considered as the source of energy for the whole world. Saudi Arabia, Iran, Iraq, Kuwait and United Arab Emirates are some of the countries with the greatest oil reservoirs in the world. Middle East has also giant natural gas reservoirs. Iran and Qatar possess the first and second biggest natural gas reservoirs in the world, respectively. The economy of oil-rich countries in the Middle East is mostly mono-product and depends on oil export; the oil resources are rarely used in the industrial sector of these countries.

Figure 10- Map of the Middle East

3.1. Capacity

Table below shows the capacity of methylamine production in Middle East. By establishing a new unit in Saudi Arabia in 2010, the production capacity has significantly increased. Saudi Arabia and Turkey are the only countries having methylamine production unit in Middle East, and the production capacity of this region is associated with these two countries.

Table 3- Capacity of Middle East- Thousands of metric tons

Year	Capacity
2004	17
2007	17
2010	60
2013	68
2017	68

3.2. Middle East production

Table below presents methylamine production in Middle East. By establishing a new unit in Saudi Arabia in 2010, the production rate has significantly increased.

Table 4- Production in Middle East –Thousands of metric tons

Year	Production
2004	15.3
2007	15.3
2010	34
2013	56.5
2017	61.3

3.2.1 Introducing producer companies

Currently, there are only two countries– Saudi Arabia and Turkey– having methylamine production capacity. The capacity of Saudi Arabian and Turkish company is 50,000 and 17,000 tons/year, respectively.

Table 5- Methylamine producers in Middle East - 2017

Country	Brand	Company	City	Capacity (Thousands of metric tons)
Saudi Arabia	CHEMANOL	Methanol Chemicals Company	Al Jubail	50
Turkey	Akkim	AK-KIM Kimya Sanayi ve Ticaret A.S.	Yalova, Istanbul	17

Chemanol produces 50,000 tons/year methylamine in Al Jubail, Saudi Arabia, part of which is exported. The dimethylamine produced in this unit is consumed directly in the DMF unit, which is recently established. The major products of this company is exported to India, South Korea, and Japan.

The main product of Akkim unit, Turkey, is dimethylamine, most of which is used by AK-KIM Kimya Sanayi ve Ticaret A.S. for DMF production.

Figure 11- Geographical location of Methanol Chemical Company

Figure 12- Geographical location of AK-KIM Kimya Sanayi ve Ticaret A.S.

3.3. Middle East consumption

Methylamine is the most widely used alkylamine. Methylamine consumption rate for DMF production has significantly increased in Saudi Arabia, and in the Middle East as a result, since 2010. It is anticipated that the annual growth rate of methylamine consumption in Middle East will be 2.7% during 2017-2022.

Table 6- Consumption in Middle East – Thousands of metric tons

Year	Consumption
2004	18.1
2007	18.5
2010	34.6
2013	56.4
2017	62.4
2022	70.8

Consumption as solvent has significantly increased since 2010, with the launch of the DMF project in Saudi Arabia. In Turkey, the major dimethylamine is used by AK-KIM Kimya to produce DMAc and DMF solvents.

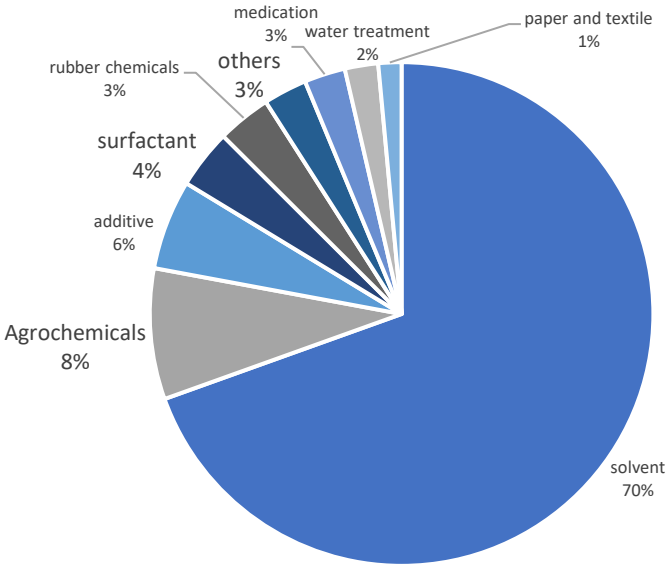

Figure 13- Methylamine consumption by the use in the Middle East - 2018

3.4. Trade in Middle East

The trade volume of methylamines in Middle East has significantly increased during the recent years. The investigations reveal that the export volume of this product had a considerable increase since the launch of Saudi Arabia unit. The main export of methylamine and its chains in the area is done by Saudi Arabia, while its import has increased from 6,600 tons in 2015 to 10,400 tons in 2018. It has to be noted that methylamine export of Saudi Arabia in 2017 is mentioned to be about 70,000 tons in the statistics, while Saudi Arabia production is about 50,000 tons. This amount of export includes DMF and methylamine salts as well since methylamine salts are also mentioned in the tariff.

Table 7- Methylamine trade in Middle East – Thousands of metric tons

Year	Import	Export
2012	7,500	8,900
2013	2,600	6,800
2014	6,000	11,200
2015	6,600	17,600
2016	6,500	44,000
2017	7,800	76,000
2018	10,360	73,000

The main methylamine export of Turkey is to West European countries, while the main export of Saudi Arabia is to Asian countries, especially India.

4. Raw materials

As mentioned, the raw materials needed for the production of methylamine are ammonia and methanol. The reaction of ammonia and methanol to produce methylamine is as follows:

$$CH_3OH + NH_3 \rightarrow CH_3\,NH_2 + H_2O$$

$$2CH_3OH + NH_3 \rightarrow (CH_3)_2\,NH + 2H_2O$$

$$3CH_3OH + NH_3 \rightarrow (CH_3)_3\,N + 3H_2O$$

Following, we look at nominal capacity, actual production rate, consumption and price of ammonia, methanol and ethylene oxide in the world and the Middle East.

4.1. Ammonia

Ammonia is the most important hydrogenated nitrogen compound naturally resulting from the decomposition of nitrogenous organic matter. It is a colorless gas with an extremely spicy and nasty taste that is also tearful and suffocating. Ammonia is lighter than air, easily convertible to liquid, highly soluble in water and freezing at -77.7°C and boiling at -33.5°C.

Ammonia is used in ice making plants, in the manufacture of fertilizers such as nitrate, sulfate and ammonium phosphate, in the preparation of nitric acid, drugs and explosives.

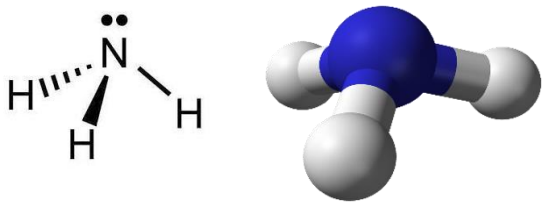

Figure 14-Ammonia chemical formula

The following table reports information on nominal capacity, actual production and ammonia consumption in the world in 2016. Eastern Europe has the largest nominal capacity of about 23,000 tons. Europe has the most of actual production with around 18,000 tons. That's while, the highest consumption rate is assigned to North America with about 18,000 tons of ammonia in 2016.

Table 8- Global data on ammonia production and consumption – Thousands of metric tons

Region	Nominal capacity	Actual production	Consumption rate
North America	16,997	14,689	17,952
Central and South America	8,860	6,950	3,791
Western Europe	10,595	9,216	11,403
Central Europe	6,933	4,623	4,635
Eastern Europe	23,140	18,772	15,460
Middle East	20,186	13,621	12,092

South East Asia	10,137	7,500	7,897
Southwest Asia	17,775	15,450	17,615
Pacific	2,117	1,450	1,144
Total	**191,787**	**148,261**	**148,261**

Now, we look at the nominal capacity, actual production, and ammonia consumption in Middle East in different years.

Table 9- Ammonia production and consumption in Middle East – Thousands of metric tons

Year	Nominal capacity	Actual production	Consumption rate
2008	10,431	8,963	7,708
2009	12,536	9,086	7,634
2010	12,556	10,419	8,862
2011	14,081	11,647	9,491
2012	15,331	11,982	10,048
2013	15,931	12,429	10,852
2014	16,351	12,574	10,580
2015	17,771	12,879	11,098
2016	20,186	13,621	12,092
2021	23,311	17,057	13,107

The nominal capacity of ammonia in Middle East is projected to grow at an annual growth rate of 3.1% during 2016-2021. While actual ammonia production is projected to grow at an annual growth rate of 5.04% during 2016-2021. The table below provides information on the major ammonia producers in Middle East and their capacity in 2016.

Table 10- Major producers of ammonia in Middle East – Thousands of metric tons

Company	Capacity	Percent
NPC	3,888	19.3
QATAR	2,250	11.1
SABIC	1,668	8.3
Oman Oil	835	4.1
Yara	750	3.7
Arak Petro	704	3.5
Andoc	660	3.3
Maaden	634	3.1
Gubre fabri kalari turk	624	3
Suhail bahwan group	600	3.1
Other	7,573	37.5
Total	**20,186**	**100**

The chart below shows the share of each of the ammonia producing companies in Middle East.

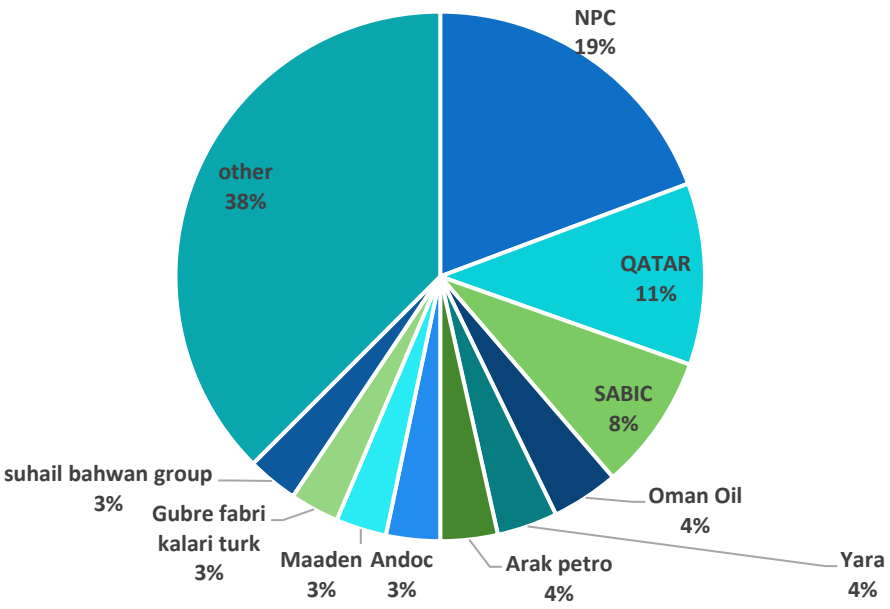

Figure 15- Share of Ammonia Production Units in Iran - 2016

4.2. Methanol

Methanol is one of the major products that is highly consumed in the chemical industry and many commodities are derived from it. It is an alcoholic fuel and can be produced from natural gas, wood, coal and other natural resources. Since methanol production from natural and renewable sources is economically more expensive than gas, in recent years a significant part of it in the world is obtained from the natural gas, so it can be said that ammonia is the second most abundant material after ammonia which is mostly produced by natural gas.

Methanol is commercially produced by the reaction of the synthesized gas in the presence of a catalyst in high pressure. The synthesis gas consists of carbon monoxide, hydrogen gases and a small amount of carbon dioxide and other gases.

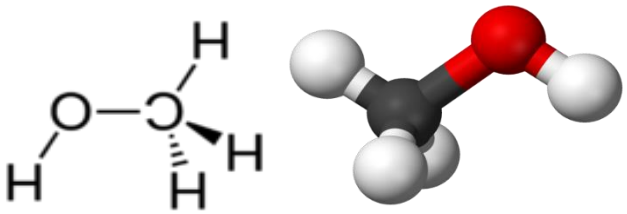

Figure 16- Chemical formula of methanol

The table below reports the nominal methanol capacity in the world for 2017 and 2022. Most of the nominal capacity is in Northeast Asia with about 62,000 tons in 2017. In 2017, Middle East accounts for about 14% of the nominal methanol capacity and is projected to rise by 15.8% in 2022.

Table 11- Nominal capacity of methanol - Thousands of metric tons

Region	2017	2022
North America	6,844	11,548
south America	9,996	10,829
Western Europe	3,079	3,079
Central Europe	400	400
CIS and the Baltic region	5,450	7,405
Middle East	16,194	21,794
Africa	3,320	5,970
Indian Peninsula	667	832
Northeast Asia	62,029	68,579
South East Asia	6,760	7,660
Total	**114,739**	**138,096**

The chart below shows the share of different regions in nominal methanol capacity in 2017.

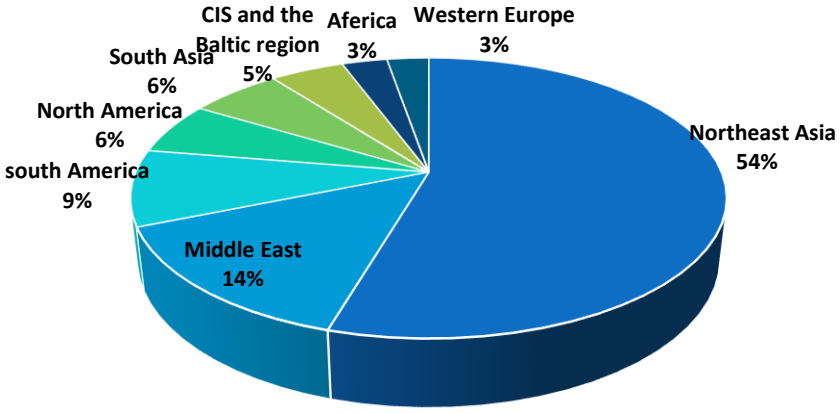

Figure 17- Share of different countries in nominal methanol capacity - 2017

Middle East accounts for 14% of methanol production capacity and is the largest producer in the world after North East Asia. The following table reports the methanol nominal capacity, actual production and consumption in different years.

Table 12- Methanol production and consumption in Middle East - Thousands of metric tons

Year	Nominal capacity	Actual production	Consumption rate
2008	12,059	1,448	2,434
2009	13,889	12,039	2,404
2010	15,464	13,339	2,759
2011	16,114	14,079	2,927
2012	16,114	12,632	2,945
2013	16,114	12,719	2,967
2014	16,114	12,080	2,970
2015	16,114	13,376	3,077
2016	16,114	13,430	3,081
2017	16,114	13,401	3,166