METHANOL FUEL IN CHINA 2020

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ABBREVIATION

MIIT	Ministry of Industry and Information Technology
NDRC	National Development and Reform Commission
MOST	Ministry Science and Technology
MFVs	Methanol fueled vehicles
CAAEFA	China Association of Alcohol and Ether Fuel and Automobiles
MI	Methanol Institute
CNFIA	China Nitrogen Fertilizer Industry Association
CAREI	China Association of Rural Energy Industry
VOCs	Volatile Organic Compounds
IPR	Intellectual Property Rights
IOT	Internet of Things
GDP	Gross Domestic Product

FOREWORD

Along with the development of the Chinese economy and people's living standard, the demands for energy has rapidly increased, and hence the Chinese government has made a remarkable achievement in securing energy supply. However, facing new challenges from environmental protection and energy security, China has to continue its efforts in clean utilization and sustainable development of its energy with consideration of price affordability. Methanol is an important chemical commodity, and meanwhile its nature as an energy resource has risen to prominence. As a clean, low carbon liquid fuel, methanol fuel has already been applied in vehicles, boilers, cook stoves and other related markets. The feasibility of methanol fuel, including the reliability, safety, environmental benefits in large scale application has received a considerable recognition from central and local governments, authorized organizations, and the market in China. In 2019, eight ministries and administrations of China's central government led by the MIIT, along with the NDRC, MOST and other five Ministries issue a promotional policy paper of "Guidance of Developing Methanol Vehicles Applications in Some Parts of China"[1]. This policy recognizes the rationale to develop methanol-fueled vehicles (MFVs) in China, and set a clear direction for the future promotion of MFVs in China.

Although the scientific research and development, engineering and commercialization of methanol fuel in China has made considerable progress, challenges still exist in practice, potentially impeding further development. In 2019, in order to develop a comprehensive understanding of companies and application markets for methanol fuel, and to build the foundations for the next steps of work, CAAEFA issued "Circular on Carrying Out the Survey of Methanol Fuel Industry"(CAAEFA published [2019]No.4) and launched a survey in the whole industry of methanol fuel in China.

This survey focused on the basic information of companies in manufacturing and market applications, with high coverage of the whole supply chain representation, including technology, products, and market performance, etc. This survey adopted multiple methods such as questionnaire, phone inquiry and site visit to have a deep understanding of enterprise backgrounds, products, technologies, market, and other information of methanol fuel industry. A total of 77 companies responded to the questionnaire, and around 300 companies accepted phone inquiries. In addition, the survey team visited dozens of companies in Sichuan, Shaanxi, Shanxi, Jiangsu, Zhejiang, Beijing, Henan, Anhui, Fujian, Guizhou provinces and municipalities. As estimated, in 2019 the 400-plus participating companies accounted for over 70% of overall methanol fuel consumption in China.

This survey received support from the Methanol Institute and Methanex Corporation. Special thanks to local associations and institutions includes CNFIA, CAREI, Anhui Methanol Fuel Industry Association, Yunnan Automobile New Fuel Industry Association, Hebei Clean Energy Industry Association, Gansu Clean Energy Industry Association, Fujian Methanol Fuel Stove Industry Association, Shanxi New Energy Development Center, Henan Methanol Fuel Industry Technology Innovation Strategic Alliance, and enterprises such as Geely Auto Group, Zhong Run Oil New Energy Group, Shanxi Jiaxin Energy & Chemical Industry Co., Ltd, Shaanxi Ankang Hanjiang New Energy Technology Co., Ltd, Fujian Dawei Energy Co., Ltd, Tianjin Enguang Technology Co., Ltd, Anhui Shengbao New Energy Technology Co., Ltd, Hefei Zhongke Weineng Safety Technology Co., Ltd, Xi'an Langbo Energy-Saving Technology Co., Ltd, and Shanxi Yuneng Energy-Saving Environmental Protection Equipment Manufacture Co., Ltd.

EXECUTIVE SUMMARY

Methanol is a basic building block in chemical production. As a clean and efficient liquid fuel, methanol has already had significant success across a variety of applications. In 2019, CAAEFA launched a survey of the methanol fuel industry in China. This survey analyzes and presents the methanol fuel industry from different aspects including representative companies, market consumption, and market distribution, and addressed the challenges confronted by this industry.

Methanol fuel products system and industrial chain has been gradually improved

In looking at the differences of industrial equipment, methanol fuel in China can be divided into two major areas: methanol fuel for motors/devices for mobility, like certified vehicles, methanol gasoline blending in vehicles; and methanol for heat (thermal), such as methanol fuel in burners, kilns, and cook stoves. Along with the maturity of technology for methanol-fueled applications, the number and scale of companies in this industry are all at the stage of high-speed commercial development. Industrial chains of certified facilities and equipment, special apparatus, special components have already been established, and related system of political policies, standards and technology support also has been increasingly improved. Leading manufacturers of MFVs have high concentration in industrial production and distribution and they win competitive market advantages in technology and scale. For methanol fuel thermal markets companies in methanol fuel distribution, and combustion equipment, etc. are usually in a relatively small scale with low market concentration. However, as the market develops, these enterprises are expected to grow into larger scale.

Methanol clean fuel in transportation has been at the stage of large-scale development

As acceptance approval of the Chinese provincial/municipal MFV pilot results completed by 2018, the population of M100 (neat methanol) vehicles has boosted in some districts in 2019. The total population of M100 vehicles of Xi'an and Guiyang city is 18,941 at the end of 2019, and both of them are expected to have larger population of M100 vehicles. The total population of M100 in Guizhou, Shaanxi, Shanxi and Gansu provinces reached 19,401 at the end of 2019. By 2019, the consumption of M100 and M85 (a blend of 85% methanol and 15% gasoline) fuel achieved 507,000 metric tons of methanol. The consumption of methanol fuel in transportation is expected to significantly increase in the future with more related policy implementation.

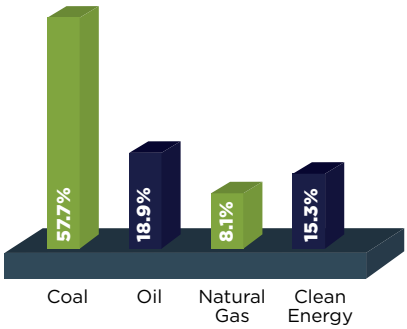
Methanol fuel for thermal has gone into mature stage

Methanol fuel for thermal markets have seen development for a long time with mature technologies. In June 2018, "Three-Year Plan on Defending the Blue Sky"[2] issued by the central government was a catalyst to the increase of market size of methanol fuel for thermal application. In 2019, the consumption of methanol fuel in this area from boilers, kilns and cook stoves reached over 5 million metric tons (MMTs), with expansion in 27 provinces and municipalities. The amount of this consumption is expected to increase steadily as more subsidies and favorable polices are implemented.

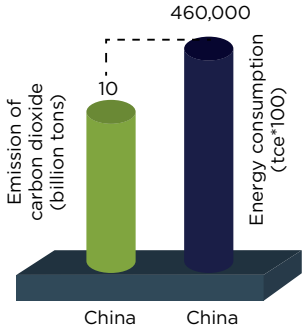
1. BACKGROUND

China is the world largest energy producer and consumer and at the same time emits the most greenhouse gas compared to other countries around the world. Every energy source can find its applications in China. Thus, Chinese government has been continuously working on public policy in order to balance the supply and demand sides between energy producers and consumers, with the top level aim of enhancing national energy security, environmental protection and economic impact. In 2014, concepts like revolutions of energy consumption, energy supply, energy technologies, and energy system were raised from the highest level policy makers in China. Furthermore, China has adopted a more open-minded standpoint to strengthen international cooperation and improve the top-down energy strategy of energy security. Besides, at the United Nations Conference on Climate Change held in Paris in 2015, the Chinese government announced that by 2030, China will deliver on the promise that the proportion of non-fossil fuels in primary energy will reach 20%. Furthermore, at the General Debate of the 75th session of the UN General Assembly in2020, President Xi announced China will achieve carbon neutrality by 2060 with more forceful policies and measures.

The characteristics of energy reserves in China is "short on oil, lean on gas, but rich in coal," which determines that over half of Chinese energy consumption is depending on coal. Up to 2019, coal energy consumption accounted for 57.7% of China's whole energy consumption., and meanwhile, total oil and natural gas energy consumption only accounted for 27%[1]. Although Chinese official reports showed that emissions of carbon dioxide have been reduced 4% per GDP[4], Carbon Brief inferred that the emission of carbon dioxide would top 10 billion tons in China in 2018[5]. Nowadays, Chinese government has already realized that current structure of energy consumption is increasingly incompatible with the country's development as well as the social needs.

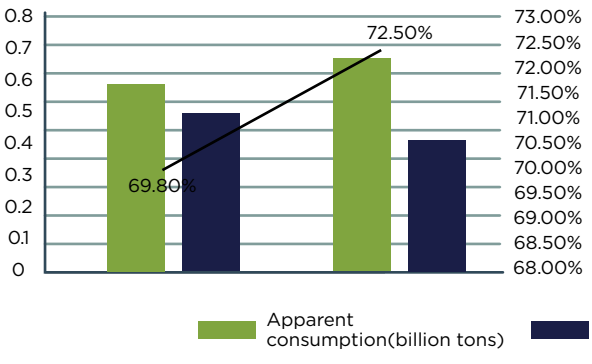


Pic 1: Primary energy consumption structure of China in 2019 [1]

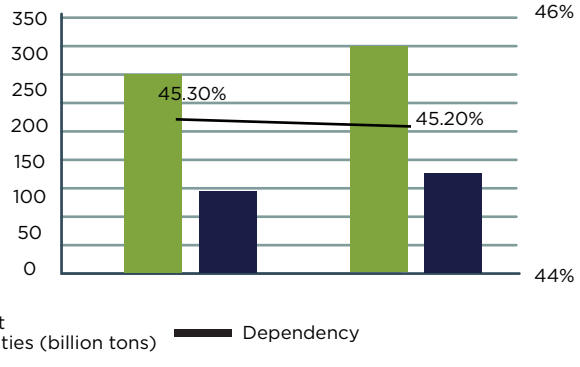


Pic 2: Primary energy consumption and emission of carbon dioxides of China in 2018 [1][5]

Reducing the percentage of coal consumption has been the consensus among the whole Chinese energy industry. But it is not easy for China to increase the percentage of oil or natural gas consumption because of the structure of energy reserves in China. In 2019, the apparent consumption of oil and natural gas in China still increased rapidly and so does the amount of import. Oil import dependence has seen increases, as natural gas import dependence in 2019 remained fairly flat compared to 2018.



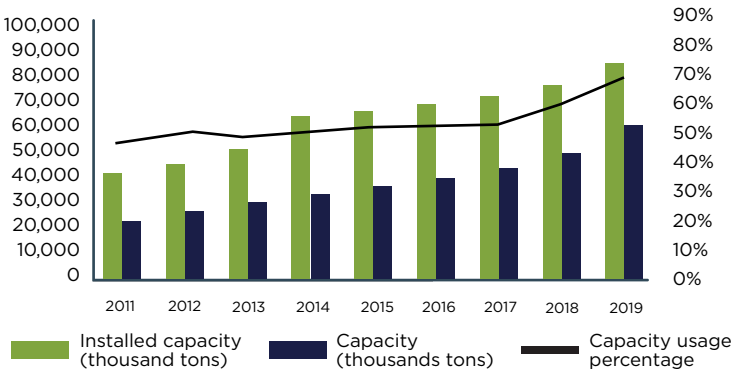
Pic 3: Apparent consumption and import quantities of oil in China in 2018-19 [10][11]



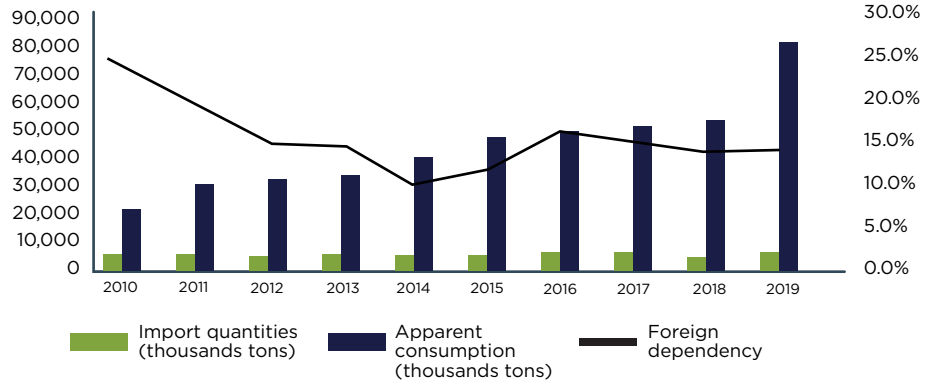
Pic 4: Apparent consumption and import quantities of natural gas in China in 2018-19 [10][11]

Methanol can be produced from a variety of feedstocks such as natural gas, coal, and biomass. The main source of methanol around the world is natural gas, while China heavily relies on coal as the main feedstock because of its reserve structure. Methanol as a fuel serves to transfer coal energy into clean energy through advanced technologies, so that the environmental problems can be significantly improved and meanwhile the national energy security can be safeguarded.

China now is the world largest methanol producer and consumer. According to statistics from CNFIA, in 2019, the installed capacity for methanol production in China reached 89.9 MMTs (including methanol produced in the Coal-to-olefin process), with the amount of methanol production of 69.9 MMTs, and apparent consumption reached around 80 MMTs (including imports of 10 MMTs). During the period of 2011 to 2019, the installed capacity, production, and apparent consumption of methanol in China steadily rose, with the import share in Chinese market staying within 20% since 2012[12][13].



Pic 5: Installed capacity and capacity of methanol in China during 2011-2019 [12][13]



Pic 6: Apparent consumption and foreign dependency in China during 2011-2019 [12][13]

Sufficient installed capacity, production, and low cost make methanol fuel an important clean fuel in China. China has become the main market for methanol fuel technology development and applications. However, the methanol fuel market has not been completed yet. Thorough and timely statistics of total methanol fuel consumption is absent and the market has not evolved into an effective system, posing challenges for the government which tries to support and regulate the industry.

2. OVERVIEW OF COMPANIES IN THE SURVEY

China is the world largest energy producer and consumer and at the same time emits the most greenhouse gas compared to other countries around the world. Every energy source can find its applications in China. Thus, Chinese government has been continuously working on public policy in order to balance the supply and demand sides between energy producers and consumers, with the top level aim of enhancing national energy security, environmental protection and economic impact. In 2014, concepts like revolutions of energy consumption, energy supply, energy technologies, and energy system were raised from the highest level policy makers in China. Furthermore, China has adopted a more open-minded standpoint to strengthen international cooperation and improve the top-down energy strategy of energy security. Besides, at the United Nations Conference on Climate Change held in Paris in 2015, the Chinese government announced that by 2030, China will deliver on the promise that the proportion of non-fossil fuels in primary energy will reach 20%. Furthermore, at the General Debate of the 75th session of the UN General Assembly in2020, President Xi announced China will achieve carbon neutrality by 2060 with more forceful policies and measures.

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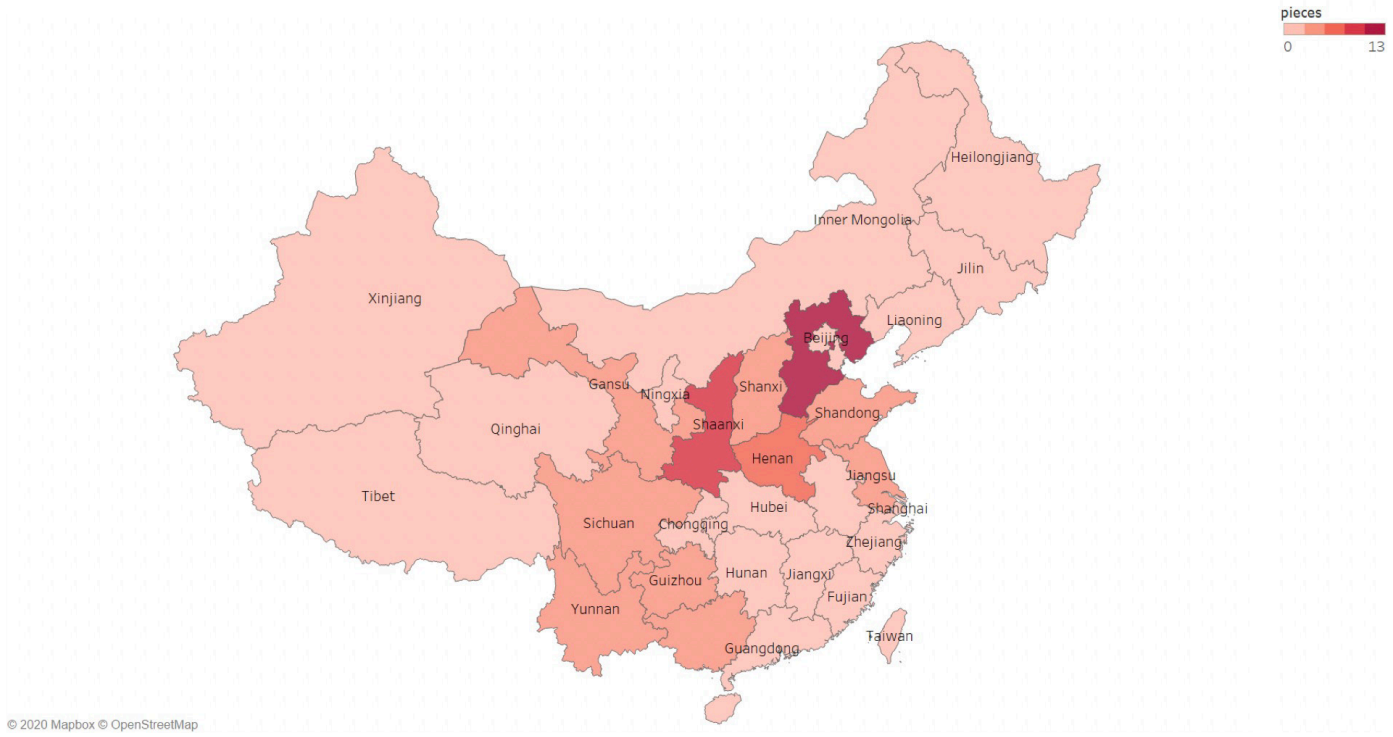
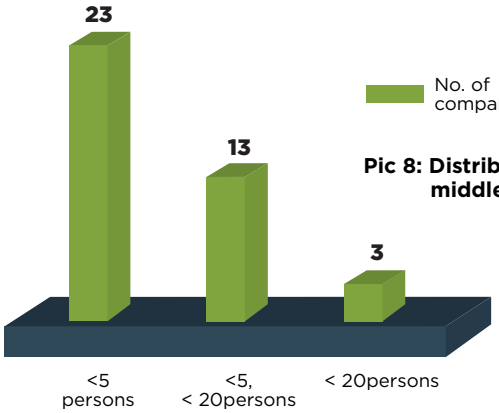


Pic 7: Questionnaires feedback distribution of this survey in China

2.1 EMPLOYEES

Most employees in charge of the research and development of technologies are senior technicians with rich practical experience. A few of them own Master degree or above. As the questionnaire shows, 21.8% of the companies have at fewer than 3 employees with Doctor degree, 34.6% of the companies have at fewer than 4 employees with Master degree, and at least 50% of the companies hire engineers with senior titles.

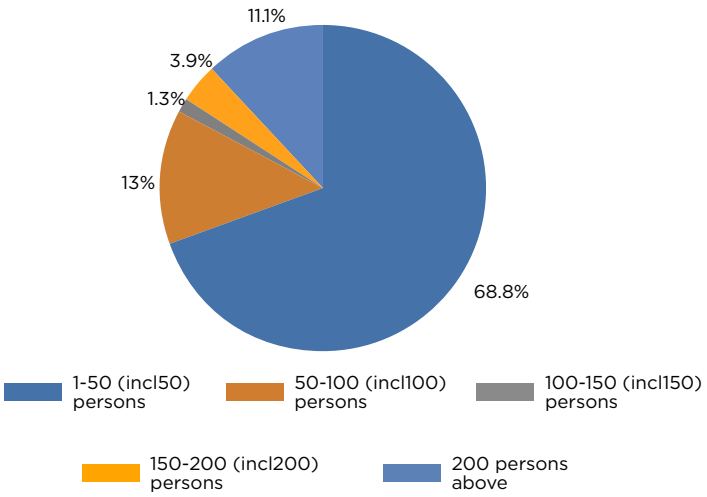


Pic 8: Distribution of number of middle or senior engineers

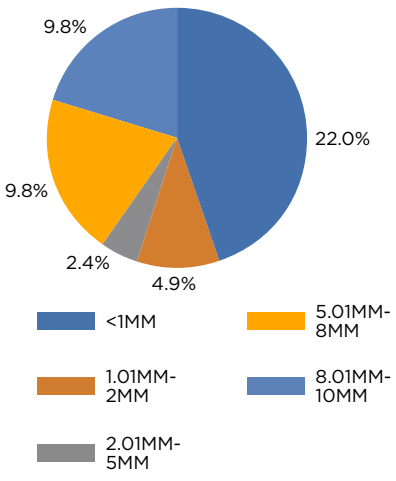
2.2 SCALES OF COMPANIES

The remarkable characteristics of methanol fuel industry are small and scattered, meaning there are a large amount of small-scale local companies with low market concentration ratio in the industry. As the questionnaire shows, 68.8% of companies have no more than 50 employees. Near 50% of companies have methanol fuel or equipment revenue under 10 million RMB, and 22% of companies have total revenue under 1 million RMB. There is a lack of leading companies whose main business is methanol fuel relevant. While there are some large-scale vehicles manufactures, their MFVs and other relevant products are only sold in some specific areas of the country. Most companies whose main business are methanol fueled boilers, kilns and cook stoves need to supply the full service ranging from equipment and fuel sales, the construction and reconstruction of engineering projects to follow-up maintenance with low standardized level of products and long service chain. Cross-regional companies on a large scales have not yet come into being.

Meanwhile, there remains a large number of micro-companies, and some of them are even self-employed, primarily in charge of the supply and delivery of end-use of fuel and equipment, especially the fuel used for cook stoves. These companies with the annual revenue under 1 million or even 0.5 million RMB are excluded in this survey due to the limit of time and research methods.



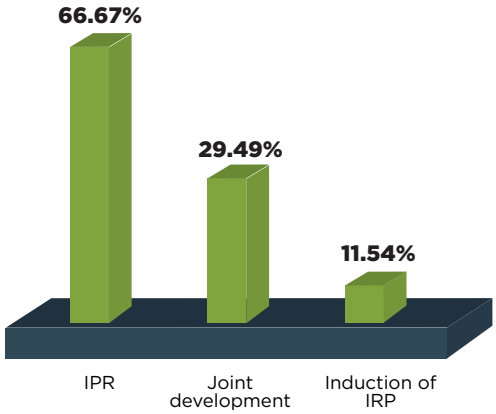
Pic 9: Distribution of number of employees in companies fulfilling the questionnaire



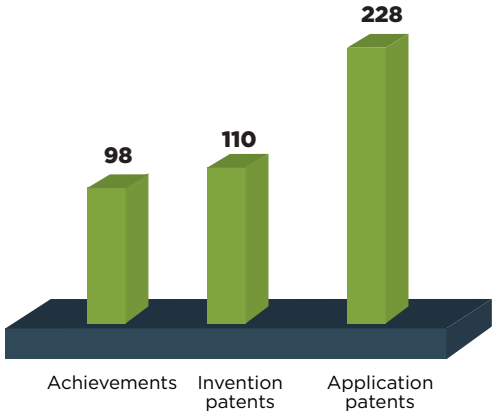
Pic 10: Distribution of revenues of companies fulfilling the questionnaire

2.3 TECHNOLOGY

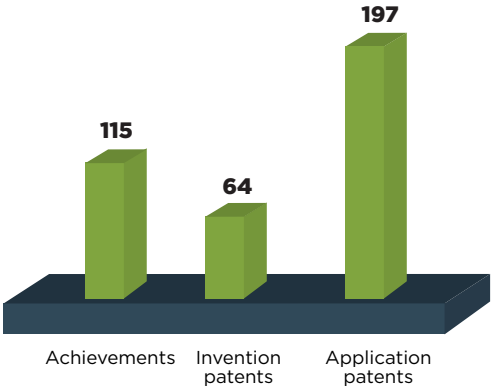
Most employees in charge of the research and development of technologies are senior technicians with rich practical experience. A few of them own Master degree or above. As the questionnaire shows, 21.8% of the companies have at fewer than 3 employees with Doctor degree, 34.6% of the companies have at fewer than 4 employees with Master degree, and at least 50% of the companies hire engineers with senior titles.



Pic 11: Intellectual properties sources of companies



Pic 12: Achievements and patents of methanol fuel



Pic 13: Achievements and patents of methanol fuel equipment

2.4 MAIN BUSINESS

The methanol fuel industry has long industrial chains, with companies of different main business. Most companies in this survey are major methanol fuel and equipment producers and sellers. In the questionnaire, 49 companies work on fuel production and sales, and 19 companies on equipment production and sales. Besides, there are 15 companies related to methanol fuel reserve and transfer.

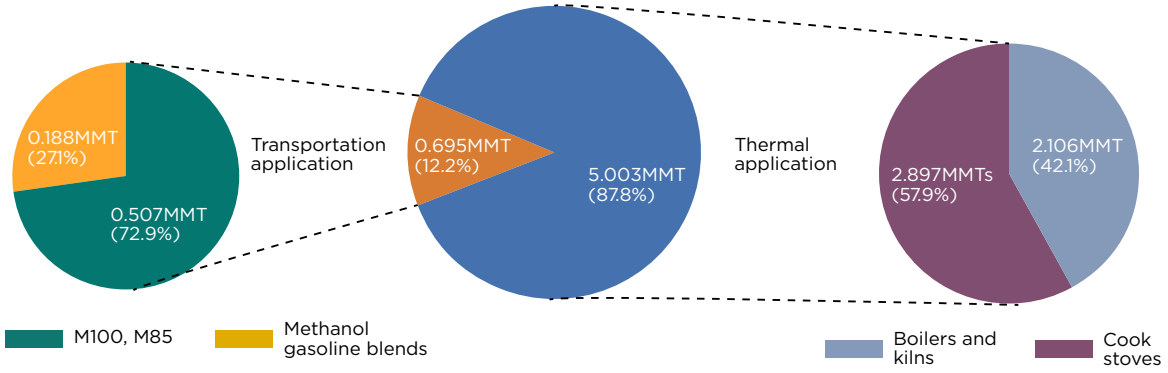
2.5 SUPPLIERS AND CUSTOMERS CHOICE

Long distance transportation will lower the economic efficiency of companies. Meanwhile, strict chemical transportation regulations will further push up the cost, and so weaken the advantage in price. As the service offered to retailer customers is trivial and personalized, companies should be close to the customers to maintain high quality service and satisfy customers' demands. In this case, companies in this industry are usually close to both suppliers and consumers. The survey also testifies this result. Shanxi and Shaanxi are both among the top 5 of provinces with greatest installed methanol production capacity and the top 2 provinces with largest methanol consumption in China in 2019. Companies indicate that the main reasons customers choose methanol fuel are low cost, profitable, safety and considerate service. In conclusion, close to both raw materials and target market can cut cost, reduce risks and provide high quality service.

3. MARKET OVERVIEW IN 2019

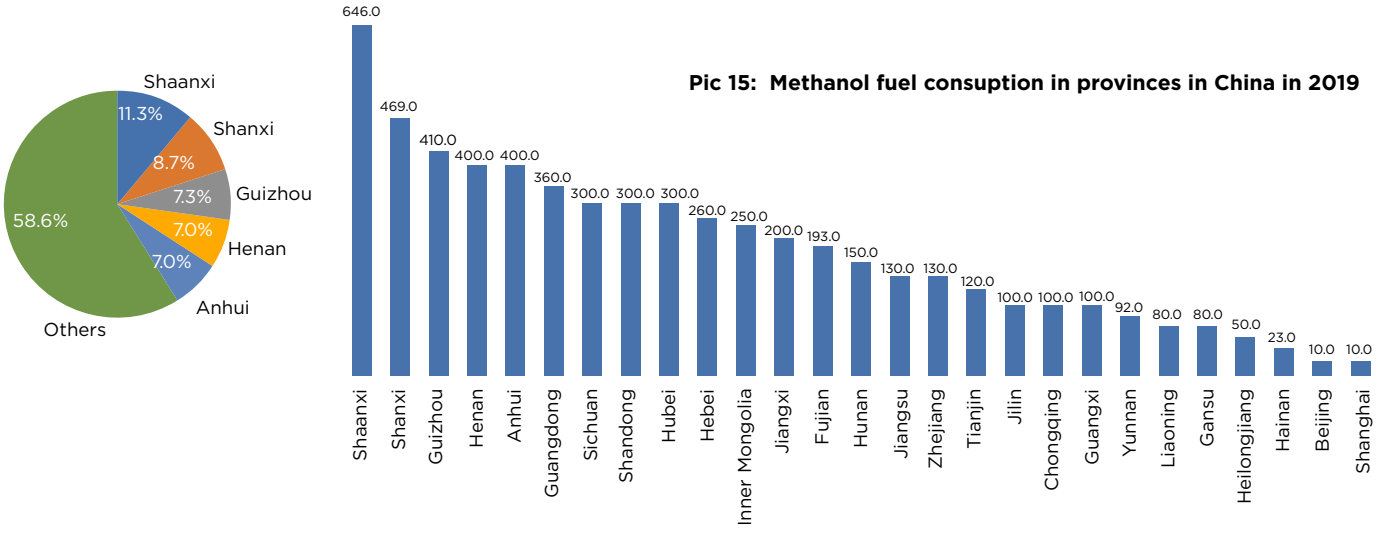
3.1 APPLICATION MARKET DISTRIBUTION AND CHARACTERISTICS

As the survey shows, methanol fuel is primarily applied in transportation application and thermal application in China. Transportation fuel includes methanol vehicle fuel M100, M85 and methanol gasoline blending, as well as marine fuel, fuel-cell and other fledgling applications which are still in development. Thermal application includes boilers, kilns, and cook stoves. In 2019, the total consumption of methanol fuel in China reached 5.698 MMTs, accounting for 7.1 % of total methanol consumption in 2019 in China. The consumption of methanol fuel in transportation accounted for 12.2% of this demand, as well as the consumption of in thermal application accounted for 87.8% of the overall consumption of methanol fuel in China.

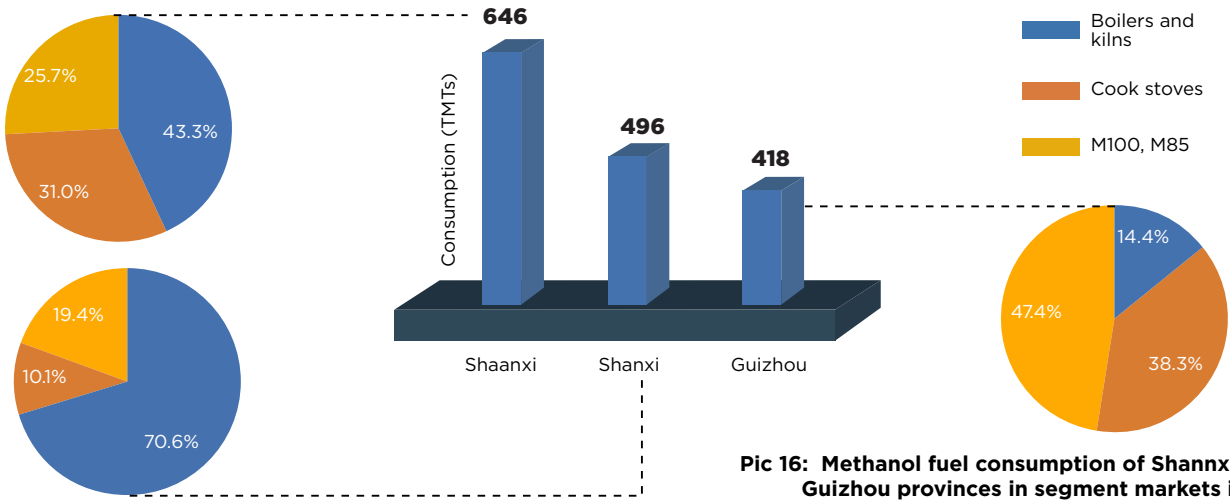


Pic 14: Methanol fuel consuption in China in 2019

In 2019, Shaanxi, Shanxi, Guizhou, Henan and Anhui provinces were the dominant market for methanol fuel, accounting for 41.4% of total consumption. But the specific applications of methanol fuel in these provinces are slightly different. In Shaanxi and Shanxi, methanol fuel is mainly used for boilers, kilns, and cook stoves. In particular, these applications in Shanxi reached up to 70.6% of the total provincial methanol fuel consumption. Meanwhile, Guiyang is at the leading position of transportation fuel application, especially M100 methanol fuel.



Pic 15: Methanol fuel consuption in provinces in China in 2019



Pic 16: Methanol fuel consumption of Shannxi, Shanxi and Guizhou provinces in segment markets in 2019

3.2 TRANSPORTATION APPLICATION OVERVIEW IN 2019

In 2019, M100 methanol fuel had a rapid development in some specific regions, with the total amount of 19,401 MFVs in China by the end of the year. The total consumption of all transportation fuel (gasoline blending, M100 and M85 methanol fuel) reached to 0.695 MMT, accounting for 12.2% of methanol fuel demand.

In 2019, as used in retrofitted vehicles using high percentage methanol fuel and certified methanol fueled vehicles, the consumption of M100 and M85 methanol fuel reached 0.507 MMT, accounting for 72.9% of total transportation fuel consumption. Benefitting from the policy of "Guidance of Developing Methanol Vehicles Applications in Some Parts of China"[1] adopted in March 2019, MFVs in some specific areas such as Xi'an and Guiyang city have been rapidly put into mass production and commercial application stage. With the follow-up policies, methanol fueling stations and other infrastructure construction will be improved. Methanol vehicle fuel market is expected to be the most potential incremental market. In 2019, the consumption of methanol gasoline blending, including M15, M20 and M25, was 0.188 MMT, accounting for 27.1% of total transportation fuel consumption in China.

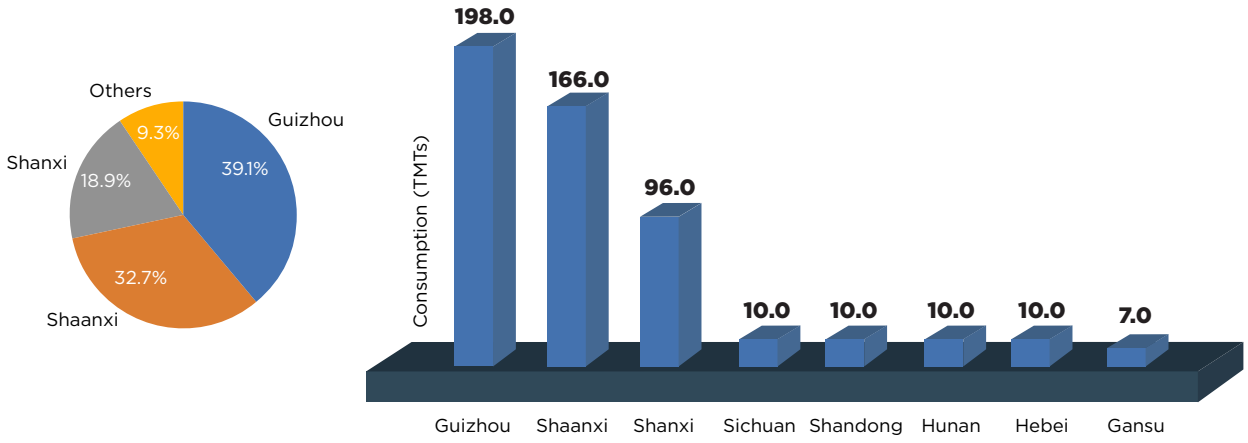
According to consumption tax policy of methanol gasoline blending from State Taxation Administration and disapproval of methanol gasoline blending by the central government, the development of methanol gasoline blending pilot projects is nearly suspended, causing dramatical decrease in sales since 2014.

It is noteworthy that the consumption of methanol in three cases is hard to be counted. First, because some gasoline fueling stations add low percentage methanol into gasoline without public notification; second, as some companies sell methanol gasoline blends in the name of motor detergents, denaturants or energizers; and third, with some companies directly selling methanol gasoline blends in small packages like plastic bottles to the customers.

Pic 17: M100, M85 comsumption of provinces in China in 2019

Guizhou, Shaanxi, and Shanxi consumed the most M100 and M85 methanol fuel, which reached to 0.460 MMT altogether, accounting for 66.2% of overall consumption in transportation, and 90.7% of M100 and M85 consumption in China.

From this survey, the consumption of methanol gasoline blending was 0.188 MMT in 2019, mainly distributed in Yunnan, Shanxi, Hebei and Zhejiang provinces.



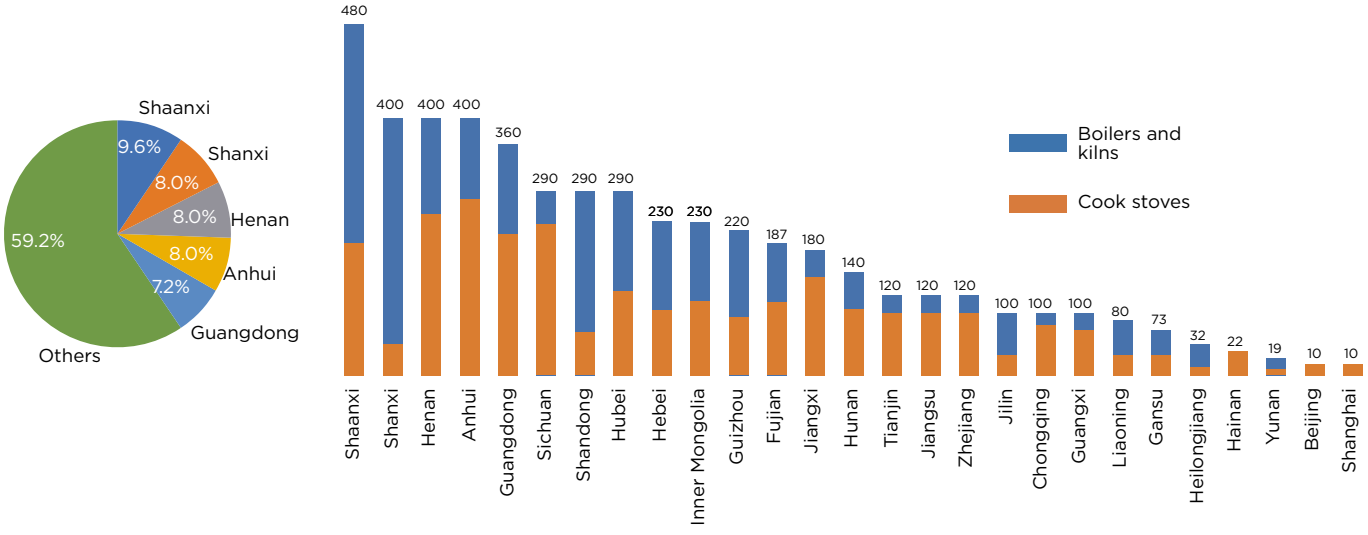
Pic 18: M100, M85 methanol comsumption of provinces in China in 2019

3.3 THERMAL APPLICATION OVERVIEW IN 2019

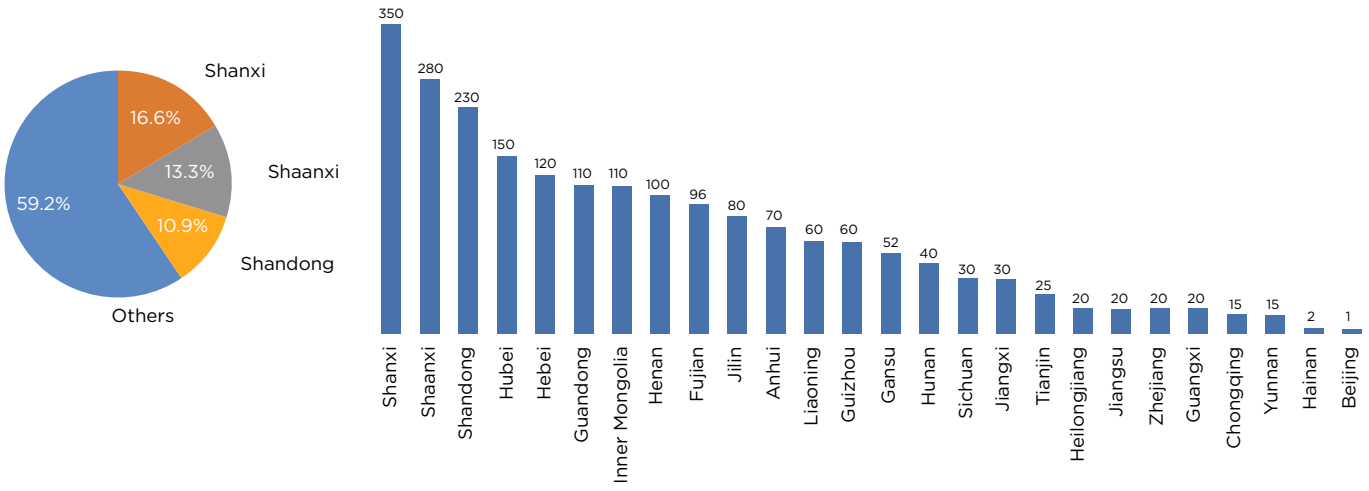
The largest methanol fuel segment in China is for thermal applications, namely boilers, kilns, and cook stoves. Its consumption reached 5.003 MMTs in 2019, accounting for 87.8% of total consumption of methanol fuel. The consumption of methanol fuel in cook stoves occupied the largest proportion, with consumption of 2.897 MMTs, accounting for 57.9% of consumption in thermal application and the rest is mainly used in boilers and kilns, with consumption of 2.106 MMTs. Since 2018, the central government and local governments have issued several standards and regulations for methanol boilers and its methanol fuel. At the same time, cities like Dalian and Wuhan also introduce local standards and regulations for the application of methanol fuel in cook stoves, showing that more local governments have recognized methanol.

Shaanxi, Shanxi, Henan, Anhui and Guangdong provinces are the places where methanol fuel gains most popularity and is widely used in boilers, kilns, and cook stoves. The consumption of these five provinces made up 40.8% of the overall consumption in thermal application in China. Shanxi province prefers to use methanol fuel in boilers and kilns, while Henan, Anhui and Guangdong prefer the application of cook stoves. In 2019, Shanxi, Shaanxi and Shandong each consumed over 0.2 MMT of methanol fuel in boilers and kilns on average. They have consumed 0.860 MMT in total, accounting for 40.8% of the overall methanol fuel consumption in boilers and kilns across the whole country. Among provinces of Anhui, Henan, Sichuan. Guangdong and Shaanxi, each consumed over 0.200 MMT of methanol fuel in cook stoves. These five provinces consumed 0.190 MMT in total, accounting for 46.3% of total methanol fuel consumption in cook stoves.

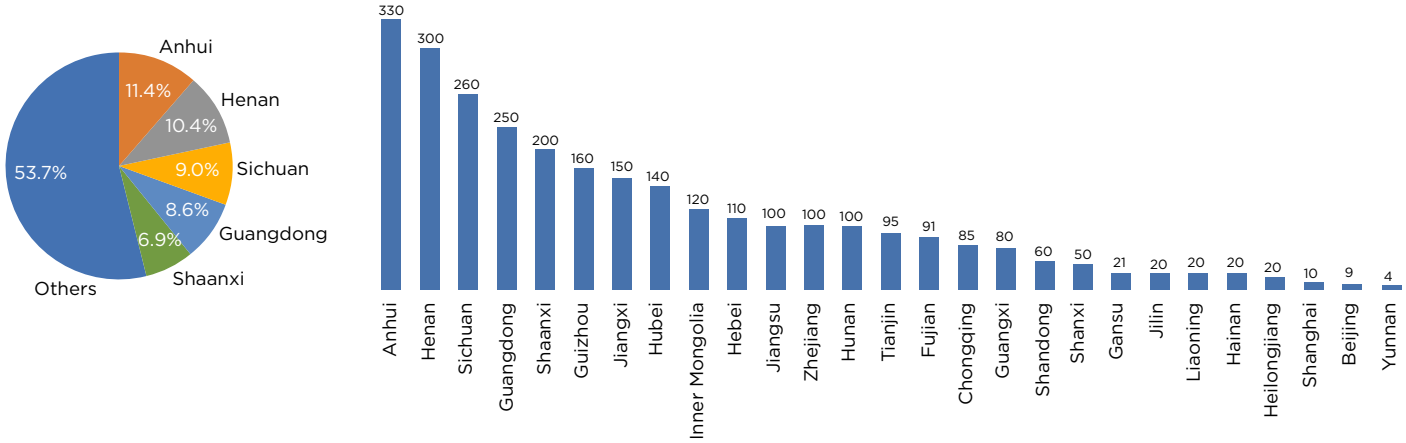
Several companies achieved notable sales performance of methanol fuel in 2019. According to the survey, in 2019, Shanxi Jiaxin Energy & Chemical Industry Co.,Ltd sold 21,000 metric tons (thousand metric tons or TMTs) methanol fuel, including 16 TMTs for heating, 2 TMT for civilian use, and 3 TMTs for vehicles. Shanxi Yuneng Energy-Saving Environmental Protection Equipment Manufacture Co., Ltd sold 14 TMTs for heating. Anhui Shengbao New Energy Technology Co., Ltd sold most methanol fuel in cook stove, the amount of which reached 5 TMTs. Fujian Dawei Energy Co., Ltd retrofitted most boilers and kilns to be suitable for methanol fuel, consuming 23 TMTs methanol fuel in total in 2019.



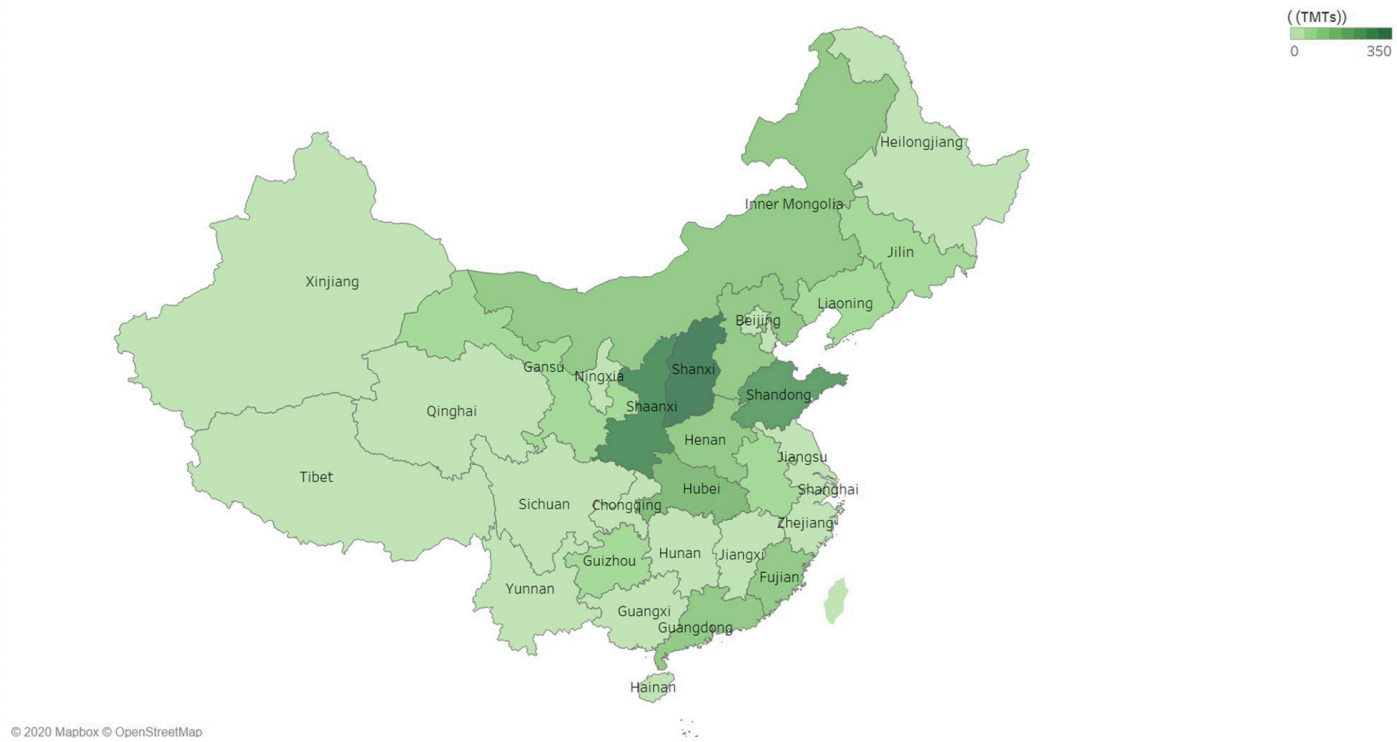
Pic 19: Consumption of methanol fuel for thermal application of provinces in China in 2019



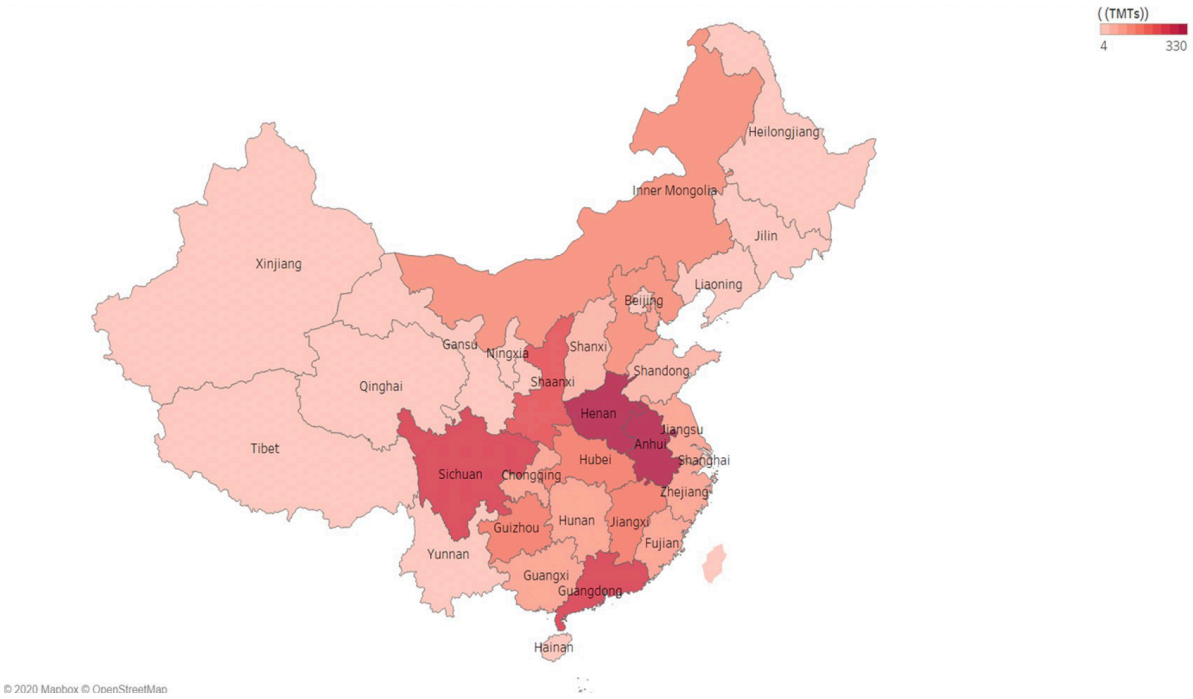
Pic 20: Consumption of methanol fuel in boilers and kilns of provinces in China in 2019



Pic 21: Consumption of methanol fuel in cook stoves of provinces in China in 2019



Pic 22: Map of consumption of methanol fuel in boilers and kilns in China in 2019



Pic 23: Map of consumption of methanol fuel in cook stoves in China in 2019

4. APPLICATION ANALYSIS

4.1 APPLICATION ANALYSIS OF HIGH PERCENTAGE METHANOL FUEL IN TRANSPORTATION

As a clean fuel in transportation, methanol fuel can be used in equipment such as internal combustion engines, fuel cells, with applications like vehicles and vessels. This survey mainly focuses on the high percentage methanol fuel M100, M85, and methanol gasoline blending, as the most widely consumed in the market to replace gasoline and diesel. The consumption of methanol fuel in transportation consumption reached 0.695 MMT in 2019.`

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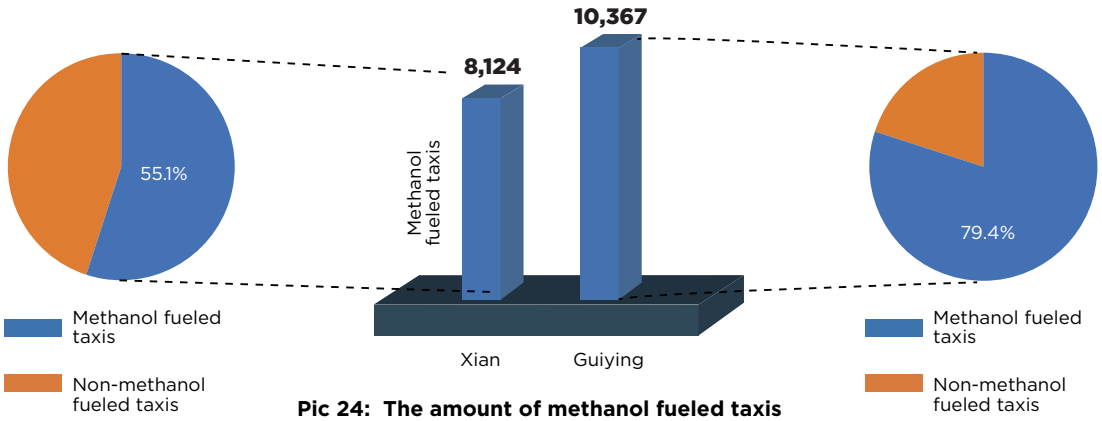
According to the statistic from National Development and Reform Commission, China consumed 329.61 MMTs refined oil in 2019 [14]. Oil consumption is expected to be on a steady rise because of the increasing number of vehicles on the road. The latest population in China is nearly 1.4 billion, and annual average income of just over 10,000 dollars[1]. The number of vehicles per capita in China is still much smaller than the other countries with similar GDP. On-line shopping has rapidly and wildly expended from urban to rural, which promotes the boost of diesel trucks. The consistently increasing vehicles will lead to serious environmental problems. As a result, clean fuel is largely demanded in the market. As an environmentally friendly, safe, and reliable fuel, methanol fuel has been verified by large-scale applications, and has obtained special attention from the government and been generally accepted by the market.

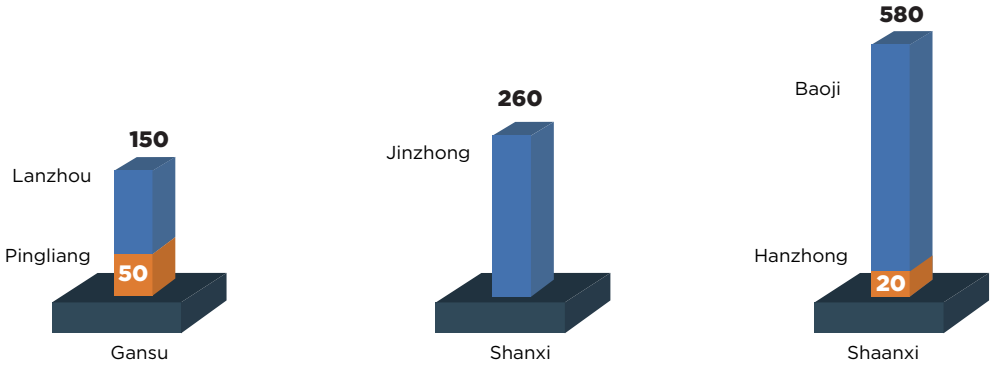
High percentage methanol fuel includes M85 and M100. Strictly speaking, M85 is defined as M85 vehicle-used methanol gasoline in the Chinese standard. M100 only contains neat methanol and trace amounts of additives. Both M85 and M100 are applied in after-market retrofitted vehicles or certified OEM dedicated methanol vehicles. In 2019, the consumption of high percentage methanol fuel reached 0.507 MMT in China.

In the early age of development, high percentage methanol M100 and M85 were mainly used in retrofitted vehicles applied in some provinces like Shanxi and Shaanxi. According to the survey, there are currently about 10,000 retrofitted vehicles in China, mainly distributed in Shanxi, Shaanxi, Yunnan, Hunan, Sichuan, Shandong and Jiangxi provinces. M100 is mainly applied in certified dedicated methanol vehicles which have obtained official certificate, with types of passenger vehicles, commercial vehicles, and engineering vehicles, using M100 or M100 and diesel dual fuel. Chinese domestic automotive OEM of M100 vehicles includes Geely Auto with passenger vehicles, as well as Yu Tong Buses, with M100 heavy duty engines produced by FAW JY Engine Co. “Guidance of Developing Methanol Vehicles Applications in Some Parts of China”[1] launches pilot projects of certified dedicated methanol vehicles in Shanxi, Shaanxi, Guizhou and Gansu provinces to speed up the development of M100 vehicles. The guideline highlights the project development in areas whose energy resource and practical experience is suitable for methanol fuel. The guideline also calls for improving methanol fuel producing and refueling system, MFVs standard system, and policies of applications. This guideline represents that the compliance and legitimacy of certified dedicated M100 vehicles have been recognized by the central government and large-scale commercial application can be expected. Influenced by central policies and pilot projects, several regions have issued local policies to push forward the development in local areas.

Taxi market naturally requires an environmentally friendly, clean and affordable fuel, not only because it has been mandated to save energy and reduce emission by the government, but also due to profit demands through saving fuel cost. Natural gas, electricity and methanol fuel are now the most popular clean fuels in the Chinese market. Because of the decrease in subsidies, high maintenance fees, limited endurance mileage, long waiting time for refueling due to the infrastructure, etc., taxis fueled by natural gas have gradually gone out of use. “The industry structure adjustment contents ”[15] has moved taxi natural gas retrofitting into obsolete stage in its 2019 update. Battery electric taxis and methanol fueled taxis will be the two major competitors in the market and their development in different districts usually depends on local polices. As the pic 26 shows, by 2019, the population of methanol fueled taxis in Xi’an is 8,124, accounting for 55.1% of total amount of taxies in Xi’an, while the statistic in Guiyang reaches to 13,052, accounting for 79% of total amount of taxis in Guiyang[16][17]. Apart from Xi’an city, the population of methanol fuel taxis in other cities in Shaanxi province is as shown in pic27. Gansu province has released an action plan in 2019, which plans to gradually deploy 10,000 methanol taxis totally in the market during 2019-2025. Until the end of 2019, Lanzhou and Pingliang city in Gansu province had put 150 and 50 methanol taxis in the local market separately, as shown in pic 27.[18]



Pic 24: The amount of methanol fueled taxis in Xi'an and Guiyang city in 2019 [16][17]



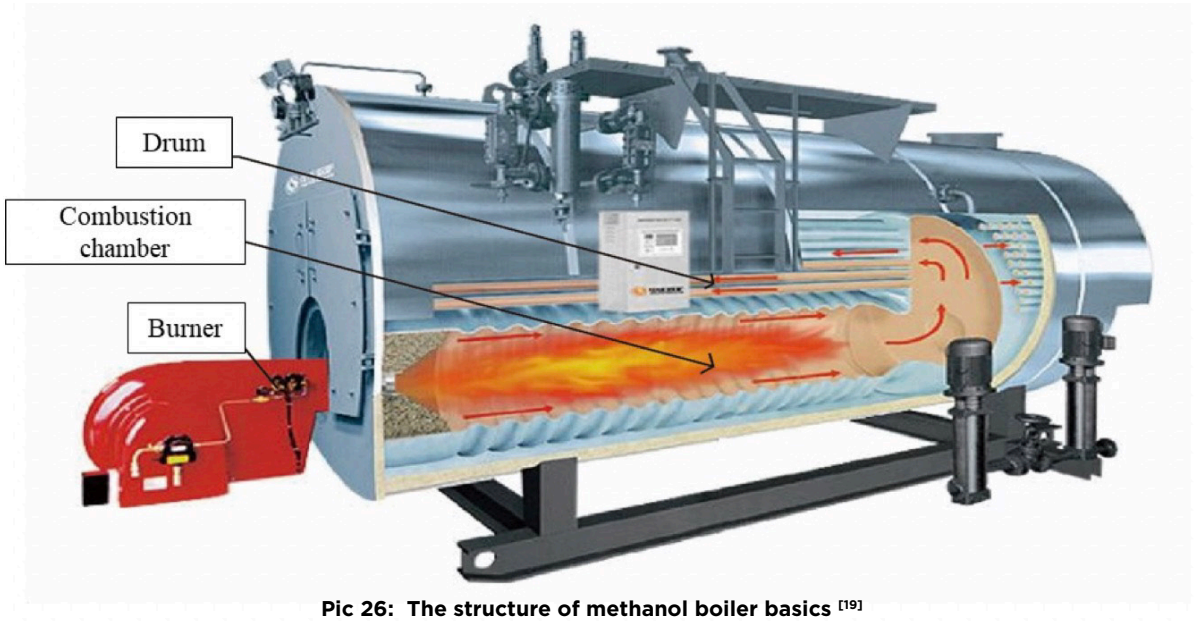
Pic 25: The amount of methanol fueled taxis in cities of Shaanxi, Shanxi and Gansu provinces besides Xi'am city in 2019

Furthermore, trucks -- especially heavy-duty trucks -- are a market for methanol fuel in the future with great potential. The pollution caused by the emissions of trucks has come under criticism for years. The central government has been upgrading the quality standard of truck fuel and calling for clean fuel substitution to diesel fuel. Shaanxi Heavy Duty Automobile Co., LTD, Chinese Heavy Truck Co., LTD and Hualing Xingma Automobile Co., LTD have already developed methanol/diesel dual fuel heavy duty trucks. In 2019, Geely Auto Group also launched M100 trucks with price from 353,000 RMB, which is only around 5% higher than traditional diesel trucks. In the meanwhile, battery electric trucks are reported from 1 million RMB. Geely also promises the endurance mileage of its M100 trucks can achieve 1500 kilometers with standard fueling.

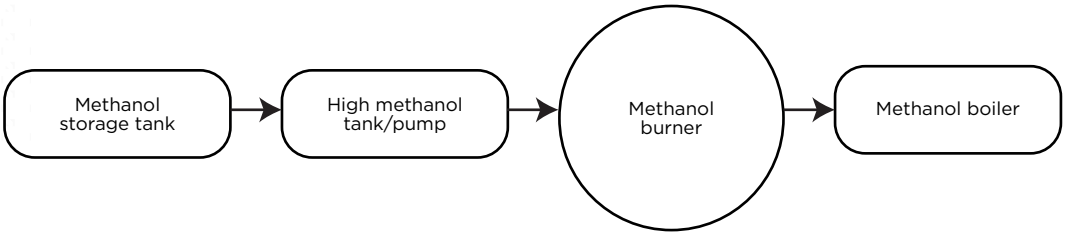
"Guidance of Developing Methanol Vehicles Applications in Some Parts of China"[1] strictly forbade the blending of methanol in normal gasoline, and also prohibited the retrofit of traditional vehicles into methanol fuel or methanol gasoline blending vehicles. As a result, the consumption of methanol fuel in transportation now mostly depends on the amount of certified methanol fueled vehicles entering the market.

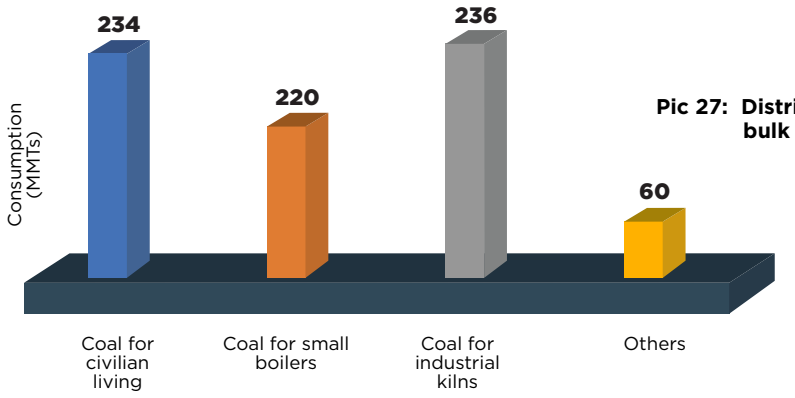
4.2 APPLICATION ANALYSIS OF METHANOL FUEL IN BOILERS

Boilers are widely used in rural households in Northern China where bulk coal has been the main fuel source in the past, leading to serious environmental problems. According to "A survey report of governance of bulk coal in China 2017", the consumption of bulk coal in 2015, in China reached 0.75 billion tons[20]. The details are shown in the following figure.



Pic 26: The structure of methanol boiler basics [19]





Pic 27: Distribution of consumption bulk coal in China in 2017 [20]

As policies now require, civilian boilers have been gradually retrofitted with updated emission treatment technology or to better adapt themselves to the use of clean fuel. In the "Publication Of Winter Heating Plan In Northern China(2017-2020)"[21], the central government directed that by 2021, clean heating rate in northern China shall reach 70%, and 0.15 billion tons bulk coal should be replaced. Furthermore, the Chinese government has also circled "2+26" core cities' around the capital Beijing to be fully covered by clean heating, and all coal boilers under 35 steam tons should be dismantled. The area between urban and rural district should reach 80% clean heating rate, and coal boilers under 20 steam tons should be dismantled. The rural district should reach 60% clean heating rate.

"Substitution of all coal with natural gas" was in full swing in Northern China. But in practical implementation, the lagging of natural gas infrastructure and the shortage of natural gas supply led to the failure of this project. In 2019, the National Energy Administration issues "Circular on problems during clean heating methods such as 'substitution of coal with gas' and 'substitution of coal with electricity'"[22], which clarifies that "substitution of all coal with natural gas" is not advisable, and on the contrary the circular advocates the development a variety of clean heating energy depending on each local situation. Methanol fuel benefits from this circular and has seen a rapid development in some regions. Currently, companies in China have already developed 35 steam tons of methanol fuel burners and large steam tons methanol fuel and natural gas blending burners. Meanwhile, wall-hung methanol furnaces have appeared in the market in recent years. Heating from these units can cover an area of 2400 square meters at most. These heating systems can be widely used in such places as family residences, offices, and small hotels. The advantages of wall-hung methanol boilers are significant, such as easy installation, low capital cost and maintenance fees, quick temperature rising, etc.. Some local governments have introduced financial subsidies for household furnaces to encourage people to install the methanol fuel furnaces instead of the bulk coal furnaces.

In 2019, Shanxi Province consumed the most methanol fuel with 0.350 MMT for the application of boilers and kilns. This market has primarily benefited from effective and practical local policies, which facilitates the energy structure transformation, especially through the aspects of industrial standards, industrial planning, policy preference, and financial incentives.

In order to standardize the market, maintain the safety in use, and to guarantee the steady development of methanol fuel industry, all levels of associations and institutions will need to gradually elaborate on the standards of methanol fuel boilers.

The national standard "Specification for liquid fuels and gaseous fuels burners of boilers", sets the rules of methanol fuel burner types and compositions, and the requirements of design, production, examination, installing, adjustment, usage and maintenance. This standard has regulated the design and manufacture of burners and methanol fuel boiler markets, and reduced emissions due to unqualified methanol-fueled boilers. With the guidance of CAAEFA and support from Methanex Corporation and other institutes, the "Specification for alcohol-based fuel reserve and liquid equipment", and "Standard for boiler alcohol-based fuel" were formulated and published in 2018. These standards have set the cannons of methanol fuel properties, reserve and usage.

CASE STUDY 1: METHANOL CLEAN FUEL APPLIED IN HOUSEHOLD FURNACES IN JINZHONG CITY

Jinzhong city is located in Shanxi province, and is rich in coal. Bulk coal is widely used by local citizens because of its low cost and easy availability. It is not surprising that Jinzhong city is listed as one of the most seriously polluted areas in China. The local government is devoted to pushing forward the development of the replacement of coal with methanol fuel.

The emissions generated by bulk coal burning for heat is a remarkable factor of pollution in the winter. In order to solve this problem, the local government initiated a pilot project of replacing coal with methanol fuel in 2018. Institutes supported by Finance Bureau in Yuci district are the experimental places adopting methanol fuel boilers. Yuci totally invested around 10 million RMB, and retrofitted 93 boilers, covering 200,000 square meters of heat area.

It is reported that the retrofitted methanol fuel boilers have effectively improved the environment, with reduction of 12 TMTs coal, 385 tons of sulfur dioxides, 350 tons of soot (PM) and 36 tons of nitrogen oxides. Since then the replacement of coal with methanol in boilers has gradually been applied in many more places which are not covered by natural gas supply infrastructure in Yuci district. Local government supplies subsidies and requires related companies to supply methanol fuel by a door-to-door delivery service, methanol fuel reserve service and other preference methods.

As a result, this project has been popular with local citizens. This project has brought a significant result for urban air quality in Jinzhong which has suffered from severe air pollution. China measures air quality on a scale from 1 to 3 representing good to poor days, and in 2018 the city recorded fewer level three days with 210 days at level 2, versus only 183 days in 2017, which is the most remarkable improvement in the whole province.[25]

Pic 28: Retrofitted methanol fuel boiler in Jinzhong city

4.3 APPLICATION ANALYSIS OF METHANO FUEL IN KILNS

Kilns are used to take advantage of thermal energy generated by solid, liquid or gas fuel during burning, to process products by smelting, calcining, firing, fusing and others. Kilns are widely used in steel, coking, metallurgical, chemical, petrochemical industry, etc.. Subject to the limited energy structure, kilns in China have been fueled with bulk coal, petroleum coke, residual oil, heavy oil as main fuel until the end of last century. As China's energy consumption structure has changed since 2000, traditional kilns are being retrofitted with emission treatment technology, adapted to the use of clean fuel or just dismantled.

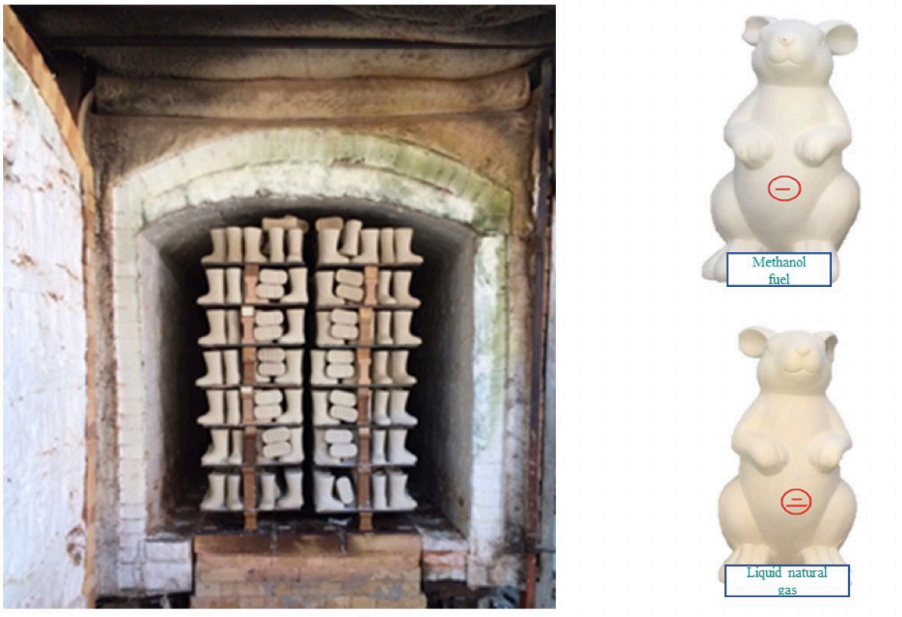
In 2019, four Ministries jointly release the "Comprehensive Management Schemes for Air Pollution of Industrial Kiln"[23], which directed that 20% of particulate matter PM 2.5 in and around Beijing-Tianjin-Hebei region is generated by emissions from kilns. A large number kilns in China are antiquated production facilities with high energy consumption and serious pollution, especially in glass, refractory, ceramic, casting, and secondary non-ferrous metals industries. Local governments also have released policies to adopt classification management of kilns, and gradually complete the retrofitting and update work, or dismantling of kilns.

In light of the energy structure and the features of boilers and kilns in China, replacing traditional fuels with an alternative clean fuel is a suitable choice. Sorted by the production mode, kilns in China are divided into continuously producing type, including pushing tunnel kiln, roller hearth tunnel kiln, walking-beam kiln, hover kiln, up-draft kiln, etc., and discontinuously producing type, including shuttle kiln, drawer kiln, shaft kiln, bell type kiln, down-draft kiln, etc.. Sorted by energy source, kilns in China are divided into firewood kiln, coal kiln, gas kilns, alcohol-based fuel kilns, electrical kilns, solar energy kilns, etc..[24]. Firewood kiln and coal kiln are gradually retrofitted to use clean energy or dismantled. Outdated up-draft kiln and down-draft kiln, whose fuel or emission fails to meet the standard, are listed into dismantled program in "The industrial structure adjustment contents 2019"[15]. As a result, there are urgent and huge demands for clean energy retrofitting of kilns in China.

Different from the replacement of coal with natural gas and electricity which needs a whole set of high-capacity transformer, gas pipeline and other requirements, methanol fuel applied in industrial kilns is much easier, only requiring the retrofitting of the equipment itself with low cost.

Furthermore, compared to 45% foreign dependency of natural gas, methanol has high self-sufficient rate in China. In 2019, domestic methanol production in China was 69.9 MMTs, with installed production capacity of methanol at 89.9 MMTs and it is expected to be 100 MMTs by the end of 2025. In conclusion, the abundant capacity of methanol makes it possible to be the main alternative clean fuel in boilers and kilns. Methanol fuel is an ideal distributed clean energy.

Last but not least, due to clean exhaust gas, for some specific sintering products, kilns with methanol fuel make better quality. The left of the following picture is a methanol fuel kiln retrofitted by Fujian Dawei Energy Co., Ltd, and the top of right is the ceramic product sintered by it. Compared to the bottom one which is sintered by the kiln before retrofitting with liquid natural gas, it is obviously that methanol fuel kiln makes ceramic products brighter color, with 3-5 degree higher[26]



Pic 29: A ceramic kiln of methanol fuel and its products [26][27]

4.4 APPLICATION ANALYSIS OF METHANOL FUEL IN COOK STOVES

In 2019, methanol fuel in cook stoves occupied the largest methanol fuel market, with consumption of 2.89 MMTs, accounting for 50.8% of total consumption. The consumption in Anhui province was found to be the largest in China, achieving 0.330 MMT. The features of the companies in the methanol cook stoves industry can be described as small scale, short service radius, and long service term. Most of the companies not only sell and maintain methanol fuel cook stoves, they also supply methanol fuel with door-to-door delivery and following supplement. Methanol fuel cook stoves are popular in rural areas which are not suitable for natural gas pipeline construction, restaurants, canteen in companies, schools, and similar large industrial kitchens. In China, methanol fuel used in cook stoves is usually called “alcohol-based fuel”.

The research and application of methanol fuel cook stoves started in China in the 1990s. Standards of “Alcohol-based liquid fuel” and “Alcohol-based civilian fuel stoves” were published in 1996 and 1997. These two standards are still followed today. In practice, there is no uniformed regulations or policies for this application. In districts such as Shenzhen and Nanjing city, the local governments issued policies to ban the use of methanol cook stoves. However, areas such as Shaanxi, Shanxi, Gansu, and Anhui provinces, the local governments support the industry by taking the tactics of improving related local standards and promoting methanol fuel cook stoves. In 2018, the Gansu government pointed out at a news conference that through the replacement of coal with electricity, natural gas and methanol fuel, Gansu has completed retrofitting oil fume emission treatment over 30,000 restaurants. Recently, several local governments have developed beneficial policies and regulations for methanol cook stoves which will have far-reaching impacts in shaping the industry.

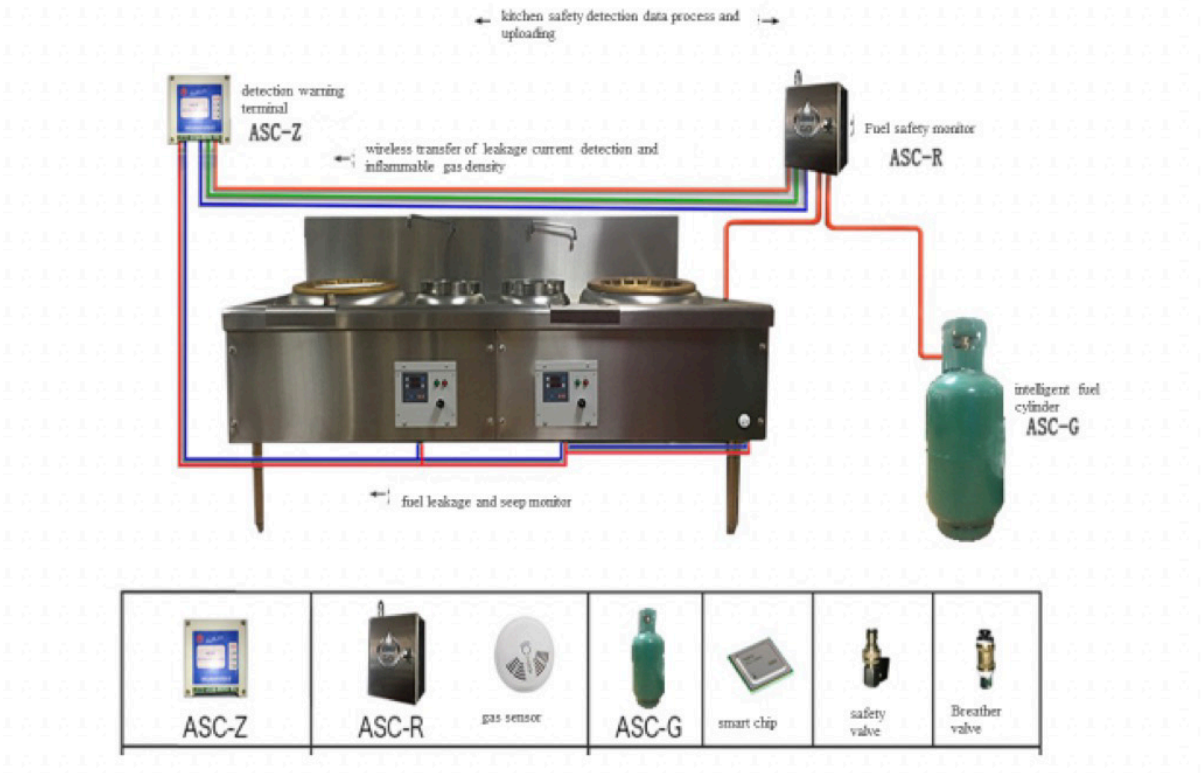
Different from natural gas which requires construction fees and pipelines, methanol fuel cook stoves are easy to install with low cost. Normally, methanol fuel fee is close to natural gas when used for cooking. As a result, application scenarios of methanol fueled cook stoves mainly places which serve a large amount of people per meal, and consume huge quantities of fuel each day, or rural places where clean fuel replacement is urgent but other clean fuel is not suitable, not available or too expensive. Methanol fueled cook stoves have a huge potential development in this niche market.

CASE STUDY 2: INTELLIGENT METHANOL FUELED COOK STOVES IN ANHUI SHENGBAO COMPANY

Anhui Shengbao is the biggest methanol fueled cook stoves producer in Hefei city. Its production base in Quanjiao was granted with “Safe Production license” from the local government.

Intelligent methanol fueled cook stoves from Shengbao are the industry benchmark for the market. The system includes methanol fuel safety monitory systems with international patent, electrical vaporizing burner, sensors for gas leak, electric leakage, temperature, voltage and so on. With the aid of big data and cloud computing, the information from individual customer stoves is fed back to the central control room of Shengbao through IOT so that the formation and transformation of potential hazards can be detected immediately. Meanwhile, users can also realize real-time monitoring and alarming through a mobile phone app. Plus, there is a GPS system inside the fuel storage tank and each tank has its own scan code, so that the related staff can locate tanks and trace them. This system also can distinguish whether the fuel filled is produced by Shengbao, effectively preventing the use of unqualified fuel. The whole transportation delivery process is also monitored though the intelligent system.

As a result, Shengbao is popular in Hefei city where the company has thousands of restaurants using its methanol fueled cook stoves. And Shengbao is planned to expand its market reach to other cities in Anhui province in the next few years[27].



Pic 30: Intelligent methanol fueled stoves in Anhui Shengbao company[28]

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