



# Methanol Fuel Blending In China

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Trinidad and Tobago Methanol Fuel Blending Forum  
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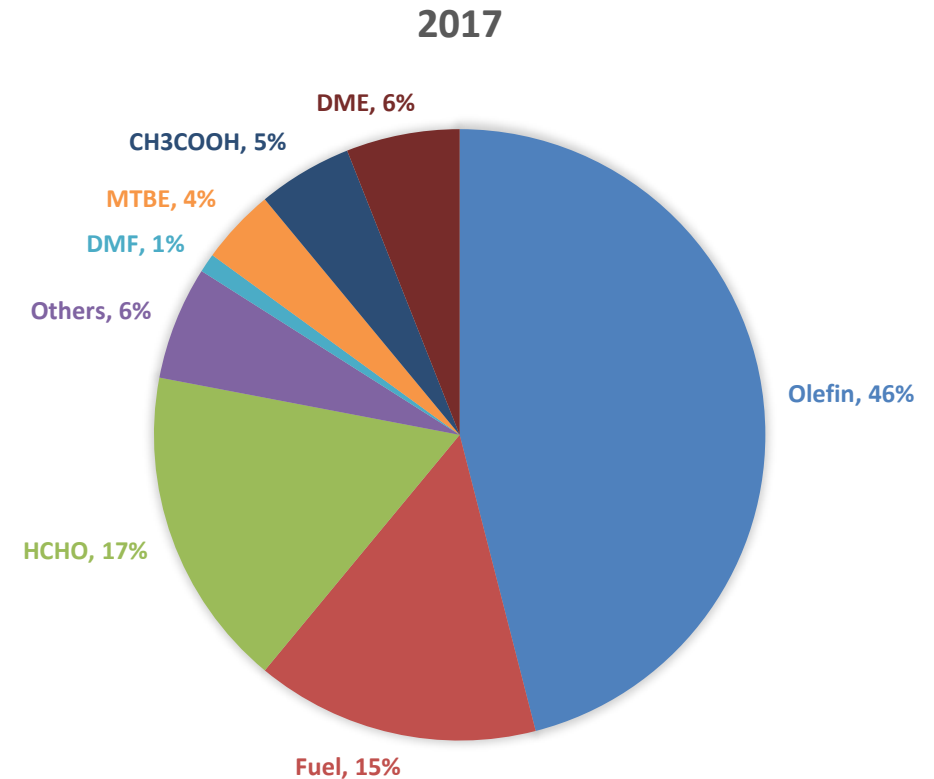
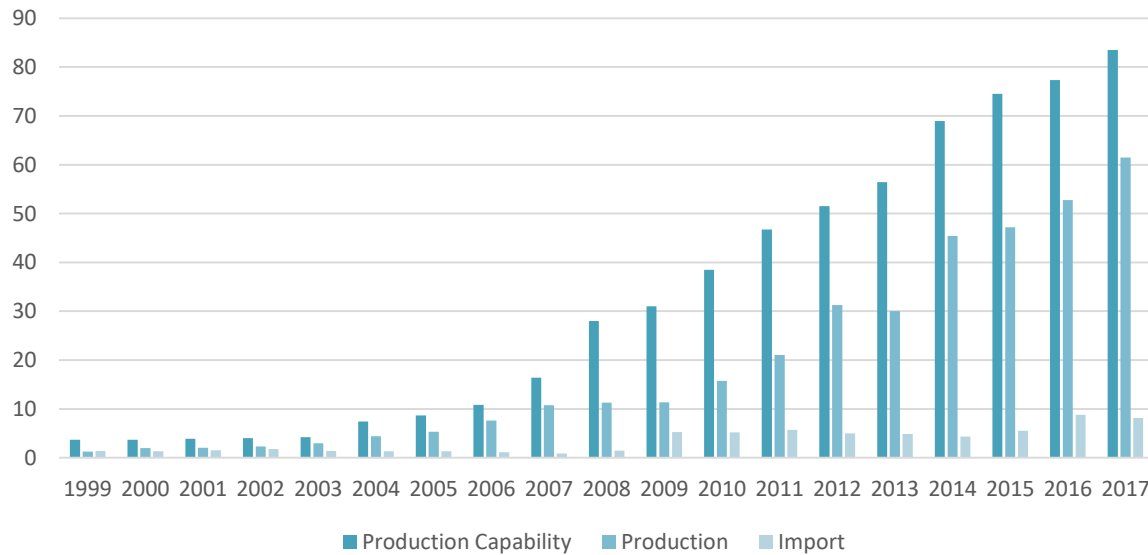
**01**

# Methanol Fuel Applications- China

# Methanol's Evolving Global Demand

## Methanol Demand vs Supply in 2017

Methanol Production/Import in China (mln tons)



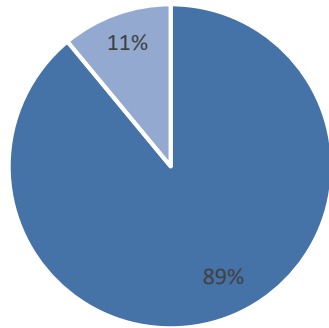
Source: CNFIA Statistics

# Fuel Application the Largest Downstream

- Methanol consumption increased to 69.5 MMTs in 2017
- Total Fuel Application (Direct Fuel, DME, MTBE) accounting for 25% of the total consumption in 2017
- Formaldehyde share dropped, MTBE share will be affected potential in 2020 when E10 promoted nationally.
- Methanol Direct Fuel in Industrial Boilers and Cookstoves increasingly contributed in the directive fuel blending
- Fuel blending is also suspected to contribute in “Others” in the official statistics

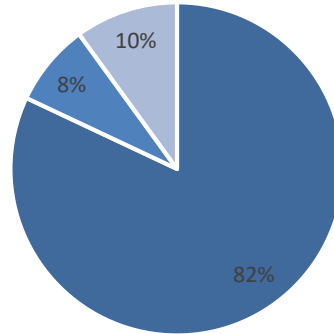
Source: CNFIA Statistics

# China Methanol Production and Energy Security



■ Dedicated ■ Ammonia Combined

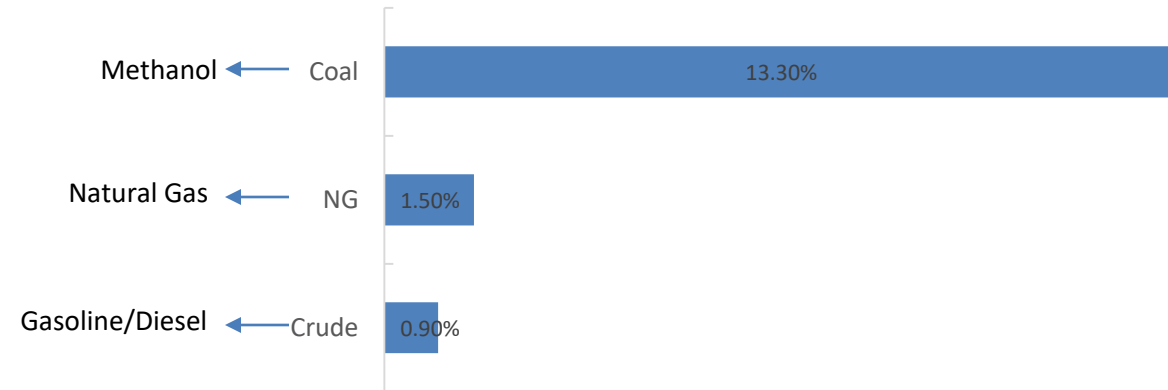
Source: CNFIA Statistics



■ Coal ■ NG ■ Coking Gas

- China methanol production capability: 83.5 MMTs, mainly dedicated coal to methanol projects
- New NG stock feed methanol project suspended, coking gas limited by steel industry
- Advanced coal gasification and world scale methanol production

China Domestic Energy Resources in Global Share



Source: BP analytical Statistics

- China: coal reserve rich country (115bln tons) with rare crude (2bln tons) and NG reserves
- Increasing concerns of energy security, mainly crude, over 70% overseas import
- methanol imports ~8 MMTs in recent years, in a similar assumption, China methanol overseas import only 11%
- China Vehicle Population in 2018: 240 mln, consuming 100 MMTs gasoline and 140 MMTs diesel

**02**

## Direct Fuel Blending (M15-M25)

# Methanol Gasoline/Methanol Vehicle in China

## M15-M25

- No Change on vehicle by blending low level methanol
- China uses M15  
*Estimated 7 million metric tons*
- *~75% of cars built by international automakers*

## Fuel and chemical Properties

- Octane
- Heat value
- Ignition/flame temperature
- RVP
- Burning speed
- Solubility between each other
- .....

## M85-M100

- Dedicated vehicles (e.g. Geely)
- Use of SI technologies in light duty vehicles
- Both SI and CI for heavy duty vehicles
- Few changes needed to existing vehicle technologies at low cost

# Methanol Gasoline-General Information

- China trailed M15 from 1980s
- First official promotion of M15 in Shanxi from 2002, late with Sinopec cooperation
- Shanxi's experience to other provinces in China, including Shannxi, Zhejiang, Guizhou, Gansu, ect.
- Methanol blended for methanol gasoline around 2.5 MMTs by CAAEFA official statistics in recent years
- Certain amount of methanol officially in regular gasoline





## CHINA EXPERIENCE-National Standards

### Fuel Based

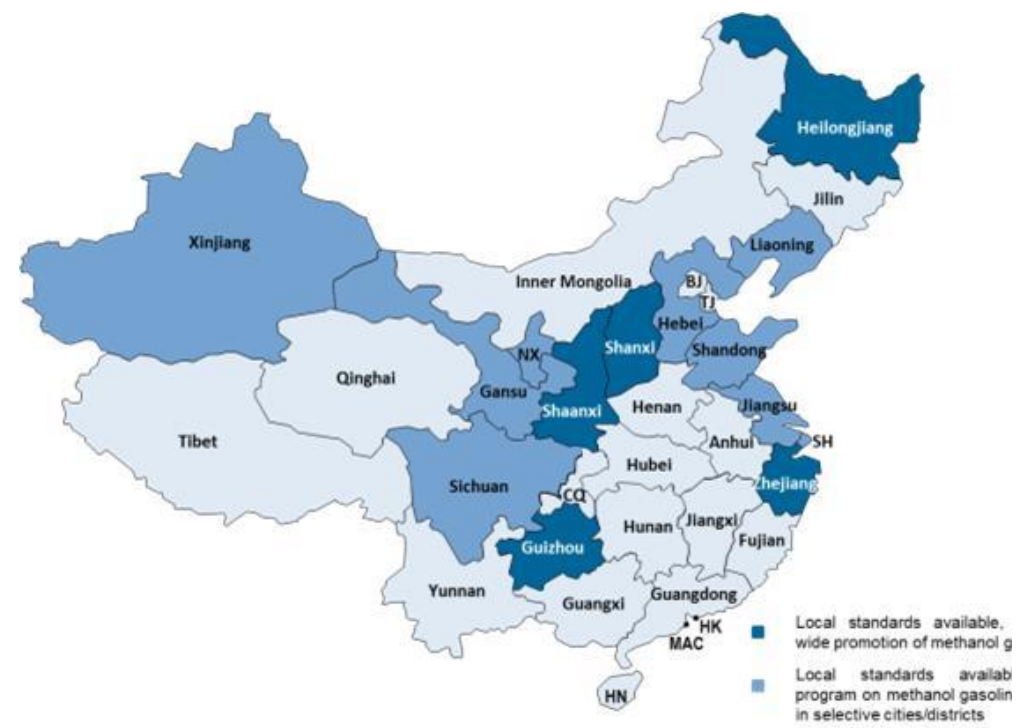
- The Additive of Methanol Gasoline for Vehicles
- Determination Method of Methanol Content in Methanol Gasoline for Motor Vehicles
- Methanol Gasoline (M85) for Motor Vehicles
- Fuel Methanol for Motor Vehicles
- Still on-hold: Methanol Gasoline (M15) for Motor Vehicles

Standard	No.	Implemented Since
<i>The Additive of Methanol Gasoline for Vehicles</i>	GB/T 34548-2017	2018
<i>Determination Method of Methanol Content in Methanol Gasoline for Motor Vehicles</i>	GB/T31776-2015	2015
<i>Methanol Gasoline (M85) for Motor Vehicles</i>	GB/T 23799-2009	2009
<i>Fuel Methanol for Motor Vehicles</i>	GB/T23510-2009	2009

### Infrastructure and Management Guideline by MIIT

- Same for both M15 and M100
- Construction of Methanol Fuel Fueling Stations
- Guidelines for Safety Operation of Methanol Fuel

CHINA EXPERIENCE-Local Standards



省份		地方甲醇汽油标准	生效时间
Province		Local Methanol Gasoline Standards	Implemented Since
甘肃	Gansu	M15 + M30	2009
贵州	Guizhou	M15	2010
河北	Hebei	M15 + M30	2010
黑龙江	Heilongjiang	M15	2005
江苏	Jiangsu	M45	2009
辽宁	Liaoning	M15	2006
陕西	Shaanxi	M15 + M25	2004
山东	Shandong	M15	2012
上海	Shanghai	M100	2013
陕西	Shanxi	M5, M15, M85 + M100	2008
四川	Sichuan	M10	2004
新疆	Xinjiang	M15 + M30	2007
浙江	Zhejiang	M15, M30 + M50	2009
宁夏	Ningxia	M15 + M30	2014

Local standards available, province-wide promotion of methanol gasoline

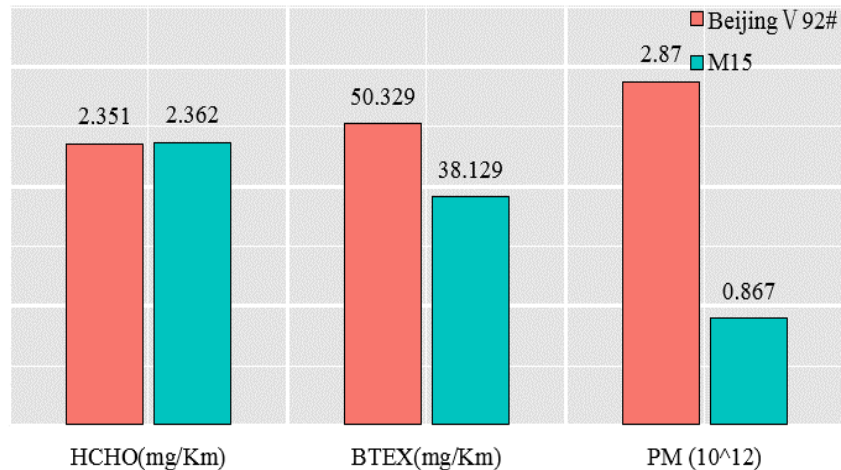
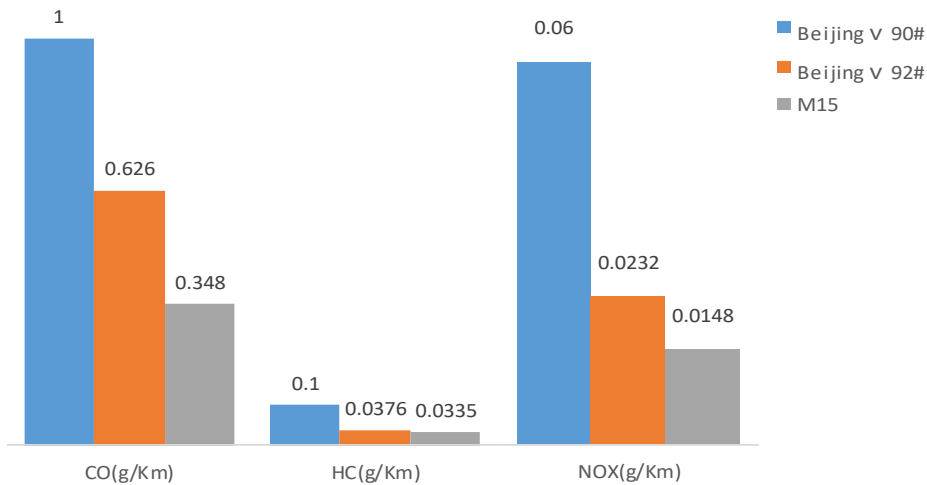
Local standards available, pilot program on methanol vehicles initiated in selective cities/districts

# Methanol Gasoline Infrastructure Achievements

- 50 methanol gasoline blending terminal centers completed/under construction in 15 different provinces
- Over 1.2 million metric tons (400 million gallons/1.5 billion liters) of annual methanol fuel blending capacity
- Total number of over 1200 refilling stations
- In 2013, 0.8 MMTs of M15 sold in Shanxi, accounting for 23% of the total gasoline market



# M15 Emission Tests in China



- M15 emission test in Beijing Institute of Technology (BIT)
- Conventional Emission:
- Methanol improving tailpipe emission of CO, HC and NOx
- For unconventional emissions:
- NO increase of HCHO by introducing methanol
- Significant reduction of BTEX and PM
- BTEX (benzene, ethylbenzene, toluene, xylene)
- PM major contributor to smog in cities and difficult to reduce, especially in numbers

# Other Technology Concerns on M15

## Metal Corrosion and nonmetal swelling

- Methanol corrosive to some metals, modern vehicles engineered to accommodate alcohol fuel like E10
- Proper corrosion inhibitor used in China
- Methanol small molecular structure swells the rubber and plastic components
- Modern vehicles can working with low level of alcohol gasoline
- China national standard of GB/T 24141 requiring rubber tubes in the fuel piping MUST accommodate oxygen-contained gasoline
- **High level methanol fuel like M100, must use swelling resistant technology**
- Swelling inhibitor may needed for old year model

Corrosion Test of a Chinese M15 Inhibitor under US SAEJ1747 Standard									
Testing plate			Red copper	Steel	Stainless Steel	Cast aluminum	Zinc	Tin	Brass
Weight loss per area (mg/cm <sup>2</sup> )	Surface unit	Max	0.061	0.041	0.013	0.067	0.272	0.044	0.039
		Min	0.000	-0.047	-0.012	0.014	0.102	0.000	0.015
		Average	0.026	-0.011	0.001	0.027	0.208	0.019	0.023
		US Standard Limits	0~0.070	-0.050 ~ 0.050	-0.020 ~ 0.020	0~0.080	0~0.350	0 ~ 0.0450	0 ~ 0.050

Comparison Test on Regular Rubber Fuel Tube in Methanol Gasoline of 3 Different Ratios and Standard Gasoline

Fuel	Tube size before immersion			Tube size after 4 weeks of immersion			Swelling scale		
	Diameter (mm)			Diameter (mm)			Diameter (mm)		
	Inner diameter	Outer diameter	Length (mm)	Inner diameter	Outer diameter	Length (mm)	Inner diameter	Outer diameter	Length (mm)
93# gasoline	4.52	10.66	21.22	5.2	12.66	23.48	15.04%	18.76%	2.26
M10	4.58	10.5	20.6	4.86	12.72	22.88	6.11%	21.14%	2.28
M15	4.76	10.62	20.26	5.36	12.58	22.26	12.61%	18.46%	2
M30	4.52	10.5	20.7	5.2	12.52	22.66	15.04%	19.24%	1.96

**NO Difference!**

Phase Separation, Vapor lock, injector block...

**03**

## **Direct Fuel Blending and Dedicated Vehicles (M100)**



# High Level Methanol Fuel Blending-General Information

- China R&D work from late 1980s with the US cooperation
- First official promotion of methanol vehicles using high level blends in 2000s in Shanxi
- National Pilot by Ministry Industry and Information Technology (MIIT) since 2012 in 5 regions with over 1,000 vehicles
- New Policy paper is introduced in 2019 for national promotion
- Roughly 100K retrofitted vehicles for M100 in China consuming over 1 MMTs of methanol each year
- OEMs Involved Geely Auto, FAW, Yu Tong, etc



# MIIT Methanol Vehicle Pilot

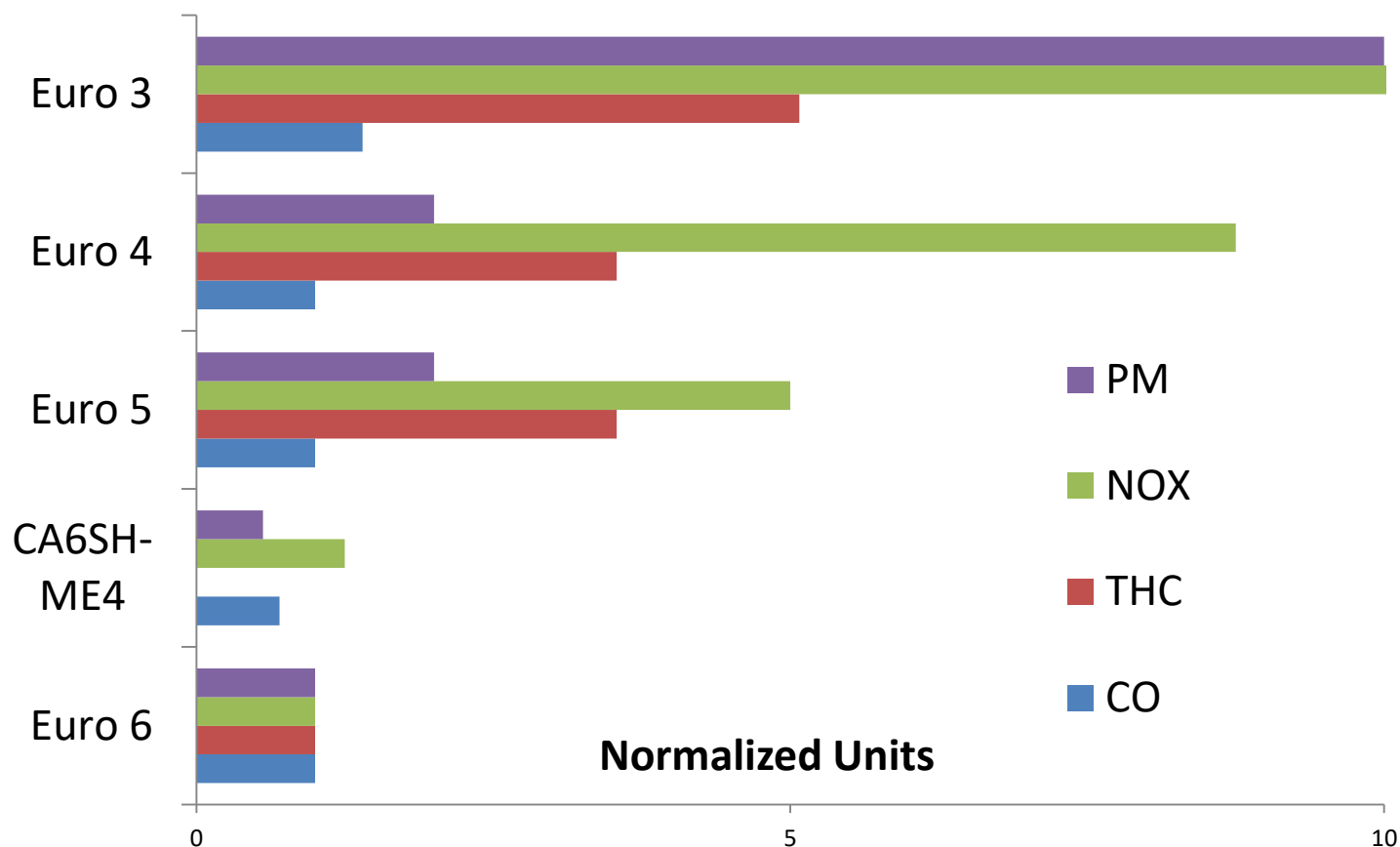
- Over 1,000 vehicles received acceptance review
- Total pilot mileage over 184 million km
- The methanol fuel consumption over 24 kts.
- Health check to 1,199 people from a variety of occupations with potential methanol exposure like vehicle drivers & maintenance works , fueling station staff, operators in methanol fuel blending
- Taxi fuel cost saving around 30%
- Total number in operation over 7,000 now and projected to reach 15K-20K in 2019

Methanol Vehicle Operation in China (by January 2019)			
Province	City	Vehicle Type	Vehicle No.
Shanxi	Jinzhong	Taxi	260
	Changzhi	HD Bus	96
Shanghai	Minhang	Taxi	18
Shannxi	Xi'An	Taxi	1500
	Baoji	Taxi	200
		Mini MPV	15
	Yulin	Self-Dumping Truck	5
	Hanzhong	Taxi	20
Guizhou	Guiyang	Taxi	4776
Gansu	Lanzhou	Taxi	150
	Pingliang	Taxi	50
		Total	7090



# Environment Benefit for Methanol Vehicles

- Methanol improving tail pipe emission significantly
- Future Vehicles certified according to Euro 6 equivalent
- Other technology solution with same emission level of Euro 6, requiring higher cost after treatment like Urea Doping
- No formaldehyde increase, even below US standard



**CA6SH-ME4 HD SI M100 ( GB17691-2005, Eqv. Euro 5, ESC) VS  
China Emission Standards of Diesel Vehicle**

# Fueling Infrastructure for Methanol Vehicles

- 20 fueling infrastructures: 13 fixed stations and 7 skid mounted
- NO significant cost to change gasoline station to M100
- Promotional plan targeting of 35 by 2020 and 45 by 2019 in Cities of Guiyang and Xi An
- Market fuel price according to gasoline and NG prices



# China M100 Vehicle OEMs

## Geely Auto

- SI M100 with key components improved on corrosion, lubrication, fuel injection
- 14 M100 cars demonstration in Iceland
- HD bus and trucks under development
- Engine Calibration by MI member **Fuel Injection Tech**



## FAW Truck and Yu Tong Bus

- SI M100 HD engine for HD trucks and buses produced by FAWJY

## Tianjin University

- CI, Diesel Methanol Compound-Combustion (DMCC)  
HD trucks, marine and locomotives  
Applied to truck retrofitting





# M100-Geely Dakar Racing 2019



Geely “methanol power”

# M100-Geely Dakar Racing 2019

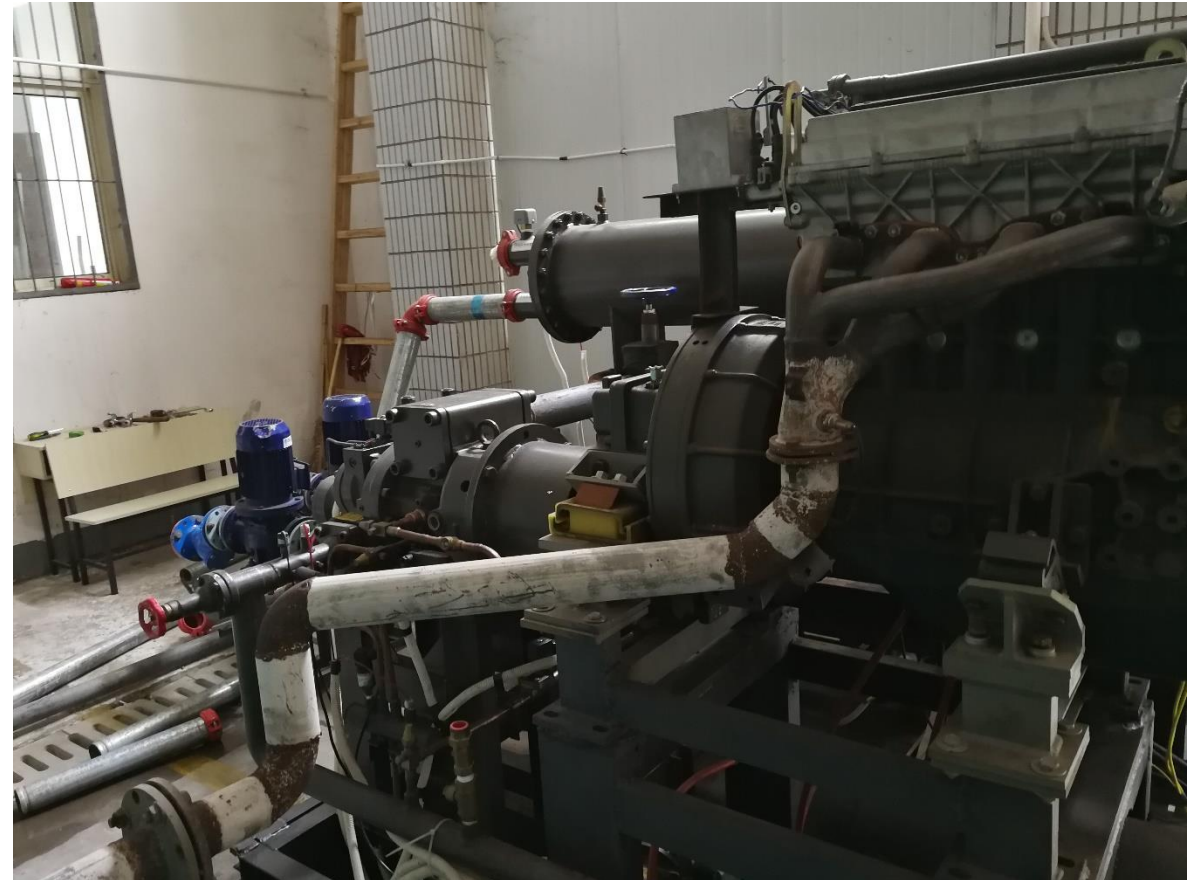
- GEELY AUTO SHELL LUBRICANT COOPER TIRE Team
- M100 Fuel used in the racing
- M100 engine was calibrated in Spain and tested in Middle East
- Methanol originated from Trinidad and Tobago
- Fuel Supply Supported by Geely's car dealer in Peru
- Methanol quality instability discovered by Geely from color





# Methanol Engine for Electricity and Heat

- Methanol engine can be used for electricity and CHP (combined heat and power)
- High efficiency achieved from optimized engine speed and exhaust heat recover
- Even lower emission than road applications
- Distributed power and air-conditioning for remote areas and islands
- Engine size can be as large as 6MW, the same for Stena Germanica marine engine



**A 4 cylinder engine SI for CHP in trial**

**04**

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