



# Prospect of the Utilization of Low Concentration Coal Mine Methane in China

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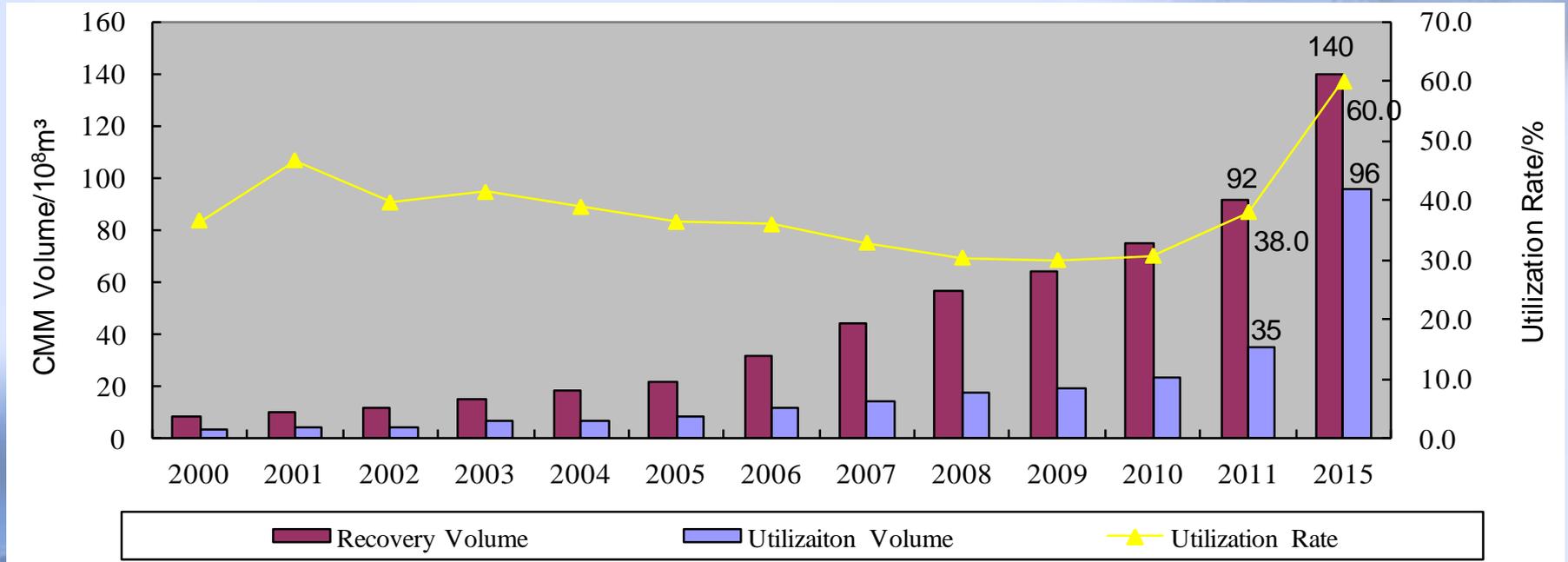
## Outlines

1. Current situation and issues of CMM utilization in China
2. Safety transportation technologies of low-concentration CMM
3. Major low-concentration CMM utilization technologies
4. Policies and standards related to CMM utilization in China

# 1. Current situation and issues of CMM utilization in China

CMM Drainage: 11.4 billion m<sup>3</sup> in 2012

CMM Utilization: 3.5 billion m<sup>3</sup> in 2012



**Recovery Volume, Utilization Volume and Utilization Rate of CMM from 2000 to 2011 and 12<sup>th</sup> Five-Year Plan in China**

# 1. Current situation and issues of CMM utilization in China

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- One of the major reasons of such situation is that the coal seam occurrence conditions in China are relative complicated and the permeability of coal seams is low which is about 0.002-16.17 millidarcy. Given the occurrence conditions and the limitations in terms of drainage technologies, the issues such as drainage difficulties and low concentration of the CMM (<30%) are common in the major mining areas in China.
- Because the utilization methods of the low concentration CMM are mostly in the industrial demonstration stage, and have not been widely promoted, a huge amount of low concentration CMM would be directly emitted into the air every year.

# 1. Current situation and issues of CMM utilization in China

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- The safety transportation technology is a key process link in processing and utilizing low concentration CMM. The reasonable configuration and safe and reliable operation of the technology are directly related to the normal operation of the power generation units and would influence the safety of the CMM drainage system, which is playing a key role in the comprehensive utilization of CMM.

## 2. Safety transportation technologies of low-concentration CMM

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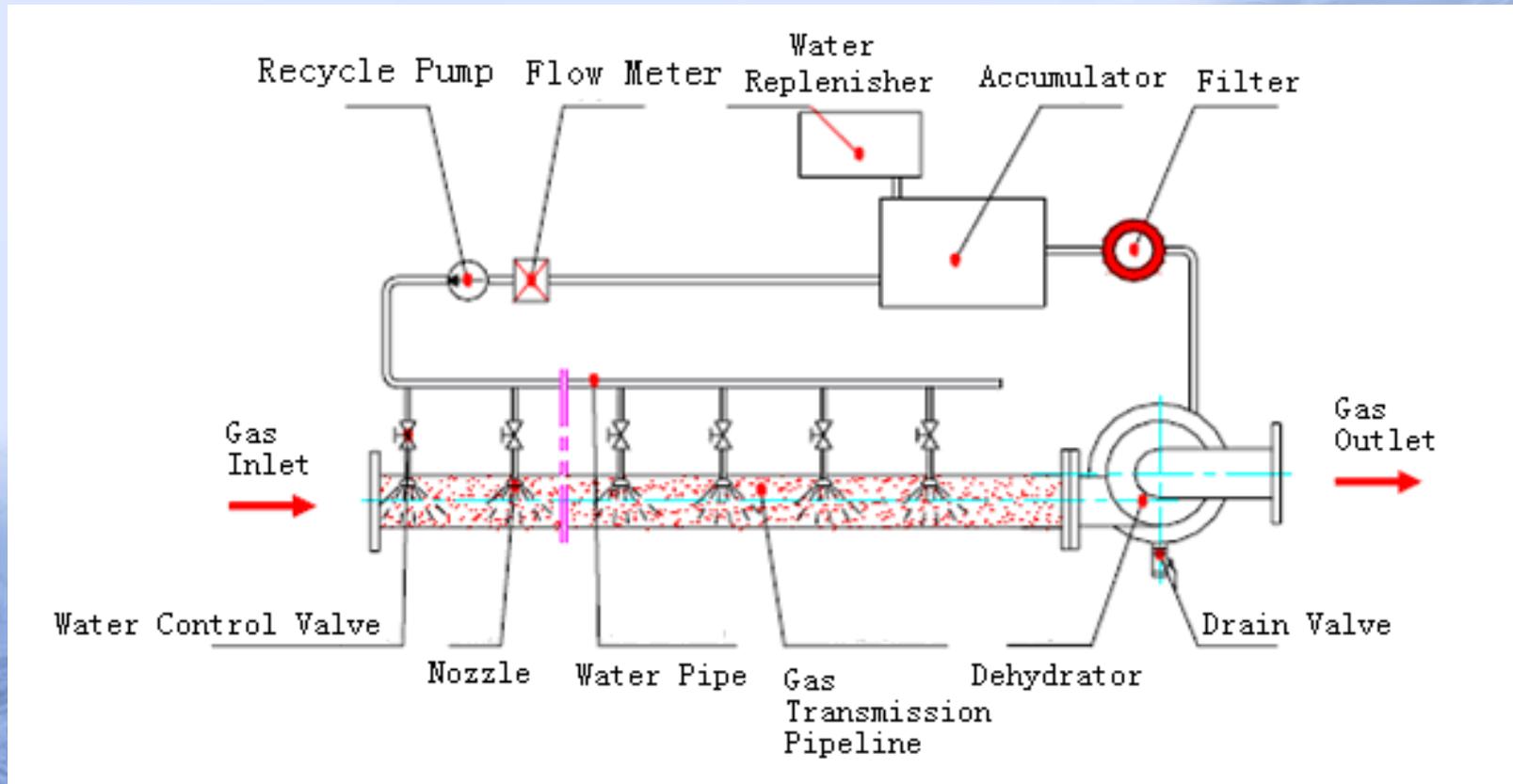
- At present, there are two mature low-concentration CMM transportation technologies which are using water as the safety medium:
  - The *Fine Water Mist Safety Transportation Technology for Low-Concentration CMM* developed by Shengli Oil Field Shengli Power Machinery Group, China; and
  - The *Gas-Water Two-Phase Safety Transportation Technology for Low-Concentration CMM* developed by National Engineering Research Center for Coal Gas Control, China.

## 2. Safety transportation technologies of low-concentration CMM

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- Fine Water Mist Safety Transportation Technology for Low-Concentration CMM
  - The Fine Water Mist Safety Transportation Technology for Low-Concentration CMM was authenticated by the academicians team organized by the State Administration of Work Safety (SAWS) in December 2005, and was defined as the industry standard by SAWS in 2009. At present, more than 1000 systems using this technology have been installed throughout China.

## 2. Safety transportation technologies of low-concentration CMM



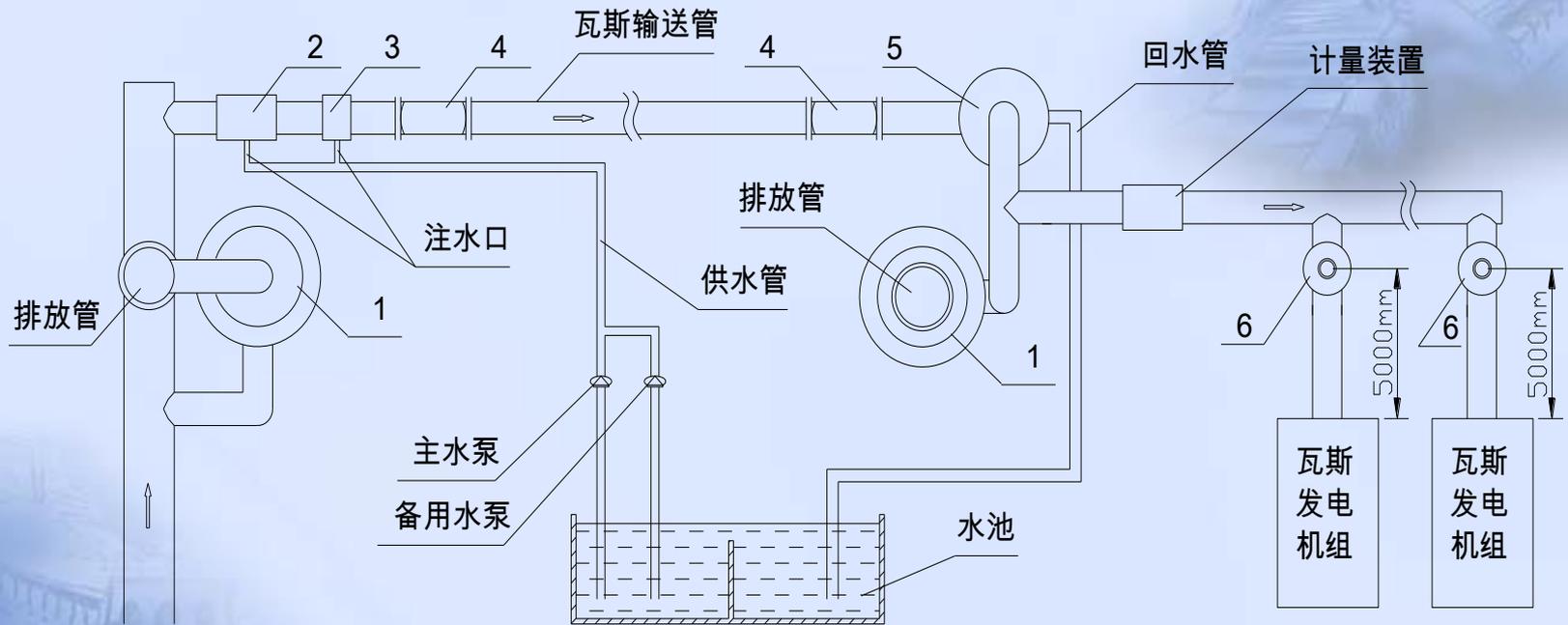
Process of Water Mist Low Quality CMM Transmission System

## 2. Safety transportation technologies of low-concentration CMM

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- The Gas-Water Two-Phase Safety Transportation Technology for Low-Concentration CMM
  - The industrial operation test for this technology was conducted in the Xieqiao Coal Mine of Huainan Mining Industry Group in April, 2008. At present, seven sets of test and experiment facilities have been established. The application for the national industrial standard and the national standard based on this technology is undergoing.

## 2. Safety transportation technologies of low-concentration CMM



**Process of Gas water Two-phase Transmission System**

排放管 Discharge pipe; 回水管 Return pipe; 注水口 Filling pipe end; 计量装置 Metering device; 主水泵 Main feed pump; 水池 Water tank; 备用水泵 Spare pumps; 瓦斯发电机组 Gas power generation; 瓦斯输送管 Gas transmission pipeline; 供水管 Water supply pipe

## 2 Safety transportation technologies of low-concentration CMM

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- The utilization technologies of low-concentration CMM that are mature or in the industrial demonstration stage at present include:
  - Direct power generation technology with combustion engine;
  - Concentration and purification technology;
  - Catalytic oxidation gas turbine power generation technology;

### 3. Major low-concentration CMM utilization technologies

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- Direct power generation technology with combustion engine
- The CMM will easily explode at the concentration of 5~16%. The explosion will be most powerful when the concentration of methane reaches about 9%. In such case, the explosion speed may reach 2000~3000m/s, generating a substantial amount of energy. The direct power generation technology with combustion engine uses this principle to drive engine.

### 3. Major low-concentration CMM utilization technologies

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- Direct power generation technology with combustion engine
  - In terms of direct power generation technology with combustion engine, China has made breakthrough first. Shengli Oil Field Shengli Power Machinery Group is the first company that has successfully developed the low-concentration CMM power generation unit in the world, which could transfer the CMM with a concentration of more than 6% into electricity.
  - By seeing the huge potential market of the low-concentration CMM power generation in China during the 12th Five-Year Plan, Caterpillar Inc. in USA has entered in the field of low-concentration CMM power generation, and developed the power generation units that can be used with the low-concentration CMM with the concentration of more than 10%.

### 3. Major low-concentration CMM utilization technologies



胜动500kw低浓度瓦斯发电机组

Generator units using low quality CMM produced  
by Shengdong Group



河柴1000Kw低浓度瓦斯发电机组

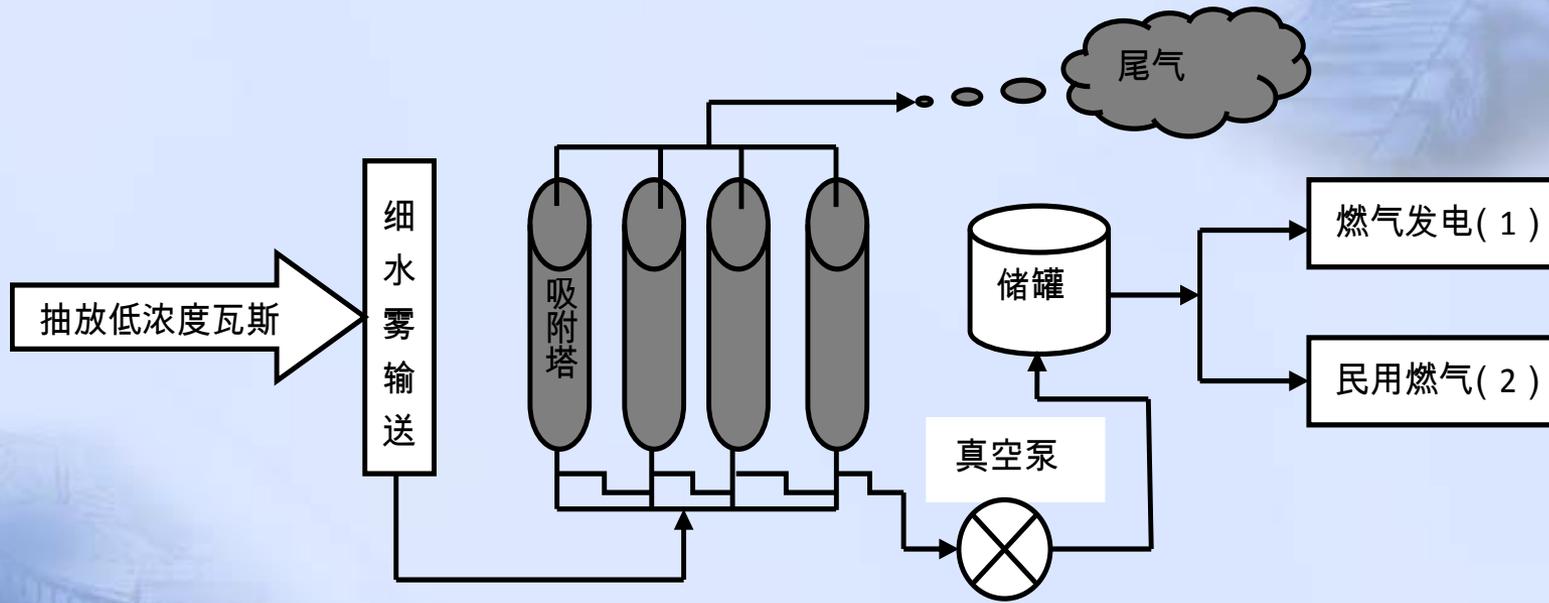
Generator unit using low quality CMM produced  
by Henan Diesel Engine Industry Co., Ltd

### 3. Major low-concentration CMM utilization technologies

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- Concentration and purification technology
  - Vacuum Pressure Swing Adsorption (VPSA) is a relatively mature technology that can be used to concentrate and purify the low-concentration CMM.
  - The main technology principle of this technology is to improve the purity of CMM by vacuuming after the low-concentration CMM has been adsorbed under normal pressure, or using vacuuming to reduce the partial pressure of the adsorbed component so as to desorb the adsorbed component (CH<sub>4</sub>) under negative pressure.

### 3. Major low-concentration CMM utilization technologies



Technological process diagram of concentration and purification technology of Low Quality CMM

### 3. Major low-concentration CMM utilization technologies

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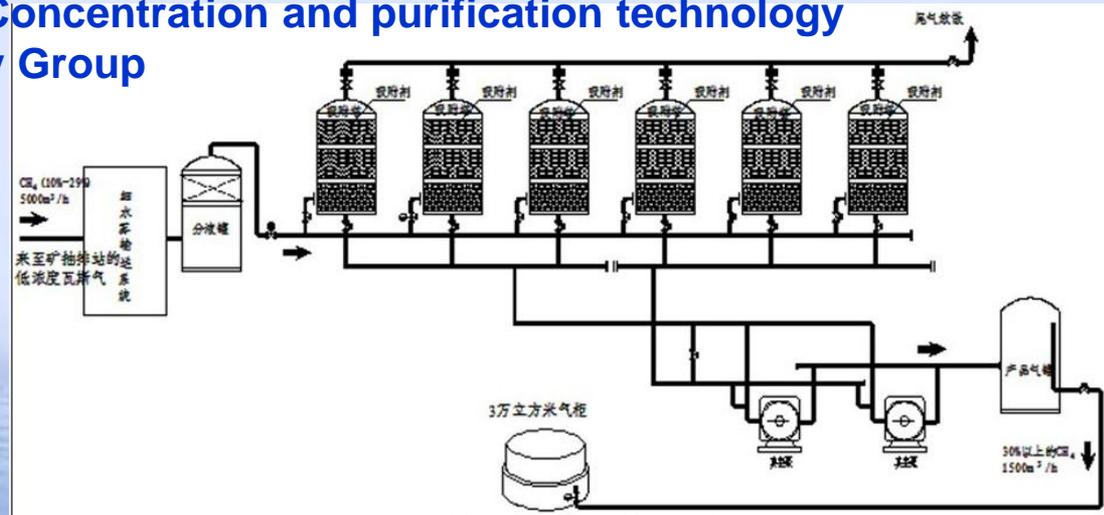
- Concentration and purification technology
  - The industrial test run of VPSA has been conducted in Huainan Mining Industry Group. The commissioning of the project has been started in April, 2011. At present, the low-concentration CMM with the methane concentration of 12% could be purified to 30% for civil utilization. The capacity of the project is 1800 Nm<sup>3</sup>/h.

### 3. Major low-concentration CMM utilization technologies



淮南矿业集团低浓度瓦斯提纯示范项目

### Demonstration Project of Concentration and purification technology in Huainan Mining Industry Group



示范项目工艺流程

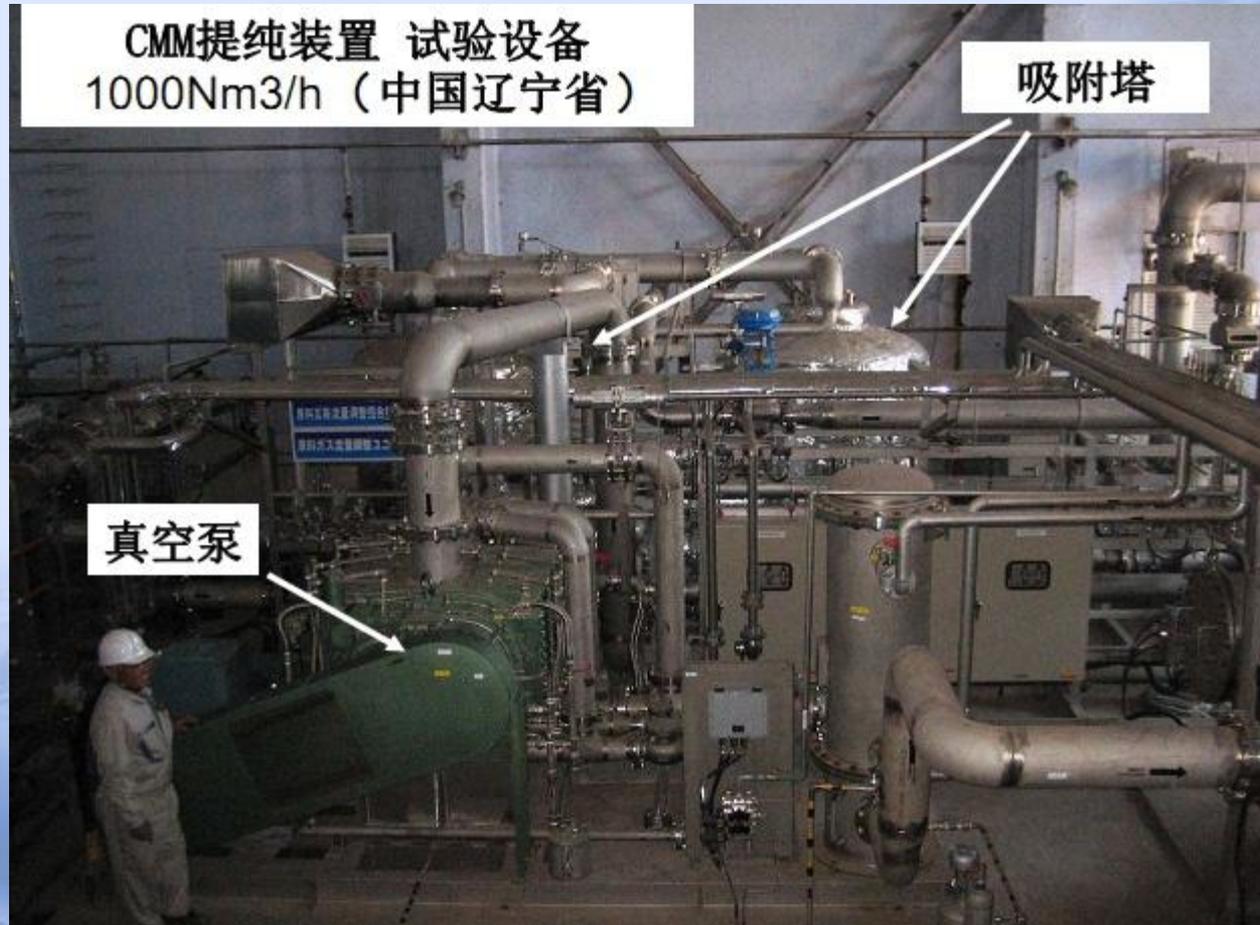
### Technological Process of Demonstration Project

### 3. Major low-concentration CMM utilization technologies

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- Concentration and purification technology
  - Sichuan Tianyi Science & Technology Co., Ltd. is working with GE Company to develop the power generation technology based on the VPSA of low-concentration CMM.
  - The Japanese Osaka Gas Joint-Stock Company and the Liaoning Fuxin Mining Industry Group conducted the pressure swing adsorption purification test for low-concentration CMM in 2009, purifying the concentration of the CMM from 20-30% to 45-55%.

### 3. Major low-concentration CMM utilization technologies



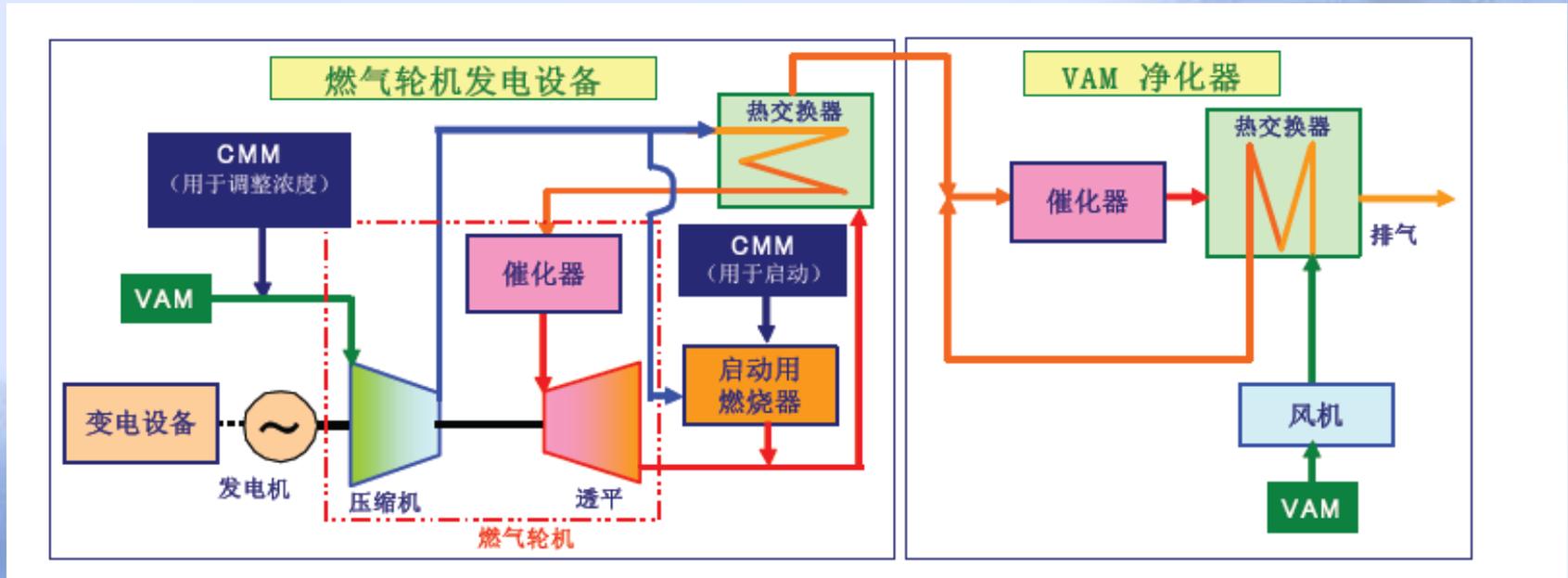
Demonstration Project that Japanese Osaka Gas Joint-Stock Company  
Built in Liaoning Fuxin Mining Industry Group

### 3. Major low-concentration CMM utilization technologies

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- Catalytic oxidation gas turbine power generation technology
  - The catalytic oxidation gas turbine power generation technology with low-concentration CMM (2%) is developed by the Kawasaki Heavy Industries of Japan;
  - The major process flow is that the gas turbine automatically absorb the CMM with the concentration of 2% (if the concentration is higher than 2%, the equipment may mix certain amount of air to dilute the CMM), and then the gas turbine will generate power through catalytic combustion.

### 3. Major low-concentration CMM utilization technologies



Technological Process Developed by Kawasaki Heavy Industries of Japan

## 4. Policies and standards related to CMM utilization in China

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- Utilization policies

- On January 21, 2010, the State Administration of Work Safety issued the No.29 order to cancel the limitations on the utilization of gas concentration that are specified in the *Coal Mine Safety Procedures*, providing the legal guarantee for the utilization of low concentration CMM.

- The original regulation: During the utilization of gas, the concentration of the gas shall not be lower than 30%.
- New regulation: If the concentration of the gas is lower than 30%, the gas shall not be directly used to burning. For combustion engine power generation and other purposes, the utilization and transmission of the gas shall be implemented according to the related standards, and the safety technical measures shall be made.

## 4. Policies and standards related to CMM utilization in China

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- Standards regarding to safe transmission
  - The State Administration of Work Safety issued ten safe production standards including the *General Technical Conditions of AC Power Generation Units driven by Low Concentration CMM Reciprocating Internal Combustion Engine*, and the *Code of Designing of Safety Guarantee System of Low Concentration CMM Pipeline Transmission System*, which have been implemented since July 1, 2010
  - The implementation of such standards has played an active role in improving the utilization rate of low concentration CMM.

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You are sincerely invited to attend:

*2013 International Workshop on CBM/CMM in China*

*October, 2013, Beijing, China*





**谢谢!**

***Thank you!***