Coal Subcommittee
Country-Specific Profile

JAPAN

Summary of coal industry and CMM recovery/use

During the peak period of coal production, Japan had about 600 coalmines and produced about 55 million tons of coal annually. But result of energy revolution, only one coalmine "Kushiro coal mine" has been in operation now.

Kushiro coal mine is only one underground coal mine in operation in Japan, producing about 0.7 million ton annually. At Kushiro coal mine, about 2.5 million m3/year of methane gas is recovered from mined out area and recovered gas is utilized as fuel for a utility boilers at the mine.

At abandoned Akabira coal mine, about 0.5 million m3/year of methane gas is recovered from mined out area and recovered gas is used for five sets of micro turbine generators.

Overview of CMM upstream/downstream technologies

[Upstream technologies]:

1. Gas simulation software

It is very important to estimate methane gas emission and recovery accurately in underground coal mines for the safe operation. Permeability to methane gas is affected by stress distribution of surrounding rock mass which is deformed by the excavation. Therefore, it is necessary to know stress change and deformation condition of rock mass in a series of mining process from roadway development to coal extraction.

1) MGF-3D

Japan Coal Energy Center (JCOAL) has developed a FEM simulation program named Mine Gas Flow 3D (MGF-3D). MGF-3D is designed to predict the volume of methane gas emitted from surrounding coal and rock seams based on stress distribution and permeability change which are determined by 3D stress analysis.

MGF-3D also can set up a number of pre-drainage holes and estimate drainage gas volume from each hole. These simulations for gas recovery can contribute to mine gas utilization plan.

2) COSFLOW

An integrated simulation software package, COSFLOW, has been successfully developed as a result of a joint research project entitled Predevelopment Studies for Mine Methane Management and Utilization between NEDO (New Energy and Industrial Technology Development Organization)/JCOAL, Japan and CSIRO, Australia.

COSFLOW couples fluid (gas and water) flow through a porous medium with rock deformation and stress, and is designed to simulate ground deformation and water/gas flow during longwall mining.

2. Gas drainage drilling

Underground gas drainage has been conducted in Japan to decrease gas emission into the coal mining face as well as to prevent the gas out burst. As geological condition and mining method are different in each coal mine, many kinds of gas drainage drilling system have been developed, such as in seam drilling, cross measure drilling and horizontal long length disturbance gas drainage drilling, etc. In general, gas drainage drilling has been conducted without coring and drilling length for each system was, 30 to 50 m for inseam drilling due to collapsing in drill hole, 50 to 80 m for cross measure drilling and 200 to 1,000 m for long length drilling. And for horizontal long length drilling, the directional drilling method has been applied. Drilling equipment was designed in light weight and compact size suitable for Japanese coal mines, and with some power supply source options, such as air, electricity and hydraulic power. To prevent collapsing in drill holes for long length drilling, insertion of steel pipe casing and injection of cement milk around drill holes have been also conducted. At the drill hole mouth, collar pipe has been inserted and cement milk has been injected to prevent air leakage into drill holes and spontaneous combustion.

3. Gas drainage system from of mined out area

Mined out area and roadways have been sealed out airtight with fly ash injection to prevent the gas emission from mined out area into mining face. In the mined out area, methane gas with very high concentration would be stored. For the effective utilization of recovered gas by gas drainage drilling system, gas from mined out area has been recovered and mixed to stabilize the quality and quantity of gas. The gas drainage from mined out area has been monitored and controlled automatically to prevent the spontaneous combustion in mined out area.

4. Monitoring system

Monitoring and control of gas drainage have been conducted by sensors and magnetic valves in the pipe lines. Gas quantity, concentration of CH_4, concentration of CO and drainage pressure has been monitored by sensors continuously and all collected data have been sent to the centralized station at the surface to be monitored and recorded. And at the gas drainage pump station at the surface, gas quantity, concentration of CH_4, concentration of CO, temperature and drainage pressure have been monitored and these data have also been sent to the centralized station.

[Downstream technologies]:

1. Advanced Gas Engine

The micro-pilot fuel ignition system is applied on this advanced gas engine. It can provide about 5,000 times huger ignition energy than a conventional spark ignition system. Pilot fuel oil, such as diesel oil or heavy fuel oil corresponding to approximately one percent of the thermal input, is used as the ignition source.

The huge ignition energy contributes to the reliable ignition of the lean mixture and stable combustion. With these advantages of micro-pilot ignition, the combustion period becomes very short, resulting in a thermal efficiency ten percent higher than a conventional gas engines with maintain the very low NOx emission level.

This advanced gas engine can be applied for low-calorie gas e.g. low to high concentration CMM (theoretically 5% to 100% methane concentration), due to the above technical advantage.

2. Gas turbine

Taking advantage of the high reliability of a gas turbine, it excels in the spread nature as mine mouth power generation in each coal mine sites, and applicability is high to CMM use expansion of a minor scale. This gas turbine with which many improvement was performed, there are many actual results after being developed especially, reliability and the maintenance cost were completed on the very high level, technology has matured.

These things are suitable for large-scale spread and application on a continent.

It is possible to recover all heat as steam also as cogeneration, and the use of the heat use is large. Heat and power ratio variable type operation is possible, operation according to heat demand and electric demand is possible, and it is easy to match a user's needs.

Low concentration CMM has low gas calorific value as compared with a common type

natural gas, and is changed seasonally in time, so a subject is in the stable combustion. However, since it has the premixed combustion type combustor beforehand as this gas turbine was mentioned above, about the mixed gas of air and methane, like CMM, the combustion stability is very high. This system can fully respond to CMM.

3. Circulating fluidized bed boiler (CFB)

Fluidized Bed Boilers have come to be widely used in Japan since its first commercial fluidized bed boiler has been developed in 1983. The fluidized bed boiler technology was first put to practical use in the form of the bubbling type, then recently, the circulating fluidized bed boiler (CFB), which is friendlier to the environment and can a wider range of fuels, has been drawing attention.

The features of IHI CFB are as follows;

- High combustion efficiency fuel flexibility
- Low SOx emissions (No DeSOx system required)
- Low NOx emissions (No DeNOx system required)
- Simplified bed temperature control
- No furnace wall slagging

In case of CMM, the CFB can be applied for mixed combustion with CMM and low calorie coal.

4. Di-Methyl Ether (DME=CH_3OCH_3)

DME, which is clean fuel and easy to handle, can be produced from CMM after removal of impure matters and reforming.

The main characteristics of DME are as follows:

- Similar properties to propane gas.
- Easy transportation and easy storage in liquid under 6 atmospheric pressure.
- No toxicity and no harm for human body.
- No concern over ozone-layer depletion and no green house effect.
- Clean fuel containing no sulfur.
- Alternative clean diesel fuel.
- Hydrogen carrier for fuel cell.

Taking into consideration of its advantages to conventional fuels, wide variety of applications, as listed hereunder, is realized or under study.

- Clean diesel fuel (no soot is emitted as there are no direct structural combination among carbons)
- Propane + DME fuel for vehicle.

- Household use.
- Propellant for spray cans.
- Clean and high-efficiency power generation fuel.

5. Town gas use

Flexible polyethylene pipe technology can be utilized to prevent uneven ground subsidence, a phenomenon liable to occur as a result of coal mining. This technology includes detector equipment for detecting gas leaks due to uneven ground subsidence, demoisturizing equipment for removing the water contained in CMM, a calorific value regulators to meet variations in the concentration of the supplied gas, high-pressure gas holders resistant to extreme cold climate zones, high-efficiency gas pressure-feeding compressors, and a total monitoring and control system.

Challenges and /or priorities to greater CMM recovery and use

1. Gas ownership

Coal mine owner has the ownership of CMM.

2. Legal framework

There is no legal systems specially tailored for CMM, the existing legal framework is applied. They are as follows:

-Mining Law, enacted to provide basic system concerning mining of mineral resources

-Mine Safety Law, enacted to prevent harm to the mineworkers, to prevent the injurious from mining, and to promote reasonable development of the mineral resources

-Electricity Utilities Industry Law, enacted to manage the electric utilities industry, to protect the profit of the user of electricity, and to promote reasonable development of the electric utilities industry, and at the same time by controlling the construction and maintenance work to ensure public safety and to preserve the environment.

-Gas Utility Industry Law, enacted to manage the gas utility industry, to protect the profit of the user of gas, and to promote reasonable development of the gas utility industry, and at the same time by controlling the construction and maintenance work to ensure public safety and to preserve the environment.

-Fire Defense Law, enacted to prevent, to watch, to repress a fire, to protect people's life, body, and properties from a fire, to reduce damage due to the disasters such as

a fire or earthquakes, to maintain the public peace order, and to contribute to the improvement of the welfare of a public society.

-Basic Environment Law, enacted to promote the measure concerning the maintenance of the environment in overall, to contribute to securing the civilized living and human race's welfare in now and the future, by providing the basic philosophy of the maintenance of the environment, clarifying country, local authority, entrepreneur, and people's obligations, and providing the matter that is basic of the measure concerning the maintenance of the environment.

-Air Pollution Control Law, enacted to protect public health by providing the tolerance limit that restricts the exhaust of smoke and dust, etc. discharged by factories, business activities and scrapping of buildings, and harmful air pollutant of car exhaust gas, and to attempt the protection of the victim by providing the responsibility of entrepreneur's compensation for damages concerning health of the person caused by the pollution of the atmosphere.

Climate change position

Japan ratified to the Kyoto Protocol in 2002.

R&D resources

Japan has following R&D resources for CMM.

-High efficiency CMM recovery system

-High efficiency power generation system

-Town gas system for subsidence area in coal mining region

-Technologies for DME production from CMM

Market assessment and reform issue

None

Key stakeholders in the CMM industry

Coal mining companies

Engine/turbine/boiler manufacturers

Financing

1. Internal mechanisms

Support for Environmental Conservation and Improvement by JBIC (Japan Bank for International Cooperation)

JBIC has been increasing financing for projects that address global environmental problems, including global warming, and environmental projects, such as those aimed at reducing pollution.

In ODA loans, preferential terms are applied to such projects in support of environmental efforts in developing countries.

2. External supports None
3. Private sector investment None
4. Multilateral agreement None
5. Incentives

Governmental subsidy system and financial system with preferential interest prepared for projects under Kyoto Mechanism (CDM and JI) are applicable for CMM project.

Current cooperation among countries

1. Feasibility study for joint implementation project

New Energy and Industrial Development Organization (NEDO) has been subsidizing the project finding activity and feasibility study for JI and CDM projects.

Some projects for recovery and utilization of CMM have been applied for this scheme.

2. Training project for CMM recovery and utilization

Japan International Cooperation Agency (JICA) has been conducting special training project for Ukraine and inviting trainees to Japan for the training of CMM recovery and utilization technology.

"Wish List"

If requests are made for cooperation in the area of CMM recovery and utilization technology, Japan with its proven know-how capability in this field can offer cooperation at the private sector level.

While there are no cooperation schemes specially tailored for CMM, there are possibilities for cooperation making use of the existing systems, including the finding of joint-implementation projects such as CDM and JI projects, the subsidy fund schemes for implementation, and the fund aid system offers loans at preferential interest rates.

Types of outreach

1. Summary of outreach strategy or plan

2. Stakeholders or recipients

The Japan CBM Forum was founded in January 2003 under the Japan Institute of Energy. The Forum members consist of specialists from many different fields who have common interests in CBM/CMM development. There are many associate organizations including the University of Tokyo, Hokkaido University, Japan Coal Energy Center (JCOAL), Japan National Oil Corporation (JNOC), Kawasaki Heavy Industries, the New Energy Industrial Development Organization (NEDO), and Mitsui Mining. Every type of CBM is discussed including CMM, abandoned mine methane, and ventilation air methane along with processes ranging from exploration and production to utilization.

3. Models of vertical communications to policy makers

Ministry of Economy Trade and Industry
(Government)
|
New Energy and Industrial Technology Development Organization (NEDO)
(Independent administrative institution)
|
Japan Coal Energy Center (JCOAL)
(Nongovernmental organization)
|
Private sectors

Conclusion and observations

The Japanese coal industry has lost its international competitiveness due to Japan's adverse geological conditions. As a result, coal mining is currently taking place on a very minor scale at only one colliery, the Kushiro Coal Mine, with an annual output of a mere 700,000 tons.

The situation is similar with regard to CMM where emphasis has shifted from domestic operation to technical cooperation overseas.

References and sources

List of CMM Project conducted by Japan

Type of Project	Project Site	Year	Outline
Demonstration	China	1998-2002	Recovery of CMM and utilization for town gas
	China	2002-2006	Gas drainage by directional long hall drilling system
F/S	China	1998	Recovery of CMM and utilization for power generation and town gas
	Russia	1999	Recovery of CMM and utilization for power generation
	Poland	2000	Recovery of CMM and utilization for power generation
	Ukraine	2000	Recovery of CMM and utilization for power generation
	China	2001	Recovery of CMM and utilization for production of acetic acid
	China	2002	Recovery of CMM and utilization for power generation
	Kazakhstan	2003	Recovery of CMM and utilization for power generation
	China	2003	Recovery of CMM and utilization for power generation
	Poland	2004	Recovery of CMM and utilization for power generation
R&D	Japan	1997-2001	Production of DME from CMM
	Japan & Australia	1999-2004	Development of gas simulation software for gas emission and drainage
	Japan	2002-2005	Development of lean burn gas engine for CMM
	Japan	2002-2006	Development of gas simulation software for gas emission and drainage