

Coal for Our Times

Compared to wind power generation, coal-fired power generation seems “old,” but progress is being made in the development of advanced techniques in this field. The Japan Journal’s Ames Pomeroy reports on Japan’s world-leading clean coal technology.

As an energy resource, coal has three advantages. First, unlike oil, it is not hidden only in certain locations. Second, compared to oil and natural gas, reserves are very large. [According to the 2010 BP Statistical Review, the proven reserves (the number of years possible to continue production) for oil is 46 years, 63 years for natural gas and 119 years for coal.] The third advantage is low price.

Because of these reasons coal is widely used all over the world. “Approximately one quarter of Japan’s electricity is produced by coal, so it is a very important energy resource in Japan,” says Minoru Yoshida, executive director of the Japanese Center for Asia Pacific Coal Flow of Japan Coal Energy Center (JCOAL), which among other things develops coal technologies, supports their commercialization, and spreads and transfers technologies.

However, as an energy resource, coal has a

drawback. Since it is made up mostly of carbon, when it is burned, much CO₂ is produced compared with oil and natural gas. Large amounts of NOx and SOx are also produced.

Due to this, Japan focuses on research and development of clean coal technology which will reduce environmental burden when using coal including reducing CO₂ emissions along with dust, SOx and NOx emissions.

One prominent technology that continues to be examined with the aim of marketing it within a few years is Integrated coal Gasification Combined Cycle (IGCC). Conventional coal-fired power generation burns coal to produce steam, which then drives a turbine. IGCC transforms coal into combustible gas, which is then used as fuel for a gas turbine. In addition, the hot exhaust fumes produced when driving the gas turbine are fed into a boiler to produce steam which drives a steam turbine. This means increased power generation efficiency because both gas turbines and steam turbines are used to produce power.

Ten Japanese power companies including J-Power have jointly built an IGCC demonstration plant in Nakoso, Iwaki City, Fukushima Prefecture, where the demonstration of IGCC is being carried out in advance of its commercialization.

Yoshida states, “the power generation efficiency of existing coal-fired power generation is approximately 42%, but with IGCC, when it is commercialized, power generation efficiency of



EAGLE pilot plant in Wakamatsu Research Institute in Kitakyushu City, Fukuoka Prefecture

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approximately 50% is expected to be achieved.”

Of course, with an increase in power generation efficiency there is a reduction in production of CO₂. IGCC reduces the amount of CO₂ emissions by about 15% compared with conventional coal-fired power generation. In other words, IGCC emits almost the same amount of CO₂ and generates the same amount of power generation as that of oil-fired power generation.

IGCC development is being conducted in Europe and the United States as well. That IGCC is the oxygen-blown type, utilizing oxygen that has been separated from nitrogen in the air and then used to convert coal into gas. The Nakoso IGCC being developed is the air-blown type, utilizing air as is to convert coal to gas. The oxygen-blown type requires that power which has been generated be used to produce oxygen. The air-blown type aims to achieve high efficiency by reducing said energy penalty.

Though the Nakoso demonstration plant was heavily damaged by the tsunami caused by the Great East Japan Earthquake, it will be restarted at the end of July.

Going Underground

Work has also begun on R&D of a clean coal technology that goes even further than IGCC, which is expected to be commercialized. Integrated coal Gasification Fuel Cell combined cycle (IGFC) aims to achieve even more efficient power generation than IGCC. This method, in addition to the gas turbine and steam turbine, creates fuel consisting of hydrogen and carbon monoxide in the coal gas, and generates power in fuel cells. By using this method, CO₂ emissions can be cut by around 30% compared with existing coal-fired power plants.

The EAGLE (Coal Energy Application for Gas, Liquid & Electricity) Project taking place at J-Power's Wakamatsu Research Institute (Kitakyushu City, Fukuoka Prefecture) is conducting R&D on technologies that will play an indispensable part in commercializing IGFC as well as IGCC.

Until now, the EAGLE Project has completed the first step of developing a gas conversion furnace that is able to produce coal gas at high efficiency, and the second step of establishing a CO₂ separation and collection technique. Through these technologies the efficient isolation of CO₂ from coal gas has become possible.

By isolating CO₂ it is possible to prevent almost any emissions from emitting outside, as well as making possible its collection and storage. This technology is called CCS (carbon capture and storage). CCS is being researched not only in Japan, but also in countries all over the world. One place that CO₂ can be stored is underground. By injecting it underground it can be sequestered from the atmosphere almost forever.

“Through the combination of IGFC and CCS, coal-fired power generation with absolutely zero CO₂ emissions can be achieved,” states Yoshida. “I hope to promote this technology abroad in the future.”

At present, J-Power is moving forward with the third step of technological development at the Wakamatsu Research Institute, as well as working with power companies in planning the construction of a large-scale demonstration test plant in Osaki, Hiroshima Prefecture, that reflects the fruits of research thus far. Proving tests, namely the Osaki CoolGen Project, will be run at this plant with the goal of actually implementing IGFC and CCS. 