Statistics have shown that the world’s proven recoverable coal reserves are 984.211 billion tons, including 246.643 billion tons in the USA, 157.01 billion tons in Russia, 114.5 billion tons in China, 74.733 billion tons in India, 67 billion tons in Germany, 55.333 billion tons in South Africa, 34.356 billion tons in Ukraine, 34 billion tons in Kazakhstan, 14.309 billion tons in Poland and 11.950 billion tons in Brazil. Coal resources account for 25% of the world’s energy consumption structure, and play a critical role in global economic development.

In 2015, China consumed 3.95 billion tons of coal (including 3.75 billion tons of self-production and 0.2 billion tons of imports), 0.543 billion tons of oil (0.215 billion tons of self-production; 0.328 billion tons imports) and 196.4 billion m³ of natural gas (135 billion m³ of self-production; 61.4 billion m³ imports). Among the proven recoverable reserves, coal occupies 72.7%, oil 5.9% and natural gas 1.4%. The coal consumption, which accounts for 70% of China’s primary energy consumption, has remained essentially unchanged in recent decades.

According to the data from the U.S. Energy Department, the USA produced 0.567 billion tons of oil and consumed 0.852 billion tons of oil in 2015. In the same year, the USA produced 767.3 billion m³ of natural gas and consumed 778 billion m³; it produced 0.89 billion tons of coal and consumed 0.636 billion tons. Coal resources accounted for 16% of the USA energy consumption structure in 2015.

In 2012, the Chinese Ministry of Land and Resources announced that China had 3.24 billion tons of remaining recoverable oil reserves and 114.5 billion tons of coal. Based on these predictions and China’s annual consumption, it is inferred that China’s oil will last for another six years and coal mined for 29 years.

The above data are indicative of China’s energy resource reality of much coal and little oil, which urges Chinese scientists to concentrate on the deep development and utilization of coal, and, as a result, the conversion of coal to oil has long been pursued.

As early as in 2008, China announced a draft of “The Long-Term Development Plan of Coal Chemical Industry”, and proposed that China would produce 30 million tons of coal-to-oil, 660 million tons of coal-to-methanol, 20 million tons of coal-to-dimethyl ether and 8 million tons of coal-to-olefine, with an accumulative coal demand of 0.252 billion tons for the coal chemical industry.

On December 21st, 2016, the 400 t/a coal-to-oil production equipment from the Shenhua Group of the Ningdong coal chemical industry base in Ningxia was put into production, which marks the beginning of large-scale coal-to-oil production in China.

Statistics show that a total of five coal-to-oil projects had been put into operation in China until 2016, i.e., the Ningxia project just noted with production of 4 million t/a, the Ordos project of the Shenhua Group with production of 180000 t/a, the Yitai project with production of 0.16 million t/a, the Lu’an project with production of 0.16 million t/a, and the Xianfeng coal-to-oil project in Yunnan with production of 0.20 million t/a. At present, there are ten projects under construction, with a total capacity of 14.25 million t/a (Table 1).

China has three more coal-to-gas projects put into production, i.e., the Hexigten Banner project of the Datang Corporation with production of 1.33 billion m³/a, the Ordos project of Huineng Group in Inner Mongolia with production of 0.4 billion m³/a, and the Yili project of Kingho in Xinjiang with production of 1.375 billion m³/a. Another six projects are under construction, with a total capacity of 18.4 billion m³/a. The total coal-to-gas capacity is expected to reach up to 126.8 billion m³ by 2020.

Till now, there are nine coal-to-olefin projects in operation. Among these, the Shenhua Group Baotou coal-to-olefin project is the most successful, with annual production of 0.6 million tons. In addition, there are 29 projects under construction in China, with a total capacity
of 22.89 million t/a. There are also nine coal-to-glycol projects in operation and 11 other facilities under construction, with a total capacity of 2.87 million tons. For converting coal to aromatic hydrocarbons, the Yuheng Company in Shaanxi of the Huadian Corporation is now in a 10000-ton class industrial test stage, with two sets of 0.1 million ton instruments under construction.

However, there is still controversy and misunderstanding of China’s coal-to-oil projects.

(1) Immaturity of technology. Converting coal to oil is mainly direct liquefaction and indirect liquefaction, both of which have good transformation effects, with comprehensive energy efficiency of up to 45.9%. In addition, China has formed its own set of technical systems and anequipping manufacturing capacity greater than 85%.

(2) Uneconomic cost. In theory, the production of one ton of coal-to-oil requires about five tons of coal, and the production of 1000 m³ of coal-to-gas requires about three tons of coal. In contrast, the one million t/a coal-to-oil project in Yulin, Shaanxi, which was built jointly by the Yanzhou Coal Mining Company and Yanchang Petroleum Group, can produce one ton of oil by consuming 3.441 tons of coal, with notable economic efficiency. Statistics show that the coal-to-oil cost of the whole industry is about $40 per barrel oil, such as the Yulin project at coal-to-oil cost of about $37 per barrel oil in May of 2016, which is roughly the same as the current world oil prices.

(3) Serious waste of water resources. In theory, the production of one ton of coal-to-oil needs to consume 10–15 tons of water, and the production of 1000 m³ of coal-to-gas requires 6 tons of water. Water resources are a bottleneck which restricts the realization of converting coal to oil. At present, the one million t/a coal-to-oil project in Yulin, noted above, needs 2.68 tons of water to produce one ton of oil; the water reuse rate reaches up to 98.26%, which has generally solved the problem of water waste.

(4) CO₂ emission. The CO₂ emission of one ton of coal-to-oil is 4.5–5.0 tons. If the coal-to-oil production reaches 100 billion m³ in the future, the annual increase of CO₂ will be about 0.5 billion tons. At present, China has mature technology to use CO₂ to produce industrial dry ice and to enter CO₂ into the underground through the chemical reaction to form calcium carbonate.

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