Dewatering Technology for Coal at Normal Temperature Using DME

Background

In order to have a more stable supply of coal, sub-bituminous coal and brown coal, which are currently underutilized, must be utilized on a larger scale. CRIEPI has invented a new dewatering process that uses DME (dimethyl ether)*1 as the dewatering agent. This process is a method involving the use of DME, which is condensed and evaporated under a certain pressure in the range of 0.5–0.7 MPa at normal temperature, where after the water in the coal is absorbed by liquefied DME, the mixture of water and DME is depressurized and only DME is evaporated. The process capabilities are already determined and the following theoretical result has been obtained: it is possible to dewater with less energy than the previous high-temperature heating-type techniques. To put this technique into practical use, a prototype must be developed. Further, along with evaluating the applicability of this technique for various coals, there is a requirement to elucidate the characteristics of dewatering and wastewater features of coal, as well as to determine the operation condition in reality and the required energy.

Objective

The objectives of this technique are to dewater various coals with DME using a test tube level apparatus, to evaluate the applicability of this technique for various coals, and to elucidate the spontaneous combustion of the dewatered coal. In addition, a prototype for the DME-recyclable dewatering process is to be developed, so as to elucidate the fact that DME can be recyclable, to determine the operation conditions such as temperature and pressure, and to determine the required energy and wastewater features.

Principal Results

1. Coal Dewatering Capabilities of DME Dewatering Technology Using a Simple Apparatus of Test Tube Level

(1) A dewatering experiment was conducted, where seven types of coal in various states (1 mm in size) were packed into a column of 150 mm in length and 11 mm in inner diameter, and liquefied DME was flown through the column for 12 min at a speed of 10 g/min. The longer the flow time of DME, the greater was the amount of water removed from the coal, and it could be dewatered until the entire coal water was finally 10 wt%. Since the existing technology completely dewaters the coal, there is a risk of spontaneous combustion. In response to this, since this technology leaves the water at almost the same level as the bituminous coal, the risk can be reduced.

(2) It had become clear that the spontaneous combustion of the sub-bituminous coal, which contains high amount of water, was less after being dewatered with DME than before dewatering (Figure 1). In addition, a portion of the coal was extracted by DME at the same time as dewatering, and it was also clear that the more the quantity extracted, the less was the spontaneous combustion.

2. Elucidation of dewatering and wastewater features of the coal by means of DME dewatering process prototype

(1) A DME dewatering process prototype (Figure 2) with a coal processing capacity of 10 L/batch was developed. The Warra coal with the highest dewatering effect in the test tube level experiment was dewatered using the prototype and it succeeded in reducing the water from 40% to 1%. In addition, it became clear that the spontaneous combustion of the Warra coal, which was dewatered with the prototype, was also reduced.

(2) The industrial and elemental analysis values of the Warra coal did not change before and after dewatering. Furthermore, the dewatered Warra coal water returned only to 15% even after being left in an environment with 100% humidity for two weeks, and from that, it was clear that the re-humidification was reduced.

(3) The water separated was at pH 3–4, and the suspended substances, BOD, and oil concentration were either equal to or higher than the standard values stated in the Sewage Water Law*2; however, the metals or halogen compounds, which are difficult to process, were detected below the lower limit, and it was clear that it can comply with the existing wastewater treatment technology.

3. Elucidation of the operation conditions and required energy of the DME dewatering process prototype

The DME-recycled operation was possible under the conditions of normal temperature and low atmospheric pressure; these conditions were verified by means of the prototype. In addition, the prototype was compact, and regardless of the detailed structure and the un-optimized operating conditions, it was clear that it can dewater 2,069 kJ/kg water (the compressor capacity), and the required energy can be reduced below the requirement of the existing technology (actual machine scale calculated value).

Future Developments

The continuous loading and unloading of coal into the dewatering plant will be studied in order to scale up for actual applications.

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Reference Affiliated Reports: H. Kanda, and H. Makino., 2008, "Characteristics of Dewatered Coal by Using Prototype of Energy-Saving DME Dewatering Process," CRIEPI Report: M08020; N. Noda, H. Kanda, and S. Ito., 2008, "Dewatering characteristic of coal employing DME and spontaneous combustion of dewatered coal," CRIEPI Report: M08902

*1: The standard boiling point is at -25°C at 0.5 MPa, the boiling point is at 20°C. Liquefied DME has the ability to absorb water from various substances. DME dissolves 7–8% by the weight of water at normal temperature. In China, DME is also used as a synthetic fuel; it is popular as a cheaper alternative fuel to imported LPG.

*2: Comparison with the standard value stated in the Sewage Water Law was not done on the premise that the wastewater produced by this technology will be discharged into the sewer, but to be used as an if it can comply with the existing waste-water treatment technology.

(Awards after last year's report: H. Kanda, Best Project Award, The Association of Environmental & Sanitary Engineering Research, Kyoto University, H. Kanda, Research Encouragement Award by The Association of Powder Process Industry and Engineering, Japan)

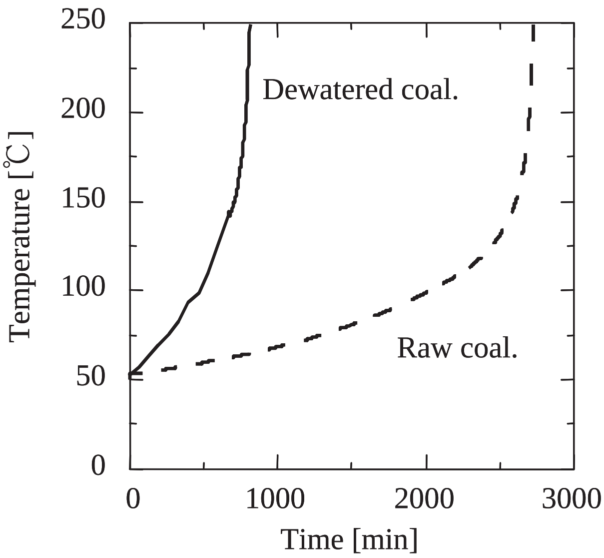

Fig.1 Adiabatic induction times of dewatered Warra coal before and after DME dewatering

Warra coal before DME dewatering and Warra coal after dewatering were exposed to dried air at 50℃, and the heat generating "spontaneous combustion" due to the presence of oxygen in air was measured. The quicker the increase in Warra coal temperature, the higher is the spontaneous combustion. It takes time for the temperature of Warra coal to increase after DME dewatering; therefore, the spontaneous combustion of Warra coal is reduced.

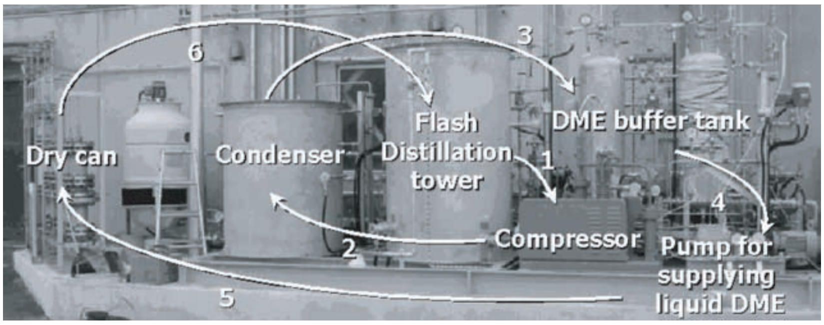

Fig.2 Photograph of the prototype that carries out the DME dewatering process (The arrows and numbers are the DME cycle route)

The "DME dewatering process prototype" can recover, liquefy, and then re-use the DME that was used in dewatering after it was evaporated at normal temperature.
The objectives of this prototype are to elucidate the world's first dewatering and wastewater features of coal, to determine the actual operating conditions and required energy, and to elucidate the detailed structure of the apparatus.
The optimization of the operating conditions is not conducted.

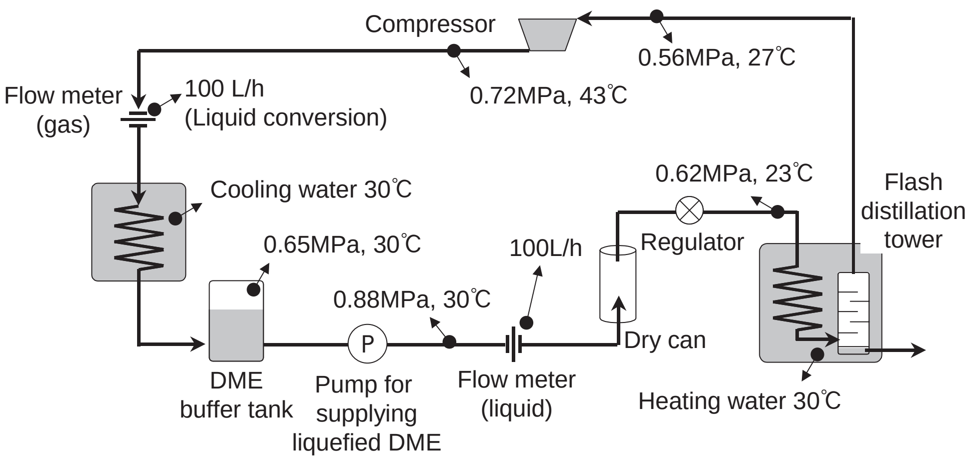

Fig.3 Operating conditions of the DME dewatering process prototype

As for the prototype, the temperature was maximum at 43℃ and the pressure was maximum at 0.88 MPa. The fact that the prototype can operate under mild conditions of normal temperature and low atmospheric pressure can be verified.
Under such operating conditions, the dewatering energy was 2,069 kJ/kg-water, and it was clear that it can be below the required energy of the existing technologies.