

Development of Low Rank Coal Upgrading and Coal Water Mixture Preparation Technologies

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LIPI - 10311

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The development of clean coal technology is important for the stability of energy supply. The utilization of low rank coal (LRC), such as lignite and sub-bituminous coal is important as well as that of high rank coal (HRC). LRC should be used close to mine site due to its low calorific value, high moisture content, low thermal efficiency, richness in oxygen, and high tendency to spontaneous combustion. Therefore, LRC needs to be upgraded to make its characteristics resemble with HRC. Various dewatering and upgrading processes were conducted in this study. They were upgraded brown coal (UBC), hot water drying (HWD) and steam drying (SD) processes. The characteristics of the coals before and after upgrading processes were carried out to study the change due to the upgrading processes.

The UBC process was conducted in laboratory and pilot scale. The UBC process in laboratory scale was conducted by using an autoclave with 5,000 ml/batch in capacity at many temperatures as variable of process. One sample comes from Berau, East Kalimantan was used in this test. While the UBC process in pilot scale was conducted in the UBC pilot plant at Palimanan, Cirebon with 5 ton/day in capacity. All of the samples were carried out were 6 (six) samples come from Berau, Samaranggau, Tabang and Bunyu (East Kalimantan), Banko (South Sumatera) and Mulia (South Kalimantan). The HWD and SD processes were conducted in laboratory scale by using an autoclave to obtain the effective temperature process by using an LRC from Berau. After obtaining the temperature process, the researches were continued by using LRC's come from Samaranggau, Tabang and Bunyu (East Kalimantan) and Banko (South Sumatera).



From left: Dr. Yoshiyuki Komoda, Prof. Dr. Hiromoto Usui (my Japanese advisor), me (Datin Fatia Umar) and Associate Prof. Dr. Hiroshi Suzuki

Results indicate that the upgrading processes could reduce moisture content. Consequently, the specific energy of all of the upgraded coals was significantly increased. The upgrading coal processes produce coal

with better combustion characteristics than that of the raw coal. However, it does not affect the

char characteristics of coal. The liability to spontaneous combustion of upgraded coal is lower compared to that of the raw coal and HRC like Kaltim Prima coal (KPC). The upgraded coals by the HWD and SD processes were generally better compared with those of the upgraded coal by the UBC process. It could be understood, because the UBC process was held in lower temperature and lower pressure compared to those of the HWD and SD processes.



Me (Datin Fatia Umar), at Yukata wearing moment, in the front of Kobe University International Residence

In the future, the upgraded coal is possible in the form of the coal water mixture (CWM), which could be pumped by pipelines and utilized without dewatering. The rheological properties and stability of the CWM which was prepared by using upgraded coal produced by the UBC process (UBCWCM) was conducted to obtain the most suitable dispersing and stabilizing additive. Beside that, the preparation of carbonized biomass water mixture (CBWM) by using carbonized plants and carbonized coconut cells were also studied as reference. Three kinds of anionic dispersing additives, naphthalene sulfonate formaldehyde condensate (NSF), polymethacrylate (PMA) and polystyrene sulfonate (PSS) and three kinds of stabilizing additives, carboxyl methyl cellulose (CMC), S-194 (ransham gum) and S-60 (gellan gum) some kinds of polysaccharide the trade mark of Dainippon Pharmaceutical Co. Ltd. were used in this study.

Results indicate that the addition of NSF 0.3 wt% as a dispersing additive together with stabilizing additive of S-194 or CMC 0.01 wt%, produces UBCWCM with the best fluidity and stability compared to that by the addition of PSS and PMA for each 0.3 wt% with the apparent viscosity was less than 1.00 Pa.s at the shear rate of 100 s⁻¹.

The UBCWCM technology can be applied in the near future. The target of coal content in the UBCWCM could be reach. However, before the UBCWCM is implemented in commercially production, the detail investigation on the UBCWCM transportation using pipe line and the UBCWCM combustion should be conducted. While the CBWM technology is being difficult to put at the present stage, because the CBWMs produced by using carbonized plants and carbonized coconut cells have lower solid concentration compared to that of the target of solid content in the CBWM. The investigation to find the most suitable dispersant should be conducted to reach the target.