学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Study on Susceptibility to Spontaneous Combustion of Anthracite in Vietnamese Coal Mines
(ベトナムの炭鉱における無煙炭の自然発火性に関する研究)

Generally anthracite hardly starts spontaneous combustion because it has few free radicals. However, at Vietnamese anthracite mines (Triassic Period of Mesozoic Era), 18 spontaneous combustion incidents have been observed at 5 mines since May 2004, which did not cause fatal accidents fortunately, but led to the negative impacts of coal mines such as abandon of the precious part of coal resources, stagnation of coal production and long-term firefighting processes. Thus, it is necessary to prevent the frequent outbreak of the spontaneous combustion. The purpose of this research is to clarify the mechanisms of spontaneous combustion of anthracite by field investigations at coal mine sites as well as experiments in the laboratory. This paper consists of 7 chapters.

The general overview of coal industry in Vietnam is introduced in chapter 1. In particular, coal fields in Vietnam, geology of the coal fields that induce spontaneous combustion, coal winning methods, coal production policies of VINACOMIN, coal production in Vietnam, coal development program, and safety record of Vietnamese coal industry are described.

Chapter 2 describes the incidents of spontaneous combustion at anthracite coal mines in Vietnam. The characteristics of 18 spontaneous combustion incidents up to date at five coal mines are discussed based on the observed data. Fifteen spontaneous combustion incidents among 18 (83 percent) occurred in summer, squall seasons from May to September. Aside from the spontaneous combustion of bituminous, no higher-grade hydrocarbon gas was observed except for methane, and higher concentration of hydrogen gas (maximum concentration of 4.3 percent) was observed inside the sealing wall.

Chapter 3 describes gas generation from heated coal in the laboratory. Anthracite coal samples were heated in an electric furnace in the laboratory and the generated gasses were analyzed to compare the gasses generated from the mine site. The results showed the agreement between the site data and the laboratory data. In case of heating tests of Vietnamese sub-bituminous coal, hydrocarbon gasses, such as C_2H_6 and C_2H_4, were found.

Chapter 4 describes the evaluation of the susceptibility of various coal samples to spontaneous combustion by comparing conventional methods proposed by Russia, Japan and Poland. These methods are effective in evaluating spontaneous combustion of bituminous or sub-bituminous coal. The results indicate that these methods cannot be applied for anthracite.

Chapter 5 describes the mechanisms of susceptibility of anthracite to spontaneous combustion based on the oxidation rate at lower temperature. Oxidation tests were conducted by using a spontaneous ignition tester under an adiabatic condition to identify the oxidation mechanisms of anthracite at lower temperature. Not only anthracite but also a bituminous from Kushiro Coal Mine, Japan and a sub-bituminous coal from Vietnam (Phan Me Coal Mine) were used. The results showed that anthracite

coal samples from coal mines confronting spontaneous combustion problems had much higher oxidation rate at lower temperature, i.e., less than 150^0C. This corresponded to two times higher than those of anthracite from coal mines without the problem of spontaneous combustion, and four times higher than those of bituminous or sub-bituminous coals even from coal mines with the problems of spontaneous combustion.

Chapter 6 describes factors affecting the susceptibility of anthracite to spontaneous combustion. The factors, such as porosity and original moisture of anthracite, and oxygen adsorption by anthracite after sampling from mine sites were examined based on the start of spontaneous combustion. A strong correlation was observed between the porosity of anthracite and spontaneous combustion at the site. In addition, the original moisture of coal had a predominant effect on the start of the oxidation process at lower temperature. Some anthracite had high oxygen adsorption capacity after sampling from the coal wall of the underground site.

Chapter 7 describes conclusion of this study and recommendation for future works.