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Leading Edge of Coal Utilization Technologies

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Abstract
Coal resource has a great potential as world energy resources. The amount of proved coal reserves is 891 billion tons [1]. However, more than 50% of coal resources are low quality because of high moisture content or high ash content etc. It is difficult to use these coals with high energy efficiency by conventional technologies. So, research and development of low rank coals utilization technologies have been strongly needed all over the world. This paper introduces the development of coal utilization technologies status and future challenges

1. Introduction

The amount of proved coal reserves is 891 billion tons in 2014[1]. More than 50% of coal resources are low quality coals. It is difficult to use these coals with high energy efficiency by conventional technologies. So, research and development of low rank coals utilization technologies have been strongly needed all over the world.

2. Coal utilization technology

Main coal utilization technologies are as follows. (1) Carbonization (Cokemaking), (2) Combustion (Power generation), (3) Gasification (4) Liquefaction. In this paper, conventional cokemaking process, coal gasification technology and development of new cokemaking technology (SCOPE21) are introduced.

2.1 Cokemaking technology

The main product of carbonization technology is metallurgical coke. More than 90% of the coke produced in Japan is used for steelmaking.
Figure 1 shows the cokemaking process flow[2, 3]. The raw coals are imported from abroad mainly Australia, Canada, USA, Indonesia etc. Several raw coals are blended, and crushed suitable for cokemaking material and charged into coke oven after pretreating. For producing high quality metallurgical coke using low grade coals without deteriorating coke quality, coal pre-treating technology such as coal moisture control (CMC), briquetting and coal preheating technology were introduced into commercial cokemakinhg plant. These technologies are very unique coal pretreating technologies. After coal is carbonized to 1000 oC in coke oven chamber, coke is quenched by using CDQ equipment.
Conventional cokemaking process has some problems involving the strict of raw coals brands, low productivity and environmental problems. So, development of innovative new cokemaking process was conducted from 1994 to 2003 as a Japanese national project. Details of new cokemaking process are described in Section 3.

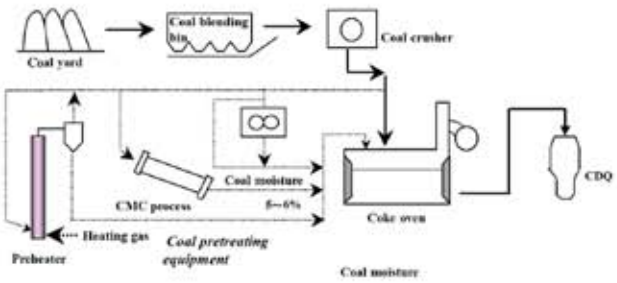

Figure 1. Process flow of cokemaing plant

2.2 Coal gasification technology

Coal gasification is a key technology for producing high quality gas and chemical resources by using low rank coals. Now coal gasification technologies have been come on stream all over the world. New coal gasification process using efficient two stage entrained gasifier (ECOPRO®) was developed by Nippon Steel & Sumikin Engineering Co., Ltd.

Figure 2 shows the feature of ECOPRO® process [4]. ECOPRO® has the two-stage type gasifier. Firstly, pulverized fine coal is introduced into lower part, and the partial oxidation reaction by oxygen is occurred. The main components of generated gas are carbon mono oxide (CO) and hydrogen (H_2) etc. Then the generated gas is introduced into upper part of gasifier. Coal pyrolysis reaction occurs by reacting high temperature gas and coal introduced into upper part of the gasifier. Thermal decomposition gas component such as methane (CH_4) is generated in the upper part of gasifier. Thermal efficiency of ECOPRO® process is higher than other gasification processes due to two-stage gasification reaction.
Pilot plant scale gasification operation tests with a coal feed 20 t/d have been conducted with

sub-bituminous coals and brown coals from 2006. As a result, it was clarified that this process is feasible and applicable to low rank coals such as sub-bituminous coals and brown coals.

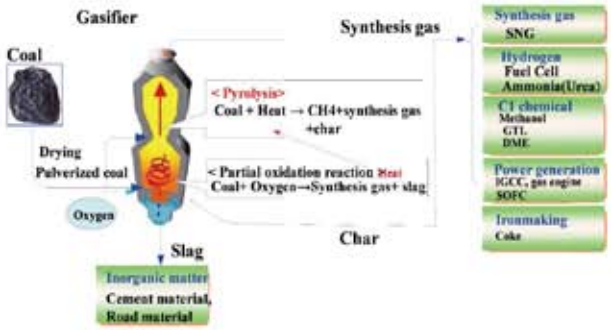

Figure 2. Process flow of ECOPRO®

3. Development of new cokemaking technology

Coal is very important resource for producing high quality metallurgical coke. In Japan, improvement of coke quality is strongly needed to operate large inner volume blast furnaces smoothly. So, effective coal utilization technologies involving new cokemaking process were developed for a long period. Research themes are mainly focused on the expansion of coal resources useable for cokemaking, improving coke productivity and reducing energy consumption. Especially, improvement of coke quality is very important, because it generally leads to increase the blending ratio of low grade coals in coal charge without deteriorating coke strength. In this session, new cokemaiking technology SCOPE21 is introduced.

SCOPE21 process mainly consists of three units [5, 6]. First is coal rapid preheating unit, second is coal carbonizing unit and third is coke quenching unit. The aim to divide the whole cokemaking process into three parts is to make full use of the function of each process to maximize the total process efficiency.

The quality of coke can be improved by upgrading the coking quality of coals. Rapid preheating can improve properties of coal, increasing its bulk density in coke oven chamber. These improvements raise the blending ratio of non- or slightly caking coal up to 50%, while it is only 20% in the conventional process.

SCOPE21 plants were constructed at Nippon Steel & Sumikin Oita works and Nagoya Works. Both of the plants have been operated smoothly.

4. Conclusion

Coal is a very important energy resource in the world. To propose the effective coal utilization, improvement of coal quality, energy saving and environmental protection technologies are important. In research section, the appropriate evaluation of coal properties is important research theme. Development of low rank coal utilization technologies is strongly demanded all over the world. Understanding of this situation is expected to contribute to further innovative development of new process,

Reference

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