3B1. Fluidized-bed Advanced Cement Kiln System (FAKS)

Technology overview

1. Features

The Fluidized-bed Advanced Cement Kiln System (FAKS) efficiently combusts low-grade coal, significantly reduces NOx emissions, and increases the heat recovery efficiency between solids and gases discharged from the process. This is accomplished by leveraging the advantages of the fluidized-bed process, including the combustion efficiency, and the heat transfer efficiency, as well as the particle dispersion and granulation features. Thus, the ultimate objectives of the development are to contribute to global environmental conservation, energy conservation, and to fulfill demands for various types and/or special grades of cement.

Photo 1 Clinker produced from a fluidized-bed kiln

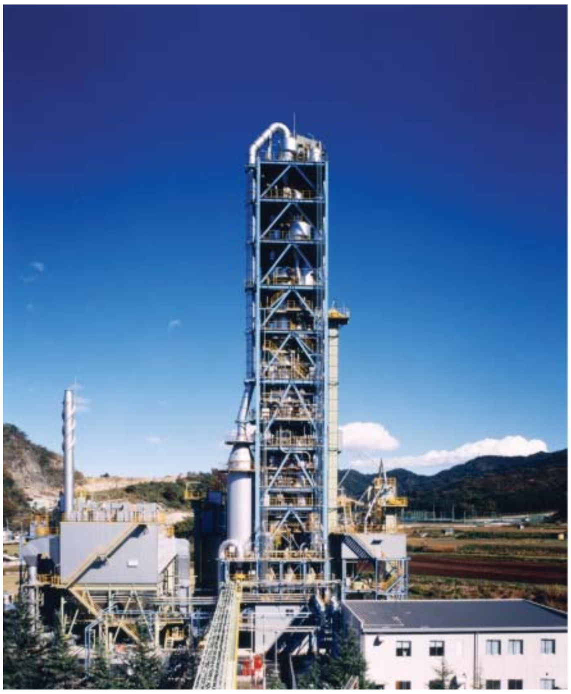

Photo 2 Overview of 200 t/day plant

2. Technology overview

A FAKS includes a fluidized-bed cement kiln and a two-stage cooler. The fluidized-bed cement kiln reduces the raw material to a specific size for melting it into high quality cement, and then sinters the granulated raw material at a high temperature. The two-stage cooler combines a quenching cooler and a packed-bed, slow-cooling cooler to increase the heat recovery efficiency. The most important technology in the system is the granulation control technology. Compared with conventional technology, which required that seed clinker be fed from the outside and which required control of the granulation process thus allowing high temperature raw material powder to adhere and accumulate to the seed clinker, FAKS employs a first-ever "self-granulation" process. Self-granulation is the process where granule cores are generated through the agglomeration of a portion of the raw material, allowing the rest of the raw material to adhere and grow on the core in order to control granulation. The fluidized-bed cement kiln furnace integrates two major technologies to control the granulation: a raw material injection unit, and a bottom classification and discharge unit.

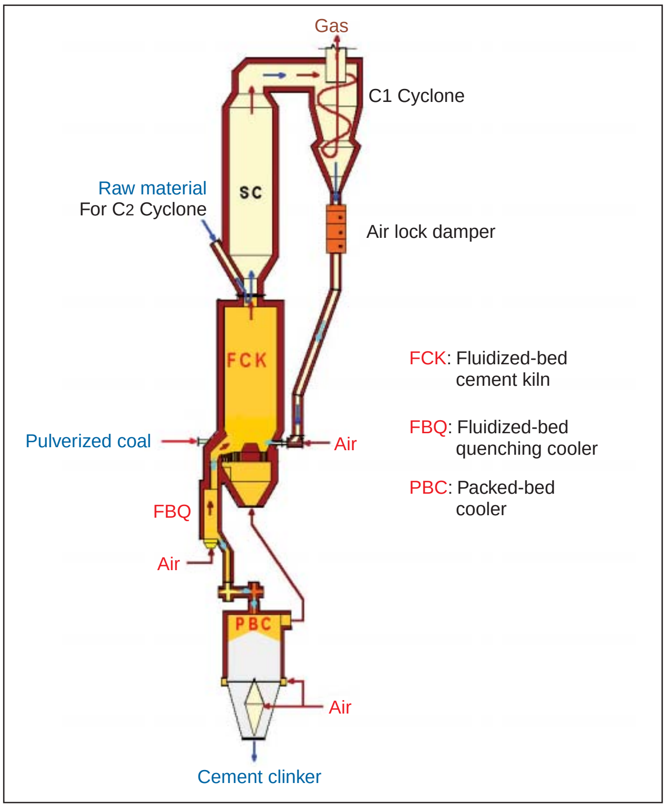

Fig. 1 FAKS process flowchart

3. Demonstration site and application

1) 200 t/day demonstration

[1] Demonstration site: Sumitomo Osaka Cement Co., Ltd.'s Tochigi plant
[2] Application: Cement production
[3] Development period: 1996 to 1998

2) 1,000 t/day demonstration

[1] Demonstration site: Shandong Paoshan Biological Building Materials Co., Ltd.
Liubo City, Shandong Province, China
[2] Application: Cement production
[3] Development period: 2005 to 2007

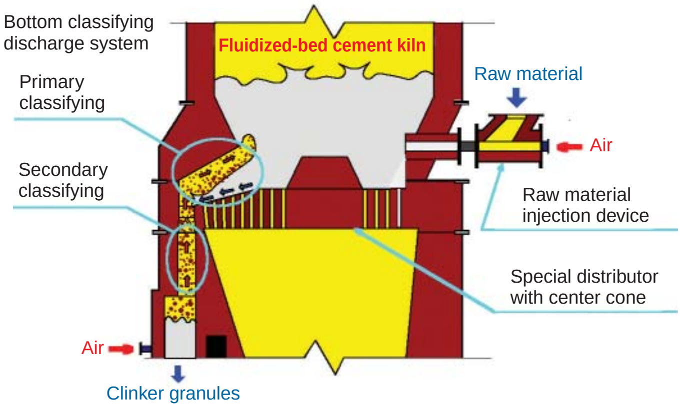

Fig. 2 Key technology

4. Demonstration site and application

A basic study of FAKS technology was originally launched in 1984 as a voluntary project by Kawasaki Heavy Industries, Ltd. and Sumitomo Osaka Cement Co., Ltd. Based on the results of the study, research and development have been sponsored since 1986 under a Coal Production and Utilization Technology Promotion Grant project of the Agency of Natural Resources and Energy of the Ministry of International Trade and Industry. In June of 1989, a 20 t/d pilot plant was constructed jointly by Japan Coal Energy Center, Kawasaki Heavy Industries, Ltd., and Sumitomo Osaka Cement Co., Ltd. The plant was subsequently put into test operation. The basic planning and design of a 200 t/d plant were jointly undertaken by Japan Coal Energy Center, and the Japan Cement Association in April 1993. This scaled-up plant was put into test operation for commercialization in February 1996. After the system was validated, test operations of the plant were completed at the end of December 1997.

NEDO also launched a joint demonstration project for a 1,000 t/d FAKS plant at Shandong Paoshan Biological Building Materials Co., Ltd. in Liubo City, Shandong Province, China, as an International Coal Utilization Project in May 2005.

5. Issues

A performance comparison between the conventional technology and FAKS for a 1,000 t/d commercial plant is shown in the Table 1 below. FAKS is expected to be commercially adopted as an innovative, alternative cement production technology.

Table 1 Comparison of environmental improvement effects of FAKS vs. a rotary kiln type process at a 1,000 t/d plant

Discharge quantity		Rotary Kiln & AQC	FAKS
NO_2 1% N and10% O_2 content in coal Emissions Rotary Kiln & AQC FAKS	Emissions (mg/Nm^3)	708	476
	Annual emissions (tons-NO_2/year)	341	233
CO_2* depends on electric power and fuel consumption	Emissions (g/Nm^3)	245	220
	Annual emissions (tons-CO_2/year)	118×10^3	108×10^3
Basis of calculation			
Production capacity	tons-clinker/day	1,000	1,000
	tons-cement/day	1,050	1,050
Annual operating time	days/year	330	330
Heat consumption	kJ/ton-clinker	$3,411 \times 10^3$	$2,993 \times 10^3$
Power consumption	kWh/ton-clinker	27	36
Exhaust gas specific quantity	Nm^3/kg-clinker	1.46	1.49
Lower calorific value of coal	kJ/kg-coal	25,116	25,116

*Based on IPCC: Guideline for National Greenhouse Gas Inventories, Reference Manual Carbon Emission Coefficient/Basic Calculation;
Carbon Emission Factor = 26.8 tC/TJ, Fraction of Carbon Oxidized = 0.98

Reference

1) Isao Hashimoto, Tatsuya Watanabe, et al., Development of Fluidized Bed Advanced Cement Kiln Process Technology (Part 9), The 8th Coal Utilization Technology Congress, Japan, September 1998.