

4B1. Multi-purpose Coal Conversion Technology (CPX*)

Research and development: Japan Coal Energy Center; Nippon Steel Engineering Co., Ltd.; JFE Steel Corp.; Sumitomo Metal Industries, Ltd.; Kobe Steel Ltd.; Ube Industries, Ltd.; Idemitsu Kosan Co., Ltd.; Nippon Steel Chemical Co., Ltd.
Project type: Subsidized coal production/utilization technology promotion
Period: 1996-2000 (5 years)

*Coal Flash Pyrolysis Process: CPX stands for Coal Pyrolysis suffixed with X, indicating diverse products.

Technology overview

1. Technological features

In an attempt to further expand coal's versatile uses, the aim of this project was to develop multi-purpose coal conversion technology with excellent efficiency, economic feasibility, and environmental-friendliness, mainly for the purpose of manufacturing medium-calorie gas as industrial fuel and liquid products as feedstocks for chemicals.

The technological objectives were as follows:

1. Moderate operational conditions

- A pyrolysis reactor operating at temperatures as low as 600-950°C.
- A reaction pressure of less than 1Mpa, much lower than several to tens of Mpa used in the coal liquefaction and hydro-gasification processes.

2. High overall thermal efficiency

- Flash pyrolysis of coal combined with a partial recycling of generated char to gasify more char, thereby improving thermal efficiency of the process.

3. Multiple varieties of coal

- Utilizing lower grades of coal, from sub-bituminous to highly volatile bituminous coal, as primary material to enable high gas/tar yields.

4. Efficient separation of coal ash

- Coal ash discharged from gasifier as molten slag and then granulated with water.

5. Diversified utilization of available products

- Among products, gas can be used as industrial fuel, liquids (light oil/tar) as feedstocks for chemicals, solid char as fuel or a reducer, and slag as a raw material for cement.
- Heating value of gas produced from the process to approach approximately 3,500kcal/Nm³.
- Combined yield of gas and liquid (light oil/tar) 70% or more of coal input.

6. Controllable yield of products

- A change in pyrolysis temperature (600-950°C) or type of coal allows product yields to be adjusted accordingly.

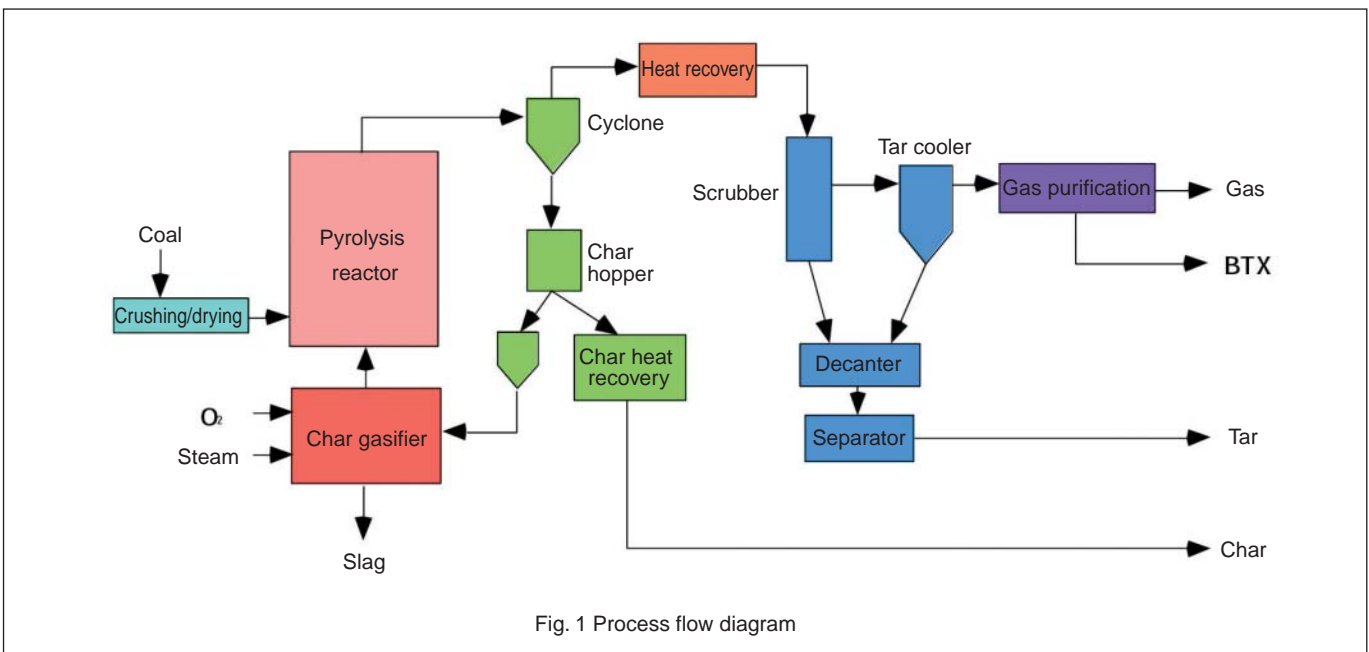


Fig. 1 Process flow diagram

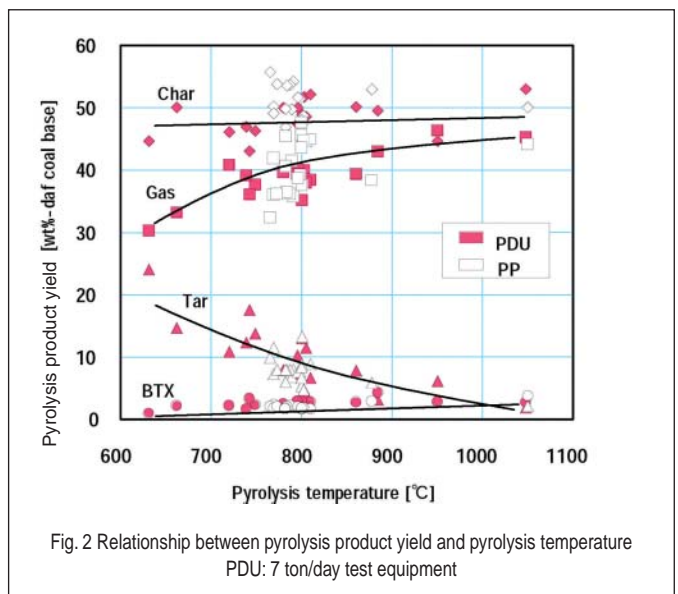
2. Summary of technology

This conversion process is characterized by higher overall thermal efficiency, achieved with a compact, low-pressure char/oxygen gasification system that combines the flash pyrolysis of coal and the partial recycling of pyrolyzed char to use the sensible heat of the char gasification gas as a heat source for the flash heating/pyrolysis reaction of pulverized coal (Fig. 1). The entrained-bed coal flash pyrolysis process has been developed to not only produce more high-value-added gas and liquid (tar and oil) with a coke oven gas (COG)-equivalent heating value, but also supplies the heat necessary for pyrolysis. Pulverized and dried coal (of about 50 μm in grain size) is injected into the pyrolysis reactor and mixed with 600-950°C gas and several atm. In a reaction lasting two seconds, the coal is flash heated/pyrolyzed. Part of the pyrolyzed solid char is recycled to the hot gas generation section (char gasifier) to be partially oxidized by oxygen and steam, thus allowing an approximately 1,500-1,600°C gas stream, mainly composed of CO and H₂, to be generated so that the sensible heat of the gas can be used to supply heat for the pyrolysis reaction. The pyrolysis reactor employs an up-flow system where the hot gas generated at this gasifier is fed from the lower part of the reactor and, after pyrolyzed coal is mixed, leaves the system at the reactor's upper part together with pyrolyzed products. A portion of the solid

product (char) separated at the cyclone is recycled to the char gasifier and the remainder is offered as a product after heat recovery. Heat is recovered from the gas containing pyrolyzed products until it cools down to approximately 350°C through an indirect heat exchange with thermal oil while tar passes the venture scrubber/tar cooler to be recovered. Pyrolysis gas is made available for use as industrial-purpose fuel gas after purification, such as through light oil (BTX) recovery and desulfurization. At the pilot plant (Photo 1), built within the Yawata Works of Nippon Steel Corp., tests were conducted mainly with a view to the evaluation/verification of process component/total system technologies to establish the technological basis for commercialization as well as to obtain data that would aid in the design of an actual plant (1,000t/d) and to evaluate its economic feasibility. In a period of two years, beginning in 1999, it was test-run ten times in all, achieving a maximum 210 hours of stable, continuous operation. During this period, the aforementioned features were verified, assuring the controllability of products at certain pyrolysis temperatures (Fig. 2) prior to completing the data collection process.



Photo 1 Pilot plant



References

- 1) Hiroyuki Kozuru et al., Advanced Clean Coal Technology Int'l Symposium, 2001.
- 2) Masami Onoda et al., 10th Annual Conference on Clean Coal Technology abstracts, 2000.
- 3) Shigeru Hashimoto et al., Pittsburgh Coal Conference, 2000.