4D1. Hyper-coal-based High-efficiency Combustion Technology (Hyper-coal)

Research and development: Japan Coal Energy Center; National Institute of Advanced Industrial Science and Technology; and Kobe Steel, Ltd.
Project type: Development and Survey of Next Generation Technology for Coal Utilization, promoted by New Energy and Industrial Technology Development Organization (NEDO)
Period: 2002-2007 (6 years)

Technology overview

1. Background and objectives

Because of abundant coal reserves, the expectations of a stable supply, and low cost, the demand for coal is expected to increase. The emission of CO_2 and other substances during the combustion of coal, however, has a more significant impact on the environment than does the use of other fossil fuels.

Given this, it is essential to decrease CO_2 emissions from coal-fired power plants, which account for a large percentage of the coal consumed. To do so, new power generation technology with higher thermal efficiency must be developed and disseminated worldwide.

If coal is directly utilized as a gas turbine fuel, the adoption of combined-cycle power generation systems (a combination of gas turbines and steam turbines) achieves more efficient power generation than existing pulverized coal-fired power generation. If impurities such as ash and alkali metals can be removed from coal, the clean coal can be used as fuel to be directly combusted in gas turbines.

NEDO is promoting the development of combined power generation technology, where coal treated by solvent extraction and ion exchange processes to remove the ash and alkali metals to obtain clean coal (Hyper-coal), can be directly combusted in gas turbines.

2. What is Hyper-coal?

A solvent with a high affinity to coal is applied during the ash extraction process. Ash present in the coal is removed from the solution though the use of a solid-liquid separation technology. Once the solvent is removed from the solution, the final product, Hyper-coal, has little ash content.

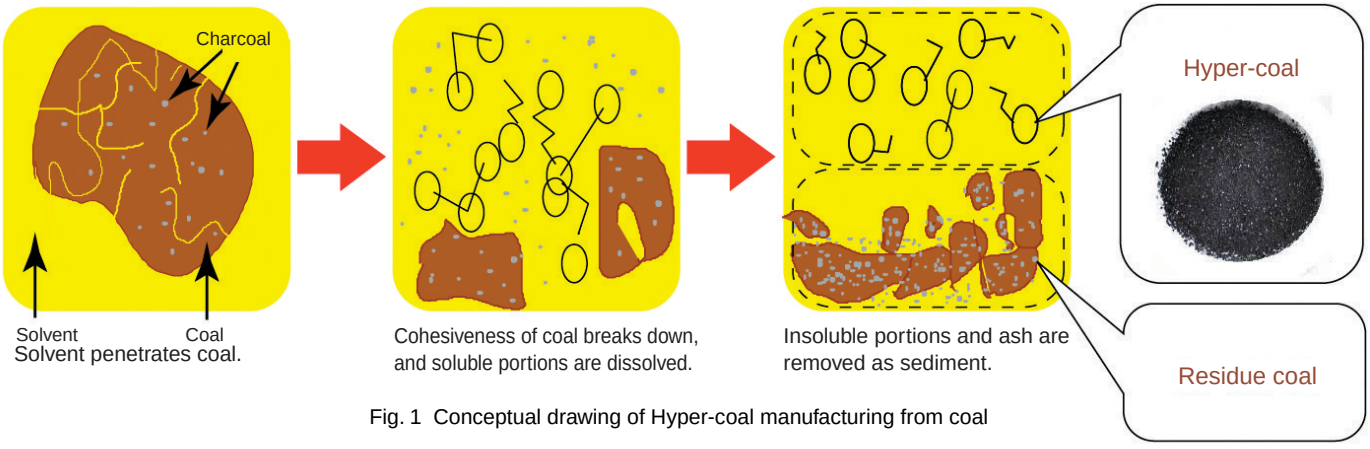


Fig. 1 Conceptual drawing of Hyper-coal manufacturing from coal

3. Hyper-coal production facilities

(1) Heating-extraction unit

Coal is first treated with a solvent, and then the solution is treated by a high-temperature filtration process to remove residue, thus producing Hyper-coal. (Design temperature: 500°C, design pressure: 3MPa) This unit can produce various grades of Hyper-coal samples.

Photo 1 Heating-extraction unit

(2) Solid-liquid separation unit

Pictured in Photo 2 is a settler with the ability to separate coal from the sediment, (design temperature: 500°C, design pressure: 5 MPa). Five vertically arranged valves collect samples to determine the sedimenting state of un-dissolved matter under pressurized and heated conditions.

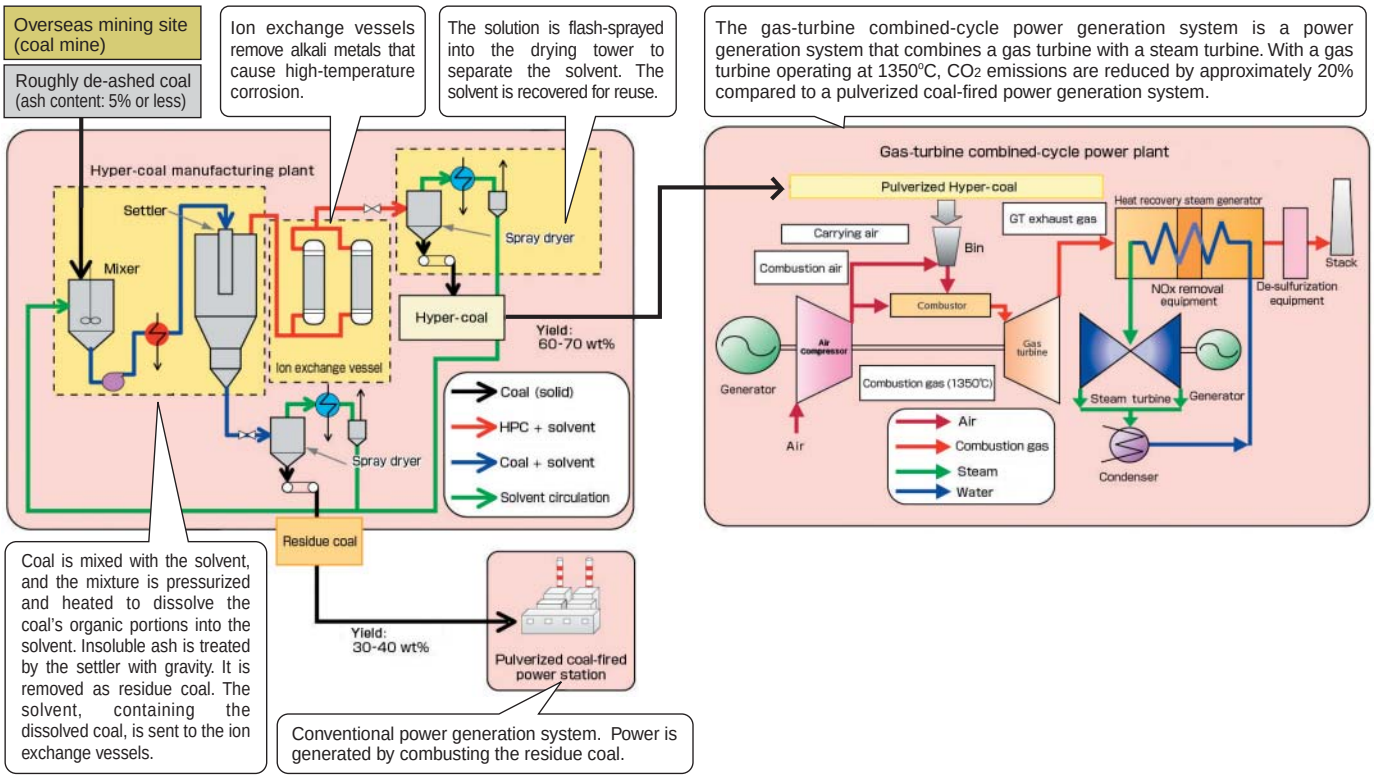
Photo 2 Solid-liquid separation unit

4. Features of Hyper-coal

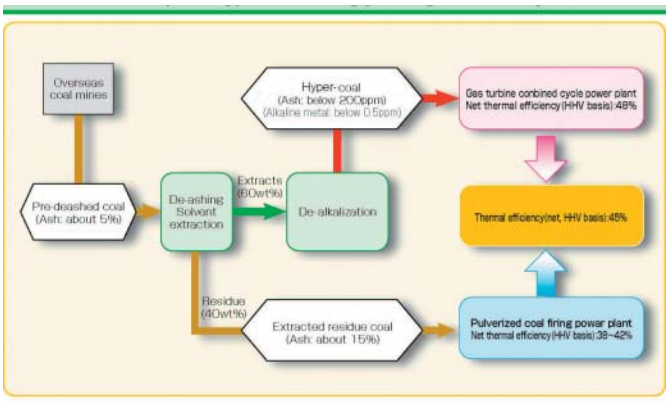
- Ash content is decreased to 200 ppm or less. The concentration of alkali metals (Na, K) is decreased to 0.5 ppm or less by ion exchange.
- Calorific value increased by approximately 10-20% versus that of original coal.
- Inorganic sulfur is completely removed.
- Heavy metal content is significantly decreased to 1/100 or less.
- Residue coal, which amounts to 30-40% of original quantity of coal, can be used as steam coal.
- Low production costs: about $100/ton of Hyper-coal (HPC).
- HPC has excellent ignitability and combustion properties.
- HPC exhibits good thermal plasticity, and is a good carbon material for direct reduced iron and for smelting nonferrous metals.
- Since HPC is rich in volatile matter and is free from ash, it is an excellent gasification feedstock, and it is expected to improve the efficiency of gasification.

Photo 3 Test apparatus for continuous manufacturing of Hyper-coal

5. Configuration of Hyper-coal-based high-efficiency power generation system



6. Concept of Hyper-coal based power generation system



7. Research and development timetable