# 5C1. Coal Ash Generation Process and Application Fields

## Technology overview

### 1. Background and general status of generation process

Coal ash has, since it was commercialized as a cement admixture in the first half of the 1950's, been widely used in applications such as a raw material for cement, cement mixtures, roadbed material, backfilling material, and embankment material, finding its way mostly into the cement sector, particularly, as a clay-alternative raw material for cement.

Coal combustion methods are roughly divided as follows:

(1) Pulverized coal combustion (dry-type)
(2) Stoker firing
(3) Fluidized-bed combustion
(4) Circulating fluidized-bed combustion

### 2. Generation rate

According to a survey conducted by the Center for Coal Utilization in 2003, the coal ash generation rate in Japan was 9.87 million tons a year, up 6.8%, or 630,000 tons, from the preceding year. Most coal-fired boilers for the electric utility industry are combusting pulverized coal. In addition, in general industries, 132 One-MW or larger coal-fired boilers are in operation, a majority of which combust pulverized coal. In terms of boiler capacity (steam generation rate), 50-ton/hr or smaller boilers are mostly of a stoker combustion type while many of the 100-ton/hr or larger boilers combust pulverized coal. Figure 2 shows changes in the rate of coal ash utilization and generation from electric power utilities and One-MW or larger installed power generation plants in general industries from 1993 through 2003.

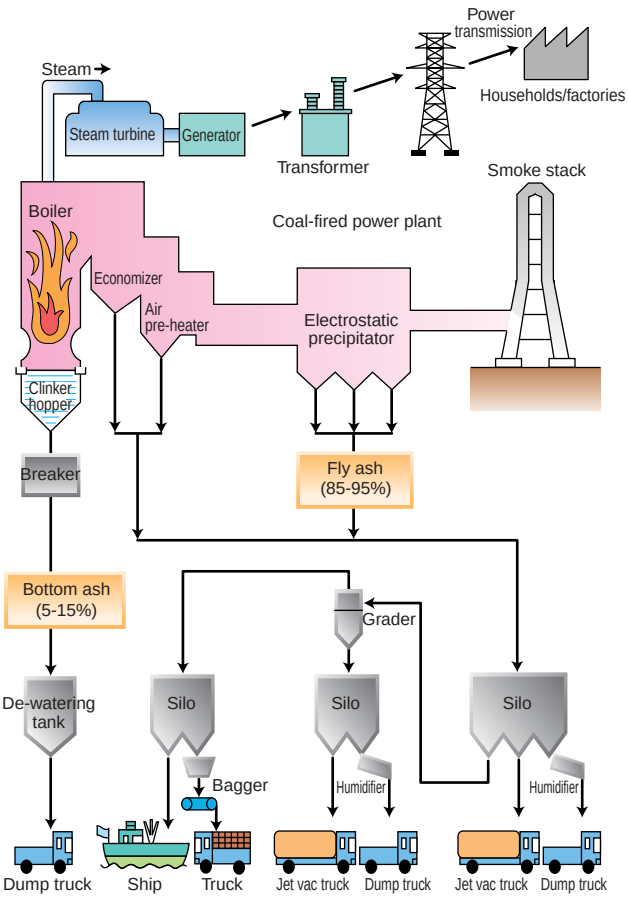


Fig. 1 Coal ash generation from a pulverized coal-fired boiler
Source: Japan Fly Ash Association

### 3. Composition of coal ash

In Japan, 90% or more of the coal ash generated is from pulverized coal combustion, dwarfing the 7% or so from fluidized-bed and some 1-2% from stoker combustion. The generation ratio of fly ash to clinker ash (bottom ash) is 9:1.

As for the shape of coal ash particles, low-melting point ash is often globular while much of high-melting-point ash is indeterminate in shape. The average grain size of fly ash from pulverized coal combustion is approximately 25$\mu$m, similar to silt in fineness, between finer clay and coarser fine-grained sand for use as a soil material.

The chemical composition resembles mountain soil, with two inorganic components, silica ($SiO_2$) and alumina ($Al_2O_3$), comprising 70-80% of the total composition. Other than these, ferric oxide ($Fe_2O_3$), magnesium oxide (MgO), and calcium oxide (CaO) are also contained in slight amounts. In Japan, the composition of coal varies widely since 100 or more varieties of coal are imported from all over the world.

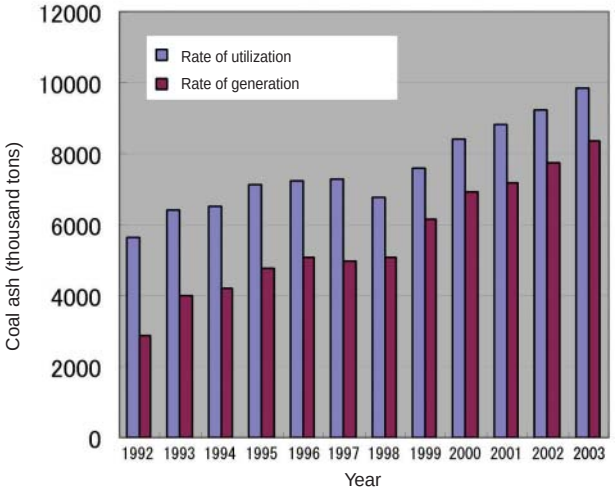


Fig. 2 Changes in coal ash generation and utilization rates

### 4. Application fields

Table 1 shows the effective utilization of coal ash in FY2003 by field. Usage in the cement industry is increasing annually. Of the 8.38 million tons used, the cement industry accounted for 6.33 million tons, or 75.5%. Recently, however, cement production has been declining and the prospects for substantial future increases are not bright. To cope with a likely increase in coal ash in the future, expanding utilization in other sectors will be important. In particular, the civil engineering field is expected to use more coal ash because of its high potential for consuming large quantities.

Table 1 Breakdown of fields for the effective use of coal ash (2003)

(Unit: thousand tons)

| Total | | Electric utilities | | General industry | | Total | |
|---|---|---|---|---|---|---|---|
| Field | Application | Rate of utilization | Composition ratio (%) | Rate of utilization | Composition ratio (%) | Rate of utilization | Composition ratio (%) |
| Cement | Cement raw material | 4,354 | 71.32 | 1,522 | 66.90 | 5,876 | 70.12 |
| | Cement mixture | 149 | 2.44 | 159 | 6.99 | 308 | 3.68 |
| | Cement admixture | 95 | 1.56 | 48 | 2.11 | 143 | 1.71 |
| | Sub-total | 4,598 | 75.32 | 1,729 | 76.00 | 6,327 | 75.50 |
| Civil engineering | Foundation improving material | 138 | 2.26 | 104 | 4.57 | 242 | 2.89 |
| | Civil work | 103 | 1.69 | 25 | 1.10 | 128 | 1.53 |
| | Power supply construction | 79 | 1.29 | 0 | 0.00 | 79 | 0.94 |
| | Roadbed material | 50 | 0.82 | 110 | 4.84 | 160 | 1.91 |
| | Asphalt/filler material | 9 | 0.15 | 0 | 0.00 | 9 | 0.11 |
| | Coal mine filling material | 204 | 3.34 | 0 | 0.00 | 204 | 2.43 |
| | Sub-total | 583 | 9.55 | 239 | 10.51 | 822 | 9.81 |
| Construction | Construction materials (boards) | 213 | 3.49 | 164 | 7.21 | 377 | 4.50 |
| | Artificial light-weight aggregate | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| | Secondary concrete product | 18 | 0.29 | 1 | 0.04 | 19 | 0.23 |
| | Sub-total | 231 | 3.78 | 165 | 7.25 | 396 | 4.73 |
| Agriculture/ forestry/fisheries | Fertilizer (including snow melting agent) | 53 | 0.87 | 26 | 1.14 | 79 | 0.94 |
| | Soil conditioner | 11 | 0.18 | 82 | 3.60 | 93 | 1.11 |
| | Sub-total | 64 | 1.05 | 108 | 4.75 | 172 | 2.05 |
| Others | Sewage treatment agent | 4 | 0.07 | 1 | 0.04 | 5 | 0.06 |
| | Steel making | 13 | 0.21 | 8 | 0.35 | 21 | 0.25 |
| | Others | 612 | 10.02 | 25 | 1.10 | 637 | 7.60 |
| | Sub-total | 629 | 10.30 | 34 | 1.49 | 663 | 7.91 |
| Total | | 6,105 | 100.00 | 2,275 | 100.00 | 8,380 | 100.00 |

References

1) The Center for Coal Utilization, Japan (now known as JCOAL): National Coal Ash Fact-Finding Survey Report (2003 results), 2005.
2) Environmental Technology Association/the Japan Fly Ash Association Coal Ash Handbook 2000 Edition, 2000.
3) Nobumichi Hosoda: CCUJ, Coal Ash Utilization Symposium lecture collection, 1998.
4) Natural Resources and Fuel Department, the Agency for Natural Resources and Energy: Coal Note (2003 edition), 2003.