Ecocement

New recycling resources reborn for an affluent future

What is Ecocement?

Ecocement, a coinage associated with Ecology and Cement, is a new type of cement produced from municipal incineration ash, sewage sludge and additional limestone and clay.

There are two types of Ecocement, Ordinary type and Rapid hardening type.

Ordinary type Ecocement

Ordinary type Ecocement, having virtually the same performance as Ordinary Portland cement, can be applied to reinforced concrete structures or a variety of other uses including as soil stabilizer or solidifying agent for sewage sludge.

Rapid hardening type Ecocement

Rapid hardening type Ecocement can be used in the non reinforcing concrete market, taking advantage of its rapid hardening property, which strengthens quicker than high early strength Portland cement.

Municipal incineration ash contains minerals that are all essential for producing Portland cement. (See Table 1) However, its high chlorine content makes it an obstacle to use it as a raw material in Portland cement. We have found an effective way of removing the chlorine together with accompanying heavy metals, thereby developing Ordinary type Ecocement whose chemical composition is similar to that of Ordinary Portland cement.

Rapid hardening type Ecocement, on the other hand, turns the chlorine into a useful component of a special cement clinker mineral($C_{11}A_7CaCl_2$) which has a very fast hardening property being a match for Jet Cement.

History of Eco cement

The research project on Ecocement started in 1994, the Ecocement manufacturing technology was established in 1997. The first and second Eco-cement plants started operation in 2001 and 2004, respectively.

Chemical composition of raw materials and incineration ash

(Table 1) (%)

material \ Chemical composition	CaO	SiO_2	Al_2O_3	Fe_2O_3	SO_3
Ordinary Portland cement	62~65	20~25	3~5	3~4	2~3
Incineration ash	12~31	23~46	13~29	4~7	1~4
raw material: Limestone	47~55				
raw material: Clay		45~78	10~26	3~9	
raw material: Silica sand		77~96			
raw material: Iron				40~90	
raw material: Gybsum	28~41				37~59

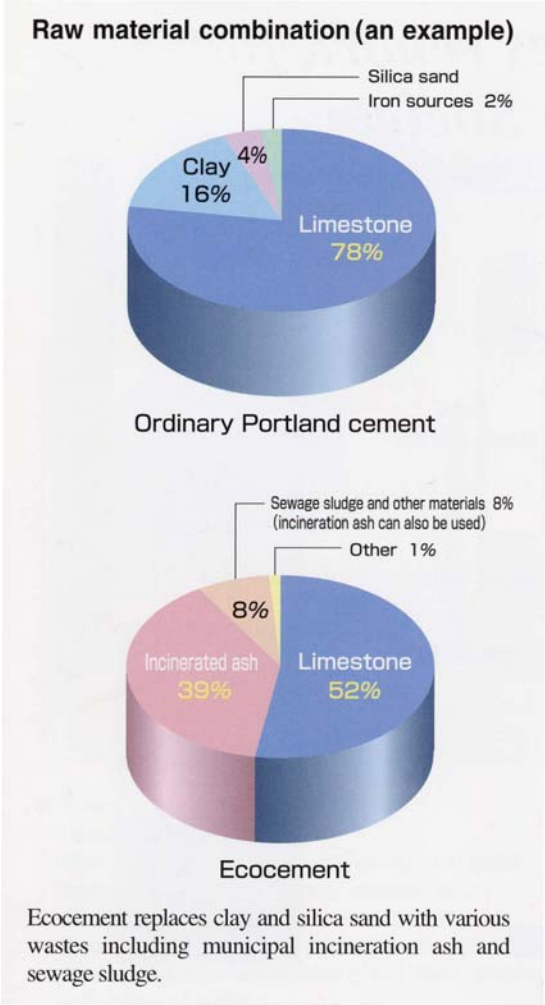
(Table 2) (%)

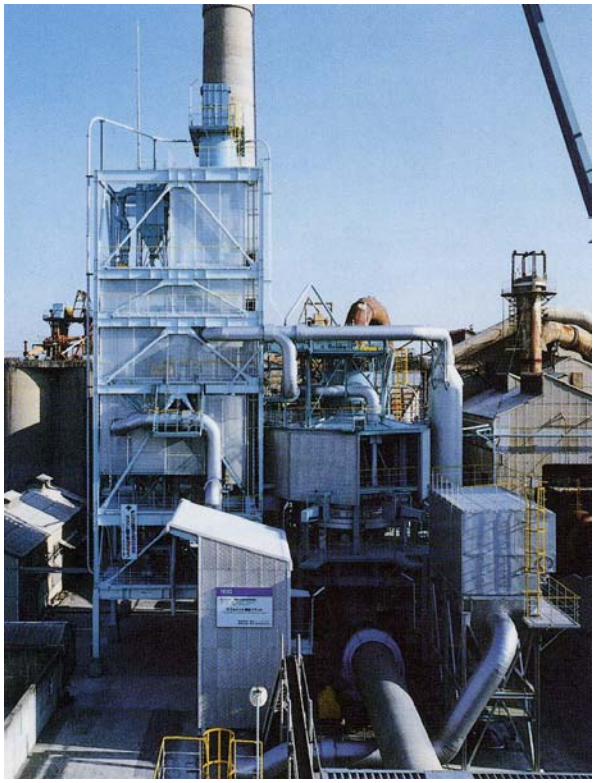
material \ Chemical composition	ig.loss	SiO_2	Al_2O_3	Fe_2O_3	CaO	SO_3	R_2O	Cl
Ordinary type Ecocement	1.1	17.0	8.0	4.4	61.0	3.7	0.26	0.04
Rapid hardening type Ecocement	0.8	15.3	10.0	2.5	57.3	9.2	0.50	0.90
Ordinary Portland cement	1.5	21.2	5.2	2.8	64.2	2.0	0.63	0.01

(%)

material \ Physical properties	C_3S	C_2S	C_3A	$C_{11}A_7 \cdot CaCl_2$	C_4AF	$CaSO_4$
Ordinary type Ecocement	49	12	14	0	13	6.3
Rapid hardening type Ecocement	44	10	0	17	8	16.0
Ordinary Portland cement	56	19	9	0	9	3.4

◆ $C_3S=3CaO \cdot SiO_2$、$C_2S=2CaO \cdot SiO_2$、$C_3A=3CaO \cdot Al_2O_3$、$C_{11}A_7 \cdot CaCl_2=11CaO \cdot 7Al_2O_3 \cdot CaCl_2$、$C_4AF=4CaO \cdot Al_2O_3 \cdot Fe_2O_3$

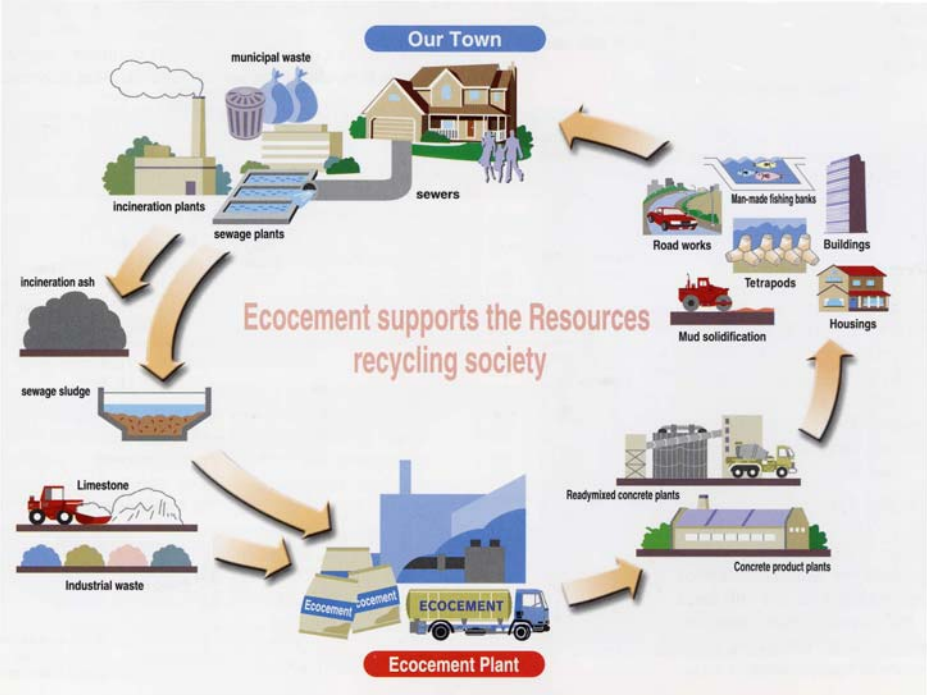


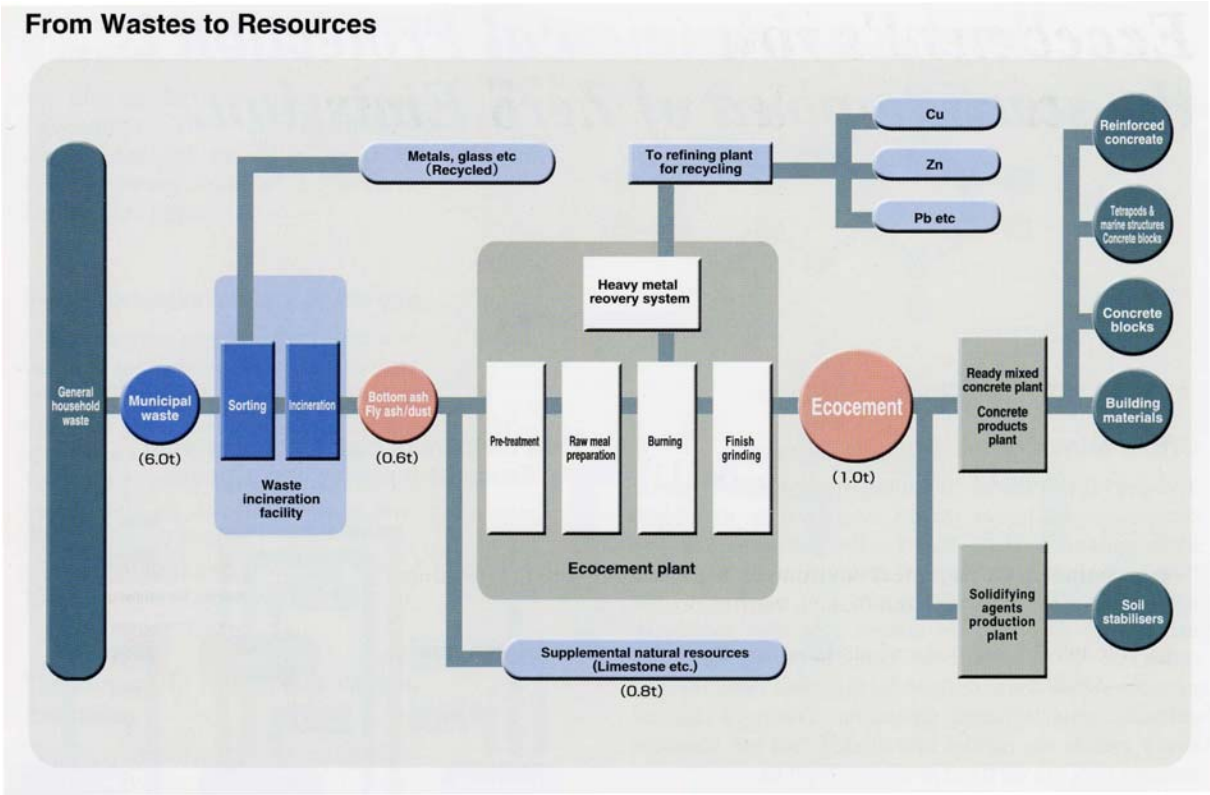


Ecocement experimental plant

Ecocement process:

- produces cement appropriate for a variety of uses due to its stable quality,
- makes contaminants in municipal waste harmless,
- is an excellent Zero-Emission production process.
- is equipped with a perfect environmental protection system including heavy metal recovery and flue gas purification.
- prolongs the life of precious landfill sites and greatly contributes to the Resources Recycling Society.

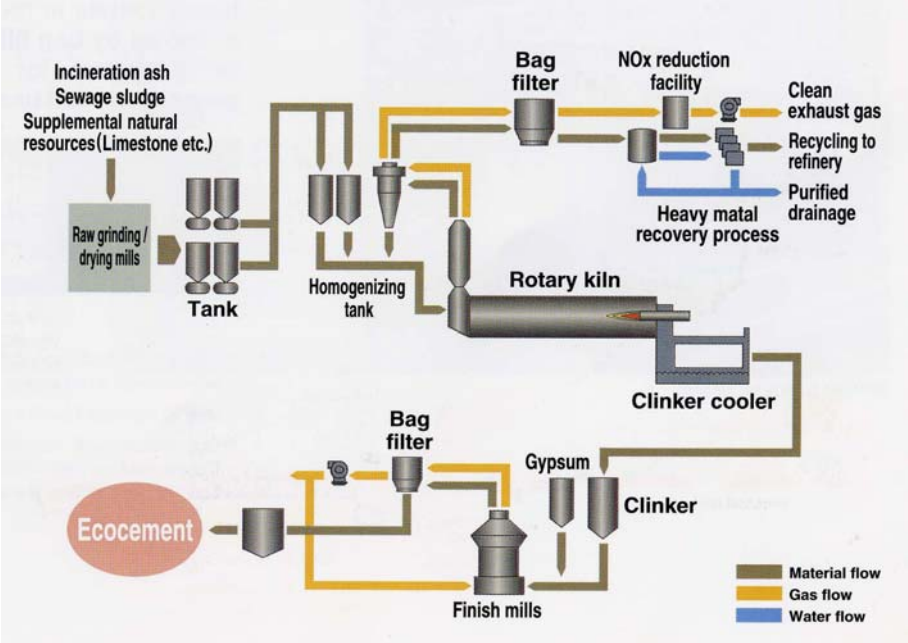


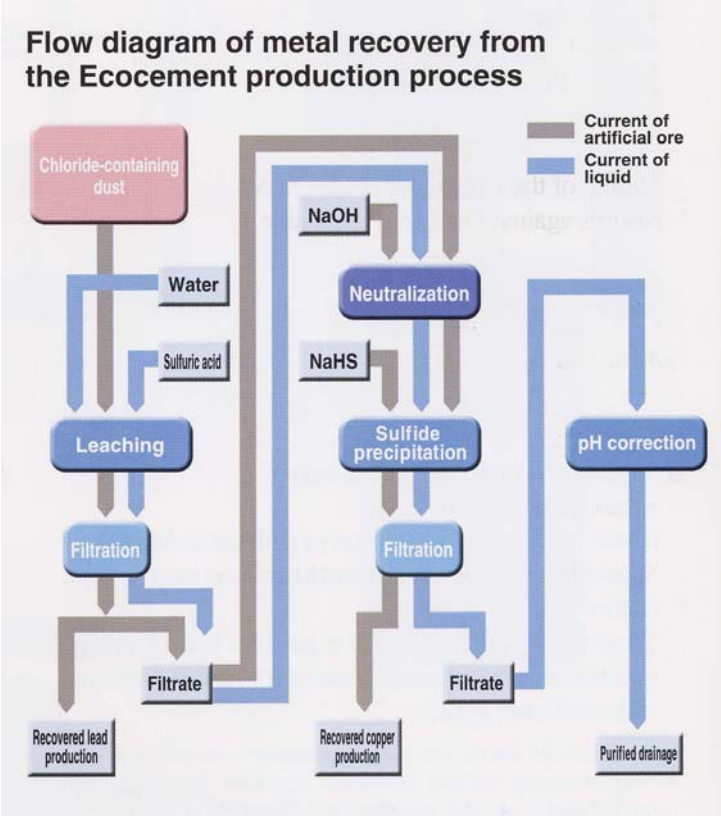


- Typical raw material combination
  Municipal incineration ash: 0.6ton (generated from 6.0 tons of garbage and trash)
  Supplemental natural resources (Limestone, etc) : 0.8 tons
  These raw materials are used to produce Ecocement by grinding and subsequent burning and finish grinding with additional gypsum.
- Ecocement substitutes calcium oxide in incineration ash for a part of limestone (calcium carbonate) which is required for producing cement, thus reducing de-carbonation energy and CO_2 emission.

Process flow

To prevent cement clinker from heavy metal contamination, heavy metals contained in municipal incineration ash are maximally separated from the flue gas stream in the form of metal chloride. Separated metal chlorides are concentrated and purified to the extent that they can be reprocessed as useful metals in refineries. In this way, the Ecocement process saves precious metal resources and at the same time, realizes enhanced environmental protection. Traces of residual heavy metals are melted into clinker, but are harmless because they are all fixed in clinker crystals.





Property of Ecocement

Table 1, Figure 1 and 2 comparatively show the physical properties and the setting/hardening properties of Ecocement (Ordinary type and Rapid hardening type) and Ordinary Portland cement.

Ordinary type showed the setting time and strength development to be similar to Ordinary Portland cement. Rapid hardening type develops strength very fast. (3-hour compressive strength of 12N/mm^2)

Physical properties of Ecocement

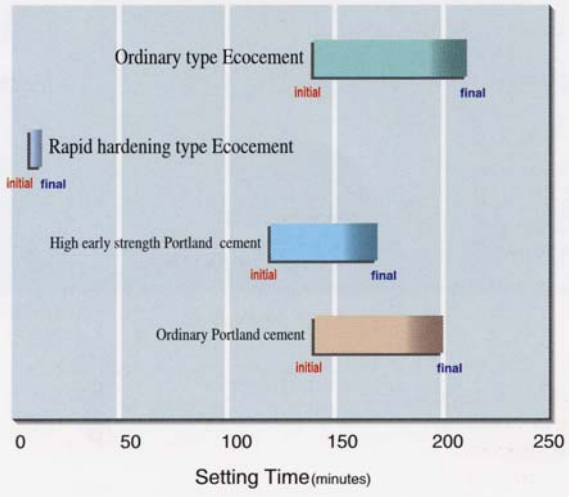
(Table 1)

type of cement	density (g/cm^3)	specific surface area (cm^2/g)	setting (hr:min)		compressive strength (N/mm^2)			
			initial	final	1d	3d	7d	28d
Ordinary type Ecocement	3.16	4,300	2:20	3:30	10.0	27.0	40.0	55.0
Rapid hardeningtype Ecocement	3.13	5,300	0:09	0:13	25.0	38.0	52.5	58.0
High early strength Portland Cement	3.13	4,340	2:03	2:50	27.0	43.0	57.0	65.0
Ordinary Portland Cement	3.15	3,220	2:22	3:20	14.5	27.5	43.0	59.0

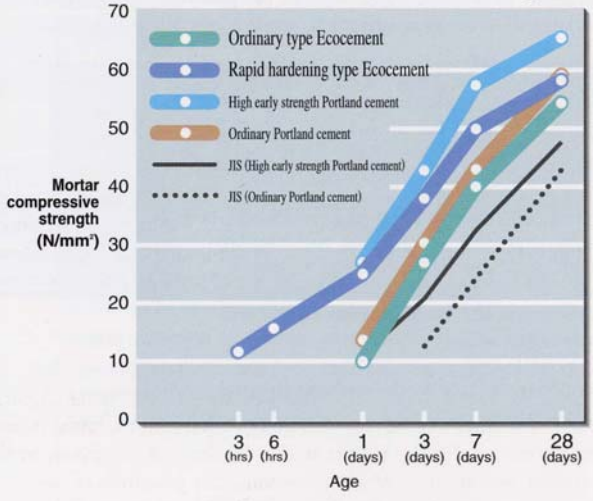
The setting and hardening of Ecocement

Physical test results according to JIS R 5201

Comparison of setting time (Figure1)



Mortar compressive strength (Figure2)



Examples of applications

Interlocking blocks at Hitachi Seaside National Park

Tetrapods set by Mikawa Harbor Office, Aichi prefecture

Soil stabilization using Geoset Eco, cooperatively developed
by the Ministry of agriculture, Forestry and Fishery of Japan and Taiheiyo.

from the pamphlet of Taiheiyo Cement Corporation