Development of Novel Environmentally-Friendly Waste Incinerator System Using Steam Recovery Membranes

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[Abstract]

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In Japan, about 80% of general waste is incinerated. General waste contains approximately 50% moisture, which is discharged from the chimney as exhaust gas from incineration, and in furnaces that are not equipped with a boiler to reduce the temperature below 200°C, about twice as much water is sprayed on the waste to reduce the temperature from about 850°C at the outlet of the incinerator to below 200°C.

This study proposes a waste incineration treatment system that recovers and reuses water vapor contained in combustion exhaust gas (process temperature: 150-170°C) using bis(triethoxysilyl)ethane (BTESE) -derived organosilica membranes. The system enables "water production from flue gas," which not only saves and creates water at waste incineration facilities by reusing and recycling water, but also enables effective utilization of energy by recovering the latent heat of condensation of the water vapor.

A new organosilica membrane with excellent hydrothermal stability, BTESE/i-BTESE membrane, which consist of organosilica subnaoporous layer coated on nanoporous organosilica layer, was successfully developed and used for long-term tests of water vapor recovery from simulated exhaust gas. The BTESE/i-BTESE membrane was tested at 150°C under 50 kPa water vapor partial pressure with 40 ppm of HCl for 112 days, and then at 200°C and 50 kPa water vapor partial pressure for 78 days (total of more than 6 months), and it was found that the BTESE/i-BTESE membrane was stable with maintaining high steam permeance of $2x10^{-6}$ mol/(m^2 s Pa) with high N_2/H_2O selectivity over 200, which are beyond the target values.

A water recovery process was designed based on the silica membrane performance developed in sub-theme 1. A membrane separation unit was fabricated and implemented in a plant currently in operation, and bench tests were conducted. In addition, we will compare the proposed process with other possible water recovery processes, evaluate its economic feasibility, and simulate CO_2 and water reductions in an actual plant scale to clarify the superiority of the proposed process.

[References]

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