

Radiation Processing of Flue Gases

Flue Gas Treatment

- Flue gases (e.g., gases produced on burning of coal) contain oxides of nitrogen and sulfur (NO_x , SO_x)
- NO_x and SO_x are harmful to the environment (acid rain, damage to plants, detrimental to fish in lakes)
- Conventional methods (e.g., treatment with CaO) are cumbersome and only remove SO_x
- The Ebara Process (electron irradiation of flue gases) can remove > 90% of both SO_x and NO_x

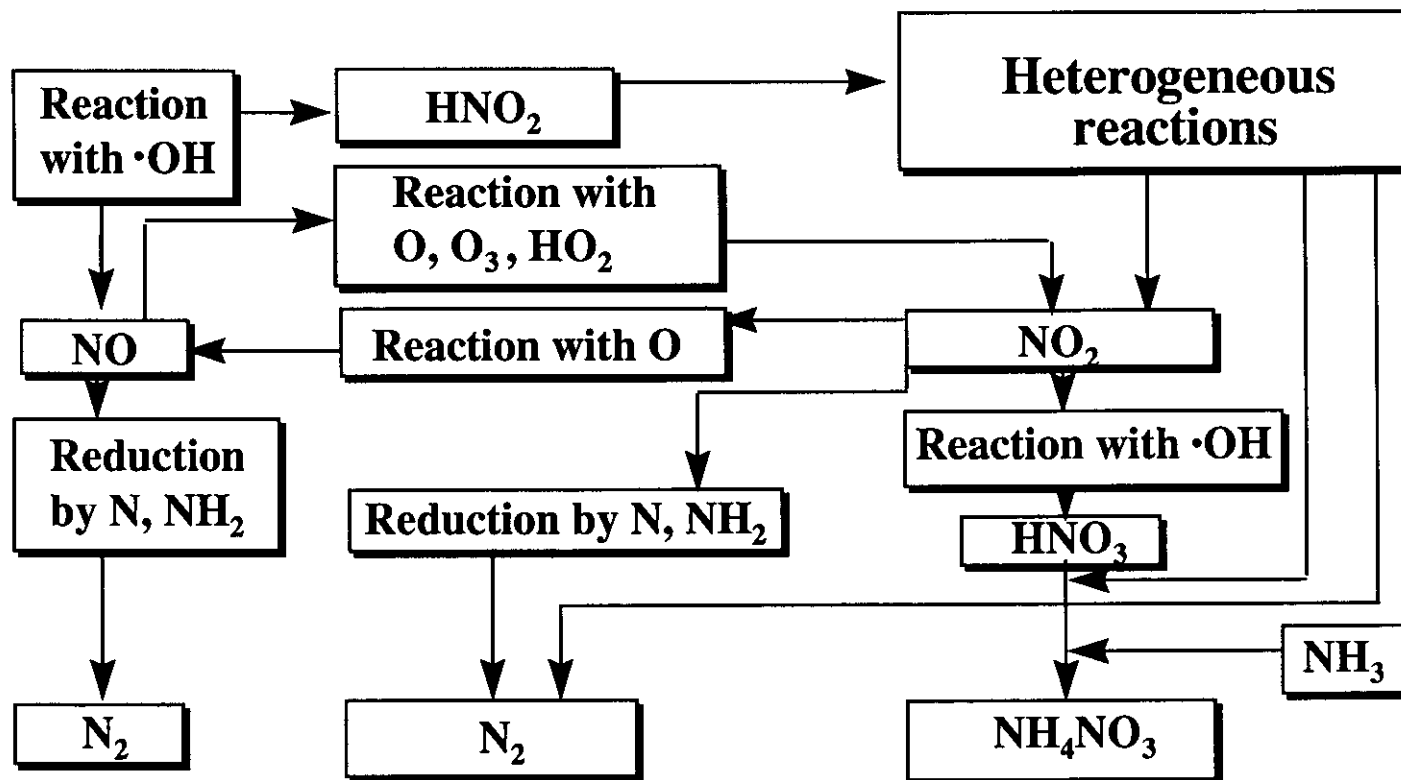
Essentials of the Ebara Process

- **Conversion of SO_2 and SO_3 to $(\text{NH}_4)_2\text{SO}_4$**
- **Conversion of NO_x to NH_4NO_3**
- **Separation and purification of $(\text{NH}_4)_2\text{SO}_4$ and NH_4NO_3 for use as fertilizer**
- **A very large scale process for electron irradiation**

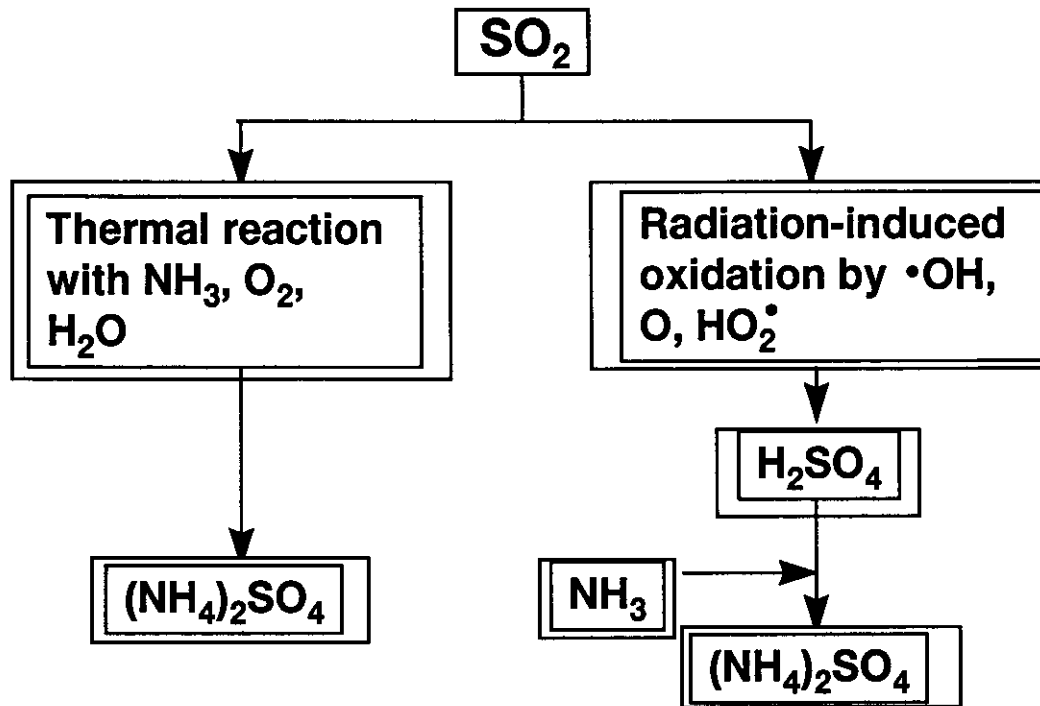
Demonstration Work on Flue Gas Irradiation

- **Japan, Ebara Co., 0.75 MeV, 45 kW electron accelerator, $3-10 \times 10^3$ m³/h flue gas treated, 10-15 kGy (1977-78)**
- **Indianapolis, USA, 1985; 0.8 MeV, 2 x 80 kW; $1.6 - 3.2 \times 10^4$ m³/h**
- **Karlsruhe, Germany, 1985; 0.3 MeV, 2 x 90 kW, $1- 2 \times 10^4$ m³/h**
- **Kaweczyn, Poland; 0.5-0.7 MeV, 2 x 50 kW; 2×10^4 m³/h**
- **Commercial plant being built in Poland**

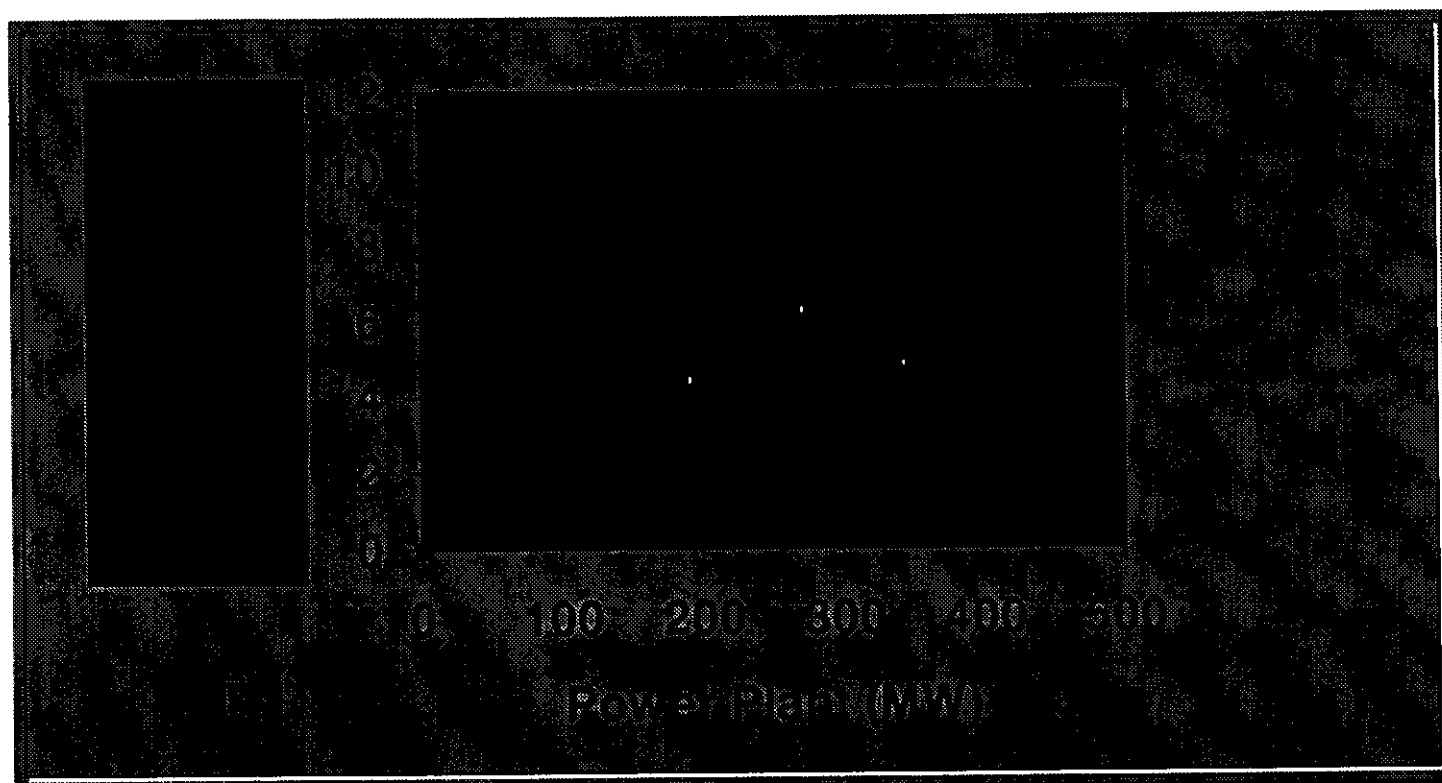
Main Reactions for the Removal of NO and NO₂ From Flue Gases (Ebara Process)



Main Reactions for the Removal of SO_2 from Flue Gases (Ebara Process)



Electron-Beam Power Required to Purify Flue Gases Using the Ebara Process



(Woods and Pikeav, 1994)

Future of Radiation Processing for Better Environment

- **Increasing use of radiation processing for dealing with environmental pollution is warranted**
- **Sewage treatment, flue gas treatment and purification of drinking water potential candidates for radiation processing technology**
- **Reduction in cost of radiation processing (cheaper electron accelerators) would help increased use of radiation processing in these areas**