

Advanced Design Project in Mongolia: Germanium from Coal Ash



TECHNISCHE
UNIVERSITÄT
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At the German-Mongolian Institute for Resources and Technology in Nalaikh, Mongolia
Face-to-face from May 6, 2024, to May 17, 2024

Germanium within the Global Economy

Germanium is an element of strategic importance. The European Union lists germanium in the list of Critical Raw Materials [1], and the National Academy of Sciences in the U.S. considers the element as critical [2]. For Germany, Germanium is the raw material with both the highest supply risk and the highest vulnerability [3].

Germanium Use

Germanium is primarily used in the semiconductor industry, for optical glass fibers, infrared optics, and as a catalyst in the production of PET plastics. Radar sensors and night vision assistants in cars contain germanium. Photovoltaics based on germanium are twice as efficient (40%) as photovoltaics based on silicon (20%). As the Ge-based cells are very expensive, they are currently mainly used in space.

Germanium Winning

Coal ash contains up to 0.1 wt.% germanium. The germanium is leached with acids, precipitated as GeS_2 , converted to GeCl_4 , distilled, hydrolyzed, and reduced with H_2 to give metallic germanium.

Design Task

Interdisciplinary teams of American, German, and Mongolian chemical engineers, process engineers, mechanical engineers, electrical engineers, and industrial engineers design a production plant for the production of 20 t/a of germanium metal. The design follows the German design methodology [4].

The task comprises:

- Basic flowsheet on the functional level
- Mass balance using Nagiev's method
- Process flowsheet on the physics level
- Design and sizing of exemplary reactors, apparatus, and machinery
- Exemplary HAZOP analysis
- Process control and automation
- Partial P&I flowsheet on the embodiment level
- Cost estimation
- Written report and oral presentation

Information

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Fachgebiet Nano- und Mikrofluidik



Nano- and
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