Contribution ID: **293** Type: **Poster Presentation**

Effect of gas volume expansion on carbothermic reaction of phosphoric acid to produce white phosphorus

Tuesday 7 October 2025 19:39 (1 minute)

White phosphorus is one of element listed by European Union (EU) as strategic substance that facing supply crisis. Therefore, method to recover phosphorus from various resources such as steel slag, sewage sludge, and semiconductor waste is urgently needed for a stable white-phosphorus supply.
We propose a novel approach for white phosphorus production through the carbothermic reduction of waste phosphoric acid. To implement and optimize production process, the mechanism of reduction needs to elucidate because this reduction is special, where high volumes of gases are generate (1 mole H3PO4 to 16 moles CO, 6 moles H2, and 1 mole P4) For that purpose, we conducted experiment using two types of carbon material, activated carbon (AC) and metallurgical cokes (MC), where AC have two order larger surface area compare to MC. However, despite the two order larger surface area, the reduction degree of MC is comparable to AC. It is concluded that reaction in the pores is not dominant and mainly occurred at the external surface (packed bed surface area).
To understand the H3PO4 carbothermic reduction mechanism in the packed bed, the reaction model considering the gas volume expansion in the packed bed (as the function of the packed-bed height), was developed. The proposed reaction model, reasonably agree with the experimental values, indicating the validity. In the case of AC, the carbon at the top of the packed bed is rapidly consumed during the carbothermal reduction of H3PO4 and that the packed-bed height decreases rapidly, compared to MC. Therefore, for stable, industrial-scale white-phosphorus production, an adequate supply of carbon material to replenish the depleting material is necessary.

Primary author: SIAHAAN, Andrey Stephan (New Industry Creation Hatchery Center, Tohoku University, Japan)

Co-authors: Dr ISHIHARA, Shingo (New Industry Creation Hatchery Center, Tohoku University, Japan); Prof. NAGASAKA, Tetsuya (New Industry Creation Hatchery Center, Tohoku University, Japan); Dr SASAKI, Yasushi (New Industry Creation Hatchery Center, Tohoku University, Japan)

Presenter: SIAHAAN, Andrey Stephan (New Industry Creation Hatchery Center, Tohoku University, Japan)

Session Classification: Poster Session

Track Classification: Environmental and energy aspects in iron and steelmaking