A COMPREHENSIVE NUMERICAL ANALYSIS OF THE INDUSTRIAL REDUCTION OF TUNGSTEN OXIDES

Alvaro Antonio ESTUPINAN DONOSO and Bernhard PETERS
Université du Luxembourg. Faculté des Sciences, de la Technologie et de la Communication, Campus Kirchberg, 6, rue Coudenhove-Kalergi
L-1359, Luxembourg, Luxembourg
alvaro@estupinan.net

ABSTRACT

Tungsten oxides (WOx) are industrially reduced by streaming hydrogen (H_2) in excess over it. The incoming H_2 diffuses into the WO_x-bed, reacts with the oxides and water vapor is produced. Retention of water vapor is a non-desirable phenomenon since vapor may react with the existing oxides forming volatile compounds (e.g. $WO_2(OH)_2$) that are transported and further deposited in lower oxides. The above-mentioned transport and deposition mechanism is responsible for abnormal tungsten grain growth. Such abnormalities may act as breakage points for tungsten carbide-made products. This contribution, presents an effort in the prediction of such volatilization and further deposition of tungsten oxides. Thus, it offers a new insight on grain size evolution upon industrial WO_3 reduction.

Herein, the eXtended Discrete Element Method (XDEM) concept is implemented to describe and obtain detailed information about tungsten oxide reduction in, both, dry and wet hydrogen atmospheres. In the previous POWDERMET edition, the XDEM (eXtended Discrete Element Method) framework was presented as a novel and promising technique to model tungsten-oxides reduction by comparison with laboratory experimentation. This research relies on XDEM to represent the temporal and spatial thermochemical conversion and gaseous species transport arising in the course of industrial reduction of tungsten oxides.

The evolution of the chemical conversion of tungsten oxides, as well as predictions for the resulting water vapour will be presented and discussed. In addition, predictions are compared with experimentation for the industrial reduction of tungsten trioxide under industrial conditions. Hence, it is shown that this new and comprehensive technique is capable of representing the different thermochemical processes as well as the fluid flow involved in the industrial reduction of tungsten oxides.