

## **Influence of silica and alumina ( $\text{SiO}_2 + \text{Al}_2\text{O}_3$ ) on thermal conductivity of synthetic coal slags**

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Entrained flow coal gasification is most widely used in the production of numerous chemicals and shows favorable prospects on the Integrated Gasification Combined Cycle (IGCC). In a water-cooling membrane wall entrained flow gasifier, molten slag deposited on refractory material would accumulate a protection layer against the high operating temperatures. The thermal conductivity of slag layer is an important factor affecting the heat transfer of membrane wall in the gasifier. The  $\text{SiO}_2$ - $\text{Al}_2\text{O}_3$ - $\text{CaO}$ - $\text{Fe}_2\text{O}_3$ - $\text{MgO}$  synthetic coal slags with mass ratio of silica and alumina (silica/alumina keeps constant) ranging from 35 to 85 wt. % were prepared for measurement of thermal conductivity using the non-stationary hot wire method. Bulk quenching samples were produced in a high temperature quenching furnace and analyzed by XRD to determine phases. Raman and infrared spectroscopy were combined to investigate the microstructure of the internal lattice of the synthetic slags. The thermal conductivity of slags with a high amount of ( $\text{SiO}_2 + \text{Al}_2\text{O}_3$ ) increased significantly with the ( $\text{SiO}_2 + \text{Al}_2\text{O}_3$ ), whereas there was a slight variation in the thermal conductivity of slags when the ( $\text{SiO}_2 + \text{Al}_2\text{O}_3$ ) fluctuated between 35 and 55 wt. %. The thermal conductivity of slags involves phonon vibration that depends on the polymerization degree of slags. The combined effect of the vitreous phases and the crystalline phases on the polymerization degree determines the tendency of thermal conductivity. Spectroscopic research shows that the peak of high frequency band region ( $800$ - $1150 \text{ cm}^{-1}$ ) which is associated with the vibration of  $\text{Q}^4$ - $\text{Q}^0$  groups (where Q donates the number of bridging bonds) moves toward to the high Raman shift with the increase of ( $\text{SiO}_2 + \text{Al}_2\text{O}_3$ ). The deviation of Raman shift means the de-polymerization of the internal structure of the vitreous phase, resulting in the reduction of thermal conductivity of slags. The main crystalline phases are akermanite, diopside and anorthite when the ( $\text{SiO}_2 + \text{Al}_2\text{O}_3$ ) are 35, 55 and 75 wt. %, respectively. The transition of crystalline phases causes the polymerization degree dropping then rising in the whole ( $\text{SiO}_2 + \text{Al}_2\text{O}_3$ ) range.