Abstract

The production of crude steel has found a significant rise in the last decade. With the production of steel, an undesired product, namely, the slag, is also obtained. In recent years, recycling of steel slag is of prime concern. Many techniques have been proposed to recycle the steel slag. This dissertation focuses on one such technique, Dry Centrifugal Granulation. The main objective of this study is to perform a hydrodynamic cold experimental analysis of Dry Centrifugal Granulation technology of Linz-Donavitz/Basic Oxygen Furnace (LD/BOF) steel slag using Spinning Disc Atomization in the Ligament Formation mode of disintegration of liquids. An experimental setup has been developed to perform video-graphic study. The effect of different process parameters, like, height of nozzle from disc surface (H), direction of disc rotation with respect to that of air flow, and eccentricity (ϵ) in position of the nozzle from the centre of the disc, on liquid flow characteristics, have been studied. A detailed study, to determine the effect of disc angular velocity (ω_D) on the liquid flow characteristics, has been performed. Also, an experimental study has been performed to determine the trajectory of a falling liquid and, resultingly, the depth of fall of liquid at the wall of the granulator. Further, a correlation has been generated by utilizing the combined data of the three modes of disintegration in the controlled environment. Extending the study, post-experimental image processing study has been performed to find out the effect of change in Reynolds number (Re) on ligament diameter (d_{liga}) and Ligament-to-Ligament Distance with Ligament number (k_m). Additionally, this study includes the air blast study to determine the effect of air blast on liquid flow characteristics, i.e what quantity of air blast is optimal for ligament break up. An analytical model, to predict the formations of thin film on a rapidly spinning disc, ligaments from the edge of the disc, and drops from the ligaments, has been developed. The model has been validated against established benchmarks. The model has been, further, used to investigate the effects of various parameters, that are disc angular velocity (ω_D), liquid flow rate (Q_L), disc radius (R), liquid density (ρ), liquid viscosity (ν), and liquid surface tension (γ), on the droplet diameter (d). Based on the experimental and analytical studies, a concept design has been proposed.

Keywords: Dry Centrifugal Granulation (DCG); Spinning Disc Atomization (SDA); Liquid disintegration; Ligament Formation (LF) mode; Experimental methodology; Linz-Donavitz/Basic Oxygen Furnace (LD/BOF) steel slag.