MODELLING OF FURNACES AND COMBUSTION SYSTEMS

(593) - CFD INVESTIGATION OF ALUMINIUM MELTING FURNACE PERFORMANCE FOR DIFFERENT BURNERS' HEADS

Aleksandra Kiedrzynska (Poland)[1]; Beata Glot (Poland)[1]; Jaroslaw Hercog (Poland)[1]; Akin Obali (Turkey)[2]; Kadir Kosoglu (Turkey)[2]; Deniz Urk (Turkey)[2]; Tutku Ozen (Turkey)[3]; Hasan Taskin (Turkey)[3]

1 - Institute of Power Engineering, Thermal Processes Department, Mory 8 Street, 01-330 Warsaw, Poland; 2 - Sistem Teknik Industrial Furnace Ltd. R&D Center, TOSB 1. Cad. 14.Sok. No.3 Çayırova - Kocaeli - Turkey; 3 - ASAS Aluminyum A.S.

Draft Paper

Aluminium and its alloys have been used in a wide range of applications from automotive to aeronautics because each alloys has different and special properties. Moreover, aluminium recycling is one of the well-developed economies in the world since aluminium is 90% recyclable metal. Considering its progress in aluminium recycling, the aluminium industry still faces two main environmental problems which are energy consumption and pollutant emission. Further research in aluminium production and processing is necessary to fulfil the requirements of the environmental regulations, reduce non-renewable fuel consumption and pollutant emissions and improve energy efficiency.

The objective of this study is to investigate the influence of different burner's heads on the emissions and operational conditions for aluminium melting process. The numerical calculations were performed using Ansys Fluent software. The conditions inside the melting furnace were simulated using the 3D CFD model with detailed turbulent combustion flow including heat and mass transfer. The species transport model was employed to take into account the gas combustion with the eddy dissipation turbulence combustion model. The discrete ordinate (DO) radiation model was used with the Weighted-Sum-of-Gases Model (WSGGM) to describe the radiative heat transfer.

The studied case is a melting furnace with a capacity of around 2 tonnes of melting material per batch. The furnace is equipped with two natural gas-fired burners located at the front wall, which work alternately. Three different burners heads were tested with different quarl shape and air distribution. The burners were tested for power from minimal (1 MW) to nominal (3.5 MW) and for air excess in a range of 1.16-1.61.

It was observed that the burner's head design influences considerably the NO_x emissions at the furnace outlet and the heat flux to the molten aluminium. When the quarl has a confusor shape this results in velocity increase of mixture of air and fuel and generates large flame jet directed down to the aluminium surface. In that region the heat transfer is more intensive than in other burner geometries. It increases the rate of melting process but can also cause the problems of higher dross formation. That kind of burner's head reduces the internal recirculation and causes high temperature in the flame which increases the formation of thermal NO_x (according to Zeldovich mechanism). When the quarl shape has a cone structure it results in wider flame and lower maximal temperature caused by intensive internal recirculation close to the burner. Additionally, the dividing the air into two streams (primary and secondary) also reduces temperature in the flame. That results in lower NO_x emissions but simultaneously reduces the heat flux to aluminium surface what increases the time of melting process.

According to the analysed cases, the type of used burner's head has significant impact on the aluminium melting process and NO_x emissions but if properly chosen it can increase energy efficiency by reducing the processing time.

The study was carried out within the RETROFEED project under financial support of the European Union's Horizon 2020 research and innovation programme under grant agreement No 869939.

Palavras-chave : aluminium melting furnace, CFD modelling, burners performance, industrial processes retrofitting, energy and resource efficiency