ABSTRACT

Coal is an important component in enabling the worlds energy demands to be met. This is largely due to the fact that coal is a relatively inexpensive fuel when compared to the other options such as oil, gas and nuclear. In 2005 coal fired power generation accounted for 41% of the worlds electricity supply with this figure expected to rise to around 46% by 2030 (Energy Information Administration, 2009). Despite the world's dependence on coal as a means of producing electricity, the combustion of coal in coal fired plants has received international scrutiny due to the pollutants (CO_2, NOx, SOx and trace elements) generated from the combustion of coal in a chain grate boiler. This research focuses on the trace elements released by the combustion of coal and the partitioning behaviour of selected trace elements (As, B, Be, Cd, Pb, Hg, Se, Cr, Ni, Sb, Co, Mn, Ur and Th). These trace elements were selected because they are included in the US Clean Air Act Amendments Law of 1990 which states that they are potentially toxic airborne pollutants and the lowering of their concentrations in the environment is important (Aunela-Tapola *et al.* 1998). There is little or no available literature on trace element partitioning and emissions in South Africa, despite the fact that there are approximately 8000 industrial boilers in this country (personal communication, Falcon February 2010).

Inductively Coupled Plasma-Mass spectroscopy was used to obtain the concentration of the selected trace elements in the four samples being investigated (feed coal, bottom ash, fly ash and stack emission) which were obtained from a chain grate boiler. Proximate analysis and particle size distribution (PSD) were performed to explain certain trends observed with the trace element partitioning and emission results.

The results from the research show that the concentration of most of the trace elements increases throughout the value chain i.e. from feed coal through bottom ash and flyash to stack emission. Furthermore, the presence of highly volatile trace elements such as Hg and Se in the

bottom ash is best explained by the proximate analysis which indicates that unburnt coal is present in the bottom ash. This indicates that the combustion of coal in the chain grate boiler in this research is relatively inefficient. All trace elements were found to be highly enriched in the stack emission which is due to the inefficient capture of particulate and vapour species by the environmental control device/s (in this case, only an ESP). This was verified by the PSD results which showed that particles of up to 17μm were present in the stack emission.

The research concludes that although industrial boilers combust lower amounts of coal than larger pulverized fuel boilers, the trace element emissions from industrial boilers are significant. This may be due to cost reduction practices resulting in the implementation of cheaper, less efficient environmental control devices leading to the escape through the stack of a larger concentration of trace elements adsorbed onto particulate matter.