Environmental Benefits of Using Spent Pot Lining (SPL) in Cement Production

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Abstract

Spent pot lining (SPL) is a toxic waste material produced during the pot replacement process in the aluminium industry. Recently, SPL has been diverted from landfills to cement manufacturers as a raw material replacement. This paper presents a comprehensive environmental assessment of a case study in the United Arab Emirates (UAE), where SPL from Emirates Global Aluminium (EGA) was used as a feedstock at a cement plant in Ras Al Khaimah, UAE. Three areas of environmental concern were studied: fuel savings and CO_2 reductions, changes in NO_x emissions, and raw material repurposing and toxic substance destruction. Using 0.6 % SPL in feedstock was estimated to reduce coal consumption by 3.5 %, CO_2 emissions by 0.65 %, and NO_x emissions by 3.8 %. These changes are primarily attributed to the fluoride content in SPL creating fluoride fluxing effects that reduce the high temperature requirements of the cement kiln. Lower kiln temperatures lead to lower coal consumption and thermal NO_x generation. Toxic materials such as cyanides and fluorides were destroyed or fixed during the cement production process to below detection limits. However, SPL addition to cement production is limited by maximum alkali content standards of cement products. The use of SPL in cement production is shown to yield significant environmental benefits in terms of reducing emissions and coal consumption and destroying toxic substances. This initiative bolsters the concept of a circular economy in which different industries collaborate to improve environmental sustainability.

1. Introduction

Aluminium smelting is often viewed as significantly detrimental to the environment [1]. The primary reason for this perspective is the large amount of electricity that is required by the electrolytic process to produce aluminium metal and the oxidation of the carbon anode, both of which would release substantial amount of carbon dioxide (CO_2) if the electricity is generated through fossil fuel combustion. In addition, the process also produces significant quantities of toxic spent pot lining (SPL) materials as a by-product [1]. Consequently, the motivation for this study was to understand the viability of repurposing SPL waste material while deriving environmental and sustainability benefits.

In aluminium production, the cathode and refractory lining of the pot is exhausted after it has spent 4 – 5 years producing aluminium in the pot line. The pot is then taken out of service and the lining material removed becomes spent pot lining. The SPL contains toxic materials such as cyanides and fluorides. As one of the primary aluminium producers in the world, Emirates Global