

Multi-objective Optimization Of Calcination Process Fuel Input For Lowering Carbon Footprint

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The Intergovernmental Panel on Climate Change (IPCC 2021) has reported >50% likelihood of global warming reaching or exceeding 1.5°C in the near term, even for the very low greenhouse gas emissions scenario. The world's total greenhouse gas (GHG) emission has increased by approximately 50% since 1990 (from 32.5 Gt CO_{2e} in 1990 to 48.8 Gt CO_{2e} in 2020). The construction industry is responsible for approximately 18% of total greenhouse gas emissions. Concrete is the world's second most consumed material (after water). Australia consumes approximately 29 million m³ of concrete per year. The carbon footprint of structural concrete is 250 to 410 kg CO_{2e}/m³. Portland cement is the highest carbon footprint material in a concrete mix. The embodied carbon of the Portland cement is approximately 925kg CO_{2e}/t. A major part of emissions relating to cement production is attributed to the process energy input and release of CO₂ during the calcination process. In this paper, we analyze cement production processes with specific consideration of the energy input and the potential for including recycled and low CO₂ emission fuels. We use fuel calorific value and embodied carbon data to inform an optimisation technique that considers the benefits of keeping embodied carbon at the lowest practicable level. If widely adopted, this approach will enable the cement industry and legislators to make informed decisions as they seek to reduce the embodied carbon within this component of the construction industry as well as provide insight into the overall potential of reducing the global CO₂ emissions.