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Assessment and operation optimization of iron ore products under industry-scale blast furnace conditions towards decarbonization using state-of-the-art CFD models

The iron ore products should be assessed in terms of in-furnace behaviour and overall furnace performance, and their operation should be optimised under industry-scale blast furnace (BF) conditions, in order to be sustainable and competitive, especially in the context of decarbonization efforts in ironmaking. While lab and pilot-scale experiments can provide useful kinetics, they are expensive and risky and cannot replicate industry-scale blast furnace conditions for proper assessment and optimization. In this paper, we present our recent progress in using state-of-the-art Computational Fluid Dynamics (CFD) models to assess iron ore products and examine the effects of their operations on BF behaviour in basic terms, including in-furnace phenomena (flow field, temperature field, species distribution fields etc.) and overall BF performance (coke rate, reduction efficiency and top gas temperature etc.). We have developed state-of-the-edge CFD models for different purposes, ranging from the static-state BF model featuring unique layered burden structures for offline assessment and optimisation knowledge building-up for iron ore products, to the transient-state BF model for online assessment and optimisation of iron ore productions by describing the transient behaviours of iron ore productions under industry-scale conditions. First, we have studied several iron ore products including the iron ore products used in the present BFs and emerging iron ore products like carbon composite briquette and iron-coke. Second, several iron ore operations are studied including optimisation of conventional burden operations like oxygen enrichment, batch weight tuning and new operations like coke central charging and hydrogen injection in BFs. Third, some time-sensitive operations are also investigated including the use of wet burden materials and the drop in blast temperature on BF performance. These CFD models offer a cost-effective research tool for understanding the effect of iron ore products on BF performance and serve as a reliable marketing tool for existing and emerging iron ore products under a wide range of BF conditions.

AUTHORS
Y S Shen
School of Chemical Engineering, University of New South Wales