Fuzzy chance constrained linear programming model for scrap charge optimization in steel production

Optimizing the charge in secondary steel production is challenging because the chemical composition of the scrap is highly uncertain. The uncertainty can cause a considerable risk of the scrap mix failing to satisfy the composition requirements for the final product. In this paper, we represent the uncertainty based on fuzzy set theory and constrain the failure risk based on a possibility measure. Consequently, the scrap charge optimization problem is modeled as a fuzzy chance constrained linear programming problem. Since the constraints of the model mainly address the specification of the product, the crisp equivalent of the fuzzy constraints should be less relaxed than that purely based on the concept of soft constraints. Based on the application context we adopt a strengthened version of soft constraints to interpret fuzzy constraints and form a crisp model with consistent and compact constraints for solution. Simulation results based on realistic data show that the failure risk can be managed by proper combination of aspiration levels and confidence factors for defining fuzzy numbers. There is a tradeoff between failure risk and material cost. The presented approach applies also for other scrap-based production processes.

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