Master Project

Smart control of slag viscosity in the HIsarna iron-making process

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Context

The steel industry is one of the largest emitters of greenhouse gases. Therefore, there is a need to develop revolutionary sustainable methods for producing iron and steel. HIsarna is one such sustainable method developed by TATA Steel Europe for a long time. Currently, work is going on to stabilise and optimise this iron-making method. This new method of iron production skips a vital step used in traditional iron making, which involves pre-processing the impure iron ore. This enables further reduction in the emission of greenhouse gases.

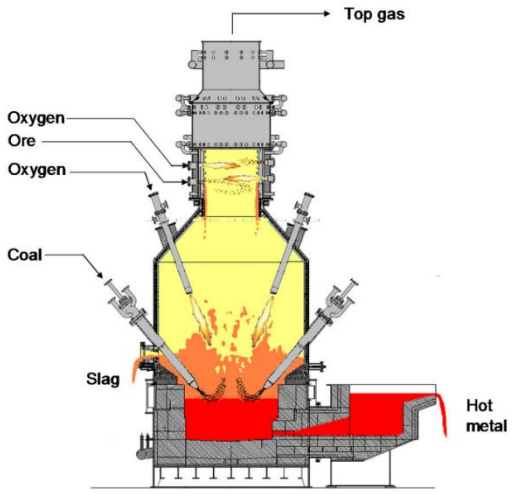

Figure 1 HIsarna Iron-making process

One of the steps of the HIsarna process is maintaining the optimal level of slag in terms of its chemical composition. It is important to regulate the slag viscosity to maintain the quality of iron produced. Due to the use of unprocessed iron ore, the fluctuation in the slag viscosity varies randomly. This is where the concept of stochastic control comes into use, where we aim to maintain slag viscosity by varying the input.

Dynamic Programming (DP) can help determine the optimal action at every step of this process. The optimal control policy has already been developed as part of a previous project. The HIsarna process can be modelled as a sequential decision-making process where the end goal is to maximise the reward, which in this case will be to maintain the viscosity of the slag. Sometimes the optimal action for maintaining slag viscosity, suggested by solving the DP, may not be the best action for the entire iron-making process, and the actions suggested by the optimal policy may not be practical. To help such cases, a recommender system can be implemented that displays to the end operator the possible consequences of the suggested optimal action.

Project tasks

This master thesis project aims to compare the existing plant model and the newly developed plant model by TATA Steel to assess the differences and implement improvements if possible. The second objective is to develop an online recommender system which suggests the future consequences of following the optimal policy.

1. Implement the previously developed optimal control table and compare it with the newly developed plant model by TATA Steel.
2. Compare the models critically and make changes in the implemented optimal controller table based on the comparisons.
3. Investigate algorithms for developing an online recommender system.
4. Implement an online recommender system to improve the developed control strategy.
5. Compare the results of the implementation with and without a recommender system