World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

An Energy Integration Study While Utilizing Heat of Flue Gas: Sponge Iron Process

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Abstract : Enormous potential for saving energy is available in coal-based sponge iron plants as these are associated with the high percentage of energy wastage per unit sponge iron production. An energy integration option is proposed, in the present paper, to a coal based sponge iron plant of 100 tonnes per day production capacity, being operated in India using SL/RN (Stelco-Lurgi/Republic Steel-National Lead) process. It consists of the rotary kiln, rotary cooler, dust settling chamber, after burning chamber, evaporating cooler, electrostatic precipitator (ESP), wet scrapper and chimney as important equipment. Principles of process integration are used in the proposed option. It accounts for preheating kiln inlet streams like kiln feed and slinger coal up to 170^{O}C using waste gas exiting ESP. Further, kiln outlet stream is cooled from 1020^{O}C to 110^{O}C using kiln air. The working areas in the plant where energy is being lost and can be conserved are identified. Detailed material and energy balances are carried out around the sponge iron plant, and a modified model is developed, to find coal requirement of proposed option, based on hot utility, heat of reactions, kiln feed and air preheating, radiation losses, dolomite decomposition, the heat required to vaporize the coal volatiles, etc. As coal is used as utility and process stream, an iterative approach is used in solution methodology to compute coal consumption. Further, water consumption, operating cost, capital investment, waste gas generation, profit, and payback period of the modification are computed. Along with these, operational aspects of the proposed design are also discussed. To recover and integrate waste heat available in the plant, three gas-solid heat exchangers and four insulated ducts with one FD fan for each are installed additionally. Thus, the proposed option requires total capital investment of $0.84 million. Preheating of kiln feed, slinger coal and kiln air streams reduce coal consumption by 24.63% which in turn reduces waste gas generation by 25.2% in comparison to the existing process. Moreover, 96% reduction in water is also observed, which is the added advantage of the modification. Consequently, total profit is found as $2.06 million/year with payback period of 4.97 months only. The energy efficient factor (EEF), which is the % of the maximum energy that can be saved through design, is found to be 56.7%. Results of the proposed option are also compared with literature and found in good agreement.

Keywords : coal consumption, energy conservation, process integration, sponge iron plant
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020