

Ironmaking Mathematical Modelling

Blast Furnace

Process Option Model



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BASIC CONCEPT

The need for a rapid and simple method for investigating various strategic options on a Steelworks is being met with the Process Option Model. This model resides on a small PC and produces a graphic display. The program generates a flow chart showing the steady state material, fuel and electricity flows, together with important process variables and purchased material costs. All data is displayed on the screen.

The model calculates the necessary material and energy flows to and from the various units as a function of the overall operating level of the Works and of the various imposed process operating parameters. It determines the necessary quantities of all raw material and calculates the nett operating cost.

The system is designed so that it can be used to obtain, easily and immediately, answers to "what if" questions. No computing experience is needed. In essence, the user moves the cursor to the relevant position(s) on the screen and types in a new value(s). On the press of a key, the system calculates the effect of the change(s) on the operation of all plants over the entire works and generates the overall operation cost. This is presented as a new flow chart, so that the various resulting effects are easy to appreciate and understand.

MODEL OPERATION

The full model is split into various separate areas, such as coke making, ironmaking, burden preparation etc. and so covers the entire integrated works. As well as showing the direct import of materials from suppliers, these areas have the calculated connections to the others in terms of materials, gases, steam and electricity flows. So imposed changes to one operating parameter on one unit will show the consequent changes to process variables on that unit, others in that section and units up and down stream.

The attached sheet shows an example of the display of the blast furnace operations as it would appear on the screen of the PC. It shows three blast furnaces, details of their material feeds, blast conditions, tuyere injectants, slag, and hot metal. In addition are displayed all the important furnace process variables.

Certain of the values are displayed with a yellow background. These are the operating parameters which normally can be changed directly by the plant operators and similarly can be changed by the model user. So typically, the operator and user can alter such quantities as the added oxygen to the blast or the proportion of sinter in the burden. Others are process variables which change as a result of these imposed changes and they appear on a plain white background. Thus variables such as the demand coke rate, blast volume, top gas analyses are calculated as a function of the imposed parameters and other process variables.

A few of the values displayed with a yellow background such as %Si in hot metal and hot metal production rates are not capable of being changed directly by the plant operators. However, it has been found more practical for the user to impose direct changes to these, rather than to those parameters which influence them.

MAIN BENEFITS

- Determining the optimum methods of reducing operating costs.
- Determining the true "value in use" of imports and "value for sale" of by-products.
- Reconciling apparent imbalances in materials and utilities because of poor measurement.
- Investigating the effects of increasing the recycle of revert materials, particularly cost savings and build up of tramp elements.
- Calculating the current and projected emissions of CO₂, SO₂ and NO_x.
- Carrying out detailed heat balances over each unit operation.
- Examining long term strategies to meet projected changes, possibly involving new and /or alternative plant.
- Carrying out detailed Life Cycle Inventories of steel products.
- Invaluable tool for works management, feasibility studies and operational research department