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(89) Theoretical Influence of Blast Furnace Cohesive Zone Shape on Coke Slit Gas Flow Distribution

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SUMMARY

A theoretical model has been developed to predict the gas flow distribution through a blast furnace cohesive zone of defined shape. The theoretical predictions have indicated that small changes in cohesive zone shape produce large changes in the distribution of gas flow through the coke slits.

THEORY

The pressure loss through packed beds of blast furnace burden materials may be described by a form of the Ergun equation (ref 1.) modified to take account of compressible flow.

$$p_2^{\,2} - p_1^{\,2} = K\,L_{1-2}U^n \qquad (1)$$

where p_2 and p_1 are the pressures at the inlet and outlet of the bed, L_{1-2} is the length of the packed bed, K is the burden permeability factor, U is the gas velocity and $n \simeq 2$.

The theory used for gas flow prediction through a cohesive zone of defined shape employs the assumptions proposed by Togino (ref. 2) modified to include:

(a) Calculation of the coke slit thicknesses from a material balance, taking into account change in voidage on softening, the disappearance of melted material and changing furnace cross-section.

(b) Calculation of the pressure loss through the coke slits from the integrated mean square velocity through the slit.

(c) Calculation of the overall cohesive zone pressure loss and coke slit gas flows from iterative, simultaneous solution of the non-linear equations similar to eq. (1) describing the pressure losses of interconnected packed beds of varying thickness, length and cross-section.

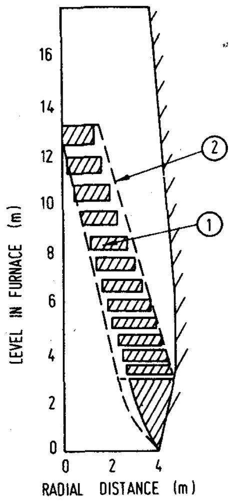

Figure 1. Theoretical cohesive zones of different shapes. Zone 2 20% wider than Zone 1.

RESULTS

The model has been solved for a wide range of conditions and has been shown to closely reproduce the results of Togino for Hirohata No. 1 furnace (Ref. 2). As an example, fig. 1 shows two theoretical cohesive zones of different shapes. Zone 2 has longer coke slits than zone 1, a situation which could be caused by a change in ferrous burden softening temperature. Figure 2 shows the predicted gas flows through the coke slits for constant wind volume. Zone 2 which has the greater width, has the position of maximum gas flow at the base of the zone adjacent to the furnace walls. Zone 1, with the shorter coke slits, has the maximum gas flow higher in the furnace and further away from the walls. Zone 1 also has the smaller total pressure loss.

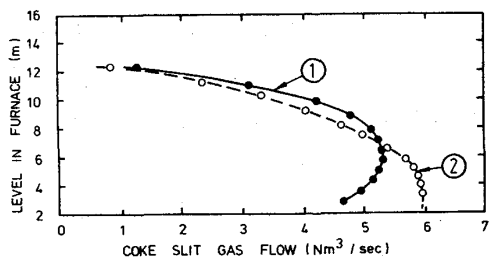

Figure 2. Predicted coke slit gas flow distributions.

CONCLUSION

The theory has emphasised the importance of cohesive zone shape on furnace operations and lining life.

REFERENCE

(1) Burgess J.M., "Development in Blast Furnace Gas Distribution Research", Chemeca 79, National Conference on Chemical Engineering, Newcastle, Australia, August 22-24, 1979.

(2) Togino Y., Report, Gakushin No. 54 Committee, (1975:11), No.1361.