

THE INFLUENCE OF FUEL INJECTANTS ON BLAST FURNACE ADIABATIC FLAME TEMPERATURES

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Summary

A more rigorous adiabatic flame temperature equation has been derived by considering the effects of temperature and gas composition on heat capacity as detailed in figure 1. The resultant equation is slightly different to the Ramm case (1) by virtue of the indicated refinements in flame zone assumptions. The analysis has been extended to include the effects of natural gas, coke ovens gas, coal-oil slurries, pneumatic injection of coal and coke ovens tar.

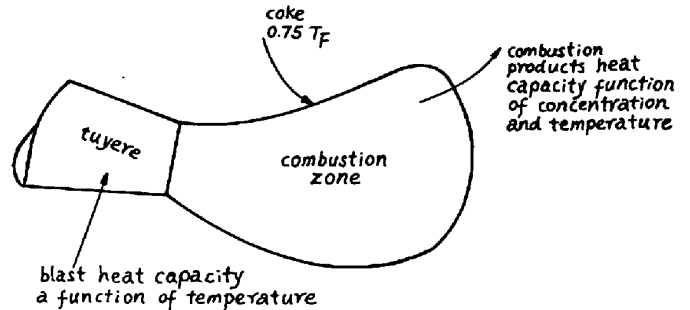


Fig.1 Blast furnace combustion zone model.

Results

1) The equation derived from the analysis is:

$$T_F = 1570 + 0.808T_B - 5850\bar{W}_{H_2O} - 4400\bar{W}_{oil} + 4370\bar{V}_{O_2} - 6280\bar{V}_{NG} + f_{COG}\bar{V}_{COG} + f_{coal}\bar{W}_{coal} - 2200\bar{W}_{tar}$$

where  $T_F$  = flame temperature °C,  $T_B$  = blast temperature °C,  $\bar{W}_{H_2O}$  = blast moisture kg/Nm<sup>3</sup> blast,  $\bar{W}_{oil}$  = oil injection kg/Nm<sup>3</sup> blast,  $\bar{V}_{O_2}$  = oxygen enrichment Nm<sup>3</sup>/Nm<sup>3</sup> blast,  $\bar{V}_{NG}$  = natural gas injection Nm<sup>3</sup>/Nm<sup>3</sup> blast,  $\bar{W}_{coal}$  = coal injection kg/Nm<sup>3</sup> blast,  $\bar{W}_{tar}$  = tar injection kg/Nm<sup>3</sup> blast, and  $f_{COG}$  and  $f_{coal}$  are the factors for the rate of change of flame temperature with level of injection for coke ovens gas and coal, respectively.

- 2) The factors for coke ovens gas and coal change with gas composition and coal analysis. Typically, the factor for coke ovens gas varies in the range  $-2970 > f_{COG} > -3280$  while the factor for potential Australian coal varies in the range  $-2370 > f_{coal} > -2750$ .
- 3) For a range of injectants, the rate of change of flame temperature with injectant flow is shown on figure 2 for variation in fuel carbon to hydrogen ratio.
- 4) For a given aim flame temperature at fixed oxygen enrichment, blast humidity and blast temperature conditions, substantially more coal and coke ovens tar can be injected than oil or natural gas, provided complete injectant combustion occurs.

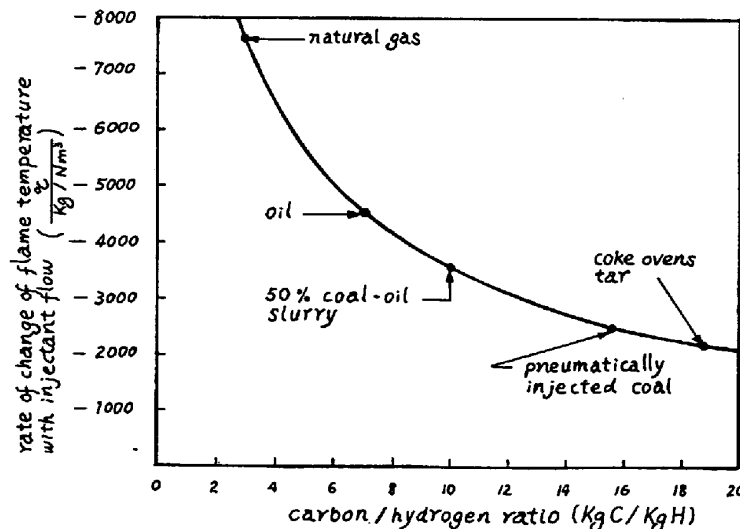


Fig.2 Flame temperature factor variation with C/H ratio.

Reference:

1) Higuchi, M., Iizuka, M., Kuroda, K., Sumigama, T. Trans I.S.I.J., 1975, 15, 516