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Discussion Of "gas Composition, Temperature, And Pressure Measurements In A Lead Blast Furnace"

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Discussion of "Gas Composition, Temperature, and Pressure Measurements in a Lead Blast Furnace"*

ARTHUR E. MORRIS AND JOHN R. KNOEPKE

Chao *et al* report on gas compositions and temperatures within a commercial lead blast furnace.[1] A particularly noteworthy occurrence was their observation of approximately 1 pct O_2 in the furnace gas, independent of position in the furnace. The authors were unable to account for the presence of this O_2 in a gas containing several pct CO. We offer proof that O_2 was actually not present in significant amounts in their blast furnace gas sample; the gas chromatograph peak ascribed by them to O_2 was actually Ar.

On various models of the Fisher Gas Partitioner or other gas chromatographs using Molecular Sieve 13X as the second column, O_2 and Ar elute from the partitioner at virtually the same time. This occurs for both H_2 and He as the carrier gas. Since atmospheric air contains about 0.93 Ar,[2] normal combustion gases always contain a bit less than 1 pct Ar. If combustion is carried out in the presence of excess carbon, the gases should contain negligible O_2. However, the Ar contained in combustion gases will give a small peak at the O_2 peak location, and thus falsely indicate the presence of O_2.

This is shown in Fig. 1, in which various strip chart recordings are reproduced for gas samples analyzed on a Fisher Model 1200 Gas Partitioner, using Molecular Sieve 13X as the second column. Figure 1(*a*) is a sample of atmospheric air; note that no peaks other than N_2 and O_2 are apparently present. Figure 1(*b*) is a sample of combustion gas obtained by using atmospheric air to burn charcoal at approximately 900 K in a tube furnace; note that peaks for N_2, CO_2, CO and *apparently* O_2 are present.

In Fig. 1(*c*), the conditions of sample (*b*) are the same except that instead of atmospheric air, a synthetic air was used, obtained by mixing N_2 and O_2 in an approximately 4.5:1 ratio from gas cylinders. Note that no peak is obtained in the oxygen/argon location. To show that argon is responsible for the peak labeled "A" in Fig. 1(*b*), an N_2/Ar mixture containing about 10 pct Ar was analyzed in the chromatograph. The results are shown in Fig. 1(*d*).

The calibration of peak height *vs* pct is about the same for O_2 and Ar, thus the presence of 1 pct Ar in the blast furnace gases analyzed by Chao *et al* would give a peak height equivalent to about 1 pct O_2, which is what they observed. If the O_2 peak height is corrected for the presence of Ar, the amount of O_2 in the

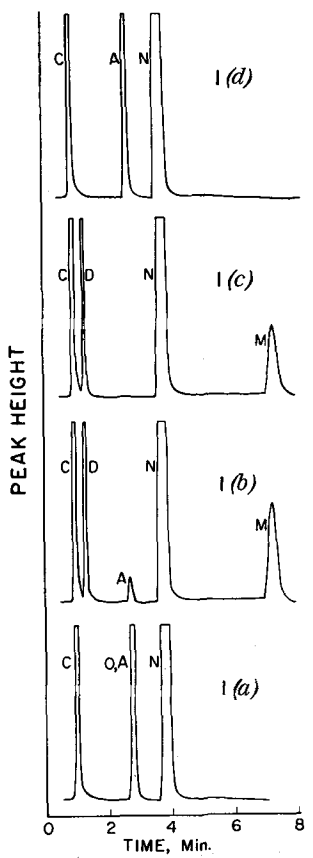

Fig. 1—Strip-chart recordings of gas analyses on Model 1200 Fisher Gas Partitioner. Zero time was taken at moment of sample injection into instrument. *C* is composite gas peak, *O* is oxygen peak, *A* is argon peak, *D* is carbon dioxide peak, *M* is carbon monoxide peak, and *N* is nitrogen peak. (*a*) Normal air sample; peak labeled *O, A* is superimposed peaks for argon and oxygen. (*b*) Combustion gas sample obtained by burning charcoal with normal air at about 900 K. (*c*) Combustion gas sample for conditions of sample (*b*), except that argon-free synthetic air was used. (*d*) Sample of nitrogen/argon gas mixture containing about 10 pct argon.

*JOHN T. CHAO, PETER J. DUGDALE, DAVID R. MORRIS, and FRANK R. STEWARD: *Met. Trans. B*, 1978, vol. 9B, pp. 293-300.

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lead blast furnace gas is probably less than 0.1 pct. The actual amount must be determined by gas analysis techniques that eliminate the interference of Ar.

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2. *Handbook of Chemistry and Physics*, Robert C. Weast, ed., 54th Edition, p. F191, CRC Press, Cleveland, 1974.

Authors' Reply

J. T. CHAO, P. J. DUGDALE, D. R. MORRIS, AND F. R. STEWARD

The authors wish to thank Morris and Knoepke for their convincing explanation of the apparent presence of oxygen in the furnace gases of the lead blast furnace. The possibility that this oxygen was in fact argon, was overlooked in the work reported and apparently in the works cited.[1,2] Thus, Caraghan and Wilson using a gas chromatograph reported oxygen concentrations in the range 0 to 2 pct at any level within the iron blast furnace. In the case of lead blast furnaces, Alcock has reported 3.9 to 4.0 pct oxygen in the Trail (British Columbia) furnace. He states that measurements have been made of gas composition at the tuyere level and at the top of some lead blast furnaces, and that the presence of approximately 1 pct O_2 indicates incomplete combustion of the blast air. The method of gas analysis used for these measurements was not reported. The possibility that the oxygen was at least in part, argon seemed not to have been considered.

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2. C. B. Alcock: *Principles of Pyrometallurgy*, p. 217, Academic Press, NY, 1976.

Correction to *Met. Trans. B*, 1979, vol. 10B

Flow Regimes in Submerged Gas Injection by E. O. Hoefele and J. K. Brimacombe

Page 634

Left column, third line from bottom should read "in the first three frames (0 to 0.036 s); the growth is . . ."

Page 642

Left column, third paragraph, third sentence should read "The greater penetration found in systems with low ρ_g/ρ_l is an indication that the bubbles are more elongated and that consequently the expansion angle of the jet is smaller."