DISCUSSION OF

"FIXATION OF ATMOSPHERIC NITROGEN" BY LELAND L. SUMMERS.

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In this very interesting paper, in the discussion of the limitation of the arc furnace process the possible concentrations are calculated on the basis of the thermodynamic equilibrium, though the work of Haber makes it very doubtful, whether the arc furnace process is a thermodynamic one.

An extensive series of investigations, which I made some years ago in Dr. Steinmetz's Laboratory, led me to the conclusion, that in the fixation of nitrogen by the electric arc the conditions of thermodynamic equilibrium are of secondary, if of any moment, and the process is essentially an electric one. A series of experiments with arcs of different temperature seemed to show no direct relation of the NO concentration to the arc temperature as depending on the arc stream material. In order of their NO producing efficiency, the arc electrode materials arranged themselves in the following order:

Iron: Highest NO concentration

Titanium

Carbon

Copper: Lowest concentration.

While the order of the boiling points of these materials is:

Carbon:	above 3600°C
Titanium:	about 2700°C
Iron:	2450°C
Copper:	2310°C.

As seen carbon, of the highest arc temperature, is very low in efficiency, while iron and copper, with approximately the same arc temperature, are at the opposite ends of the scale.

With low temperature arcs, as the mercury arc, it is easily possible to get concentrations above those representing the thermodynamic equilibrium.

From this and other results of the investigation, I am led to the conclusion that the NO production by the electric arc is essentially a dissociation phenomenon: in the arc stream, the molecules of oxygen and nitrogen are dissociated into free atoms, and when leaving the arc stream, these atoms combine with each other by the probability law. As air contains four times as much nitrogen as oxygen, each oxygen atom has four times as much chance to find a nitrogen atom, as an oxygen atom, and thus four NO would be formed for every O_2, and in the same manner $4\ N_2$ for every NO. The gases leaving the arc stream should therefore be a mixture containing 32% NO. As at high temperature the reaction velocity is extremely high, the NO concentration rapidly falls to the low concentration of the thermodynamic equilibrium. The more rapidly the gases are cooled down to the temperature where the reaction velocity is low, that is, the mixture stable, the higher a percentage of NO would be preserved. Also, the lower the initial temperature, that is, the arc temperature, the higher, with the same rate of cooling, should be the NO production, and the low temperature arc therefore should be the most efficient. In agreement herewith is, that in above table, with the exception of copper, the materials arrange themselves in their efficiency of NO production about inverse to their boiling points, and the abnormally low efficiency of copper may be explained by the tendency to instability of the copper arc.

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