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PROCESS OF REDUCING ALUMINA.

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To all whom it may concern:

Be it known that we, CHARLES E. PARSONS, a citizen of the United States, residing at New York, in the county of New York and State of New York, and SAMUEL PEACOCK, a citizen of the United States, residing at Wheeling, in the county of Ohio and State of West Virginia, have invented certain new and useful Improvements in Processes of Reducing Alumina; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a process for making metallic aluminum in a blast furnace, and has for its object to produce this metal in a manner more expeditious and less costly than has been heretofore proposed.

With these objects in view, the invention consists in the novel steps and combinations of steps more fully hereinafter disclosed and particularly pointed out in the claims.

It is well known that all efforts to reduce aluminum oxide (Al_2O_3) by carbon in a fuel fed furnace have heretofore been failures largely due to the fact that the reaction,

$$Al_2O_3+3C=2Al+3CO,$$

is strongly endothermic, and therefore absorbs such a quantity of heat that the reacting constituents are cooled so rapidly below their reacting temperatures that a commercial process has never been attained. This process, on the other hand, avoids the above objection by dividing the reducing phase into two different procedures. That is, an intermediate reaction is employed by means of which the energy consumed is divided into two different reducing effects either of which can be regulated by means readily available, and each of which can be carried out in periods of time sufficiently short to be commercially feasible.

In carrying out this process, an ordinary blast furnace of the type used in iron smelting, is employed. The furnace charge consists of coke or charcoal, alumina and a commercial oxygen containing alkali metal salt, such as a carbonate or aluminate of sodium or potassium, preferably a mixture of both sodium and potassium salts. The procedure is as follows:—

The alkali metal salt, alumina, and coke or charcoal are charged into the furnace by means of a "bell" in the usual manner, and preferably a heated air blast is employed. By such means a temperature of 1500° C. to 1600° C. is maintained in the reaction zone of the furnace, in an atmosphere positively devoid of free oxygen or carbon dioxide, and a bed of white hot free carbon is constantly maintained in a localized fusion zone.

Under such conditions the alkali metal salt, which for example may be sodium or potassium carbonate, is decomposed substantially as follows:—

$$Na_2CO_3+2C=Na+3CO.$$

If sodium aluminate is employed as the salt of sodium, the reaction becomes

$$2Na_3AlO_3+6C=6Na+Al_2O_3+6CO.$$

Elemental sodium is not exclusively produced however, as under the conditions of the reaction, more or less sodium carbide, Na_2C, and sodium cyanamid, Na_2CN_2, are also formed. These products sublime in the furnace when formed in the high temperature zone thereof, and together with the elemental sodium, rise with the gaseous reaction products until they reach the upper part of the shaft, at a temperature of about 600° C., when they are condensed upon the relatively cool furnace burden, and are more or less oxidized by the interaction of the combustion gases, substantially in accordance with the following equations:

$$(a)\quad 2CO=CO_2+C$$
$$(b)\quad 2Na+CO_2=Na_2O+CO$$
$$(c)\quad Na_2C+2CO_2=Na_2O+3CO$$
$$(d)\quad Na_2CN_2+2CO_2=Na_2O+N_2+3CO.$$

The deposited sodium oxide is carried down with the furnace burden, to the hot localizel fusion zone of the furnace, where the reactions are repeated, thus constituting a cycle, and in consequence the vapor of such metallic sodium and sodium compounds in

the high temperature zone of the furnace becomes increasingly concentrated, until the partial pressure of such vapor becomes such that a higher temperature is necessary to effect sublimation. This cycle therefore persists until a practical superheating of the metallic sodium and sodium salts becomes established, whereupon the alumina, Al_2O_3 present, is attacked and reduced substantially in accordance with the following equations:

$$(e)\quad Al_2O_3+6Na=2Al+3Na_2O$$

$$(f)\quad Al_2O_3+3Na_2c=2Al+{}_3Na_2O+3C$$

$$(g)\quad Al_2O_3+3Na_2CN_2=2Al+3Na_2O+3C+3N_2.$$

When the sodium, and sodium salts thus produced in the furnace become concentrated cumulatively in the high temperature zone, after the full cycle of reactions is established, the furnace charge then begins to produce metallic aluminum, and sodium oxide. But this oxide is reduced as fast as it is formed, and the cycle continues without the addition of any more of the initial alkali metal salt than is necessary to compensate for operating losses.

Of course, since various alkali-aluminum compounds may be employed in this process, the furnace burden will be so proportioned as will accomplish a smelting of the particular compounds used. Also it will be understood that the top temperatures will be maintained sufficiently low to effect a condensation of the sublimate on the charge material and thus prevent the escape of the same.

What is claimed is:—

1. The process of producing metallic aluminum in a fuel-fed furnace which consists in providing a charge containing carbon, a sodium oxide producing salt, and alumina; igniting said charge to reduce the sodium salt in said furnace; continuing the operation until said sodium attacks said aluminum oxide to produce metallic aluminum; and recovering the latter.

2. The process of producing metallic aluminum in a fuel-fed furnace which consists in providing a charge containing carbon, an alkali metal producing salt, and alumina; igniting said charge to reduce the alkali metal salt in said furnace; continuing the operation until said alkali metal attacks said aluminum oxide to produce metallic aluminum; and recovering the latter.

3. The process of producing metallic aluminum in a blast furnace which consists in providing a furnace charge containing carbon, and sodium and aluminum combined with oxygen; maintaining free carbon and a reducing atmosphere in the fusion zone of said furnace to cause said sodium to be liberated in the form of vapor, maintaining a top temperature low enough to cause said vapor to condense on the down coming charge material; continuing the operation until the sodium vapor is sufficiently superheated to reduce said aluminum oxide; and segregating out the metallic aluminum thus formed.

4. The process of producing metallic aluminum in a blast furnace which consists in providing a furnace charge containing carbon, and an alkali metal and aluminum combined with oxygen; maintaining free carbon and a reducing atmosphere in the fusion zone of said furnace to cause said alkali metal to be liberated in the form of vapor, maintaining a top temperature low enough to cause said vapor to condense on the down coming charge material; continuing the operation until the alkali metal metal vapor is sufficiently superheated to reduce said aluminum oxide; and segregating out the metallic aluminum thus formed.

In testimony whereof we affix our signatures.

CHARLES E. PARSONS.
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