Aug. 8, 1933. F. JOHANNSEN 1,921,825

PROCESS FOR THE RECOVERY OF METAL VALUES

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Fig. 1.

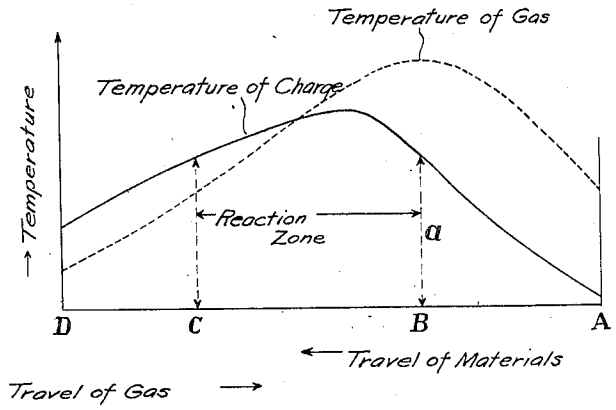
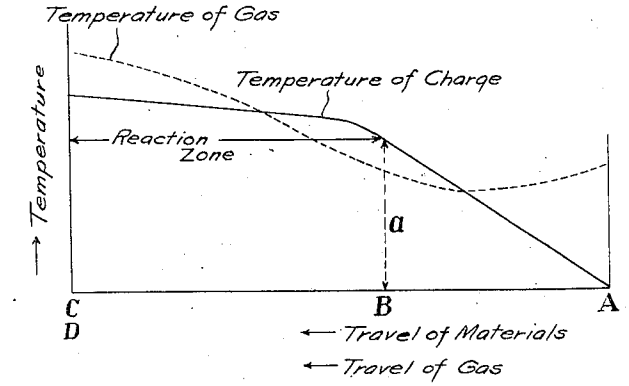


Fig. 2.



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PROCESS FOR THE RECOVERY OF METAL VALUES

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2 Claims. (Cl. 75—28)

This invention relates to processes for carrying out the volatilization of metals and metal compounds from materials containing them in rotary tube furnaces, wherein the heat required for the process is wholly or partly produced by the combustion of the fuel added to the charge. The present process is eminently adapted to all volatilization processes in which there are volatilized for example chlorides, sulphides, oxides or metals. The materials to be treated may previously have been subjected to a primary transformation process in order to convert them into a form suitable for volatilization.

Hitherto the above mentioned volatilization processes were always carried out in continuously working reverberatory furnaces in such a manner that the charge and the air for the reaction or the heating flame travelled in opposite directions to one another, since the greatest value was attached to the utilization of the waste gases for the purpose of preheating the fresh charge, and conversely to the utilization of the heat in the residue for preheating the fresh air. The present process which operates in just the opposite manner to the usual methods hitherto known and dispenses with the heat economy due to such methods, is carried out in such manner that both the charge and the gases travel in the same direction, whereby there results a fundamentally different operation of the process ensuring a complete decomposition of the materials treated and at the same time a much simpler method of working.

In the accompanying drawing the progress of the reactions is shown diagrammatically for both methods. It is assumed that in order to effect the endothermic reaction a temperature *a* is required within the charge. With the countercurrent flow methods of working heretofore employed (see Diagram 1) the reaction starts at the point B after the fresh charge has been brought to the required temperature, by means of the gases, on its way from A to B. At the point C the temperature of the substances falls, in consequence of the cooling effect due to the fresh gases, below the required limit, the reaction zone being represented by the length of path B—C. With the unidirectional flow method of working in which the charge and gases travel in the same direction the temperature no longer falls below the value *a* (see Diagram II) after it has once attained its required value at the point B, for example by means of an ignition flame at the point A and by superficial combustion on the path A—B, until the discharge point D is reached. With an otherwise identical adjustment of the process, the reaction zone thus becomes considerably longer, and corresponding to the longer duration of the reaction the decomposition becomes also more complete, that is to say for the same product it is possible to accelerate the speed of travel of the charge through the furnace, and therefore to increase the output, or, for the same output to reduce the length of the furnace.

As the velocity of reaction of all endothermic processes increases greatly as the temperature increases, it is clear that the counter-current flow method of working (Diagram I) is in this respect also inferior to the unidirectional flow method, as in the case of the former the temperature falls towards the end of the reaction.

In carrying out the process according to the present invention the temperature of the gases and materials increases towards the end of the process, and thus enables the complete decomposition resulting from the endothermic reaction to be obtained in a practically much more favourable manner.

In the case of the processes with which the present invention is concerned the process considered as a whole becomes in reality exothermic by the combustion of the admixed fuel and of the products of reduction in the several portions of the reaction zone. In the case of the counter-current flow method the decomposition starts regularly at the point B disproportionately strongly because of the comparatively high concentration of the reacting substances, and causes at the beginning of the reaction zone B—C a strong temperature rise in the material and the gases. This quantity of heat is not only lost for the process, as it is only very incompletely utilized in the preheating, but it causes as a rule an inadmissible over-heating of the charge and is conducive to the formation of crusts. In practical working it then becomes necesary to lower the speed of reaction at this point artificially, or to effect the indispensable lowering of the temperature by working with an excess of air or by the addition of cooling additions, such as for instance carbonates. In the case of the unidirectional flow method of working according to the present invention, a sufficient cooling of the charge in the proximity of the point B is effected by the air employed for the reaction which so far has been only slightly preheated, and the heat developed in the zone of the greatest reaction is made available in the neighbourhood of the discharge end D for the completion of the decomposition.

The present method is further of considerable

advantage in processes of the kind in which the products must be protected from the influence of oxidizing gases. When working according to the counter-current flow method, a superficial oxidization in the proximity of the discharge end can only be prevented if the operation is carried out with neutral or reducing gases or else with such a great excess of fuel that the superficial combustion is reduced to a minimum. Both methods result in a very bad utilization of the heat, as in the latter case a great excess of fuel is required, whilst when using the first method of working namely with neutral or reducing gases, the combustion of the products of reduction within the furnace becomes impossible. With the new process however according to the invention it is possible with a correspondingly reduced air supply to work in the greater part of the reaction zone with oxidizing gases, so that the heat of oxidation of the volatilized reduction products in this part is completely utilized, and to allow the gases to become neutral or reducing only towards the end of the reaction zone, so that they then prevent any reoxidation of the non-volatile reduction products. So far as concerns products that are to be separated from the gangue by a smelting process they are preferably allowed to fall direct into a smelting furnace, through which, in case it is constructed as a reverberatory furnace, the gases of the reduction furnace are allowed to pass and whereby, with an addition of combustion air, the carbon monoxide present can be utilized for heating.

A further advantage is offered by the new process in processes wherein there is to be obtained by volatilization an enriched intermediate product as pure as possible, for instance in the manufacture of zinc oxide from zinc-poor materials. When working with the countercurrent flow method, the gases containing zinc oxide are always charged with a certain amount of flue dust and finely divided fuel that can be eliminated only partly and by means of a secondary and very troublesome re-combustion. With the new process however the temperature of the gases and consequently their velocity of flow is much reduced at the charging end and consequently considerably less formation of dust takes place, and further these gases traverse the zone of the highest gas-temperature so that all particles of fuel are burnt out, and the particles of flue dust are melted together into granules and can be eliminated subsequently quite easily.

The regulation of the process as regards the time of reaction and the degree of temperature is effected in the usual manner, mainly by means of the following factors:—quantity of charge, depth of the layer of added fuel, quantity of reaction-air, inclination of the furnace, and its speed of rotation. The heat still present in the waste gases may be utilized in the usual manner, for instance for the generation of steam. Further wherever it appears to be economically advantageous it is also possible to work with gases enriched with oxygen or with oxygen only, this being especially the case in operations where a strongly endothermic reaction proceeds in the mass and where the heat of combustion of the products of reaction, when using air, is not sufficient to maintain the required degree of temperature.

What I claim is:—

1. In the process for the recovery of metal values from metallurgical materials containing metal compounds reducible to volatile products, by causing a mixture of the materials and a reducing fuel to travel through a rotary tube furnace solely by means of the rotation of said furnace and subjecting the mixture to the action of an oxygen-containing gas whereby the said reducible metal compounds are reduced and volatilized, and the volatilized substances and combustible gases are burned in contact with the change to furnish a substantial portion of the heat required, the improvement which comprises passing the metallurgical material, the fuel and the oxygen-containing gas, together with the gaseous products of combustion, through said furnace all in the same direction.

2. In the process for the recovery of metal values from metallurgical materials containing metal compounds reducible to volatile products, by causing a mixture of the materials and a reducing fuel to travel through a rotary tube furnace solely by means of the rotation of said furnace and subjecting the mixture to the action of an oxygen-containing gas whereby the said reducible metal compounds are reduced and volatilized, and the volatilized substances and combustible gases are burned in contact with the charge to furnish a substantial portion of the heat required, the improvement which comprises passing the metallurgical material, the fuel and the oxygen-containing gas, together with the gaseous products of combustion, through said furnace all in the same direction, the quantity of air being so regulated that a reducing or neutral atmosphere is maintained at the discharge end of the furnace.

FRIEDRICH JOHANNSEN.