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PRODUCTION OF ALKALINE EARTH METALS

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This invention relates to a method and composition for use in the production of alkaline earth metals.

Alkaline earth metals may be produced conventionally by electric furnace heating of a reducing agent with a material bearing the oxide of the metal, carbon being an example of the reducing agent.

Aluminum powder also may be used as the reducing agent. Its use, however, introduces a difficulty. Being combustible, and in extremely finely divided form, the powder is hazardous from the explosion standpoint. Being dusty, it is entrained with the alkaline earth metal vapor, so as to contaminate the metal produced. In addition, there is also waste of the aluminum powder; the loss of powder carried with the vapor makes impossible accurate calculation of amounts of the ingredients to be used in a charge, particularly since the amount of powder lost varies with the rate of release of the alkaline earth metal vapor, which, due to irregularities in furnace operation, cannot always be maintained at a uniform rate.

It is an object of the invention to provide a method in which desired intimacy of contact of aluminum with the selected oxide bearing material may be obtained, without the need of using aluminum powder. Another object is to avoid dust contamination of the distilled alkaline earth metal. Other objects and advantages of the invention will appear from the description which follows.

Briefly stated, the invention comprises the production of an alkaline earth metal by heating a material bearing its oxide with aluminum foil. The invention comprises also special means of obtaining very intimate association of the said material with aluminum supplied in the form of foil.

The invention will be illustrated more particularly by reference to the manufacture of magnesium.

The process and equipment used are conventional, except as noted herein. Thus, magnesium oxide or a source thereof and admixed aluminum are heated in the absence of air, to avoid oxidation of the metal produced, in a usual type of furnace including electrical heating elements, an outlet from the furnace for the magnesium vapor produced, and a condenser and receiver for the magnesium. There may be used, for instance, a carbon-lined furnace with exterior electrical heating elements of molybdenum, carborundum or the like. The vapors are passed through an outlet and delivery pipe, advantageously resembling somewhat a tuyère in the side of the furnace, at a position above the level of the charge therein, and thus delivered to a condenser of type commonly used in the manufacture of magnesium.

The condensed magnesium may be obtained in finely divided or compact or massive form, say, as a powder, liquid or solid, the condensation and collection of the magnesium being made in an atmosphere of hydrogen or other suitable inert or reducing gas.

A departure is made from the usual practice in that the aluminum, for reducing the magnesium oxide containing compound to the metallic or elemental condition, is foil. Preferably the aluminum foil used is thin, say, about 0.0025 to 0.0002 inch in thickness. Scrap material from the wrapping of confectionery, food products, cigars, cigarettes, or chewing gum, is satisfactory. The heat-insulating grade of aluminum foil, either by itself or backed with paper may be used.

As the magnesium oxide bearing material, there is preferred a relatively high grade magnesium oxide, such as that now being manufactured by the wet process and utilized in the commercial production of magnesium compounds. Also there may be used calcined magnesite, dolomite or brucite.

The aluminum foil and the selected source of magnesia are mixed intimately, as in a wheel or pan mill or in other suitable manner. For the sake of economy in the use of the aluminum foil, I prefer to use the magnesium oxide bearing material in amount somewhat in excess of the aluminum foil as calculated from the equivalent weights of the two materials. The foil may also be shredded preparatory to making up the charge of magnesium oxide and aluminum foil.

The charge in unbriquetted condition is heated, as, for instance, in a furnace of the kind described, to a temperature at or above the melting point of aluminum. As the foil softens, it tends, under the large force of its surface tension, to contract into spheres. But it is restrained from doing so by the presence of contacting particles of magnesium oxide. As a result, the foil is drawn into or it surface-wets the said particles.

The temperature of the mixture is then raised to that of volatilization of the resulting magnesium, so that magnesium in the form of vapor passes from the furnace to the condensing system. There is practically no aluminum carried

over as dust or as finely divided liquid mist in the distillation of the magnesium.

Since the boiling point of magnesium is about 1,100° C., the temperature of heating is preferably at least 1,110° C. or somewhat higher. It is kept well below the boiling point of aluminum but at a temperature sufficiently high to cause volatilization of liberated magnesium.

To obtain a still more intimate association of the aluminum with the magnesium oxide bearing material, the charge to be used in the production of magnesium may be evacuated, to withdraw a large part or practically all of the gas therefrom. This evacuation may be made if desired in a suitable pretreating vessel that is practically air tight. Evacuation may be made either before, during or after the heating of the charge, but the charge in any case should be above the melting point of aluminum when the vacuum is broken.

When the aluminum foil has melted, the vacuum is broken by the admission of inert (non-oxidizing) gas such as hydrogen, helium or methane. The resulting increase of pressure forces molten aluminum into the evacuated pores or spaces within the finely divided magnesium oxide bearing material, with resultant and very satisfactory association of the components of the mixture. In other words, the aluminum and the magnesium oxide bearing material are brought into intimate contact by a process of surface wetting of the oxide by molten aluminum, under the influence of vacuum and pressure successively applied. As a result there is impregnation of the molten aluminum into the magnesium oxide bearing material. An advantage of this wetting and impregnating is that the method can be applied to relatively coarse or granular material, which can be fed into a smelting furnace and reduced so as greatly to minimize the phenomenon of dusting and permit greater speed of reaction and ease of escape of the metallic vapor from the charge. When the evacuation process is used even aluminum powder may be used without excessive dusting.

Whether the evacuation and subsequent admission of the inert gas has been effected in an outside vessel or in the smelting furnace itself, the mixture is now heated in the furnace to distil magnesium therefrom.

The production of magnesium as described avoids the difficulty of excessive contamination of the distillate by aluminum carried over in finely divided condition. Also, the process is one that may be performed simply and economically, and with an improvement in the quality of the condensed product.

In place of the magnesium oxide bearing material used in the examples above, there may be substituted an equivalent amount of a material containing barium oxide, strontium oxide, or calcium oxide. When such substitution is made, the process used to produce the alkaline earth metal is the same as described, final heating in all cases being effected at a temperature somewhat above the boiling point of the metal whose oxidic material has been selected.

Among the materials that may be substituted for the magnesium oxide or the like are the carbonates of barium, strontium and calcium, preferably in calcined condition, or any materials that give under smelting conditions the oxide of the alkaline earth metal that is to be produced.

Aluminum foil backed with paper, cotton fabric or other cellulosic material may be substituted for the plain foil, the above procedure being followed otherwise. However, the temperature is preferably maintained at all times at a point below that of reduction of the alkaline earth metal oxide by carbon resulting from charring the backing.

In a modification of the method using the foil with cellulosic backing, the temperature of smelting is raised to that at which the carbon becomes effective. In that case, the distilled metal vapor is subjected to shock condensation in well known manner, to prevent a reverse reaction between the liberated metal and the carbon monoxide produced from the carbon as reducing agent for the metal oxide.

It will be understood that the term "bearing" or "containing" as applied to the oxide is used herein to include oxide providing or supplying, under the smelting conditions and at the furnace temperatures recited.

It will be understood, also, that the details given are for the purpose of illustration, not restriction, and that variations within the spirit of the invention are intended to be included in the scope of the appended claims.

I claim:

1. The process of producing an alkaline earth metal which comprises forming a mixture of aluminum foil and a material bearing an oxide of the alkaline earth metal, heating the mixture in unbriquetted condition in a furnace in the absence of air to a temperature at least as high as that of volatilization of the alkaline earth metal and below the boiling point of aluminum, passing the volatilized metal from the furnace, and then condensing the vapor.

2. The process of producing an alkaline earth metal which comprises forming a mixture of aluminum foil and a finely divided oxide of an alkaline earth metal, heating the mixture in unbriquetted condition in a furnace in the absence of air to a temperature at least as high as that of volatilization of the alkaline earth metal and below the boiling point of aluminum, passing the volatilized metal from the furnace, and then condensing the vapors.

3. The process of producing magnesium which comprises forming an intimate mixture of aluminum foil and a finely divided magnesium oxide bearing material, heating the mixture in unbriquetted condition in a furnace in the absence of air to a temperature at least as high as that of volatilization of magnesium and below the boiling point of aluminum, passing the volatilized magnesium from the furnace and then condensing the vapors.

4. The process of producing an alkaline earth metal which comprises forming a mixture of aluminum foil of thickness of the order of 0.0025 to 0.0002 inch and a finely divided material bearing an oxide of the alkaline earth metal, heating the mixture in unbriquetted condition in a furnace in the absence of air to a temperature at least as high as that of volatilization of the alkaline earth metal, passing the volatilized metal from the furnace, and then condensing the vapors.

5. The process of producing an alkaline earth metal which comprises forming a mixture of aluminum and a finely divided material bearing an oxide of the alkaline earth metal, heating the mixture to a temperature above the melting point of the aluminum and below the boiling point of the alkaline earth metal, evacuating the heated mixture, admitting an inert gas to the evacuated

mixture, so as to force molten aluminum into intimate association with the said material, and then heating the mixture to the temperature of volatilization of the alkaline earth metal and distilling the said metal.

6. The process of producing an alkaline earth metal which comprises forming an intimate mixture of aluminum and a material bearing an oxide of the alkaline earth metal, heating the mixture in an inert atmosphere to a temperature above the melting point of the aluminum and below the boiling point of the alkaline earth metal, evacuating the mixture, admitting an inert gas to the evacuated mixture subsequent to the melting of the aluminum, so as to force molten aluminum into intimate association with the said material, and then heating the mixture to the temperature of volatilization of the said metal and distilling the metal.

7. The process of producing magnesium which comprises forming an intimate mixture of aluminum foil and a finely divided magnesium oxide bearing material, evacuating the mixture, heating the evacuated mixture to a temperature above the melting point of the aluminum foil and below the boiling point of the magnesium, admitting an inert gas to the evacuated and heated mixture, so as to force molten aluminum into intimate association with the said material, and then heating the mixture to the temperature of volatilization of magnesium and distilling the resulting magnesium.

8. The process of producing magnesium which comprises forming an intimate mixture of finely divided aluminum with a finely divided magnesium oxide bearing material, heating the mixture in an inert atmosphere to a temperature above the melting point of the aluminum and below the boiling point of magnesium, evacuating the heated mixture, admitting an inert gas to the evacuated mixture so as to force molten aluminum into intimate association with the said material, and then heating the mixture to the temperature of volatilization of magnesium and distilling the resulting magnesium.

9. The process of producing an alkaline earth metal which comprises forming a mixture of aluminum foil having a cellulosic backing and a material bearing an oxide of the alkaline earth metal, heating the mixture in a furnace in the absence of air to a temperature at least as high as that of volatilization of the alkaline earth metal and below the temperature of reduction of the alkaline earth metal oxide by carbon, passing the volatilized metal from the furnace, and then condensing the vapor.

10. The process of producing an alkaline earth metal which comprises forming an intimate mixture of aluminum and a material bearing an oxide of the alkaline earth metal, evacuating the mixture, admitting to the evacuated mixture a gas that is inert to aluminum and magnesium, heating the mixture in an atmosphere of the inert gas to the temperature of volatilization of the alkaline earth metal but below the boiling point of aluminum, separating the resulting vapor of the alkaline earth metal from the said mixture, and then condensing the vapor.

11. The process of producing an alkaline earth metal which comprises forming a mixture of aluminum foil having a charred cellulosic backing and a material bearing an oxide of the alkaline earth metal, heating the mixture in a furnace in the absence of air to a temperature at least as high as that of volatilization of the alkaline earth metal and below the temperature of reduction of the alkaline earth metal oxide by carbon, passing the volatilized metal from the furnace, and then condensing the vapor.

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