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PROCESS OF METAL RECOVERY

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This invention relates to those processes of metal recovery in which a gas-vapor mixture containing carbon monoxide and a vapor of a metal miscible with molten aluminum is passed into contact with a body of molten aluminum for the purpose of condensing and absorbing the metal of the gaseous mixture and thereby effecting separation between the metal vapor and the carbon monoxide and other non-metallic components of the gas-vapor mixture.

Such a process is particularly useful when it is desired to obtain metals, such as zinc or magnesium, directly from their oxidic ores by heating said ores with carbon or a carbonaceous substance at temperatures in excess of the boiling point of the metal to be recovered. In such cases the process tends to be reversible and if immediate and complete separation is not achieved between the gaseous products of reaction, which include the metal vapor and the carbon monoxide, the CO will react with the zinc or magnesium vapor to again form the oxide of the metal and thus prevent the desired recovery of the metal. Molten aluminum is a valuable medium for effecting the desired separation, not only because of its miscibility with zinc or magnesium, but also because it forms with either of those metals a useful series of commercial alloys and it is thus possible to produce directly by the separation or absorption process a usable product which, if desired, may be utilized without further processing by distillation or other familiar step, to separate the dissolved metal from the aluminum.

Whenever a body of molten aluminum is used as a medium by which a metallic vapor is condensed and separated from a gas-vapor mixture which contains the monoxide of carbon there is formed, as a result of contact between the aluminum body and the carbon monoxide, a sludge or dross which causes serious mechanical handling difficulties and also tends to contaminate the alloy which is the product of the operations. This sludge or dross contains metal carbides, metal oxides and carbon. It is usually of great volume in relation to its weight and, if not controlled, may form with such rapidity and in such volume as to mechanically impede and clog the vessel or chamber in which contact between the gas-vapor mixture and the molten aluminum body is established.

It is the object of this invention to eliminate, or substantially impede, the formation of this sludge or dross during the above described operation and we have found that the presence in the molten aluminum body of certain metals in relatively minute quantities will achieve this object in substantial degree.

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In accordance with our invention the objects above mentioned are attained by adding to the molten aluminum a small amount of beryllium and manganese. The result of this addition is a substantial reduction in the rate of formation of the aforesaid sludge or dross and, in some observed cases, a substantially complete prevention of any dross formation. Best results have been observed where the temperature of the molten aluminum absorbing body is not much in excess of about 100° C. above the melting point of the aluminum, and we prefer to maintain the molten absorbing body at a temperature within about 125° C. of its melting point, which point will, of course, vary depending upon the amount of metal vapor which has been absorbed by the aluminum from the gaseous mixture of metal vapor and carbon monoxide with which it is contacted. The above described effect of the presence of the beryllium and manganese in the molten aluminum body is observable when the manganese is present in amounts within the range of about 0.1 to about 1.0 per cent by weight of the molten absorbing body and the beryllium is present in amount within range of about .005 to 0.5 per cent by weight of said body. The presence of these elements in selected specific concentrations within these expressed ranges will, in some cases, give better results than will other specific concentrations but usually the best results have appeared when the beryllium is in the range of about 0.0075 to 0.02 per cent and the manganese is in the range of about 0.2 to about 0.5 per cent. Simple experimentation within the indicated ranges will readily disclose the best amounts in which these elements may be present under a given set of operating conditions during the absorption of the vapor of a metal which is miscible with the molten aluminum absorbing body.

For instance, in the absorption of magnesium vapor from a mixture of magnesium vapor and carbon monoxide it appears that, in general, the best combination of beryllium and manganese in the molten aluminum absorbing body is that of about .01 per cent by weight of beryllium and 0.2 per cent by weight of manganese, but if the absorbent already contains a relatively large amount of magnesium, say over about 20 per cent by weight, it may be preferable to use higher amounts of manganese up to 1 per cent. In one instance we have observed the presence of 0.01 per cent by weight of beryllium and 0.2 per cent by weight of manganese to practically prevent

all formation of dross during the absorption of magnesium vapor from a gas-vapor mixture containing that vapor and carbon monoxide. The reasons for the remarkable results obtained by the concurrent use of minute quantities of beryllium and manganese in the molten aluminum absorbing body are not entirely apparent. When beryllium is added without manganese to the molten aluminum a slight dross reducing effect is sometimes observed particularly where the metal vapor being absorbed is magnesium. However, substantial effects are not produced unless there are concurrently present both beryllium and manganese. The manner in which the manganese functions in the molten aluminum body is obscure. Analyses of the molten aluminum body before and after contact with substantial amounts of carbon monoxide show that there is no appreciable change in concentration of manganese during the period of contact between the molten aluminum body and the gaseous reaction mixture. Hence, we assume that the function of the manganese may be that of a negative catalyst. In any event, however, best results are obtained when the manganese and the beryllium are both present in the molten aluminum absorbing body.

The effect of the beryllium and manganese is, of course, not limited to a condition where the molten absorbing body is entirely composed of aluminum. In the process of the general nature herein described it is often convenient to use a molten absorbing body, a portion of which is composed of the metal the vapor of which is to be absorbed or of a metal different than the metal vapor which is to be absorbed. However, so long as the molten aluminum absorbing body is principally composed of aluminum in the sense that it exhibits the characteristics of molten aluminum to react with carbon monoxide to form the dross in question, the presence of beryllium and manganese in the molten body will be beneficial in reducing or eliminating the tendency of the aluminum in that body to react with the carbon monoxide to form a dross.

The manner in which the gaseous mixtures of metal vapor and carbon monoxide are contacted with the molten absorbing body forms no part of this invention. The two classic methods of achieving this contact are to pass the gaseous mixture through the molten absorbing body or to pass the gaseous mixture over the surface of the molten absorbing body. The choice of either of these or other methods of contact are usually dictated by the practical aspects of the commercial operation at hand.

We claim:

1. In a process of metal recovery in which a gas-vapor mixture containing carbon monoxide and a vapor of a metal miscible with molten aluminum is contacted with a molten aluminum body and vapor of said miscible metal absorbed in said body, the improvement consisting in providing said aluminum body with a content of beryllium and manganese, the amount of said beryllium being about 0.005 to 0.5 per cent by weight of said body and the amount of said manganese being about 0.1 to 1 per cent by weight of said body.

2. In a process of metal recovery in which a gas-vapor mixture containing carbon monoxide and a vapor of a metal miscible with molten aluminum is contacted with a molten aluminum body and vapor of said miscible metal absorbed in said body, the improvement consisting in providing said aluminum body with a content of beryllium and manganese, the amount of said beryllium being about 0.0075 to 0.02 per cent by weight of said body and the amount of said manganese being about 0.2 to 0.5 per cent by weight of said body.

3. In a process of metal recovery in which a gas-vapor mixture containing carbon monoxide and a vapor of a metal miscible with molten aluminum is contacted with a molten aluminum body and vapor of said miscible metal absorbed in said body, the improvement consisting in providing said aluminum body with a content of beryllium and manganese, the amount of said beryllium being about 0.005 to 0.5 per cent by weight of said body and the amount of said manganese being about 0.1 to 1 per cent by weight of said body, and during said process maintaining said molten body at a temperature within 125° C. of its melting point.

4. In a process of recovering magnesium in which a gas-vapor mixture containing carbon monoxide and magnesium vapor is contacted with a molten aluminum body, the improvement consisting in providing said aluminum body with a content of beryllium and manganese, the amount of said beryllium being about 0.005 to 0.5 per cent by weight of said body and the amount of said manganese being about 0.1 to 1 per cent by weight of said body.

5. In a process of recovering magnesium in which a gas-vapor mixture containing carbon monoxide and magnesium vapor is contacted with a molten aluminum body, the improvement consisting in providing said aluminum body with a content of beryllium and manganese, the amount of said beryllium being about 0.0075 to 0.02 per cent by weight of said body and the amount of said manganese being about 0.2 to 0.5 per cent by weight of said body.

6. In a process of recovering magnesium in which a gas-vapor mixture containing carbon monoxide and magnesium vapor is contacted with a molten aluminum body, the improvement consisting in providing said aluminum body with about 0.01 per cent by weight of beryllium and 0.2 per cent by weight of manganese.

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