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METHOD OF FORMING NON-SPHERICAL ATOMIZED PARTICLES OF MAGNESIUM AND ITS ALLOYS

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Fig. 1



Fig. 2



Fig. 3



Fig. 4

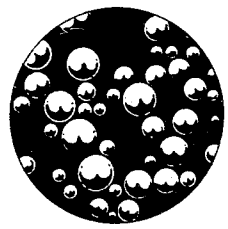


Fig. 5

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# METHOD OF FORMING NON-SPHERICAL ATOMIZED PARTICLES OF MAGNESIUM AND ITS ALLOYS

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This invention relates to improvements in the process of atomizing magnesium and its alloys to obtain non-spherical solid particles.

One of the objects of the invention is to provide a method by which irregularly shaped particles of rather uniform weight are obtained.

A further object is to provide a process in which the irregularity of shape of the metal particles can be regulated to a certain extent.

Another object is to provide a process of producing irregularly shaped particles broad enough in principle to be applicable to either disc or jet atomizing methods.

The method herein referred to as disc atomizing is defined as follows:

Molten metal is allowed to fall freely in a thin stream onto a rapidly rotating disc in the presence of a non-reactive gas. The molten metal is flung off the disc in fine particles which cool quickly, thereby producing a fine particulated product.

The method herein referred to as jet atomizing is defined thusly:

A thin stream of molten metal is discharged into a jet of non-reactive gas so that the stream of molten metal is dispersed into minute particles which instantly solidify, thereby producing particulated metal.

Other objects and advantages of the invention will be apparent during the course of the following description.

In U.S. Patent 2,676,359 there is disclosed a method of atomizing (herein referred to as jet atomizing) magnesium and its alloys which involves the impingement of a cool hydrocarbon gas (methane, ethane, propane, butane), containing an entrained neutral liquid as a fog, against a thin stream of the molten metal. The solid atomized particles of metal thus obtained are jagged rather than smooth, are capable of being compacted under pressure, and readily ignite with the flame of a match.

The present invention concerns an improvement of the foregoing method of atomizing magnesium and its alloys to produce irregularly shaped solid particles and is based upon the discovery that by adding a controlled small amount of elemental oxygen to a non-reactive gas, used either as the cooling ambient atmosphere in disc atomizing or as the dispersing means in jet atomizing, non-spherical particles of a desired irregularity of shape and uniformity of weight are obtained, whereas spherical particles are obtained upon using said same non-reactive gas without the addition of said controlled small amount of elemental oxygen. The non-reactive gas may be a hydrocarbon gas or other inactive gas or gas mixtures which allow the formation of spherical particles in the substantial absence of oxygen. The invention then consists of the method herein fully described and particularly pointed out in the claims.

Referring to the accompanying drawings:

Fig. 1 is a view at a magnification of 11 diameters of a circled portion of a sample of atomized magnesium alloy made by disc atomizing with 3.05 volume percent oxygen present in the hydrocarbon gas charged to the space in which the disc operates, the sample being spread thinly on a black background.



Figs. 2, 3, and 4 are each a similar view of a circled portion of a thinly spread sample of the same magnesium-base alloy disc atomized in an atmosphere of hydrocarbon gases containing, respectively, 0.856, 0.650 and 0.345 volume percent oxygen.

Fig. 5 is a similar view of a circled portion of a sample of the same alloy as that of the previous figures similarly disc atomized but with only 0.19 volume percent of oxygen in the hydrocarbon gas atmosphere as a blank for comparison.

According to an embodiment of the invention, the magnesium or magnesium-base alloy to be atomized is brought to the molten state. The molten metal is allowed to fall freely in a thin stream onto a rapidly rotating disc in the presence of a non-reactive gas which contains, in admixture, a small amount of elemental oxygen in the concentration range of 0.2–4.5 volume percent. Examples of non-reactive gases which may be used are hydrocarbon gases such as natural gas and more particular those containing from one to four carbon atoms, helium, argon and mixtures thereof.

The upper limit of oxygen concentration permissible in said ambient gas is the concentration which is safely below the explosive limit for the hydrocarbon gas used (approx. 5 volume percent).

For helium-oxygen or argon-oxygen mixtures safety becomes a function of the reactivity of magnesium with oxygen. Unsafe oxygen concentrations are well above the working range of this invention.

While magnesium is reactive with oxygen at temperatures near its melting point (650° C.), at much lower temperatures (150–200° C.) reactivity is decreased. Further, reactivity of magnesium with low concentrations of oxygen is less than with low concentrations of water at the temperatures which particles assume within a few seconds after the atomizing step. Atomized particles produced by our method are subject to less magnesium oxide contamination than the product made by the method described in U.S. Patent 2,676,359 in which water is the preferred fog-forming liquid.

Water vapor at concentrations normally present in natural gas has not been found deleterious to the practice of our invention. Indeed, natural gas which has not been dried is often employed in the manufacture of spherical particles of atomized magnesium. Water vapor, if present during the atomizing step in substantial concentrations will have these effects: (1) it will contribute to greater irregularity of shape of atomized particles, and (2) it will react with magnesium particles resulting in undesirable magnesium oxide contamination of the particles.

In controlling the shape of the atomized particles the level of oxygen concentration is critical as demonstrated by the following examples in which oxygen concentrations below the explosive limits are used. The four examples demonstrate the practice of the invention within the range of oxygen concentration stated. From these examples and the accompanying drawings the influence of oxygen can be plainly seen. As oxygen concentration in the ambient gas is reduced, a decreasing proportion of the desired irregular shaped particles is produced while an increasing proportion of smooth round particles is obtained.

## EXAMPLE 1

A magnesium-base alloy having a nominal composition of 3 percent aluminum, 1 percent zinc, 0.2 percent (min.) manganese, the balance being magnesium, was disc atomized in an atmosphere of natural gas containing 3.05 volume percent oxygen. The particle forms were all irregular shapes and stringers. This product is shown in Fig. 1.

## EXAMPLE 2

The same magnesium-base alloy described in Example 1 was disc atomized in an atmosphere of similar natural gas containing 0.856 volume percent oxygen. The particles formed were mostly irregular shapes with some stringers and with 25 to 50 percent near spherical. This product is shown in Fig. 2.

## EXAMPLE 3

The same magnesium-base alloy described in Example 1 was disc atomized in an atmosphere of similar natural gas containing 0.650 percent elemental oxygen. The particles formed were 25 to 50 percent irregular shapes and with 50 to 75 percent near spherical. This product is shown in Fig. 3.

## EXAMPLE 4

The same magnesium-base alloy described in Example 1 was disc atomized in an atmosphere of similar natural gas containing 0.345 volume percent elemental oxygen. The particles formed were about 95 percent spherical shapes and about 5 percent slightly irregular particles. This product is shown in Fig. 4.

In contrast to the foregoing examples, the blank below and the accompanying figures demonstrate that spherical particles are obtained when the oxygen content of the ambient gas is maintained below the stated range.

*Blank*

The same magnesium-base alloy described in Example 1 was disc atomized in the same natural gas atmosphere containing 0.19 volume percent or less oxygen. The particles formed were substantially all normal instead of irregular spherical shapes. An example of such particles is shown in Fig. 5.

While the use of a rotating disc to atomize the molten metal is preferred in carrying out our invention, other suitable atomizing means may be employed, for example, jet atomizing. Here the magnesium or magnesium-base alloy to be atomized is brought to the molten state. The molten metal is allowed to fall in a thin stream while impinged against it is a jet of non-reactive gas which contains, in admixture, a small amount of elemental oxygen in the concentration range 0.2–4.5 volume percent.

It is to be understood that the forms of our invention herewith shown and described are to be taken as preferred examples of the same and that various changes in the mode of operation may be resorted to without departing from the spirit of our invention or the scope of the subjoined claims.



We claim:

1. In a process of atomizing a metal selected from the group consisting of magnesium and magnesium-based alloys in the presence of a non-reactive gas the improvement comprising incorporating a controlled amount of elemental oxygen in the range of 0.3 to 4.5 volume percent in the non-reactive gas, thereby producing solid particles having irregular form.

2. In a process of atomizing a metal selected from the group consisting of magnesium and magnesium-based alloys by subjecting a thin stream of the molten metal to a jet of non-reactive gas the improvement comprising incorporating in the gas jet a controlled small amount of elemental oxygen in the range of 0.3 to 4.5 volume percent, thereby producting solid particles having irregular form.

3. The process as in claim 2 in which the non-reactive gas is natural gas.

4. In a process of atomizing a metal selected from the group consisting of magnesium and magnesium-based alloys by allowing the molten metal to fall freely in a thin stream onto a rapidly rotating disc in the presence of a non-reactive gas, the improvement comprising incorporating in the non-reactive gas atmosphere a controlled small amount of elemental oxygen in the range 0.3 to 4.5 volume percent, thereby producing solid particles having irregular form.

5. The process as in claim 4 in which the non-reactive gas atmosphere is natural gas.

6. The process as in claim 4 in which the non-reactive gas atmosphere is a hydrocarbon gas having 1 to 4 carbon atoms.

7. The process as in claim 4 in which the non-reactive gas atmosphere is helium.

8. The process as in claim 4 in which the non-reactive gas atmosphere is argon.

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