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PROCESS FOR THE PRODUCTION OF METALS IN A FINELY DIVIDED STATE

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1 Claim. (Cl. 75—18)

The invention relates to the preparation of metals in a finely divided state by precipitating the same from solutions of their salts by addition of aluminum thereto.

It is known that metals will replace and precipitate other metals from their salt solutions according to their respective positions in the electromotive series. Thus iron, if added to copper sulfate solutions, will precipitate copper with formation of ferrous sulfate.

It is also known that aluminum, although classed among the more highly electropositive metals, will not in the ordinary way act on other metals, even though the metal in question be as far below it in the electromotive series as copper. It is principally the slow rate of this reaction, which becomes more and more slow as the metal to be precipitated approaches the electropotential of aluminum, that prevents the practical use of the latter for the purposes of precipitation. Only the noble metals, including metals of the platinum group and mercury, are readily and normally precipitated.

I have however found that aluminum may be activated so as to react readily on solutions of salts of metals between it and copper in the said electromotive series, and my invention applies particularly to copper, lead, cobalt, cadmium, tin, and above all to nickel and iron.

Moreover I have discovered that finely subdivided aluminum will, when added at a slow rate to an appropriate solution, precipitate the metal from the solution in question in a finely subdivided state.

Further I have found that in the case of iron and nickel the size of the particles precipitated depends on the size of the particles of aluminum added for the reaction.

Thus by selecting coarser or finer grains of aluminum the precipitated nickel or iron may be obtained in any state of subdivision ranging from large grains to fine powder.

This altogether unexpected effect is impaired by the above mentioned sluggishness of aluminum to react to such an extent that it is almost always essential to overcome this difficulty by means adapted to increase the speed of the reaction. One of the most efficient means is to activate the aluminum, as explained below.

The full importance of the present invention resides in the combination of employing finely divided and activated aluminum to obtain the aforesaid result.

The sluggishness of aluminum to react which has hitherto been observed appears to be due to the fact that its surface is covered by a thin layer of oxide which very greatly reduces its chemical activity. Activation of the aluminum may be obtained, as I have found, by any preliminary treatment which removes said oxide coat or which is at least adapted largely to reduce its obnoxious influence.

This may be carried out by treating the aluminum with a dilute solution of dichloride of mercury or of hydrochloric acid, sulfuric and nitric acid having an action much inferior in result. Sulfuric acid for instance is sufficient for breaking the film of oxide in the case of copper sulfate, but fails to act in the case of metals nearer to aluminum in the electromotive series.

Satisfactory activation of the aluminum may also be obtained by adding to the aluminum or alloying therewith appropriate metals, such as calcium, which produce a galvanic couple with the aluminum.

Finally if desired activation of the aluminum may be produced in the solution to be treated by addition of chlorides such as those of the alkali metals or of ammonium, or in general of chlorides of any metals more electropositive than aluminum, provided that said chloride does not in any way interfere with the subsequent precipitation.

Aluminum activated according to the invention will instantaneously react for instance on cold copper sulfate solutions; it will replace and precipitate from their solutions lead, cadmium and particularly nickel and iron.

In carrying the invention into effect it should however be observed that aluminum, even though activated, will react relatively less rapidly the less distant it is in the electromotive series from the metal to be precipitated.

It has also been found that elevated temperature will usually speed up the reaction. Thus in the case of solutions of iron, nickel and cadmium it is advisable to work at temperatures of about 90° C; while in the case of lead the optimum temperatures lie between 40° C.–50° C.

It should further be noted that the aluminum should be added slowly.

The solutions of the metal to be precipitated may be of any desired concentration for metals near copper in the electromotive series; for metals nearer aluminum certain limits of concentration should be observed. In the case of iron and nickel best results can be obtained with solutions containing between 100 and 200 grammes of sulfate per liter, and the solutions should preferably only contain the bivalent form of the said metals.

The following examples are stated for the better intelligence of my invention without restricting or limiting the same:

(1) Aluminum powder passing entirely through sieve No. 250 is well moistened with the requisite quantity of 10% hydrochloric acid solution and then added to a cold saturated copper sulfate solution. A quantity of aluminum is chosen which represents one quarter of that equivalent to the copper present in the solution as copper sulfate. The aluminum is added in small quantities at a time. The reaction commences instantaneously liberating heat, and the temperature of the solution rises. The addition of aluminum powder should be so regulated—or the solution so cooled—as to avoid ebullition. About one fourth of the copper is precipitated in the form of a powder passing entirely through sieve No. 250.

(2) To a saturated solution of lead acetate maintained at 40° C., about 50 grams per liter of ammonium chloride are added. Aluminum powder is then added slowly, its addition being so regulated that the temperature does not exceed 50° C. The lead will precipitate in the form of globules which after separation and drying may be readily disintegrated into a powder of extreme fineness.

Finally the invention may be used to precipitate separately each metal from solutions containing two or more metals.

Should the solution contain a mixture of copper and nickel sulfates and aluminum powder be added together with a small quantity of sulfuric acid catalyst the copper alone will precipitate. Should it however be desired to precipitate the nickel, it will be necessary to use hydrochloric acid as catalyst. The two metals can therefore be separated by employing first a catalyst of sulfuric acid together with the addition of aluminum powder and subsequently adding more powder together with a hydrochloric acid catalyst. In another example iron and nickel can be separated from a mixed solution of their sulfates by conducting the precipitation with 30 to 40 grammes of sodium chloride in order to precipitate the nickel while over 50 grammes of the same reagent will be necessary to precipitate the iron. Or again mixtures of solutions of cobalt and nickel salts may be separated by first adjusting the temperature of reaction to below 30° for the precipitation of cobalt and then raising it to over 50° for the nickel.

I claim:

Process for the precipitation of finely divided iron, which comprises reacting on a ferrous sulfate solution containing less than 10 gram molecules of ferrous sulfate per litre at about 90° C. with finely divided aluminum in the presence of more than fifty and less than 100 grams per liter of sodium chloride.

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