

UNITED STATES PATENT OFFICE.

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PROCESS FOR EXTRACTING METALLIC NICKEL.

No Drawing.

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This invention is an improvement in processes for extracting nickel and has for its object to provide a process by means of which the nickel can be extracted, as metallic nickel, from nickel-bearing solutions and from ores, mattes, speisses, and alloys of nickel. My process is very suitable for recovering nickel from nickel-bearing solutions which are produced in copper refineries in the course of electrolytic refining of copper.

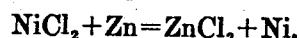
In treating ores, mattes, speisses, calcines, alloys, and other materials for the extraction of the nickel, my process consists in dissolving the material to be treated for nickel, by means of a solvent, such as an acid or acids, or a solution of a salt containing dissolved chlorine gas, or by means of any other suitable solvent; in replacing or precipitating by means of metallic nickel the noble metals, copper, etc., which may be present in the resulting solution; in precipitating the iron, if this be present, from the solution by means of zinc oxide, which precipitate will carry with it by occlusion practically all of the arsenic and antimony; in precipitating from the solution thus purified the nickel as metallic nickel by means of metallic zinc or by "blue-powder"; and in preparing a marketable form of a zinc salt.

The nickel solutions which are produced in copper refineries in the course of electrolytic refining of copper, contain sulfuric acid, some arsenic and antimony, and a trace of iron. In treating such solutions for the recovering of nickel my process is the same as that described above, with the exception that the acid present in such solutions has to be almost completely neutralized by a suitable acid consuming material, such as zinc oxide, limestone, etc., before the complete precipitation of the nickel may be effected by means of metallic zinc.

I have found that under proper conditions, which will be described below, metallic zinc, or a mixture of zinc and zinc oxide or "blue powder" precipitates practically completely all of the nickel as metallic nickel from neutral or slightly basic nickel-bearing solutions. Some nickel may be precipitated by means of zinc from acid solutions also, but in the latter case the precipitation of the nickel is not complete, since most of the zinc

dissolves by the acid, liberating hydrogen gas rather than to precipitate nickel.

The precipitation of metallic nickel by means of metallic zinc may be represented by the following chemical equation in which nickelous chloride is taken as an example:



My experiments show that zinc precipitates nickel from solutions very rapidly if the temperature of the nickel-bearing solution is raised somewhat; at ordinary temperatures the re-action is slow. The temperature range about from 40° C. to about 90° C. or higher, gives satisfactory results. Generally speaking, the higher the temperature of the solution, the faster is the reaction.

I have found that zinc precipitates nickel somewhat faster from chloride or nitrate solutions than from the sulfate solution; and that the addition of a soluble chloride or nitrate to a sulfate solution accelerates the precipitation or deposition of the nickel. As far as the completeness of the reaction is concerned, a sulfate solution behaves in a manner similar to the nitrate or chloride solutions.

Besides the temperature at which the reaction is carried out and the kind of the solution used, another factor which influences the rate of deposition or precipitation of nickel from solutions is the physical condition of the metallic zinc used to bring about the precipitation. I find that although zinc in the form of slabs, sheets or shots precipitates nickel from solutions, better results are obtained by using granulated or powdery zinc, or "blue powder".

In order to assure an almost complete depletion of the solution from nickel, I find that it will be advisable to use an excess of zinc. However, my experiments show that better results are obtained and less zinc is required to precipitate practically all of the nickel, if the necessary amount of zinc is added to the solution portion by portion at intervals and not all of it at once at the start of the run. Following this method of procedure and by keeping the solution stirred or agitated, I find that only a slight excess of zinc will be required to precipitate practically all of the nickel from the solution.

If the solution is fairly high in nickel or

if it is desired to obtain a nickel precipitate which is almost free of zinc, I find it advisable, although not absolutely necessary, to carry out the precipitation of nickel by means of zinc, in two successive steps. The first operation or step consists in adding to the nickel-bearing solution somewhat less zinc than that required for the complete precipitation of all of the nickel present in the solution, and in keeping the solution stirred or agitated until practically all of the zinc is used up to precipitate the nickel. At this stage, a nickel precipitate is formed which is practically free of zinc, and also a solution which still contains some nickel in a soluble form. The precipitated nickel is then removed or separated from the solution by filtration or by other suitable means. During the second operation the solution resulted from the first step or operation is treated with a large excess of zinc, and the mixture of zinc and solution is efficiently stirred or agitated until practically all of the nickel is precipitated from the solution by the excess zinc present. A part or all of this nickel-zinc mixture can then be returned to the system for treating new portions of nickel-bearing solutions, and the cycle of operations repeated. By dividing the process into two such successive operations, a nickel precipitate may be obtained which is practically free of zinc, and a maximum utilization of zinc may be assured.

If the nickel is present in the solution in the nickelic condition and if it is desired to recover all of the nickel as metallic nickel, it would be advisable to reduce this to the nickelous form in a slightly acid solution by means of a suitable reducing agent, such as sulfur-dioxide, or metallic nickel or zinc. It is necessary to do this because nickelic salts decompose in slightly alkali solutions and nickelic hydroxide precipitates which, under ordinary conditions of operations, will not be reduced to metallic nickel by means of zinc.

The elimination of arsenic and antimony from the solution is advisable, since metallic zinc dissolves, although very slowly, even in neutral solutions, liberating nascent hydrogen; the latter may form arsine and stibine gases, if arsenic and antimony are present. If there is sufficient iron present in the solution, arsenic and antimony are practically completely removed from the solution by the precipitated iron hydroxide. In case the solution is short of iron, some iron must be added, preferably in the form of a ferric salt, to the solution to assure the removal of the arsenic and antimony.

The final products obtained by my process are metallic nickel and a solution which contains zinc in the form of a soluble salt. The zinc salt may be recovered from the

solution by any suitable process, such as by crystallization or by evaporation, and marketed as such. The nickel obtained in the precipitated form is black and powdery, which upon being melted assumes its usual metallic luster. The nickel thus produced is practically free of copper, but it may contain small amounts of other impurities in which case it has to be refined. With careful work, however, fairly pure nickel may be obtained by my process.

What I claim is:

1. The process for the precipitation of nickel which comprises treating a nickel bearing solution to remove substantially all objectionable impurities therefrom, adding metallic zinc to the solution to precipitate the major part of the nickel, separating the nickel so precipitated, and adding to the resulting solution maintained at an approximate boiling temperature a quantity of metallic zinc in quantities sufficient to effect substantially complete precipitation of the nickel content of the solution.

2. The process for the precipitation of nickel which comprises adding to the substantially neutral nickel solution a quantity of metallic precipitants for the nickel in quantities sufficient to precipitate the major portion of the said nickel, separating the precipitant from the solution, adding a fresh portion of the precipitant to the residual solution to completely precipitate the remainder of the nickel and utilizing the resulting mixture of precipitated nickel and precipitant for the treatment of fresh quantities of the solution, until substantially all the nickel is obtained free from the precipitated metal.

3. The process for the precipitation of a metal from a solution thereof, which comprises adding to the solution a metallic precipitant for the same metal in quantities insufficient for the complete precipitation of the said metal, separating the precipitated metal, adding a relatively large excess of precipitant to the solution to precipitate the remainder of the said metal and utilizing the resulting mixture of precipitated metal and precipitant for the treatment of fresh quantities of solution until substantially all of the precipitant is dissolved from the mixture, leaving as a residue the precipitated metal in substantially pure form.

4. The process for the precipitation of nickel from the nickelous solutions which comprises adding to the solutions a quantity of zinc in amounts insufficient to precipitate the entire nickel content, separating the resulting precipitant, heating the residual solution substantially to the boiling point, adding fresh quantities of zinc thereto to complete the precipitation of the nickel and separating and reusing the mixture of pre-

precipitated nickel and zinc in fresh nickelous solutions until the precipitated nickel is substantially free from zinc.

5 5. The process of precipitating metal from nickelous solutions which comprises adding to the solution a quantity of metallic zinc sufficient to precipitate the major portion of the nickel, heating the residual solution to boiling, adding to the boiling solu-

tion a quantity of zinc sufficient to precipi- 10
tate the remainder of the nickel and reusing the mixture of precipitated nickel and zinc in successive nickel operations until the zinc content of the mixture has been removed, the precipitation being carried out in the 15
presence of nickel nitrate and nickel chloride.

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