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RECOVERY OF COBALT AND NICKEL FROM ORES

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This invention relates to the recovery of cobalt or nickel or both of them from minerals containing aluminum compounds and generally also iron, along with minor amounts of other metals which also can be recovered. More particularly the invention involves processes for the separation of the cobalt and nickel content of lateritic ores of the limonitic type containing at least one or both of said metals by steps including pulping of the ore, selective acid leaching at high temperatures and pressures, cooling, separating the acidic leach liquor from the spent ore and precipitating the nickel and cobalt from the leach liquor, each of which steps involves special conditions and controls.

In processes of this character, it has been considered essential that the free acid in the product leach liquor first be neutralized in order to make possible the economic recovery of the nickel and cobalt in purified condition, and to accomplish this neutralization, the addition of lime or other alkali has been proposed. In these processes, not only are acid values lost in the neutralization step but also acid is now known to be lost by the conversion of part of the aluminum content into basic aluminum sulfate which precipitates on the tailings.

Because of the low nickel and cobalt content of limonitic ores and the absence of appreciable amounts of other valuable metals in such ores, the problem of recovering the nickel and cobalt successfully involves difficult problems of economy. Accordingly a primary object of the invention is to provide processes for acid leaching and recovery of the cobalt and nickel contents which reduces the amount of acid consumed primarily by recovering a substantial portion of the acid values for reuse in the process.

This objective is accomplished by the utilization of procedures which avoid loss of sulfate values through discharge of the basic aluminum sulfate in the tailings and which avoids the loss of acid values through formation of calcium sulfate by eliminating the step involving neutralization of the product leach liquor by reaction with added lime. The consumption of acid is also reduced by introducing aluminum sulfate into the acid leach solution whereby dissolution of aluminum is apparently decreased. Finally, the precipitation of nickel and cobalt is preferably effected in such manner as to leave a spent liquor containing aluminum sulfate which can be recycled to the leaching step. The temperature of the leaching operation is also controlled to minimize the loss of acid in dissolution of iron.

Broadly expressed, the invention may be considered to involve an improvement in the leaching of the nickel and cobalt content from ores or ore fractions containing either or both of such metals along with aluminum and generally also iron by the action of sulfuric acid in excess at those elevated temperatures and pressures which take up in solution nearly all of the nickel and cobalt content and only part of the aluminum and minor amounts of iron and other undesired metals, in which improvement, part of the leaching action is supplied by an addition of aluminum sulfate produced in the recovery operation and recycled to the leaching step. Instead of neutralizing the excess or free acid remaining in the leach solution upon completion of the leaching reaction by the use of lime or other alkali leading to the production of salts to be discarded to waste, it is taken up from all or part of the product leach liquor in forming soluble aluminum sulfate by reaction with insoluble basic aluminum sulfate in the ore slurry, the reaction being effected by cooling the hot slurry upon completion of the leaching reaction to a temperature at which said reaction will take place (generally below about 200° F.) and permitting the slurry to stand, i. e., aging the slurry, until the free acid or most of it has been taken up, at which point the pH will have risen to a value between about 1 and 3.

Upon completion of the aging step, the leach slurry containing the recovered acid values in the form of aluminum sulfate and generally also a little free acid is separated from the spent ore solids by decanting or other process, if economically feasible, as filtering or centrifuging, then a substantial part of the leach liquor is recycled to the leaching step and the other part is treated to recover the nickel and cobalt content by any suitable procedure but preferably involving conversion to their sulfides. Optimum acid recovery and advantage is obtained when as much as possible of the product leach liquor is recycled, while at the same time the solids accumulating in the liquor are not permitted to reach an unworkable level.

In the foregoing leaching step, the dissolution of the nickel and cobalt content is effected by the action of sulfuric acid obtained from two or more sources, namely: (1) fresh acid introduced into the process, (2) acid regenerated by the heating during leaching from the aluminum sulfate contained in the recycled liquor and generally also in small amounts (3) recycled free acid, and (4) acid regenerated from any iron sulfates present in the solution.

The amount of acid required in the process to accomplish the desired results depends upon many factors including the quantity of metals in the particular ore treated which will be solubilized during the leaching process. In all instances the acid must be present in excess of that consumed during leaching. The amount of excess must be adequate to maintain the dissolved nickel and cobalt content in solution during the subsequent operations. About 15% to 25% total acid in relation to the amount of dry ore is usually sufficient. The hot solution will ordinarily contain about 1% or somewhat more free acid at the conclusion of the leaching step. The pH value of the fresh solution should preferably be below about 2.

The leaching operation is effected at high temperatures preferably of the range of 375° to 500° F. If lower temperatures are employed, such as 260° F. the dissolution of iron will be excessive and if temperatures appreciably higher than 500° F. are employed the nickel and cobalt content or part of the same may become insoluble. The heating and leaching operations are continued until substantially all of the nickel and cobalt content has been dissolved, this end being accomplished ordinarily in 1–3 hours.

Upon completion of the leaching step the slurry is wholly or in part cooled to a temperature at which the insoluble basic aluminum sulfate will in time be converted into soluble aluminum sulfate by reaction with free sulfuric acid remaining in the solution, the temperature to accomplish this result usually being below about 200° F. The slurry is preferably agitated and maintained under the cooled condition for a short time, as from 1 to 4 hours, or until the above-mentioned reaction has progressed to an extent where most or substantially all of