FROTH FLOTATION PROCESS

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This invention relates to the concentration of minerals, such as sulfide ores and the like, by the froth flotation process.

This invention is based on the novel discovery that the hydrogenation products of certain hydroxy-aromatic compounds are very effective frothing reagents. The term "hydrogenation" as used herein is intended to mean the addition of hydrogen atoms to carbon atoms in the phenolic nucleus. Such hydrogenated products have little, if any, collecting action in bringing about the separation of minerals, but they have marked frothing properties, and provide a suitable frothing action in an ore pulp containing an active (but non-frothing) collecting agent for bringing about an efficient separation of the mineral.

More particularly the invention relates to use of the hydrogenated products of phenol, the cresols, tar acid, beta-naphthol and like hydroxy-aromatic compounds, as froth flotation reagents, and may consist of either completely hydrogenated products or only partially hydrogenated products, or a mixture of the same. While various modes of producing the hydrogenation are possible, U. S. Patent 1,247,629 is cited as showing a satisfactory method.

The term "tar acids" is ordinarily used in this country to designate the mixed phenolic bodies present in ordinary (or high temperature) coal tar, and consists largely of phenol, cresols and xyleneols, namely phenolic bodies containing not over eight carbon atoms. It will be understood that completely hydrogenated phenolic bodies are represented by hexahydrophenol, C₆H₄OH and its homologues.

The hydroxy-aromatic compounds (phenol, cresols, tar acid, beta-naphthol and the like) possess some frothing action of themselves, but by their hydrogenation there has been obtained a very material increase in their frothing effect. To illustrate, the following table shows the tests being carried out in a laboratory Janney flotation cell filled with tap water to the usual height for a flotation test, three drops of the frothing reagent added, and the height of the froth measured when it had reached its maximum:

<table>
<thead>
<tr>
<th>Benzenoid structure</th>
<th>Alcohol structure (completely hydrogenated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenol</td>
<td>trace</td>
</tr>
<tr>
<td>O-cresol</td>
<td>.5 inch</td>
</tr>
<tr>
<td>M-cresol</td>
<td>1 to 1.25 inches</td>
</tr>
<tr>
<td>F-cresol</td>
<td>1.25 inches</td>
</tr>
</tbody>
</table>

These tests were comparable to the froth flotation operation in the Janney flotation cell, in which a large number of gas bubbles (usually air) are mechanically introduced into a liquid pulp to bring about the formation of a froth at the pulp surface.

The standard frothing substance, pine oil, under the same conditions as above gave a froth about two inches in height and a frothing action, in other respects closely similar to that produced by the hydrogenated cresols.

A sample of hydrogenated cresols (o, m, p mixed) was employed as a frothing agent in the flotation of a copper sulfide ore of the Utah Copper Co. analyzing about 1.0% copper, in the ratio of about twenty-five hundredths of a pound (0.25 lbs.) per ton of dry ore, and in this particular test, one tenth of a pound (0.1 lb.) of a xanthate was used as a collecting agent. The ore was subjected to the ordinary froth flotation operation in a mechanical agitation type of a flotation cell, and employing a lime circuit. A tailing analysising 0.10%, or thereabouts was obtained, together with a high grade concentrate, corresponding to a recovery of about 90% of the copper value in the ore tested.

The flotation frothing reagent of the invention can be employed with ores in general, and larger or smaller amounts of the reagent than specified above may be used, depending on the type of ore and other conditions.

Also other reagents may be used along with this ore, (in solution with, mixed with, or added separately) to supplement its frothing action or a collecting reagent may be used along with this flotation frothing agent to give good collection and frothing properties. Furthermore the invention is not restricted to the use of this reagent in any particular type of flotation machine, or instead of an alkaline circuit, as used in the above example, an acid or neutral circuit may be employed.

In the above example, reference is made to the successful use of completely hydrogenated cresols as exemplifying the flotation frothing reagent of this discovery. It is desired to be understood that other closely analogous substances such as tar acid from high or low temperature tar, after being hydrogenated, can be likewise employed; and the invention is not limited to completely hydrogenated products, but instead partially hydrogenated products can be used with good results.

As is well known, the tar acids from high temperature tar consist very largely of phenol, cresols and xyleneols (phenols containing not over eight carbon atoms), and most of which boils at not above 240° C., while the tar acids from low temperature tar contain very large fractions of higher phenols (phenols containing over eight carbon atoms), and boiling at above 240° C. These latter are alkylated phenols and the more
highly alkylated phenols contain more hydrogen than the non-alkylated or low-alkylated bodies of the high temperature tar. Sharply distinguished from the above are the substances which I employ, such as hexahydrophenol, and its homologues, whereas tar acids of high and low temperature tars are phenols or alkylated phenols.

It is of course to be understood that the frothing agents of the present case can be used to supplement the frothing action of other frothing agents present in or added to the circuit, and that they likewise can be used to supplement the frothing action of collecting agents which have a weak frothing action.

I claim:

1. In the froth-floatation of ores, the herein described improvement of providing an ore pulp containing a completely hydrogenated tar acid as a frothing agent together with a mineral-collecting agent, and aerating the same.

2. In the froth-floatation of ores, the herein described improvement which comprises adding to an ore pulp a hydrogenated tar acid as a flotation frothing reagent, and subjecting the material to froth-floatation.

3. A process which comprises hydrogenating to substantially complete saturation, a tar acid compound from high temperature coal tar, and thereafter adding such product as a frother in the froth flotation of ore, and subjecting the material to froth-floatation.

4. In the froth-floatation of ores, the herein described improvement of providing an ore pulp containing a hydrogenated tar acid as a frothing agent, in which frothing agent the hydrogenated phenols include a substantial proportion of substances, containing not over seven carbon atoms, and introducing fine gas bubbles into the same.

5. In the froth-floatation of ores, the herein described improvement of providing an ore pulp containing a hydrogenated tar acid as a frothing agent together with a mineral-collecting agent, in which frothing agent the hydrogenated phenols consist largely, at least, of substances containing not over eight carbon atoms, and introducing fine gas bubbles into the same.

6. In the froth-floatation of ores, the herein described improvement which comprises adding to an ore pulp a completely hydrogenated tar acid as a flotation frothing reagent, in which frothing agent the hydrogenated phenols consist largely, of substances containing not over eight carbon atoms.

7. In froth-floatation, the herein described process which comprises froth-floatation in the presence of a frothing agent, the main bulk of which is hydrogenated phenolic bodies of not over eight carbon atoms.

8. In froth-floatation, the step of adding to the ore-pulp, a frothing reagent derived from tar acids, catalytically hydrogenated, and subjecting the material to froth-floatation.

9. In froth-floatation of ores, the herein described steps of hydrogenating the tar acids from low temperature tar, and adding such product, as a frothing agent, to the ore pulp, and subjecting the material to froth-floatation.

10. In froth-floatation, the steps of hydrogenating phenol and adding the product as a frother into the ore pulp, and subjecting the material to froth-floatation.

11. In froth-floatation, the steps of hydrogenating cresol and adding the product as a frother into the ore pulp, and subjecting the material to froth-floatation.

12. In the froth-floatation of ores, the herein described improvement which comprises providing an ore pulp containing a frothing agent selected from the herein described group consisting of hexahydrophenol and its homologues, and introducing fine gas bubbles into the same.

13. In the froth-floatation of ores, the herein described improvement which comprises providing an ore pulp containing a frothing agent selected from the herein described group consisting of hexahydrophenol and its lower homologues, and introducing fine gas bubbles into the same.

14. The step of froth-floatation in the presence of a hydrogenated phenol containing not over eight carbon atoms.

15. The step of froth-floatation in the presence of hydrogenated cresol.

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