POSSIBILITIES FOR APPLYING FISH OIL TO ORE FLOTATION

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ABSTRACT

This is a report of a trip made to iron-ore-concentration plants in Michigan and Minnesota for the purpose of learning what possibilities there are for using fish oils in the flotation of ore.

INTRODUCTION

In an attempt to apply fish oils or fish-oil derivatives to the flotation of ores, especially iron-ores, the U. S. Bureau of Commercial Fisheries has been carrying on cooperative research since 1955 with the School of Mines and Metallurgy, University of Minnesota. Results of this research have shown that fish-oil fatty acids can be highly effective for such flotation. With iron ore, fish-oil fatty acids (because of their high degree of unsaturation) are especially effective in a reverse type of flotation in which the silica is floated away from the iron in place of the more usual flotation of the iron from the silica.

Fig. 1 - Experimental ore flotation employing fish-oil fatty acids is being carried out at School of Mines and Metallurgy, University of Minnesota.

The principal deposits of iron ore in the United States are located in Minnesota and in northern Michigan, with the deposits in Minnesota being the more important. In June 1959, a visit was made to several iron-mining concerns and their research laboratories in Michigan and Minnesota. The objectives of this visit were: (1) to learn whether or not the flotation process for concentrating iron ore is being expanded and, accordingly, whether or not the possibility of using fish oils as flotation agents is increasing and (2) to engender further interest by the iron ore-concentration industry in the Bureau's fish-oil research program, possibly to the extent that the research laboratories of the industry might investigate the use of fish oils.

The purpose of this report is to describe the findings of this trip and to inform the fish-oil industry of future possibilities for marketing their product for the flotation of ore.

EARLY USE OF FISH OIL IN ORE FLOTATION

It has been known by Bureau personnel and the fish-oil industry that many years ago fish oils were employed as flotation agents for concentrating various ores, but no specific details were available.

From a metallurgist at one concern, information was obtained on such early use of fish oils at a phosphate-flotation plant in Florida that had for many years been using menhaden and sardine fatty acids. In 1937, however, the price of fish-oil fatty acids reached about 12 cents a pound, which the management considered to be too expensive for their operation. They therefore looked into the use of tall-oil fatty acids, which had been tried earlier without success. Since tall oils in 1937 were selling for only about 2 cents a pound, research was carried out with them

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and, eventually, a way of using tall oils was found. This concern then changed from fish-oil to tall-oil fatty acids.

In 1938, another concern, in Cuba, who employed this same metallurgist, used fish-oil fatty acids for the flotation of manganese ore. In that year this concern changed to tall-oil fatty acids because the latter was much lower in price.

MICHIGAN IRON ORES

In Marquette County, Mich. (on the upper Michigan peninsula), specular hemetite ores, or specularite, were mined extensively from 1871 to 1937. By the latter date, most of the ores of higher grade had been exhausted, and many mines were abandoned. In 1947, a large iron-mining company began investigation of the possibility of reclaiming, by flotation, some of the lower grade iron ores still available in this region in large quantities. Eventually a joint operation was set up by several large iron-mining concerns. A small plant with a capacity of 300,000 tons of concentrate a year was opened at Humboldt, Mich., followed shortly, in 1956, by construction at Republic, Mich., of a plant with a capacity of 600,000 tons a year. The capacity of the Humboldt plant is now being doubled, and that of the Republic plant is being considered for doubling.

In addition to these two, a concentration plant with a capacity of 750,000 tons a year is operated by another company at Groveland, Mich. Much of the output of this plant is concentrated by spiral gravity methods, but a part of the output is concentrated by flotation.

As an example of the quantity of fatty acids used in these operations, one plant uses 1.2 to 1.5 million pounds annually.

SPECIFICATIONS FOR FLOTATION AGENTS: Several desirable characteristics for fatty acids to be used for flotation of iron ore were mentioned by industry personnel. A low titer (concentration of a substance in solution) is desirable, preferably 1° to 6° C. (33.8° - 42.8° F.). The desirable iodine value will depend upon the particular flotation process employed. At the Republic plant, values between 110 to 140 were considered optimum; some success had been obtained with fatty acids having iodine numbers as low as 100, but the higher range is considered to be preferable. The Republic and Humboldt plants currently are using tall-oil fatty acids as flotation agents.

POSSIBILITY FOR MARKETING FISH OILS FOR MICHIGAN SPECULARITE FLOTATION: Michigan specularite ores are relatively easy to float, so the choice of agent to obtain selective flotation does not appear to be critical. It was for this reason, undoubtedly, that flotation was applied on a large scale to these ores, since little research in finding a flotation procedure was required. Because the characteristics of potential flotation agents are not critical, the principal item that purchasers of these materials are apt to consider is price. Fish-oil fatty acids that can be prepared and sold at prices competitive to tall-oil fatty acids (currently selling at $7\frac{1}{4}$ to $8\frac{1}{2}$ cents a pound f.o.b. factory in Florida or West Virginia, with cost of transportation adding $1\frac{1}{2}$ to $1\frac{3}{4}$ cents a pound to these costs) should have a good chance for use in the ore-flotation industry. These prices are less than those at which most fish oils are currently selling. Some fish oils that are selling at 4 cents a pound, however, could very likely be processed to fatty acids and still be competitive with tall oil. This is particularly true if the bulk (nonfractionated) fatty acids can be employed with these types of ores and if the fish-oil fatty acids are found to be highly efficient. The Bureau is running tests on the efficiency of bulk fatty acids from some of the cheaper fish oils for specularite flotation and consequently for possibly greater recovery of this highly important and strategic American resource.

The possibility that the odor of fish oil would be objected to by the ore industry remains to be settled. Direct inquiry as to whether this would be a factor resulted in negative replies. One metallurgist who 25 years ago used fish-oil fatty acids for flotation said that he never had any complaints based upon odor during his use of those materials. Others in the field of iron-ore concentration stated that they would anticipate no serious drawback to the use of fish-oil fatty acids based upon odor. In contrasting to this opinion is the fact that at a commercial flotation plant one of the metallurgists pointed out the lack of odor in the tall-oil fatty acids and commented unfavorably on the odor of some fish-oil fatty acids with which he had been experimenting.

MINNESOTA IRON ORES

NONMAGNETIC TACONITE ORES: The Mesabi Range in Minnesota has been the principal source of iron ore in the United States for many years. It has contained relatively large quantities of high-grade iron ores that can be used without concentration, but they are approaching exhaustion. The high-grade ores are mixed with much vaster quantities of lower grade ores, which are just starting to be concentrated by a magnetic process. Two huge magnetic-process plants costing several hundred million dollars each are now in operation. Not all of the ores of lower grade in the Mesabi Range can be used in this magnetic process, since only the taconite ores possessing magnetic properties are suitable. A considerable quantity of nonmagnetic taconite ore is available, some of which has considerably higher iron content than have the magnetic ores presently being utilized. Furthermore, many millions of tons of these nonmagnetic taconite ores of relatively high iron content have been shoveled away from the surface in order to get at the ores of higher grade beneath. These intermediate-grade nonmagnetic taconite ores are placed in piles containing as much as 7 million tons awaiting the time when they can be concentrated.

In addition to the problem of how the nonmagnetic taconite ores could be concentrated, a more serious barrier to such use has existed. Iron ores are a low-priced commodity, worth only about 7 dollars a ton at the mine. Of this amount, sometimes as much as 2 dollars a ton or more has to be paid for various state taxes. A special concession was made by the State of Minnesota in the case of the magnetic taconite ores of very low iron content whereby most of those taxes were waived in order to permit the ores to be utilized. No such tax concession has existed for the so-called semitaconite ores, including the nonmagnetic type. Until those taxes were waived, the cost of any type of concentration was far in excess of what was economically feasible.

The Legislature of the State of Minnesota in June 1959 altered the tax laws to place the nonmagnetic semitaconite ores in the same preferred tax class as the magnetic taconites. Thus, for the first time, the utilization of this type of ore is feasible.

Two means are available for concentration of the nonmagnetic taconites. They can be roasted and thereby converted to the magnetic form, which can be magnetically concentrated, or they can be subjected to flotation. Flotation is the simpler, possibly cheaper process. Yet it has the disadvantage that some of the nonmagnetic taconites are not readily separated by the usual flotation processes, so the choice of the best flotation agent may be highly critical. Current research with fish oils in flotation of these nonmagnetic semitaconite ores should show whether fish oils are sufficiently efficient to warrant their use.

In June 1959, personnel at two concerns were definitely planning to concentrate nonmagnetic taconite ores. Neither concern was ready to go into operation even on a pilot-plant scale, for they were still carrying out laboratory investigations. One of these firms seemed to be inclined toward flotation rather than roasting; the other one was inclined toward roasting but had not made a final decision.

It would seem that fish-oil fatty acids might have a better chance for application as ore-flotation agents in the concentration of Minnesota nonmagnetic taconites than in the concentration of Michigan specularites, owing to the greater importance in the former case of the efficiency of the reagent. At present, however, there are no plants operating a flotation plant for the nonmagnetic taconites, so this is a possibility contingent upon favorable future developments.

MAGNETIC CONCENTRATES: Another possibility for future application of fish oils in ore flotation would occur if future developments in the iron-ore industry should require a further removal of silica from the iron-ore concentrate than is possible by magnetic methods. The iron and steel industry has been requiring ore of lower and lower silica content. If this trend continues, a point will eventually be reached where the only possibility for achieving the required low content of silica will be to use flotation after magnetic concentration. One of the operators of plants for the magnetic separation of iron ore is convinced that this use of flotation will eventually be adopted.

For such a use, the inverse process employing fish-oil fatty acids would be ideal. In the inverse flotation procedure, silica is floated from the iron ore. Because silica is already quite low in a magnetically-concentrated ore, this inverse process would be the most efficient way to effect the separation.

This combined magnetic and flotation concentration of ore will not be adopted in the near future. Therefore, there is no immediate possibility of selling fish oils for such a process. If, however, this procedure becomes a reality, it is likely to offer the greatest possibility for introducing fish oils into ore flotation.

NONFERROUS ORES

Although most of the research in the Bureau's cooperative program with the University of Minnesota's School of Mines and Metallurgy has dealt with iron-ore flotation, some preliminary tests with nonferrous ores indicate that fish oils might have application in the flotation of other materials. For example, good results were obtained in flotation of fluorite ores. Since flotation is more firmly established as a concentration method for nonferrous ores, the fish-oil industry should not overlook the possibility of marketing their oils for such nonferrous flotation purposes.

SUMMARY

1. Problems in concentrating iron ore vary enormously from one geographical area to another. Consequently, the possibilities for applying fish oils as flotation agents differ in the various ore-producing areas.

2. Possibilities for applying fish oils to flotation depend on whether the present or the future is being considered. For the present, fish oils may have little advantage over other ore-flotation agents, since price appears to be the factor determining the choice of agent used. If the future is considered, however, possibilities for the use of fish oils are greater, since there is likelihood that they will be evaluated on the basis of the efficiency of their action rather than on the basis of their price.

3. Flotation is an expanding means for concentration of Michigan specularite ores, and three plants are in commercial production. This ore is highly amenable, however, to being concentrated by flotation. Probably only the currently cheapest fish oil would have a chance for use.

4. Owing to changes made in June 1959 in Minnesota tax laws, it now has become feasible to consider concentration of certain nonmagnetic taconite ores. Although these ores are much more difficult to float than the Michigan specularite ores, many leaders in the iron-ore concentration industry are considering flotation operations. In these difficult operations, fish oils may well have advantages.

5. It is the view of some leaders in the industry that the magnetically-concentrated iron ore may eventually have to be further concentrated. Personnel in one of the concerns currently operating huge magnetic concentration plants tend to the view that in some years hence flotation will be used in conjunction with magnetic concentration. In such an operation, the use of fish oils in the reverse process where silica is floated from the iron ore may present the best possibility.

6. Need exists for the fish-oil industry to further acquaint the iron-ore industry with the properties of fish oil that might be useful in the flotation of iron ore.

7. The possibilities for applying fish oils as ore-flotation agents in noniron-ore concentrations should not be overlooked. These possibilities include, for example, the use of fish oil in the flotation of phosphate and fluorite ores.

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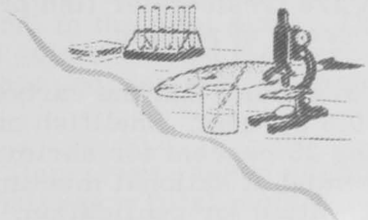

LOBSTER'S PROTECTIVE SYSTEM

If a lobster is seized by the claws, it can throw off the arms bearing the claws at a point between the second and third segments of the arms. If the shell on some part of an arm is crushed and the lobster is bleeding, it will often cast off its claw at this point. At the joint between the second and third segments of the arm the claw breaks off easily and there is a special arrangement for preventing bleeding. However, if the arm is broken in some other spot much bleeding occurs. After the old claw is thrown off a soft bud grows out from the second joint of the arm, and when the lobster molts the new claw increases greatly in size and becomes covered by a shell. It takes three or four molts, however, for a new or regenerating claw to reach its normal size again.

The smaller legs also may be cast off but not so readily as the large claws. These small legs and other appendages, such as the feelers and the swimmerets, also can be regenerated.