PENNFLOAT[7] 3
A SULFIDE MINERAL COLLECTOR

BACKGROUND - DEVELOPMENT OF PENNFLOAT 3

The organic chemicals that make up the effective sulfide collector of Pennfloat[7] 3 is normal dodecyl mercaptan, designated by ATOFINA Chemicals, Inc., as Pennfloat[7] M. The use of Pennfloat M as a copper collector was developed at a large mining company in South Africa by Dr. Adriaan Wiechers. Dr. Wiechers tried a number of different organic compounds, and settled on the C-12 mercaptan as the most effective collector for the copper minerals at this time. Extensive test work here showed that the best application for Pennfloat M was in the scavenger circuit, replacing the potassium amyl xanthate that had been used.

One of the reasons postulated for the improvement of copper recovery was faster flotation of valleriite, a slow floating mineral, causing some copper losses at this mine. Another reason was that Pennfloat M was shown to be more effective on a coarser grind in the copper circuit.

With the application of Pennfloat M in the scavenger circuit in this mill, the copper recovery was increased by 3 to 5 percent. Since the first application of Pennfloat M at the mill, the grind has been increased from approximately 25% + 65 mesh to over 30% + 65 mesh, maintaining the same recovery of copper that was evident before the use of Pennfloat. As a result, this company has been able to save money in grinding costs and maintain the same recovery that they had experienced prior to the application of Pennfloat M as a flotation reagent.

Pennfloat 3 contains 80% normal dodecyl mercaptan the remainder being a glycol to help disperse the mercaptan. The dodecyl mercaptan is an oily collector, and as such, is water insoluble. Incorporating the dispensing agent helps improve the collecting abilities of the mercaptan while helping disperse the mercaptan in the pulp for froth flotation.

Since the initial use of Pennfloat M as a scavenger collector, this mill has tested Pennfloat 3, replacing Pennfloat M. This has been done successfully with a slight improvement in copper recovery at the same dosages as the mercaptan. Thus, Pennfloat 3 is more effective than the straight mercaptan. With the application of Pennfloat 3 established in the scavenger circuit, they have tested further applications of Pennfloat 3 to replace part or all of the potassium amyl xanthate which was being used in the rougher flotation circuit. Pennfloat 3 has proven to be effective in replacing all of the potassium amyl xanthate with an increase in copper recovery in the rougher circuit. Consequently, there are two different applications of Pennfloat 3, one is in the scavenger circuit and the other in the rougher circuit.

LABORATORY TESTING AND RESEARCH

With this rather successful application of the mercaptan, ATOFINA decided to find out what other types of sulfide minerals were amenable to collection by using the mercaptan. A development testing program for Pennfloat 3 was begun, funded by ATOFINA with the testwork being performed by Hazen Research in Golden, Colorado. Neither Hazen nor ATOFINA has undertaken fundamental studies on Pennfloat 3, because it was felt that a more pragmatic approach to learning the conditions under which Pennfloat 3 would work, would be more practical. With this in mind, our development testwork has been done on operating ores from commercial operations studying such conditions as: flotation pH, point of addition, dosage, and various other collectors with which Pennfloat 3 would be working. Hazen tried a number of different applications on a wide variety of sulfide ores. Among ores tested were copper-lead-zinc, copper, copper-moly, and a few of the precious metal ores. In all cases, the results of applications of Pennfloat 3, under standard conditions, or with slight practical modifications, were significant increases in recoveries and rather dramatic improvements in a number of the different sulfide ore recoveries.

PENNFLOAT 3 PERFORMANCE ON DIFFERENT ORES

As reported by Hazen Research in two different papers, this extensive laboratory research showed that Pennfloat 3 was a highly effective and versatile collector for many sulfide minerals.

On a representative chalcocite ore containing lesser amounts of copper oxide minerals, the results obtained using Pennfloat 3 as a primary collector in place of the standard xanthate showed an improvement in copper recovery from 74% to 81%. When our Pennfloat 3 was used as an auxiliary collector in conjunction with the standard xanthate, the copper recovery was increased from 74% to 77%.

The test program on a representative chalcocite ore containing small amounts of native copper demonstrated that Pennfloat 3 was effective as a primary collector and increased recoveries at dosage levels much lower than those of the standard xanthate.

In the case of a representative chalcopyrite ore containing molybdenite, results obtained using Pennfloat 3 as a primary collector showed recoveries of copper and molybdenum of 93% and 89% respectively. This represented improvements of ten and six percentage points respectively over the results obtained using the standard reagent and practice.

On some copper-molybdenum ores, copper recoveries increased by 2 to 10 percent and some of the molybdenum recoveries increased from 5 percent to over 40 percent greater than those obtained with the standard collectors.

Pennfloat 3 was found by Hazen to be a powerful collector for molybdenum ores. One of the outstanding features of Pennfloat 3 was that the dosage required was sometimes as low as 13 to 25 percent of that typically required for the standard collectors on these molybdenum ores.

On precious metals such as gold and the platinum metals group, Pennfloat 3 again was proven to be quite effective in recovering additional sulfide minerals. On some gold ores, recoveries were increased from 2 to 4 percentage points over those obtained with the xanthate type collectors. On the platinum metals group, there was as much as a 10 percent increase in recovery of these metals.

When Pennfloat 3 was tried on copper-lead-zinc ores, one of the most prominent effects was that it promoted strong rapid copper flotation with significant increases in the copper recoveries compared to the recoveries with the standard collectors. Another important feature on the copper-lead float, where zinc is present, was that the Pennfloat 3 was selective against the zinc, allowing more zinc to report to the zinc flotation circuit, thereby improving the possibility of zinc recovery. When tried on the zinc flotation section of some of these copper zinc ores, Pennfloat 3 was very effective in place of, or in addition to, the standard collectors. Some dosages of Pennfloat 3 were as low as 50 percent of those required for standard collectors, such as Z-200 on the zinc circuits. Though the point might be made that these results are all under laboratory conditions, there is confirmation in the fact that Pennfloat 3 is being tested on a copper-lead-zinc ore in an operating mill resulting in an increase in recovery of 2 to 3 percent of the copper in the copper-lead float. This shows that there is a correlation between laboratory condition results and those under actual practice.

SUGGESTED WAYS TO USE PENNFLOAT 3

Because Pennfloat 3 in most cases is a more powerful collector, generally, we would recommend that Pennfloat

3 be applied at dosages that are equal to or lower than the standard collectors for the different sulfide ores. However, rather than recommending specific dosages for a copper ore or a copper-moly ore, we would recommend that the dosages of Pennfloat 3 to be applied be lower than the potassium amyl xanthate or the standard collectors being used. These dosages could be lowered by 10 to 50%. However, the dosage does depend upon the point of addition and the ore being tested.

When first tried at the original testing mill, the application of Pennfloat 3 was in the scavenger circuit or towards the end of the copper flotation. This is where we would recommend starting the application of Pennfloat 3. With successes in the scavenger circuit or towards the end of the rougher circuit, Pennfloat 3 can then be applied more towards the head end or towards the grind. A number of tests done by Hazen did show that Pennfloat 3 was effective when added to the grind. However, it should be noted that the effect of application to the grind on these copper ores depends on the type of ore.

To give an idea of the variety of applications of Pennfloat 3, the following examples will cover some that are in current practice at operating plants. As already mentioned, one plant is using Pennfloat 3 in the scavenger circuit as well as small dosages in the rougher circuit. Another current use for Pennfloat is the application in a sands float after a sands-slimes split on a primary copper ore. To further demonstrate the effectiveness of Pennfloat under a wide range of conditions, another commercial operation has Pennfloat added as a secondary collector to the rougher float, the mids-float, and the scavenger circuit. Thus, it is being used in small dosages all along the total copper flotation. In another instance, it is being used as a secondary collector in a copper-lead bulk float. In this case it is not replacing any of the standard collectors, but is used as an auxiliary collector - helping to improve the copper recovery in this copper-lead bulk float.

Although Pennfloat 3 is not currently being used as the primary collector, or only collector, in a sulfide application, Hazen Research has performed a number of tests that show that Pennfloat 3 *can* be effectively used as the only collector in other than molybdenum ores. We feel that this versatility of Pennfloat 3 points out the effectiveness of the collector under varying conditions for not only the grind but the rougher circuit and the scavenger circuit as well.

APPLICABILITY OF PENNFLOAT 3

Pennfloat 3 was shown to be applicable under highly variable conditions, including:

(a) pH, which ranged from 4 to over 12.

(b) grind product particle sizes, ranging from 40 to over 80% passing 200-mesh.

(c) the presence of a variety of reagent types such as pH modifiers (CaO, Na_2CO_3, SO_2, SO_3), collectors (xanthates, dithiophosphates, etc.), frothers (MIBC, polypropylene glycol, cresylic acid, etc.).

On a wide variety of sulfide ores and under varying conditions with different collectors and other chemicals used in the froth flotation processes, Pennfloat 3 has proved to be a versatile and effective flotation reagent. The practical approach that Hazen used in testing Pennfloat 3 has shown that it does quite well under standard conditions for milling practice. Thus, it can be added to an existing circuit without changing the conditions and do a commendable job of improving sulfide mineral recovery.

SOME LIMITATIONS

One limiting aspect of using an oily collector like Pennfloat 3 is that it may have some froth flattening characteristics. These can be minimized or overcome by either more frother or a judicious choice of the point of application. If, in the course of some specific testwork, it shows less than sterling performance, a change in the point of addition or the dosage of Pennfloat 3 should correct the situation. The emphasis here is that if Pennfloat 3 does not work at one point of addition on a given ore, it may work superbly at another point of addition with the same ore.

CONCLUSIONS

Given the scope of the successful applications, both in commercial operations and practical lab demonstrations, ATOFINA feels that Pennfloat 3 should enjoy even more successes with its use in the sulfide minerals industry. With the proven utility and virtues of the product, we feel that Pennfloat 3 deserves your attention as a new collector for this industry.