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BRADINA JOINT VENTURE

METALLURGICAL INVESTIGATION

March 30 - April 13, 1972

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INTRODUCTION

The Bradina Mill at Owen Lake southwest of Houston, B.C. was visited from March 30th to April 13th, 1972.

Milling operations, having started on March 9th, had run into several problems, the most serious being very slow zinc concentrate filtration and poor copper-lead separation, in addition to generally subnormal metallurgy.

SUMMARY

Unexpected presence of slime was the obvious cause of poor zinc concentrate filtration. A combination of mechanical and metallurgical measures improved the rate enough to handle the current production but a question remains as to whether this will be sufficient when concentrate production reaches the forecast tonnage rate. If necessary, a choice between providing a larger filter or installation of a concentrate thickener may have to be made.

Copper-lead separation was not rejecting lead into the zinc flotation circuit as planned. Trouble with erratic control of SO_2 feeding to the separation circuit was corrected but the separation continued to be unsatisfactory. On April 11th, some flowsheet changes were made to the circuit. Together with reagent and other operating control changes, there was indication of an improving trend at departure time.

Recoveries in both the copper-lead and the zinc primary flotation circuits were subnormal. There was some indication that the Maxwell Air Cells were not doing their expected share of the work. Emphasis on pushing these cells harder was started. If this, and the slow flotation of slimes cannot be cleared up, additional scavenger flotation cell installation should be considered.

Physically, the mill installation is quite good. With good supervision and perhaps some additions at moderate cost, as discussed above, the mill should perform satisfactorily within the limitations of ore grade and characteristics. If higher tonnage becomes desirable, a 10 to 15% increase in grinding capacity should be feasible at moderate cost. Flotation and filtration capacity would require further study.

From a metallurgical point of view, the copper-lead problem should be capable of satisfactory solution. The slime problem apparently was not forseen, and probably would not occur if only clean, undiluted fresh vein ore were treated. Unfortunately, this

is not practical in mining this type of ore body, but the severity may lessen when only current mine production is treated. Slimes not only seriously affect concentrate filtration rate but invariable slow up flotation and thereby increase tailing losses with limited flotation cell capacity.

Water and power supply were not a problem. Tailing disposal was not investigated in detail.

RECOMMENDATIONS

The work described in the Summary was done on somewhat of a "crash" basis to establish as much of a firm base as possible in the time available. From this groundwork, a period of operating adjustment to obtain best performance is advisable. Steady, full-time operation should be emphasized. Accurate operating records should be kept in as much detail as is reasonably possible.

If satisfactory tonnages, grades and recoveries, comparable to the project forecast, are not realized, a further investigation is recommended to assess the possibility of reaching some level of viable performance and to estimate what would be required to do so. If the necessity for more flotation and/or filtration capacity is confirmed, some testwork should be done to enable the proper choices to be made and for cost estimating purposes.

DETAILS

At the request of Mr. J. J. Crowhurst, fifteen days, March 30th to April 13th, were spent at the Bradina Mill about 25 miles by road southwest of Houston, B.C.

Review

Milling operations had started on March 9th, with the usual interruptions due to minor mechanical problems. This was to be expected, however, by March 18th slow filtration of Zinc concentrate had become a serious problem, causing lost milling time. The second problem was unsatisfactory separation of Pb and Cu, resulting in low Cu grade, too much Pb in the Cu concentrate and loss of payable Pb in the Zn concentrate. Although recoveries were well below forecast, this would not be unexpected, especially with a major proportion of mill feed coming from stockpile, and at lower than forecast ore grade.

Zn Concentrate Filtration

On arrival, the most urgent problem obviously was the Zn concentrate filtration rate. Because of its urgency and seriousness every avenue of correction was applied without waiting to determine relative effectiveness. Maintenance of uniform and maximum possible filter feed pulp density was stressed. The air-lift pulp circulation system on the filter "boot" was cut off as this was frothing the pulp. Several chemical reagents of possible benefit as filter aids were tried. In addition, some reagent changes to the Zn flotation circuit were made to try to reduce flotation of gangue slimes. Slight improvement was noted by April 1st, but this was only marginal.

On April 2nd, the pH of the Zn flotation circuit was increased from 9.0 - 9.5 up to 11.0 - 11.5 (by increasing lime). Bottom feeding to the filter "boot" was started on April 2nd. This provides uniform pulp, without aeration. Much improved filtration was noted at this time. On April 3rd, feeding a special slime depressant (C.M.C.) reagent was started. Each of these measures appeared to have some effect. From that point onward, Zn concentrate filtration was no longer a "bottle-neck".

Cu-Pb Separation

From the outset, a basic problem with the Cu-Pb separation was the mechanics of introducing SO_2 (liquid) to this circuit feed conditioner. Control was much too delicate and erratic to allow maintenance of a steady pH level, as required. Steps were taken to obtain the necessary fittings to allow change-over to feeding gaseous SO_2. In the meantime, it was found that increasing the $ZnSO_4$ reagent to the primary Cu flotation circuit substantially suppressed Pb flotation, passing it through to the Zn circuit. Unfortunately, it later appeared (statistically) that recovery of Ag, Cu and Zn were adversely affected, so this approach had to be reversed.

Feeding gaseous SO_2 to the Cu-Pb separation feed conditioner started on April 7th. Control was satisfactory but separation was still poor. Use of dextrin, dichromate, etc., failed to effectively suppress Pb,and Cu losses were still too high.

Flow Sheet Change

On April 11th, the Cu-Pb circuit flow sheet was changed as shown on the attached diagram, so that only #4 Bank and #5 Bank flotation tailings pass on to the Zn circuit requiring "clean-up" with respect to Cu. Previously, tailing from each of the four Cu-Pb flotation "Banks" went forward to the Zn circuit. #5 Bank now serves as a scavenger for #6 Bank on regrind flotation. #7 Bank tailing returns to regrind flotation so that the SO_2 separation need not be pushed too hard, an essential for good Cu-Pb separation. Extra dilution to hold the Cu-Pb separation pulp density down to 10% solids was instituted and showed promise of better control and a more selective type froth condition. An increase in dichromate feeding was suggested as this had been at quite a low rate. An improving trend was indicated but at departure time it was too soon to assess the results of the change.

Mill Control Aids

Throughout this period, considerable use of the vanning plaque was made. It proved to be a useful aid for quick indication of the distribution of the galena. Some rough qualitative laboratory bench tests were made as an aid in directing flotation control. Special sampling and assaying was carried on where indicated, and with good cooperation from the assay laboratory.

Progress

In general, it is felt that some definite progress was made, particularly in mill control.

SO_2 feeding was brought under control and the changed flowsheet appeared to be effective and more manageable. Zinc recovery lost some ground for a few days but began to show some improvement with special attention and emphasis on tailing clean-up, and by working the

Maxwell cell harder. Zinc filtering was much improved. Copper concentrate filtration was excellent as long as filter feed pulp density was kept up to maximum.

Metallurgical results were still far from satisfactory, but it is felt that a sound basis for gradual improvement has been established. Some operators were totally inexperienced. This condition is improving but guidance and training should continue. Moderate increase in systematic routine data recording (such as operating time, lost time explanations, pulp densities, pHs, reagent feeding, etc.,) would help in continuity of control from shift to shift, to provide for better information for supervisors.

Mechanically, emphasis should now be on keeping lost operating time to a minimum and to maintaining at least the rated tonnage and degree of grinding.

Mill Condition

For this size of operation, mill design and construction appears to be good with a few exceptions, perhaps better than average.

In the crushing plant, the smaller belts are adequate but marginal, and with a rather steep gradient. This results in considerable spillage at times. The rod-deck screen is adequate for good dry ore but not for wet sticky fines which have been encountered frequently. These two conditions reduce actual crushing time availability and require an undesireable amount of clean-up effort. This may improve after the stockpile ore is exhausted.

The grinding system seems satisfactory in general. Although the full 600 dry tons was milled only on one day, and the grind is slightly coarser than the 70% - 200 mesh planned, there is no doubt that these objectives can be attained. Very little time was spent on the grinding section.

Capacity could be increased by bringing the rod and ball mills up to full power load. The rod mill is running at only 60% of critical speed and 78% of full power. It should be possible to increase the speed by 15 to 20% by installing a larger drive pinion. The ball mill is running at 80% of critical speed and about 90% of full power load but might be crowded a bit more with new feed and discharge trunnion liners provided with adequate internal spirals (currently make-shift). Some other adjustments would probably also be needed, such as speeding up the cyclone feed pump and adjusting the cyclone apex and vortex finder openings.

The regrind was not studied but this would be adviseable after other more pressing matters are settled.

It was too soon to assess the efficiency of the Maxwell flotation cells. Indications were that they were not accomplishing a sufficient share of the flotation work. The conventional Denver scavenger machines were therefore not able to clean up the tailings. This appeared to be true for both the Cu-Pb primary #4 Bank and the Zn #2 Bank. A laboratory test on Zn tailing showed that additional flotation time alone would clean up the tailing. A program was started to try to force the Maxwell cells. This must be consistent with acceptable concentrate grades, especially in the Zn circuit where the Maxwell cell concentrate goes directly to final product filtration.

If the slow floating slimes disappear after the stockpile ore is exhausted, the problem may solve itself, however it appears probable that there will always be slime producing material from wall rock dilution in routine mining. Although not considered in mechanical detail, it should be readily possible to add more scavenger flotation cells if this is found to be economically desirable.

The three banks of Denver #15 (12 cu. ft.) flotation cells are generally satisfactory except for the small froth launders that cause undue spillage. An attempt to correct this condition with wooden extensions was partially successful and can eventually be worked out.

Reagent handling appears to be generally satisfactory except for occasional difficulty with floraters on some reagents, noteably the $ZnSO_4$ and Dextrin. For experimental use, several individual Clarkson "disc and cup" type feeders were ordered.

The pump pit, while neat and orderly, is somewhat crowded. Major spillages due to pump failures that must be expected occasionally, cause rather difficult flooding conditions. Currently, most spillage, dirty filtrate, and floor wash goes to tailing. Attempts to return this material to the mill circuit have been too upsetting. This may eventually be worked out, but at present any spill usually represents a loss.

Cu concentrate filtration is no problem and should be adequate at the forecast production rate. With proper filter feed density control, tests showed that less than 10% moisture (about 8%) can be attained without drying and this material should handle well.

Zn concentrate filtration will require more study. Even if the current improved rate can be maintained as Zn recovery is increased, capacity may be insufficient for the full forecast production of 73 dry tons per day. In such case there are two alternatives to consider;

replace the present 6 ft. x 5 disc filter with a larger one, or install a concentrate thickener to provide higher density filter feed. Settling and filtering tests should be made to help make the proper choice.

Power and water supply appeared to be adequate for mill operation. Use of warm water from the power plant excess steam condenser system was used in the mill, starting April 4th. No marked effect was observed, either adverse or beneficial.

Tailing disposal was not investigated in detail.

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Cu - Pb FLOWSHEET CHANGE (April 11th, 1972)