CHAPTER 3. PRELIMINARY METHODS

3.1 Introduction

This chapter is only semi-quantitative and it reports on a few preliminary tests used to select a carrier, frother and dosage level on Merensky ore. Laboratory scale testing of TTC's has left no doubt regarding their effectiveness as collectors. The problem remains their commercial use, almost exclusively because of the odour of mercaptans and volatile disulphides. It has been observed that once the collectors are in the pulp, adsorption of all sulphide components onto mineral surfaces is fast, and only faint traces are detectable. The conventional method of dosing the collectors on the plant is not suitable, because of the hydrolysis products of TTC's. Therefore alternative means had to be investigated.

Firstly water has to be avoided, and as will be seen later the half life of ionic TTC's in water is short. This meant that either another solvent or a dry form is needed.

3.2 Optimising TTC dosing methods

3.2.1 Tablets

Different binders and carriers were used to formulate a tablet to dose in the flotation system. The need was a suitable carrier which would convey the active ingredient into the process without changing the parameters in the flotation process, thus an inert carrier was needed. In addition an ingredient could be added which was able to inhibit or adsorb the undesired decomposition products.

TTC's powders were mixed with inorganic diluents as dry powders or pellitised. In liquid form, they were dispersed or synthesised in a solvent, where viscosity had to be adjusted to avoid sedimentation of the active constituent.

The dried TTC powder had limitations, from a dosing point of view. Accurate dosing was not possible without specialised dosing equipment and dust was a problem. Alternative methods of dosing the iC_3-TTC needed investigation and are discussed below.

Mechanical stability and readily dispersed inorganic substitutes were necessities. The tablets should not crack, capping must not occur and with powders free flowing properties of the powder were needed to keep the machine running continuously. Various binders, particularly clays of the talc, pyrophyllite, bentonite and kaolin families were studied.

An important criterion was the rapid release of the TTC's within the tablet (30% activity) once added to stirred water. Thirty seconds was chosen in which to release the active collector.

The flotation results performed with the tablet will be discussed in Chapter 4. Accurate dosing equipment is available when dosing 4mm tablets. The only concern is abrasion and dust formation and therefore a whole new plant system with scrubbers would have to be incorporated.

3.2.2 Suspension

One has to be sure the solvent will not react with any constituent and interfere with flotation, be it frothing dispersion or depression of gangue. Finding an inert solvent, which would suspend TTC's without affecting frothing is a problem. The crystals have to remain suspended as it is difficult to mix the suspension and mechanical stirring would be necessary to keep the TTC in suspension for dosing on the plant.

A kerosene solvent and non-polar polymer for thickening has been developed to accommodate these physical requirements. The specific components are still confidential. Two solvents were tested. The first solvent showed good improvements over the standard in grades, but undesirable frothing problems, which resulted in lower mass pulls. The bad odour of the mercaptan was completely eliminated. The second SX12, a blend from Philips Petroleum USA showed better results with TTC concentrations greater than 30%. Below 30% TTC in solution there is no initial froth formation. Good, stable froth forms with concentrations of thirty and forty percent TTC. If the concentration of the TTC in solutions gets too high, the product forms a paste which is too thick too pump with standard equipment.

In Table 3.1 a comparison is shown of some properties. The TTC dosage was varied most specifically to measure entrainment and grade that should be related to water recovery.

Table 3.1 Frothing properties of iC_3-TTC at different concentrations

Collector	SIBX/DTP	iC_3-TTC	iC_3-TTC(40%)	iC_3-TTC(30%)	iC_3-TTC(20%)
Frothheight:15 sec	3	3.5	3	3	0.5
30 sec	5.5	5.5	6	6.5	0.5
Conc (g)	265	361	211	243	-
Water (g)	210	300	166	188	-
Comment	Light	Darker	Dark	Dark	Froth break
Bubble size(cm)	2-3	0.5-1	2-3	1-2	-

The main result was the constant froth height, except for the 20% mixture. The conclusion was to work in the region of 30-40% active TTC in the solvent. The float was only conducted for five minutes and here we can see that the TTC's has a faster rate than the standard. The iC_3-TTC powder formed small bubbles but the mass recovered was better. With the SX12-emulsion the bubbles were larger and it produced a froth of medium depth that was fairly fast breaking and heavily loaded. Batch flotation tests as well as continuous 60l cell tests were performed on the 35% iC_3-TTC/SX12 suspension.

3.3 Mercaptan breakthrough

The objective of these tests was to determine the maximum collector dosage of iC_3-TTC one could apply to Merensky ore before odour becomes a problem. The standard conditioning times and chemical dosage were used on ore from the overflow on Section 10 of Impala Platinum (see Figure 7.1). The standard collector dosage is 60 g/ton (30 g/ton SIBX and 30g/ton DTP) ore.

A 6l Denver cell was used for the floats. The pulp was conditioned and after aeration the odour was measured. Although semi-quantitative, different personnel were asked to comment on odour after dosing below the surface, and then aerated. The results are reported in Table 3.2.

Table 3.2 Mercaptan breakthrough

Collector dosage of TTC(g/ton)	Mixing odour – no air	Flotation odour – air
40	No odour	No odour
50	No odour	No odour
60	No odour	No odour
70	Slight to no odour	Slight to no odour
80	Odour detectable	Bad odour
90	Strong odour	Bad odour

The optimum or safe maximum collector dosage was 60g/ton active iC_3-TTC on Merensky. An added result from mercaptan breakthrough is that if one smells the mercaptan, it is a warning that CS_2 probably also has formed. This is poisonous. This distinguishes this type of collector from DTC's, where the decomposition products, alcohol and CS_2 are not readily detected by personnel employed.

3.4 Frother - TTC combinations

Initially Impala used cresylic as frother and that was the case with Slabbert (1985). Subsequently Dowfroth was used, and then again the Merensky circuit changed to cresylic. The question is whether any significant differences are found with different frothers and iC_3-TTC, although the current combination on the plant would be used in the event of a plant trial.

3.4.1 Materials and methods

One kilogram rod milled samples of Merensky ore (50% solids) were added to a 3l Denver flotation cell. The solids-water ratio was 1:2. The conditioning times are reported in Table 3.3. The speed of the flotation rotor was set at 1050rpm. The concentrates and tailing of the float tests were analysed for PGM, Cu, Ni and Cr_2O_3.

Table 3.3 Chemical dosage and conditioning times

Dosing	Time	Quantity
$CuSO_4$ (1% solution)	5	60 g/ton
Collector & frother	5	0.286 mole/ton
Floating	20	

After conditioning, the air was opened and then the scraping of the froth started. Collection of sample continued for 20 minutes. The heads, tails and concentrate of the float tests were then filtered, dried, and sent for analyses. The analyses was done by Impala Platinum laboratories for PGM, Cu, Ni and Cr_2O_3. From triplicate tests of each combination the average of the results was used to calculate the results. The conditions for the floats were:

- No depressant was used to study only the interaction of the collector with the minerals.
- 60 g/t collector SIBX/DTP (1:1 mass) and all the other collector combinations were dosed equimolar to the standard collector suite.
- The size of the milled ore was 80 % -75 micron.

The tests were conducted at Biliton Process Research and were done in duplicate. The following frothers were tested:

- Cresylic acid
- Dow 200
- Senfroth 7000
- MIBC
- NaOH/cresylic acid mixture (pH = 10)

Half of the frother dosage was mixed with the collector and dosed as collector. The rest of the frother was dosed later after the collector's conditioning time for the last two tests (Table 3.4). The idea was to use a part of the frother dosage as a solvent for the TTC's. Caustic soda was added to the cresylic to increase the pH and limit decomposition.

3.4.2 Results and discussion

No depressant was used with these tests. Most of the combinations tested improved on the standard collector of Impala Platinum. Table 3.4 shows the result of optimising the frother for the TTC's.

Table 3.4 iC_3-TTC with different frothers

Frother	PGM		Cu		Ni	
	Grade	Rec	Grade	Rec	Grade	Rec
	(ppm)	(%)	(%)	(%)	(%)	(%)
STD(SIBX/DTP)-Cresylic	53.90	87.11	0.83	90.55	1.29	56.46
MIBC	86.20	82.86	1.49	87.41	1.82	45.22
Senfroth	49.45	88.12	0.74	88.98	1.23	57.94
Dow	46.60	88.94	0.66	89.87	1.11	60.25
Cresylic	61.15	88.91	0.86	89.85	1.35	57.23
Cresylic/NaOH	46.40	86.19	0.70	89.23	1.19	58.93
iC_3-TTC/Cresylic	52.80	90.03	0.82	90.43	1.28	57.96
iC_3-TTC/Cresylic/NaOH	50.20	90.76	0.71	90.90	1.19	59.89

MIBC gave good grades but not good recoveries. The good grades could be just a result of low mass-pull. The most promising combinations was that of the TTC and cresylic acid and the TTC/C_{12} mixture with Dow 200 frother. Another good combination is that of the TTC(mix) with the caustic/cresylic mixture. There is however a problem with the caustic/cresylic mixture. The two components are not miscible and therefore not completely mixed.

Although frother could at least partially be used as a solvent, it was decided not to use it as such. This would complicate froth control. It is further concluded that the TTC worked well with the currently used cresylic acid and that for plant trial purposes, no negative effect with iC_3-TTC was observed when compared to the standard. However, should frothing studies be undertaken later, MIBC because of the high grade needs closer investigation particularly for rougher concentrates.