CHAPTER 6

EFFECT OF DILUTED AND AGED TTC ON SULPHUR, GOLD AND URANIUM FLOTATION

6.1 Introduction

The effect of using diluted and aged TTC on the flotation of sulphur, gold and uranium was investigated by means of release curve experiments in which the response of a 1% wt C_{12} TTC solution was compared with that of fresh C_{12} TTC (20% wt). Both reagents were used to substitute 8 mole percent of the standard since this was shown to be the optimum in the previous chapter. The dilute solution was aged for 24 hours before it was used. Its pH was initially 12.04 and after ageing, it was 11.47. The reason for this decrease in pH can be hypothesised to be decomposition illustrated by the reverse of equation 2.17, to give the mercaptide (RSNa) and carbon bi-sulphide (Davidtz, 2005). 8% C_{12} mercaptan ($C_{12}SH$) was also tested for reference purposes.

6.2 Results and Discussion

6.2.1 Water and Mass recovery

Table 6.1 below shows water final recovery (R_{max}) and flotation initial rate (k) data for the standard and the three collector mixtures tested. Included is an R^2 term, which is an indicator of the how well the data fit this particular rate equation. As seen from the data in table 6.1, the fit was good.

Table 6.1 *Water initial rates and final recoveries*

Experimental Condition	R^2	k (min^{-1})	R_{max} (g)
Standard (20g/t SIBX)	0.9957	0.11	379.0
8% C_{12} mercaptan	0.9958	0.12	339.6
8% diluted C_{12} TTC and aged for 24 hours	0.9994	0.17	436.5
8% fresh C_{12} TTC	0.9983	0.17	443.9

The two TTC mixtures gave similar initial rates. Their final recoveries were separated by 1.7% of the smaller value. Kirjavainen (1996) showed that water recoveries can be used for predicting gangue entrainment. They have been previously shown to correlate with mass recovery in Figure 5.13 *(b).*

Final mass recoveries and initial rates are shown in Table 6.2. The standard and 8 mole percent C_{12} mercaptan gave identical initial rates that were significantly lower than for both TTC reagents. This is consistent with predictions from water recovery initial rates shown in Table 6.1.

Table 6.2 *Mass final recoveries and initial rates*

Experimental Condition	R^2	k (min^{-1})	R_{max} (%)
Standard (20g/t SIBX)	0.9859	0.33	3.1
8% C_{12} mercaptan	0.9928	0.33	2.7
8% diluted C_{12} TTC and aged for 24 hours	0.9780	0.40	3.3
8% fresh C_{12} TTC	0.9828	0.45	3.1

At long flotation times that are associated with equilibrium recovery, the standard and 8 mole percent fresh TTC gave similar final recoveries. This is useful because it allows a more realistic comparison between the two. Though not significant, 8 mole percent diluted and aged TTC gave a slightly higher final recovery than the fresh reagent. The mercaptan mixture gave the lowest mass final recovery, which is also consistent with water final recoveries. During the flotation experiments, it was noticed that the mercaptan mixture gave relatively smaller bubbles than the standard. Both TTC mixtures gave the largest bubbles. The froth height increased in the order: mercaptan mixtures < the standard < the two SIBX/TTC mixtures.

6.2.2 Sulphur Recovery

Table 6.3 shows sulphur initial rates and final recoveries. For all four collector combinations, 8 mole percent fresh TTC gave the highest initial rate and final recovery. For both responses the SIBX/diluted C_{12} TTC mixture differed by 3.5%. Compared to the standard, the 8% Mercaptan mixture gave a much lower initial rate and almost identical final recovery.

Table 6.3 *Sulphur initial rates and final recoveries*

Experimental Condition	R^2	k (min^{-1})	R_{max} (%)
Standard (20g/t SIBX)	0.9953	1.03	65.52
8% C_{12} mercaptan	0.9982	0.82	67.70
8% diluted C_{12} TTC and aged for 24 hours	0.9997	1.42	67.02
8% fresh C_{12} TTC	0.9998	1.47	69.39

Figure 6.1 shows sulphur recovery-grade curves. 8 mole percent fresh TTC showed the best performance. This was followed by substituted C_{12} mercaptan, and diluted TTC and lastly, the standard. The curve for fresh TTC/SIBX mixture was above that of the standard throughout. This shows that the collector mixture was superior all through.

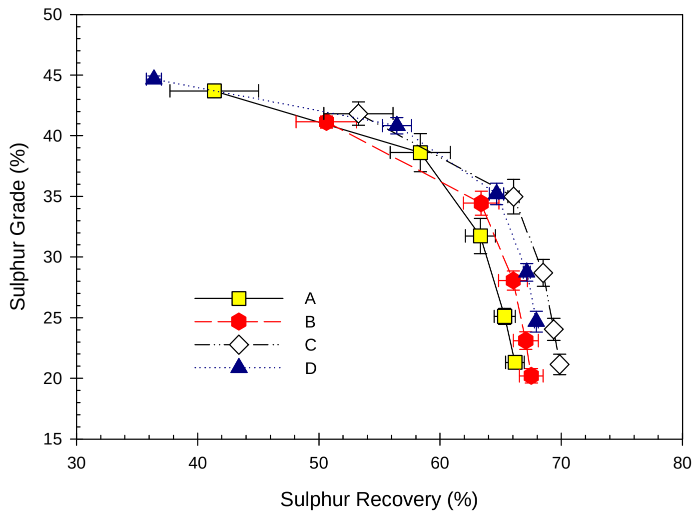

Figure 6.1 *Sulphur recovery-grade curves for [A] the standard, [B] 8 mole percent C_{12} TTC, diluted and aged for 24 hours, [C] 8 mole percent fresh C_{12} TTC and [D] 8 mole percent C_{12} mercaptan*

6.2.3 Uranium Recovery

Uranium initial rates and final recoveries are shown in Table 6.4. The mercaptan mixture gave the lowest responses. Both TTCs gave higher initial rates and final recoveries than the standard. The initial rate for the diluted and aged TTC/SIBX mixture was lower than that for the fresh TTC/SIBX combination by 10% while their final recoveries differed by only 0.5%. Based on initial rates, it appears that the fresh TTC/SIBX mixture gave better performance.

Table 6.4 *Uranium final recoveries and initial rates for the standard and the three collector mixtures tested.*

Experimental Condition	R^2	k (min^{-1})	R_{max} (ppm)
Standard (20g/t SIBX)	0.9953	0.70	27.47
8% C_{12} mercaptan	0.9962	0.62	24.30
8% diluted C_{12} TTC and aged for 24 hours	0.9952	0.83	28.4
8% fresh C_{12} TTC	0.9966	0.92	28.3

Figure 6.2 shows uranium recovery-grade curves. The standard showed the highest grade throughout. Its recoveries were however lower that for both SIBX/TTC mixtures, which showed almost identical recoveries and grades all through. 8 mole percent mercaptan gave the poorest uranium flotation response.

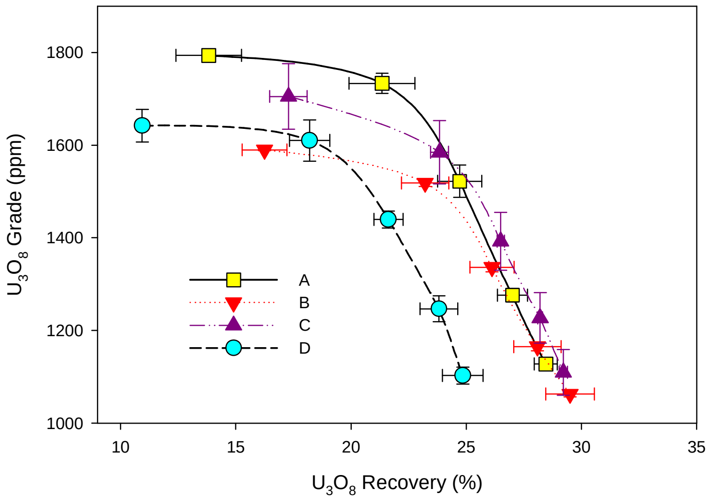

Figure 6.2 *Uranium recovery-grade curves for [A] the standard, [B] 8 mole percent C_{12} TTC, diluted and aged for 24 hours, [C] 8 mole percent fresh C_{12} TTC and [D] 8 mole percent C_{12} Mercaptan*

6.2.5 Gold

Gold flotation initial rates and final recoveries are shown in Table 6.5. Initial rates for both SIBX/TTC mixtures differed by 4% and their final recoveries by 5%. Comparison between the recovery-grade curves of the two shows that the differences are insignificant (Figure 6.3). Comparing the standard and the two TTC mixtures shows that the standard progressively gave higher concentrate grades and much lower recoveries. Its initial rate was 0.63 min^{-1} while the fresh TTC/SIBX mixture recorded 0.74 min^{-1}, which indicates an increase by a factor of 17%.

Table 6.5 *Gold flotation responses for 8 mole percent substitution of the standard*

Experimental Condition	R^2	k (min^{-1})	R_{max} (g/t)
Standard (20g/t SIBX)	0.9967	0.63	42.4
8% C_{12} Mercaptan	0.9961	0.59	39.4
8% diluted C_{12} TTC and aged for 24 hours	0.9942	0.71	47.4
8% fresh C_{12} TTC	0.9956	0.74	45.0

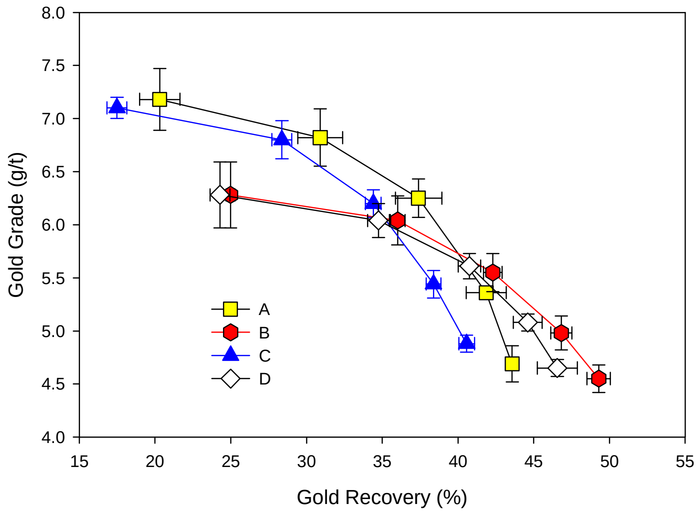

Figure 6.3 *Gold recovery-grade curves for [A] the standard, [B] 8 mole percent C_{12} TTC, diluted and aged for 24 hours, [C] 8 mole percent C_{12} Mercaptan and [D] 8 mole percent fresh C_{12} TTC*

6.2.6 Conclusions

Based on the measurement of flotation initial rates and final recoveries, together with comparison between plotted recovery-grade curves, it is clear that by combining SIBX and fresh C_{12} TTC, a better flotation activity is obtained than with SIBX alone. This is in agreement with earlier plant trials by Davidtz (2002). It has generally been concluded that the promoting effect is a synergistic one. Previous conclusions have been that the surface density of collector packing of dixanthogen is promoted by the long chain TTC (Breytenbach, 2003; Davidtz, 1999). Furthermore, the addition of TTC at the dosage levels studied does not reduce the effectiveness of SIBX. The 1% wt solution of TTC marginally lost activity when compared to the fresh TTC solution. This is probably due to the hydrolysis of TTC. The product of decomposition would then be a mercaptan. The mercaptan reference sample showed a distinct reduction in grade recovery and kinetics. The conclusion therefore is that when dosed as such, mercaptan is detrimental to SIBX activity.

du Plessis (2003) suggested that the TTC dimmer and adsorbed mercaptan, which results from a surface decomposition of an adsorbed TTC are responsible for a strong hydrophobic state. This data also suggests the mercaptan most likely has to be generated via the adsorbed TTC. Thereafter decomposition of the adsorbed TTC leads to the presence of a metal mercaptide salt.

Gibbs Excess Free Energy calculations show that the calculated hydrophobicity of a TTC adsorbed is the same as that of a mercaptan adsorbed (Davidtz, 2005),so that either the TTC or mercaptan when adsorbed on their own would generate equivalent states of hydrophobicity. However, this is a mixed xanthate TTC system with only a small fraction of the collector being TTC and mercaptan. Consequently one has to conclude that the presence of these are enhancing or promoting the effectiveness of the xanthate.

Although there was not much difference between the fresh and aged TTC the decrease in activity could be more severe if the concentrations were lower. Fresh operations are between 2 and 5 mole percent TTC in SIBX. It is therefore possible that these results are still within this region. However, pH is the dominant factor and a stability time phase diagram with pH included is needed to predict the aged TTC behaviour. Certainly the mercaptan on its own is not effective in synergism, but in fact has a depressing effect.