

MEMORANDUM

To H.E.Pawson R.J.Tucker

Date..... February 16/76

From C.O.Olesen

Ref.

Subject..... Arsenic Suppression with use of FeCl₃, CuSO₄ & NH₄OH

PROCEDURE - Samples were obtained from thickeners #6, #11 and #13. These were treated with a calculated amount of FeCl₃ and CuSO₄ and pH was varied with the use of NH₄OH. When the FeCl₃ and CuSO₄ were added to the sample, it was a batch solution and the batch was agitated by the use of rollers for a period of a half an hour. For testing purposes 200mls. of sample were attained for each sample that was to be subjected to ammonia hydroxide treatment. These samples were agitated by means of a bar stirrer for 3 - 5 minutes, and then left to settle. From the settled sample 100 mls. was retained for analysis, and 100mls. of distilled water was replaced into the flask containing the precipitate to form a dilution of one half. The procedure was repeated to obtain samples of one half and of one quarter dilutions, and were analyzed for Cu, Fe, As, and pH.

Data #6 Thickener

#6 thickener	-pH = 6.9	ppm Cu = ND	ppm Fe = 156	ppm As = 18.2
#6 thickener + FeCl ₃	-pH = 3.1	ppm Cu = 1.8	ppm Fe = 150	ppm As = 20
#6 thickener + CuSO ₄	-pH = 4.7	ppm Cu = 222	ppm Fe = 136	ppm As = 16.9

Amount FeCl₃ added .9g/2500ml or 74.4 ppm Fe (samples 1-4)Amount CuSO₄ added 2.5g/2500ml or 254.5 ppm Cu (samples 5-8)

N.B. Samples A = No Dilution
 Samples B = Dilution of $\frac{1}{2}$
 Samples C = Dilution of $\frac{1}{4}$

SD	Drops NH ₄ OH	pH	ppm CU	ppm Fe	ppm As
1A	2	6.3	ND	35.0	1.27
B		6.1	1.4	23.8	.96
C		6.3	.6	12.0	1.13
2A	3	8.0	ND	ND	.41
B		7.0	ND	ND	.35
C		6.9	ND	ND	.63
3A	4	8.9	ND	ND	.45
B		8.8	ND	ND	.16
C		8.65	ND	ND	.16
4A	10	9.75	ND	ND	.48
B		9.65	ND	ND	.28
C		9.6	ND	ND	.22
5A	1	5.4	155	35.2	5.76
B		5.5	10.8	24.0	2.34
C		5.5	12.5	10.0	1.06
6A	2	6.25	19.0	ND	1.84
B		6.4	10.5	ND	.88
C		6.5	6.0	ND	.54
7A	5	8.9	9.3	ND	.13
B		8.85	1.0	ND	.13
C		8.8	0.1	ND	.16
8A	10	9.6	70.0	ND	.11
B		9.5	10.5	ND	.15
C		9.4	1.2	ND	.13

Data #11 Thickener

 #11 Thickener -pH = 3.5 ppm Cu = 4.5 ppm Fe = 263 ppm As = 132.5
 #11 Thickener + FeCl₃ -pH = 2.65 ppm Cu = 4.8 ppm Fe = 390 ppm As = 138
 #11 Thickener + CuSO₄ -pH = 3.3 ppm Cu = 204 ppm Fe = 255 ppm As = 134

Amount FeCl₃ added 2.75g/2500ml or 227.3 ppm Fe (samples 1-4)

Amount CuSO₄ added 2.5g/2500ml or 254.5 ppm Cu (samples 5-8)

N.B. Samples A - No Dilution
 Samples B - Dilution of $\frac{1}{2}$
 Samples C - Dilution of $\frac{1}{4}$

SD	Drops NH ₄ OH	pH	ppm Cu	ppm Fe	ppm As
1A	1	2.8	5.4	395	145
B		3.0	2.6	175	62.5
C		3.2	2.8	65	31.0
2A	2	2.9	5.4	310	102
B		3.0	2.45	132	47
C		3.2	1.22	50	21.5
3A	5	5.8	0.65	125	6.78
B		5.8	0.10	61	5.93
C		5.7	0.10	15	5.46
4A	10	9.1	2.55	.65	3.39
B		9.0	0.15	2.35	2.07
C		8.9	0.10	ND	0.47
5A	1	4.8	208	200	87
B		5.1	100	87	37.8
C		5.1	40	37	17.5
6A	2	4.8	210	200	92
B		5.1	100	88	40
C		5.1	35	37	16.5
7A	5	6.6	6.1	1.7	4.71
B		6.9	2.85	1.2	3.53
C		7.0	.62	ND	1.53
8A	10	9.1	70	.2	9.89
B		9.1	19.4	1.25	2.02
C		9.1	8.0	ND	.565

Data #13 Thickener

#13 Thickener	-pH = 6.1	ppm Cu = ND	ppm Fe = 5.5	ppm As = 980
#13 Thickener + FeCl ₃	-pH = 2.3	ppm Cu = .50	ppm Fe = 1650	ppm As = 980
#13 Thickener = CuSO ₄	-pH = 4.6	ppm Cu = 1540	ppm Fe = 1.37	ppm As = 1000

Amount FeCl₃ added 8.75g/2500ml or 723.1 ppm Fe (samples 1-5)
 Amount CuSO₄ added 16.25g/2500ml or 1654ppm Cu (samples 6-10)

N.B. Samples A- No Dilution
 Samples B- Dilution of $\frac{1}{2}$
 Samples C- Dilution of $\frac{1}{4}$

SD	Drops NH ₄ OH	pH	ppm Cu	ppm Fe	ppm As
1A	1	2.3	0.55	1460	870
B		2.5	1.10	430	455
C		2.7	0.52	155	240
2A	2	2.4	0.80	1260	980
B		2.6	0.35	380	430
C		2.8	0.30	140	230
3A	5	2.6	0.50	430	650
B		2.8	0.25	155	345
C		2.9	0.15	45	165
4A	10	5.9	ND	20.7	205
B		5.9	ND	6.8	109.5
C		5.9	ND	3.25	80
5A	20	9.2	1.15	1.13	58
B		9.2	0.10	1.15	42
C		9.0	ND	0.60	34.5
6A	1	5.1	1540	ND	800
B		5.3	522	ND	400
C		5.5	378	ND	220
7A	2	5.1	1440	ND	700
B		5.3	740	ND	395
C		5.5	312	ND	230
8A	5	5.4	1000	ND	650
B		5.5	490	ND	275
C		5.7	230	ND	156
9A	10	6.9	252	ND	275
B		6.0	120	ND	150
C		6.1	60	ND	92
10A	20	9.0	264	ND	34.5
B		9.0	55	ND	19.0
C		8.8	18.6	ND	16.0

Data - Combination of #6, #11 & #13 Thickeners

#6 Thickener	pH - 6.1	ppm Cu = ND	ppm Fe = 4.45	ppm As = 25.5
#11 Thickener	pH - 3.5	ppm Cu = ND	ppm Fe = 154	ppm As = 138
#13 Thickener	pH - 5.8	ppm Cu = ND	ppm Fe = 20.0	ppm As = 295

Combination (theo)	pH = ?	ppm Cu = ND	ppm Fe = 48.8	ppm As = 100
Combination ≠ FeCl ₃	pH = 4.8	ppm Cu = 4.4	ppm Fe = 7.8	ppm As = 40
Combination + CuSO ₄	pH = 5.2	ppm Cu = 224	ppm Fe = 1.1	ppm As = 78

Amount FeCl3 added 3.00g/2500ml or 248ppm (Samples 1-4)
Amount CuSO4 added 3.00g/2500ml or 305.4ppm (Samples 5-8)

Note Samples A - No Dilution
 B - Dilution of $\frac{1}{2}$
 C - Dilution of $\frac{1}{4}$

SD	Drops NH ₄ OH	pH	ppm Cu	ppm Fe	ppm As
1A	2	7.4	ND	1.20	3.73
B		7.5	ND	1.04	2.95
C		7.5	ND	1.15	2.08
2A	5	8.9	.25	0.70	2.03
B		9.0	ND	1.04	1.70
C		9.0	ND	1.12	1.41
3A	10	9.5	1.96	0.40	2.75
B		9.5	ND	0.55	2.26
C		9.4	ND	0.55	1.81
4A	15	9.7	1.85	0.30	3.29
B		9.6	.25	0.30	2.77
C		9.6	.10	0.45	3.27
5A	2	6.5	17.0	ND	30.0
B		6.7	8.9	ND	20.0
C		6.7	5.6	ND	12.5
6A	5	8.9	9.2	0.40	12.0
B		8.8	2.5	0.40	9.0
C		8.8	.77	ND	6.0
7A	10	9.5	46	ND	14.0
B		9.4	14.5	ND	7.0
C		9.4	2.8	ND	5.0
8A	15	9.7	76	ND	17.0
B		9.6	22	ND	10.0
C		9.6	6.1	ND	7.5

CONCLUSION:

- A pattern is definitely noted at the pH ranges of 7.5 - 9.0 in the FeCl_3 samples, especially in the combined thickener study (Page 5). It shows a definite suppression of arsenic to an approximate level of 3ppm As.
- Also the precipitate attained from the combination of FeCl_3 and NH_4OH seems fairly stable and just slightly soluble as noted in the dilutions.
- With this combination ($\text{FeCl}_3 + \text{NH}_4\text{OH}$) the precipitate drops out readily (50% in 1 Hour Max.) and you are left with a clear supernate at a pH of 8.0 or more. Which could be given secondary treatment if necessitated and would be easier to treat.
- Problems arising from the use of this low pH, would be production of HCN from the barren, but how big of a problem is not yet known. Testing into this area will be made.
- One other disadvantage of this method is the handling and gaseous affects of the ammonia hydroxide when used in large quantities.
- FeCl_3 is more effective than CuSO_4 (pages 2 - 5)

RECOMENDATIONS:

- To find a substitute for ammonia hydroxide, by using a salt of ammonia, and to see if the ammonia is the suppressant agent.