REVIEW OF TAILINGS RETREATMENT PROJECT

Giant Yellowknife Mines Limited

Yellowknife Division

Kelvin Fiedler

September 1988

TABLE OF CONTENTS

1. SUMMARY OF LABORATORY TESTWORK

1.1 Lakefield Research has conducted a considerable amount of testwork on tailings samples submitted by Giant Yellowknife Mines.

1.1.1 Test Conditions

The standard test procedure adopted by Lakefield was a leach (or CIL test) with an initial cyanide solution concentration of 1000 ppm and pH controlled between 10.5 - 11.0.

The samples tested had characteristics such that cyanide additions were required during the tests to maintain adequate cyanide concentrations. Additional lime was required in some tests. The ongoing cyanide and lime consumptions which occurred in most tests, indicate the presence of cyanicides within the feed material. Dissolved oxygen levels were monitored and were generally steady over the duration of the tests.

1.1.2 Gold Recovery

Most laboratory test results gave recoveries between 30-40%.

Recovery improved slightly for longer dissolution times.

Attached is Figure 6 from the Lakefield Research report of August 24, 1988.

The graph shows an almost linear increase in recovery with respect to time after 16 hours dissolution. This is an unusual dissolution profile which could result from:

- incomplete dissolution of coarse gold;
- chemical inhibition of dissolution, or passivation of gold surfaces which retard dissolution;
- poor exposure/liberation characteristics of gold particles.

1.2 Laboratory results have been confirmed by Pilot Plant testwork. It is important that routine laboratory cyanidation tests are conducted on TRP feed samples to assess whether laboratory results reflect actual TRP operation, or give consistently better results than the TRP.

Several intensive cyanidation tests should be performed in parallel with laboratory cyanidation tests on TRP feed, to assess if improved recovery can be obtained under extreme test conditions.

Re-cyanidation of the TRP tailings samples should be conducted to assess if dissolution will continue on a laboratory scale.

2. SUMMARY OF PILOT PLANT TESTWORK

2.1 Recovery

The average gold recovery for the Pilot Plant test programme was 35.0%, which resulted from 38.9% gold dissolution, and 89.7% gold adsorption from solution onto carbon.

A histogram of daily percent dissolution values is shown in Figure 2.1. The daily dissolution values had a range from a low of 29.9% to a high of 48.2%.

The daily dissolution and adsorption results are shown in Figure 2.2. The plot of dissolution results shows considerable variability on a daily basis. It is important to note that although the results do show considerable variability, the daily dissolution results were generally above 35%.

It is understood that tailings solution losses were controlled by the addition of additional carbon to the tanks. It is unclear what carbon concentrations were in the Pilot Plant CIL tanks. It appears quite rapid fouling of the carbon occurred which required charging of fresh carbon. (Refer Figure 2.3 - plot of tailings solution loss versus date).

2.2 Dissolution Kinetics

A plot of the Pilot Plant (average) dissolution curve is shown in Figure 2.4.

Dissolution is reasonably rapid. This would be expected as the feed material was predominantly reclaimed from the Polishing Pond which has a relatively fine size distribution.

Cyanide was normally added in Tanks 1, 2, and 3. The raw data suggests cyanide was added to the Stock Tank from July 24 to July 29 inclusive, though it appeared not to make any significant difference to the ultimate recovery.

2.3 Reagents

2.3.1 Dissolved Oxygen

No dissolved oxygen data was included in the data reviewed. It would be expected that the slurry in all tanks would have been well saturated, as the compressor used for the Pilot Plant had excess capacity and had to be vented to atmosphere.

2.3.2 pH

Lime was mixed batchwise and the additions averaged over the duration of the Plot Plant. pH levels were generally above pH 10.0 except for the last eight days of operation.

The lime addition averaged 1.23 lb/s.t.

2.3.3 Cyanide

Cyanide was mixed batchwise and the additions averaged over the duration of the Pilot Plant.

The average cyanide addition was 2.01 lb/s.t.

Average free cyanide values to tailings were generally greater than 0.7 lb/s.t.

2.4 Agitation

It is expected that very efficient agitation was experienced in the Pilot Plant tanks, given the mechanical agitation was complimented by large volumes of air.

2.5 Discussion

2.5.1 Although the average recovery was 35.0% for the Pilot Plant testwork, dissolution results were quite variable.

Dissolution kinetics were quite rapid (for the averaged data), though this would be expected given the solids size distribution. Dissolution continued, though very slowly, with a cyanide contact time greater than approximately 20 hours.

There is insufficient plant data from the TRP to allow comparison of the Pilot Plant dissolution profile with TRP plant operation.

The Pilot Plant data supports laboratory bottle roll tests, which also indicate rapid dissolution kinetics.

The importance of rapid dissolution should not be underestimated in the setting of reagent levels and carbon concentrations in the TRP tanks, i.e. the first CIL tank should have a considerable excess of free cyanide to promote dissolution, together with a high carbon concentration to ensure the solution loss from Tank 1 is low.

2.5.2 Although no dissolved oxygen data for the Pilot Plant has been sighted, it is expected that all tanks contained highly saturated slurry. Recent TRP surveys have shown D.O. levels in the Surge Tank feed and Tank 1 feed to be lower than the remainder of the tanks.

It appears that there is a major difference between the D.O. levels of the Pilot Plant operation, and the TRP.

2.5.3 The lime addition to the Pilot Plant averaged 1.23 lb/s.t., with pH values generally above 10.0.

Given the refractory nature of the Yellowknife ore, it is expected that the tailings to be treated may contain a considerable amount of soluble metal ions.

It is therefore not only important to maintain a reasonably high pH to give high cyanide activity, but also to precipitate as many soluble ions as possible prior to the addition of cyanide. (Laboratory testwork sometimes required ongoing lime and cyanide additions to maintain reasonable free cyanide concentrations in solution).

2.5.4 The Pilot Plant average cyanide consumption was 2.01 lb/s.t. This figure is relatively low compared to most Australian operations that I am familiar with. It is important to monitor the free cyanide concentration in solution at the head of the circuit to ensure dissolution is not inhibited.

Normally, free cyanide in solution is kept greater than 300 ppm in the tank where cyanide is added. Regular cyanide titration of solutions is important. This allows adjustments to the cyanide addition rate to be made as feed characteristics vary.

2.5.5 Tank agitation in the Pilot Plant would presumably have been very efficient due to the mechanical agitation being complimented with high air additions.

The mechanical agitation in the TRP is inadequate, though good suspension of carbon is obtained with the introduction of compressed air. It still appears unclear if a solids density profile exists in the TRP tanks.

2.5.6 Apparently the majority of the feed to the Pilot Plant originated from the Polishing Pond. A comparison of results should be made between laboratory drill hole recoveries on samples located near the area(s) where Pilot Plant feed was obtained.

3. T.R.P.

3.1 Plant Operation

3.1.1 Carbon Profiles:

Run with more carbon at the front end of the CIL, i.e.:

	Tank 1	Tank 2	Tank 3	Tank 4	Tank 5	Tank 6
Carbon g/L	20-25	20-25	15-20	12-17	12-17	12-17

If more carbon is available, then increase the levels in Tanks 1 and 2 to 25-30 g/L.

Carbon levels in tanks should be checked once per day. It is important (given the agitation problems) that all operators use the same techniques and take samples from the same positions on the tanks.

The mechanical agitation is not satisfactory. I expect there will be sanding problems when the coarser sections of the dams are being processed. I do not see the use of air for agitation as a long term solution.

3.1.2 Dissolved Oxygen:

D.O. measurements should be taken at least every four hours at the stock tank, and all CIL tanks. If the amount of air that can be added is limited by compressor capacity, air additions to the Stock Tank and Tank 1 should take preference over the other tanks. Aim to have the D.O. level of the stock tank at a higher value than the CIL tanks (only time will tell if this is achievable).

Obviously sufficient air must be used to maintain adequate agitation in all tanks - if there are times when there are low D.O. values in the stock tank, air must not be reduced to (say) tank 1 or 2 to a point where efficient agitation is lost.

A more compact hand-held D.O. meter should be purchased to allow CIL operators to take in-tank D.O. measurements.

3.1.3 Cyanide:

Cyanide titrations should be performed every two hours on Tanks 1, 2 & 3. I feel it would be best to run at a solution cyanide concentration of 400-500 ppm in Tank 1. This strategy will mean that operators will have to adjust the cyanide addition rate depending on feed density variations, and variations in the amount of cyanicides entering the circuit.

An in-plant test should be conducted with all cyanide being added to Tank 1, to assist in enhancing dissolution kinetics.

Cyanide savings can be achieved by running at 43-45% solids (provided viscosity and agitator power-draw permits).

3.1.4 pH:

The pH of the Stock Tank should be run at 10.5-10.7. The CIL tanks should not be allowed to drop below pH 10.4. Feed variations may require lime additions along the CIL adsorption train if the oxidation of sulphide minerals continues in the CIL tanks. Even higher pH values may be beneficial.

pH checks of the Stock Tank and Tanks 1 to 6 should be performed every 2 hours.

It is worth considering relocating the pH probe from the trash screen undersize hopper to the stock tank, or Tank 1 feed launder. The existing location gives only a small amount of time for mixing and neutralization of any acidic components of the feed. Locating the probe in the stock tank may make pH control more difficult (due to the response lag), though if there is a continuing consumption of lime in the stock tank there is a chance the pH to Tank 1 could drop below 10.5.

The Stock Tank should be run at reasonably high levels to allow maximum contact with lime and air before coming into contact with cyanide in Tank 1.

A more compact hand-held pH meter should be purchased to allow CIL operators to take in-tank pH measurements.

3.1.5 Carbon Activity:

Carbon activity tests should be conducted at least twice per week on loaded carbon (acid wash feed) and regenerated carbon. If insufficient regeneration capacity is available, then carbon activity tests should be performed on stripped carbon that bypasses the regeneration furnace.

The compressors should be checked to ensure they are delivering oil free air to the tanks.

The use of a finer grade carbon should be investigated for use in the plant (carbon activity is very particle size dependent).

3.2 <u>Carbon Strip/Regeneration Rate</u>:

Design figures for a 15 g/L carbon level in the CIL tanks gives a carbon retention time through the CIL of approximately 40 days.

Some carbon has been in the plant for approximately 120 days. The Acid Wash/Strip/Regeneration rate should be increased to move all the carbon through the CIL plant more rapidly.

The design rate is 5 t/day. Ideally 10 t/day should be stripped during the "catch-up" phase, though given the present constraints with the loaded carbon screen and eductors, a rate of 15 t every 2 days may only be achievable. The operating water pressure of existing eductors should be checked. Pipe runs for transferring carbon should be rerouted to minimize bends.

Resolving the loaded carbon screen problem should be a high priority. Baffles should be placed across the feed end to reduce the velocity of the feed slurry. The kink in the feed hose should be straightened out. A speed reduction of the pump feeding the loaded carbon screen would allow the pinch valve to be opened up. This would decrease the problem of sanding up at the valve.

3.3 <u>Regeneration Capacity</u>:

The design values for regeneration throughput, temperature and retention time need to be obtained from vendor specifications, and checked against actual performance.

It appears that the existing furnace would not be able to process 10 t.p.d. at design operating conditions. A trade-off may be possible between temperature and retention time to satisfy the 10 t.p.d. throughput.

Close attention should be given to ensuring that the carbon quench hopper level is kept up to the required height. Combustion of the carbon will take place if the carbon is not quenched properly, which results in high carbon loss and very soft carbon reporting to Tank 6 (which will be lost through attrition).

3.4 Strip Circuit Water Quality:

The strip circuit operation should be checked against design values, i.e. heat-up and cool-down rates and cell efficiency (especially at high feed solution tenors).

It would be worthwhile to consider using potable or softened water for educting, stripping and quenching, rather than return circuit water. High quality water gives faster strip rates, lower stripped carbon assays, higher carbon activity and reduced scaling of heat exchangers and pipes.

It is normal in Australia to bleed off approximately 30% of the strip solution after each strip. The bleed strip solution is normally routed back to the CIL, or to tailings if the contaminants are high and the gold solution tenor is low (this prevents re-fouling carbon in the plant with contaminants eluted during stripping).

3.5 Trash Removal:

To improve trash removal prior to the CIL circuit, the new woven wire square aperture screens should be installed as soon as they arrive. Cloths should be regularly cleaned with a wire brush. It appears that trash wood chips are being regenerated and sent to Tank 6 with plant carbon. This will lead to gold loss to tailings on the soft carbon that originated from wood chips.

It may be worthwhile trying to place a baffle across the trash screens to reduce the velocity of slurry entry onto the screens. This may reduce the amount of trash that is forced through the apertures by the high velocity slurry.

If the problem of water sprays cutting screen cloths continues, a sacrificial strip of steel, rubber or conveyor belt could be placed below the sprays. Alternatively, can the spray water pressure be reduced?

3.6 Sizing Analyses:

Sizings and assays should be performed on T.R.P. tailings solids to assess the size distribution of solids and gold loss in various size fractions. Suggested size ranges are +53, +37 and -37 micron. This should be performed on a daily basis.

3.7 Tailings Dam Water:

Given the gold content of the water in the tailings dam, consideration should be given to passing tailings dam water through carbon columns. This exercise should be performed by someone other than T.R.P. personnel so that T.R.P. can maintain a high level of input into the plant.

4. RECOMMENDATIONS

4.1 Perform a daily laboratory leach test on TRP feed.

4.2 Perform a daily laboratory leach test on TRP tails.

4.3 Perform a daily sizing and assay on TRP tails.

4.4 Perform several intensive cyanidation tests on TRP feed.

4.5 Pan several TRP tails and assay the concentrates.

4.6 Perform carbon activity tests twice per week.

4.7 Compare laboratory test results of drill hole samples (near where the Pilot Plant feed was obtained) with Pilot Plant results.

4.8 Aim for high dissolved oxygen levels in all tanks. (Surge tank.)

* DO meter. 4.9 Purchase a compact, portable D.O. & pH. meter for use on the tanks.

✓ 4.10 Run tank pH's above 10.5 (higher pH's may be more beneficial).

DONE 4.11 Purchase a compact, portable pH meter for use on the tanks.

4.12 Perform in-plant testwork with Tank 1 free cyanide level greater than 400 ppm.

in process 4.13 Run carbon levels greater than 20 g/l in Tanks 1 and 2 (run Tank 1 at 25-30 g/l if possible).

4.14 Install wire square mesh cloths on trash screens as soon as they are on site. hold up due to sprays

4.15 Assess retrofit options for improving mechanical agitation.

4.16 Continue to resolve mechanical problems to allow 10 t of carbon to be stripped per day.

4.17 Increase the size of eductors and lines if improved carbon transfer rates can't be achieved.

4.18 Investigate heating the acid wash solution to improve acid wash rates and efficiency (use regeneration furnace off gasses).

4.19 Investigate the use of potable or softened water for stripping and regeneration quenching.

4.20 Compare strip circuit performance against design criteria.

up temp to 700 °C

4.21 Compare regeneration furnace performance against design criteria.

4.22 Investigate using regeneration kiln waste heat to pre-dry carbon in the regeneration furnace feed hopper.

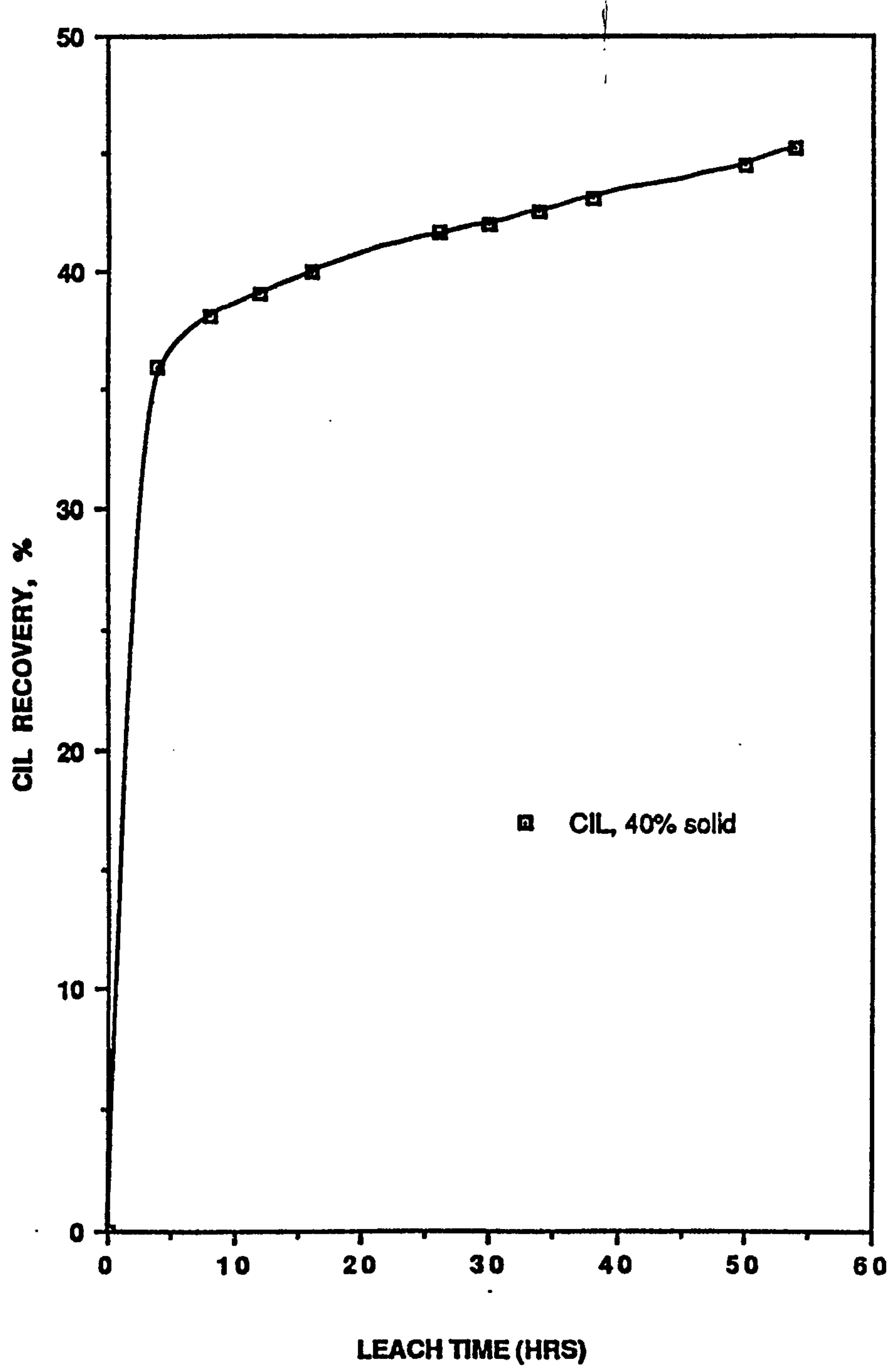
4.23 Ensure the regeneration furnace quench hopper water level is maintained at the correct height.

Kelvin Fiedler 9/9/88

Kelvin Fiedler

KF:kid
09/09/88

FIGURE NO. 6 COMPOSITE No. 1-12 (inclusive)



PILOT PLANT RESULTS: HI GRAM OF % DISSOLUTION.

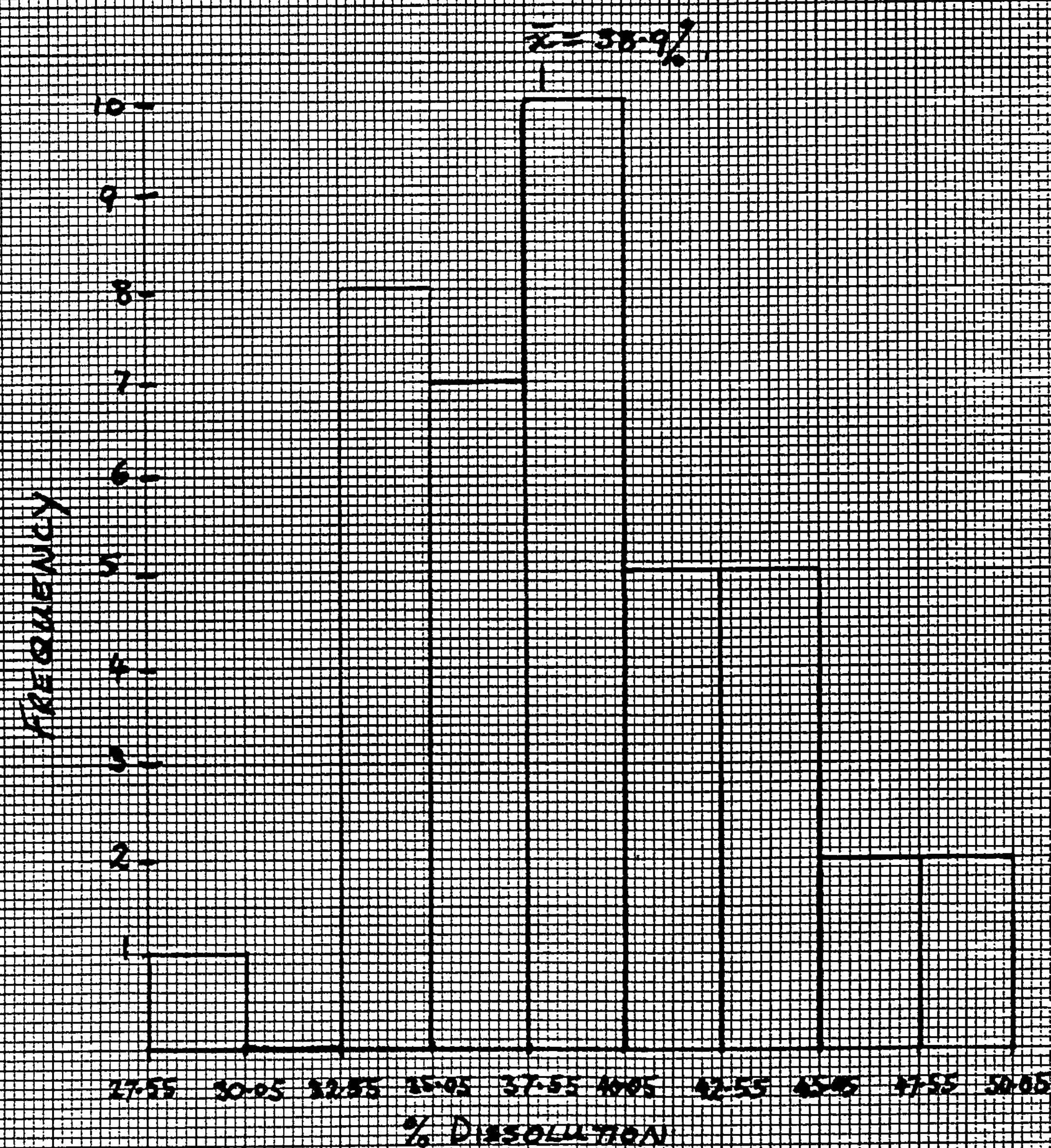


FIGURE 2.1.

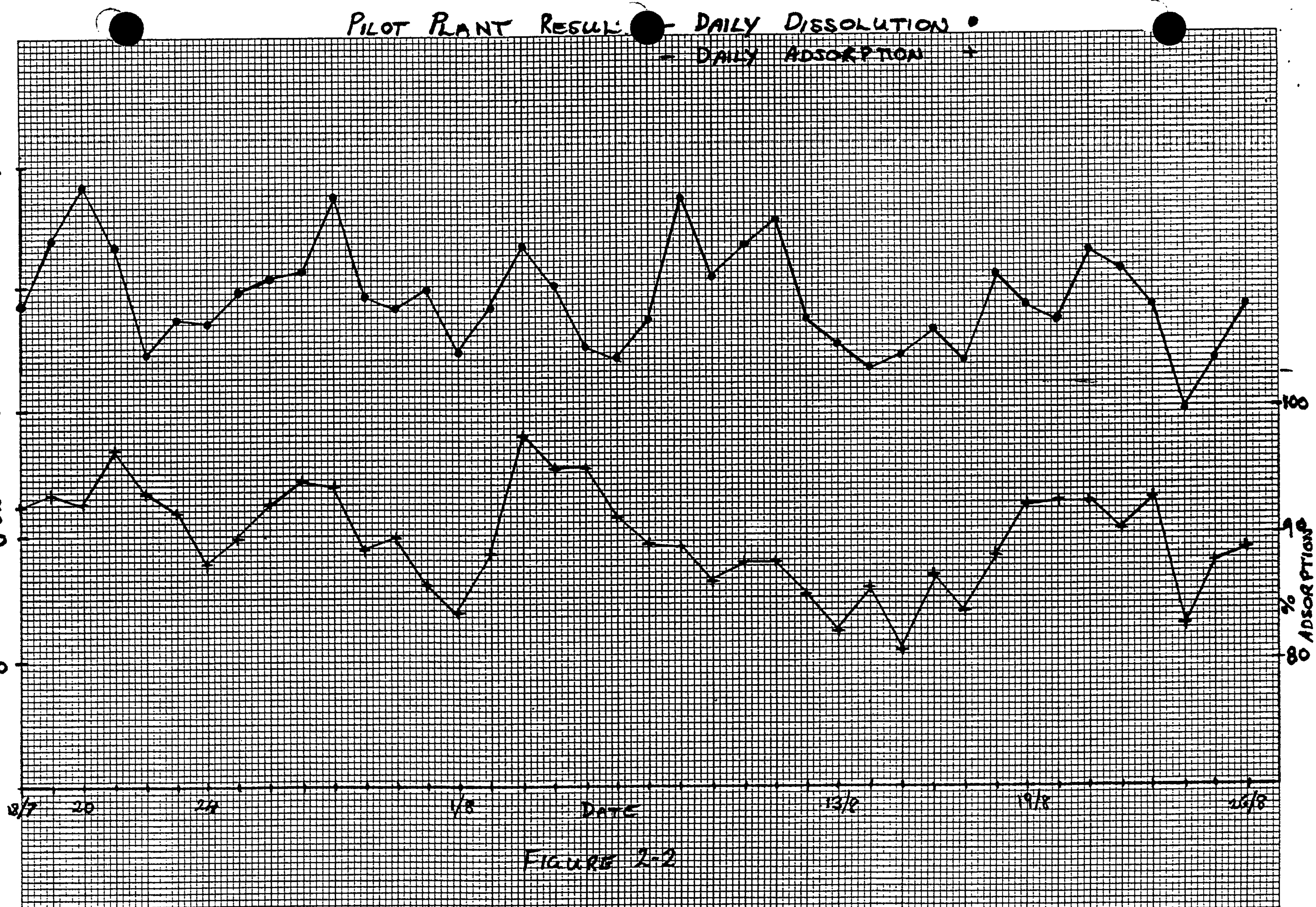
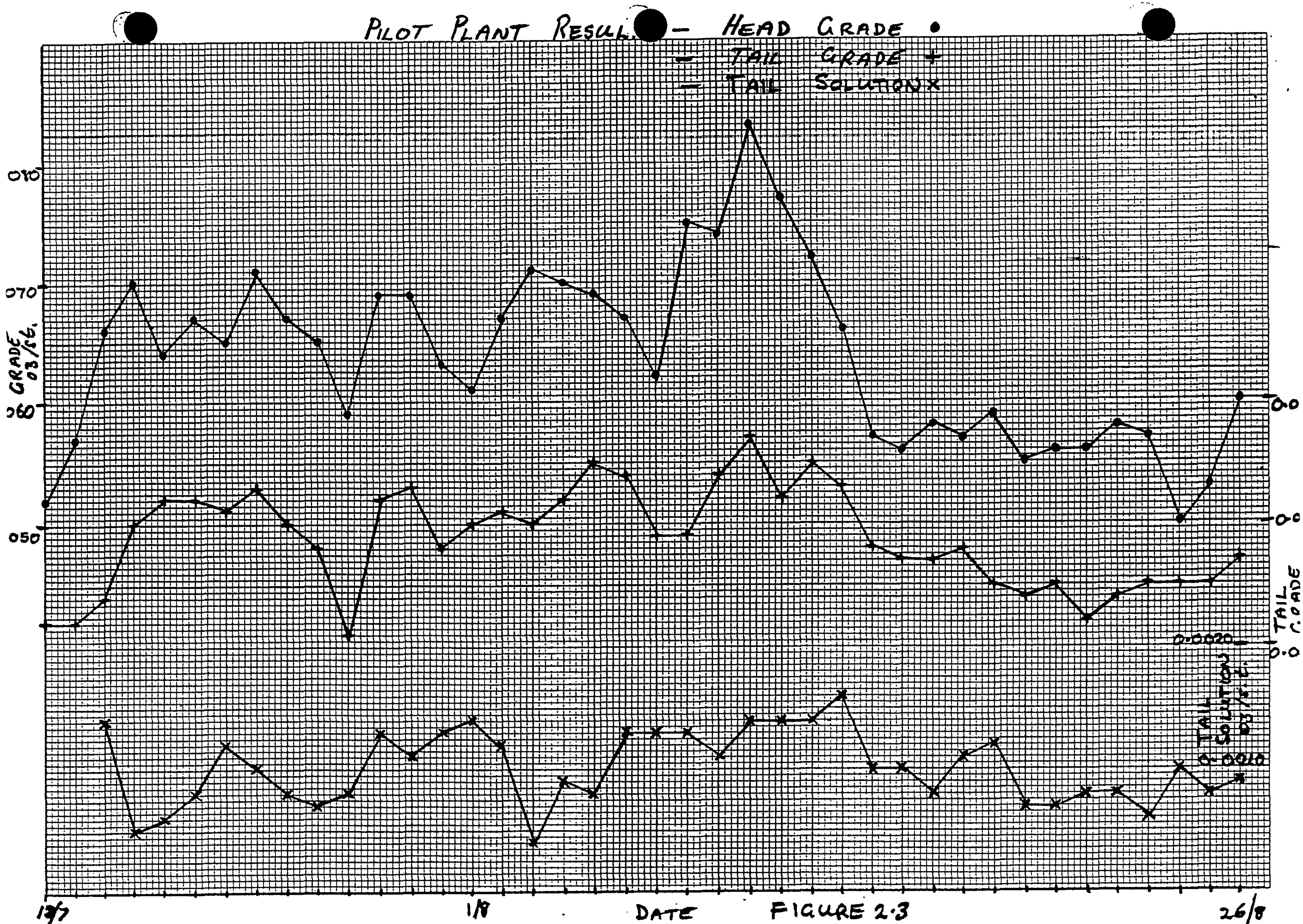

PILOT PLANT RESULTS – DAILY DISSOLUTION •
– DAILY ADSORPTION +
% DISSOLUTION
% ADSORPTION
10
100
90
80
18/7
20
24
1/8
DATE
13/8
19/8
26/8

FIGURE 2-2



PILOT PLANT RESULTS
— HEAD GRADE •
— TAIL GRADE +
— TAIL SOLUTON x
GRADE oz/st.
.080
.070
.060
.050
TAIL GRADE
TAIL SOLUTION oz/st.
0.0020
0.0010
13/7
1/8
26/8
DATE

FIGURE 2·3

PILOT PLANT DISSOLUTION CURVE (AVERAGE OF DATA)

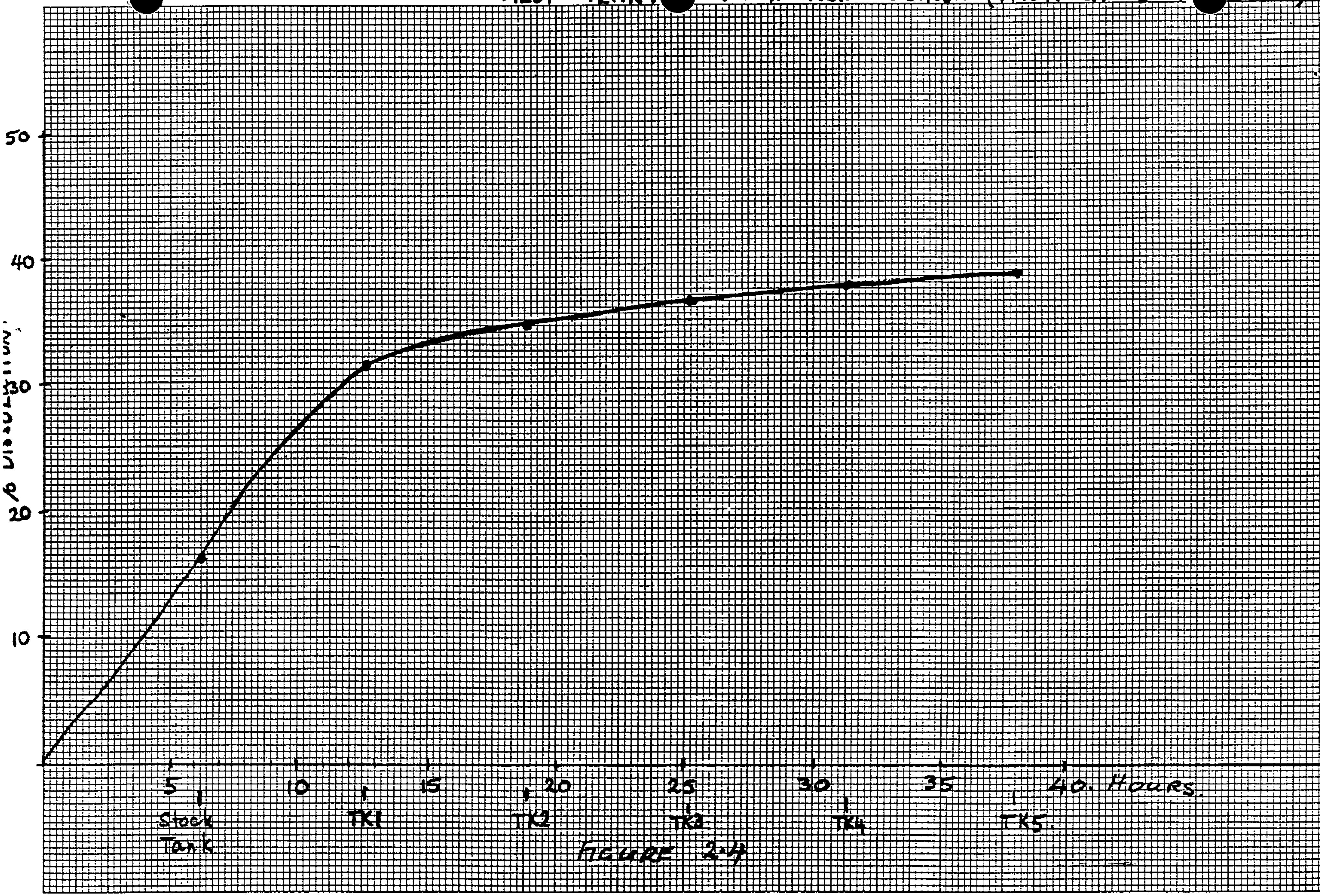


FIGURE 2.4