TREATMENT OF MILL EFFLUENT AND SEWAGE WITH AERATORS AT UMFOLOZI MILL

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Abstract

The use of anaerobic and aerobic ponds plus mechanical aerators for the treatment of mill effluent and sewage is described.

Introduction

The best solution for any pollution abatement problem is to capture and control it at its source.

This has a twofold effect; firstly it saves the company money by reducing sugar and molasses losses and secondly it reduces the load on the effluent treatment plant and, therefore, the size and cost of such a plant.

Methods of reducing pollution

Good housekeeping will result in a considerable reduction of pollution.

Usual sources of pollution are leaking pump glands, leaking tanks, overflowing vessels, pipe joints, valve spindles, spillage, etc. Routine attention paid to these points will reduce the possibility of polluting the factory drains.

The hose pipe, which is found in most factories, is pollution's biggest ally. Any spillages of molasses, massecuite, juice, sugar, is usually cleaned up by washing it all down the drain with water from a hose pipe. All hose pipes should be removed and kept under lock and key and only used once a week. In their place should be brooms, bins and shovels, and the sugar bearing products should be returned to process.

Small copper-lined drains should lead into collection pits and a sump pump be provided to pump the liquids back into process.

Rainwater from factory roofs is usually led into the factory drains and this water then enters the effluent treatment plant and thus increases the load on the plant unnecessarily.

All rain water should be separated from factory drains and be led away separately, as this water does not need treatment.

Cooling pond water from pans and evaporator condensers usually overflows continuously and this overflow has to be treated. Re-use of this overflow on the dust collectors on the boilers has reduced the amount of overflow and during the extreme period of drought last season it was mixed with the mill maceration water.

History

The Umfolozi factory is situated at Riverview, Zululand, and crushes approximately 5 500 metric tons of cane per day. The factory draws water from the Umfolozi River, which is about 2,5 km to the south. Effluent from the factory is returned to the river about 4 km below the pump house.

The Umfolozi is normally a strongly flowing river but due to several years of drought, has been reduced to a mere trickle, and last winter it stopped flowing altogether.

The effluent from the factory during the crushing season used to run untreated back to the river. It was black in colour and contained a high proportion of suspended solids. These were mainly fly-ash removed from the dust collectors on the boiler plant.

With the drying up of the Umfolozi river it became obvious that this quality of effluent could no longer be discharged into the river.

Requirements of water act

The Water Act of South Africa gives relevant effluent quality standards. In the case of Umfolozi factory these standards are:

C.O.D. not more than 120 mgm/l
Suspended solids not more than 25 mgm/l
Oil not more than 5 mgm/l.

Investigations

At the start of the 1968 season the S.M.R.I., in conjunction with the N.I.W.R., was asked to assist with the effluent problem and to suggest an economical form of treatment.

An extensive survey of all possible sources of pollution was made.

All drains were sampled over a 24-hour period for quantity and quality of the effluent. Samples were taken from drains which were adjacent to the following points in the factory.

(a) Hydrocyclones on sugar dryers
(b) Centrifugal station.
(c) Oliver filters
(d) Hydroseals on dust collectors on boiler plant
(e) Overflow from condenser water pond
(f) Mill drain
(g) Final drain.

The results showed that the effluents from the hydrocyclones, factory drains and mill drains were highly concentrated.

Immediate steps were taken to re-route all water from the hydrocyclones back into process. The drain next to the mill was sealed off and a sump pump was installed to pump all raw juice, which overflowed on to the floor, back into process.

The fly-ash laden water from the hydroseals on the dust collectors was gravitated to a sump and pumped up to a D.S.M. screen placed high above the ash bin. The fly-ash was effectively removed by the screen, which is two metres wide and has an aperture of 0,5 mm. The screen is made in stainless steel. The screened water gravitates back to the hydroseals and the cycle is repeated.

The fly-ash is fed on to the mud conveyor belt and removed to the mud dump. Make up water is added to the sump by means of a float valve, the water used is tapped from the condenser water return line to the cooling pond.

This system has worked satisfactorily for the past two seasons and there is no longer an effluent problem.

Strict attention was paid to all pump glands and different brands of packing were tried until one was found to be effective.

All leaks and spillages of products were picked up, not washed up, and then returned to process. Hose pipes were removed. Rain water drains and gutters were separated from factory drains. This has reduced the load on the effluent plant.

All these measures have helped to reduce the amount of effluent leaving the factory and have improved its quality and, in addition, have helped to reduce the undetermined losses.

While all these investigations were going on, it was decided to build a large dam between the factory and the river in a natural valley, the idea being to trap the effluent and allow the suspended solids to settle before entering the river as this was the most objectionable part of the effluent. Samples of effluent, when poured into a measuring jar and allowed to stand, gave a clear supernatant, and most solids settled to the bottom and a small amount floated on the surface.

The dam took approximately 40 days to fill and had a capacity of about 90 million litres.

In order to retain the floating fly-ash, the outlet was some 1,25 metres below the surface. The water leaving this dam then went into the river but it was now a grey colour and no longer black.

A second dam about half the size of the first and much shallower was constructed alongside the first dam and the overflow from the first dam entered the second dam before returning to the river. This effluent was much better but had a slight smell.

While the mill investigations were taking place, the effluent entering and leaving both dams was tested and both dams turned out to be anaerobic and gave off a smell early in the morning.

But due to this anaerobic action the C.O.D. of the effluent was reduced by over 95% and the C.O.D. figure of the final effluent was below the maximum figure laid down by the Department of Water Affairs. However, weekly tests showed that from time to time the figure of 120 mgm/l was exceeded and this was not acceptable to the authorities. It was obvious that further treatment would be required to ensure that the parameters laid down would not be exceeded.

Prior to the construction of the dams all the Bantu compound and factory sewerage was served with septic tanks and the run-off from these septic tanks was mixed with the mill effluent. This was not satisfactory and it had to be removed and treated separately.

Various schemes were studied and finally it was decided to install an oxidation ditch (also known as a Pasveer ditch). See Figure 1.

Factors influencing the choice of this plant were:

(a) Low initial cost
(b) Low power requirements
(c) Complete lack of smell or other nuisances
(d) Flexibility (peak loads and shock loads).

Principle of the system

The oxidation ditch is basically a single one-stage process for purification of sewage by means of oxidation.

A primary sedimentation tank is not required and the aeration circuit of shallow depth and simple form provides an extremely economical plant for the full treatment of sewage for small communities at similar proportional costs to conventional treatment plants for large cities. Furthermore both the fresh sludge and the bacterial floc, formed during the process of purification, are oxidised to such an extent that the resulting small quantity of surplus sludge can be readily dried on drying beds or kept in storage without nuisance or odour. Indeed a particular feature of this system is the complete lack of smell or other nuisance.

Oxidation is obtained by means of an aeration rotor: this has several functions. First it provides the necessary oxygen supply for the activated sludge floc and breakdown of sludge. Secondly it maintains a velocity of flow in the ditch to prevent settlement and thirdly it breaks up larger solid particles in the ditch. The rotor, known as the TNO cage rotor, was specially developed for these purposes and is a highly efficient mechanism with a range of flexibility to suit varying conditions and loads.

Ditch velocity and volume

A velocity of about 300 mm per second measured at the centre of the ditch is necessary to maintain all solids in suspension.

The ditch volume should be between 36 000 and 45 000 litres per foot length of rotor.

Settlement of mixed liquor

The mixed liquor passes to a normal final settlement tank. This tank is designed on conventional lines, having a maximum flow rate of 1 180 litres per hour per square metre of tank surface and a retention time of not less than one and a half hours.

The sludge is returned from the final settlement tank to the ditch by means of a return sludge lifting wheel. The clear overflow from the final settlement tank is returned to the river after chlorination. At Umfolozi this liquid is returned to the mill effluent pond.

Oxygen supply

The oxygenation capacity of the rotors at a speed of 70 rpm for various immersions per metre length of rotor are shown in Figure 2.

When the suspended solids concentration in the ditch reaches 60 to 65% of the sludge volume, the solids must be removed to drying beds.

This plant operated beyond expectations and in view of this it was decided to experiment with

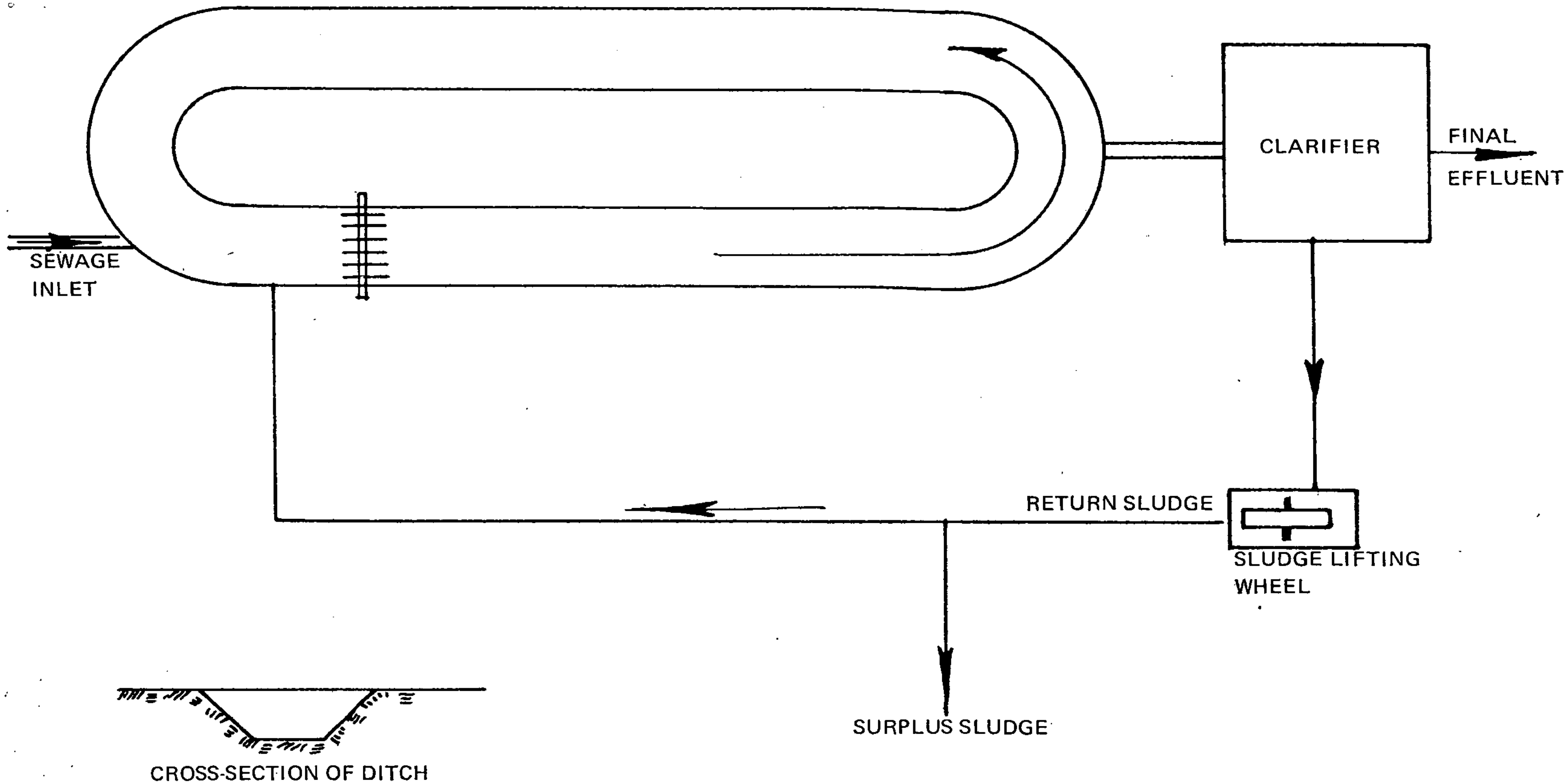

CLARIFIER
FINAL
EFFLUENT
SEWAGE
INLET
RETURN SLUDGE
SLUDGE LIFTING
WHEEL
SURPLUS SLUDGE
CROSS-SECTION OF DITCH

FIG. 1

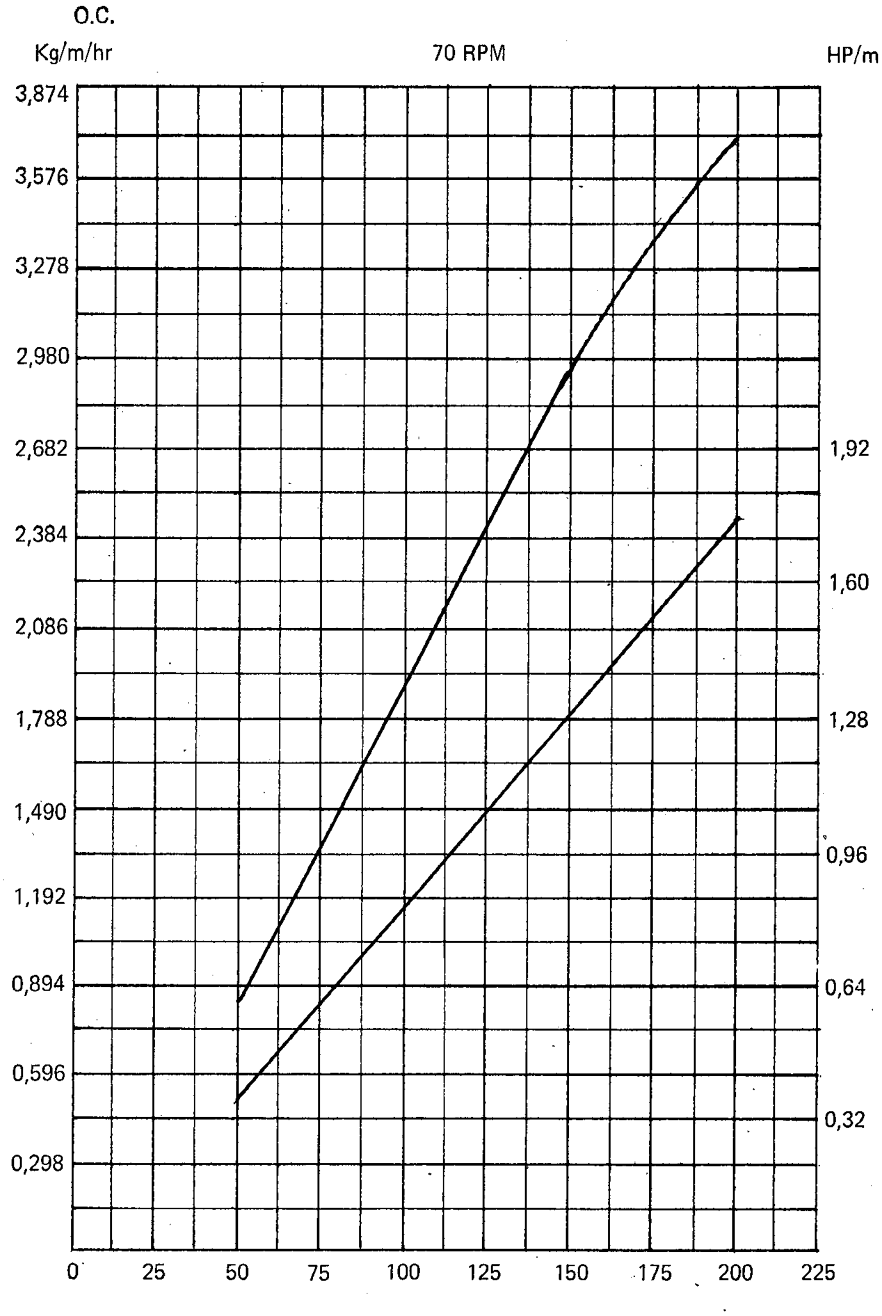

O.C.
Kg/m/hr
70 RPM
HP/m
3,874
3,576
3,278
2,980
2,682
2,384
2,086
1,788
1,490
1,192
0,894
0,596
0,298
1,92
1,60
1,28
0,96
0,64
0,32
0
25
50
75
100
125
150
175
200
225
MILLIMETRES IMMERSION

FIG. 2

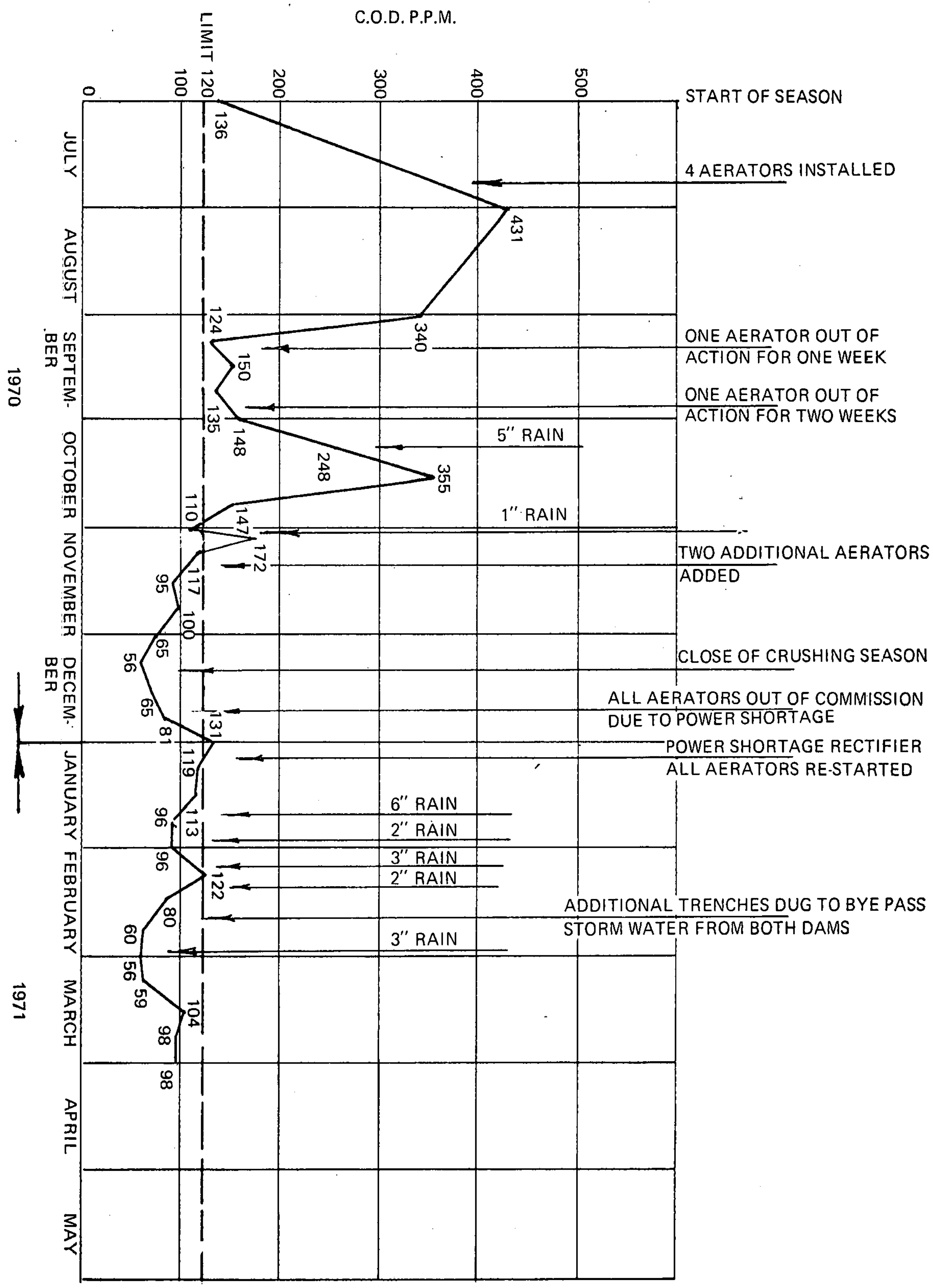
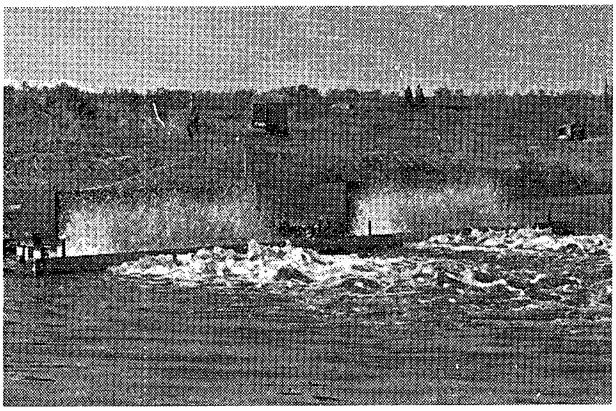

C.O.D. P.P.M.
0
100
LIMIT 120
200
300
400
500
JULY
AUGUST
SEPTEM-BER
OCTOBER
NOVEMBER
DECEM-BER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
1970
1971
136
431
340
124
150
135
148
248
355
110
147
172
117
95
100
65
56
65
81
131
119
113
96
96
122
80
60
56
59
104
98
98
START OF SEASON
4 AERATORS INSTALLED
ONE AERATOR OUT OF ACTION FOR ONE WEEK
ONE AERATOR OUT OF ACTION FOR TWO WEEKS
5" RAIN
1" RAIN
TWO ADDITIONAL AERATORS ADDED
CLOSE OF CRUSHING SEASON
ALL AERATORS OUT OF COMMISSION DUE TO POWER SHORTAGE
POWER SHORTAGE RECTIFIER ALL AERATORS RE-STARTED
6" RAIN
2" RAIN
3" RAIN
2" RAIN
ADDITIONAL TRENCHES DUG TO BYE PASS STORM WATER FROM BOTH DAMS
3" RAIN

FIG. 5

similar aerators mounted on floating pontoons (Figure 3) and placed on the second mill effluent dam in such a way to simulate the flow pattern of the oxidation ditch.

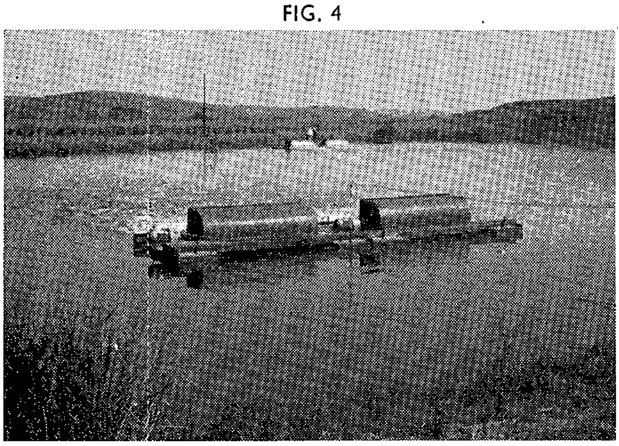
Two pairs of aerators, each driven by a $7\frac{1}{2}$ hp motor were placed on the second dam, as shown in Figure 4. The results of the effluent leaving the second dam and entering the Umfolozi river are shown in Figure 5.

FIG. 3



It can be noticed that when the four aerators were installed at the end of July, the C.O.D. began dropping and almost reached the target of 120 ppm. An immediate effect was noticed when one of the aerators went out of commission.

FIG. 4



Rain also affected the quality of the effluent because of the rainwater entering the first dam and displacing more water into the second dam, and the four aerators could not handle the additional amount.

It was then decided to add two more aerators, one to each set, making a total of six.

This was done in mid-November and from then onwards the C.O.D. was kept under control. Again in December the aerators had to be stopped because of a power shortage and the C.O.D. began to rise.

The suspended solids are also measured each week but these have been above the allowable 25 ppm. This is understandable because there is no final settlement and it has now been decided to build an oxidation ditch next to the second dam and the effluent will pass from the first dam to the ditch and then to the second dam.

This ditch will be operated intermittently thus using the ditch as the settling tank as well. The clear effluent at the top will be decanted when the rotors are stopped and at a pre-determined level they will restart and the raw effluent will then flow into the ditch again until a top level is reached and the cycle is repeated.

The existing six aerators will be used in this ditch although it is expected that only four will be necessary because the ditch will be more efficient than the pond.

Construction of ditch

The ditch will be dug in the ground and lined with polythene sheeting. Concrete abutments will be built to locate the aerators, which will still be mounted on pontoons to allow for the rise and fall of the level in the ditch.

Conclusions

From the results obtained thus far, it is felt that the effluent problem at Umfolozi has now been solved and all effluent entering the river will be below the parameters set by Water Affairs.

Acknowledgements

The assistance and co-operation of management and staff of Umfolozi Co-operative Sugar Planters Limited, S.M.R.I. and Messrs. Wright Anderson (S.A.) Ltd., are much appreciated.

Discussion

Mr. Muldoon: Was the pH of the water checked on going into the retention dam and on coming out of the dam? If the pH falls too low there is corrosion in the pipes in the irrigation sprays.

Mr. Ashe: As the Umfolozi mill does not own cane lands the water is not used for irrigation. All the pipes used are concrete pipes.

Mr. Cox: The drop in pH at Amatikulu referred to by Mr. Muldoon is due to the fact that the dam is a single anaerobic retention type dam, where a drop in pH will always occur.

The Umfolozi dam is aerobic and the pH is close to neutral.

Mr. Rennie: To what extent has Umfolozi reduced its effluent?

Mr. Buchanan: Does Mr. Ashe attribute the drop in undetermined losses at Umfolozi from ,7 to ,1 in the last two years to good housekeeping?

Mr. Ashe: I think most of it is due to good housekeeping.

Mr. Carter: The paper says that according to the Water Act the suspended solids may not be higher than 24 mg/1. I believe the Water Act says that the incoming solids should not be raised by more than 25 kg/1. River water in flood usually has considerably more than 25 kg/1 of suspended solids.

The figures for Umfolozi are taken on a Monday is there a mill stoppage prior to this?

Mr. Ashe: The mill never stops. Each Monday one of the two tandems is stopped for 8 hours maintenance but the rest of the factory operates normally.

The figures we quoted were given to us in a letter from the Department of Water Affairs and it did not refer to raising the suspended solids.

Mr. Farquharson: Have you any figures for evaporation from the dams?

Mr. Ashe: I have no figures but at the coast the evaporation is practically nothing.

Dr. Graham: Mr. Ashe mentions using more than one rotor in the ditch. Do you get a proportionate improvement in removal of COD if more than one is used?

Also, is there a level of oxygenation above which no further benefit is received?

Mr. Ashe: Yes, if more rotors, or a longer rotor, are used then results are better.

As regards level of oxygenation, there is such a point and at times when there is too much oxygen the effluent becomes cloudy and we switch off the rotors for a few hours.