# EXPERIENCE WITH AN ACTIVATED SLUDGE TREATMENT PLANT AT SEZELA

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**Abstract**

The treatment of effluent from the sugar mill and chemical plant at Sezela in an activated sludge plant is described. Over the past four seasons the hydraulic load on the plant has approached double the design value. Despite this, the mill was able to produce final effluent of acceptable quality for most of the time. The performance of the plant over the past nine seasons is discussed.

## Introduction

In 1982 an activated sludge waste water treatment plant was installed at Sezela. The plant treats domestic sewage, factory waste water and effluent from the adjoining chemical by-product plant. The chemical plant produces furfural, furfural alchohol and methanol, all of which are very toxic. Chemical plant effluent contains one or more of the above chemicals in varying quantities. Mill effluent contains mainly sugar and bagasse-contaminated wash water, and sewage from the factory ablution blocks. In recent years, sewage from part of the mill residential area has been connected to the effluent treatment plant. The plant initially failed to produce water of acceptable quality but over the past five years has produced water with an average COD content of below 75 ppm.

## Description of the plant

*Layout of the treatment plant is shown in Figure 1.*

*Inlet works*

The inlet works consist of a screen, a flow meter and a chemical house for the addition of nutrients. The screen consists of a mechanical rake with vertical screens with a nominal gap of 30 mm between bars. The unit operates automatically, with the start initiated by a timer. Total effluent

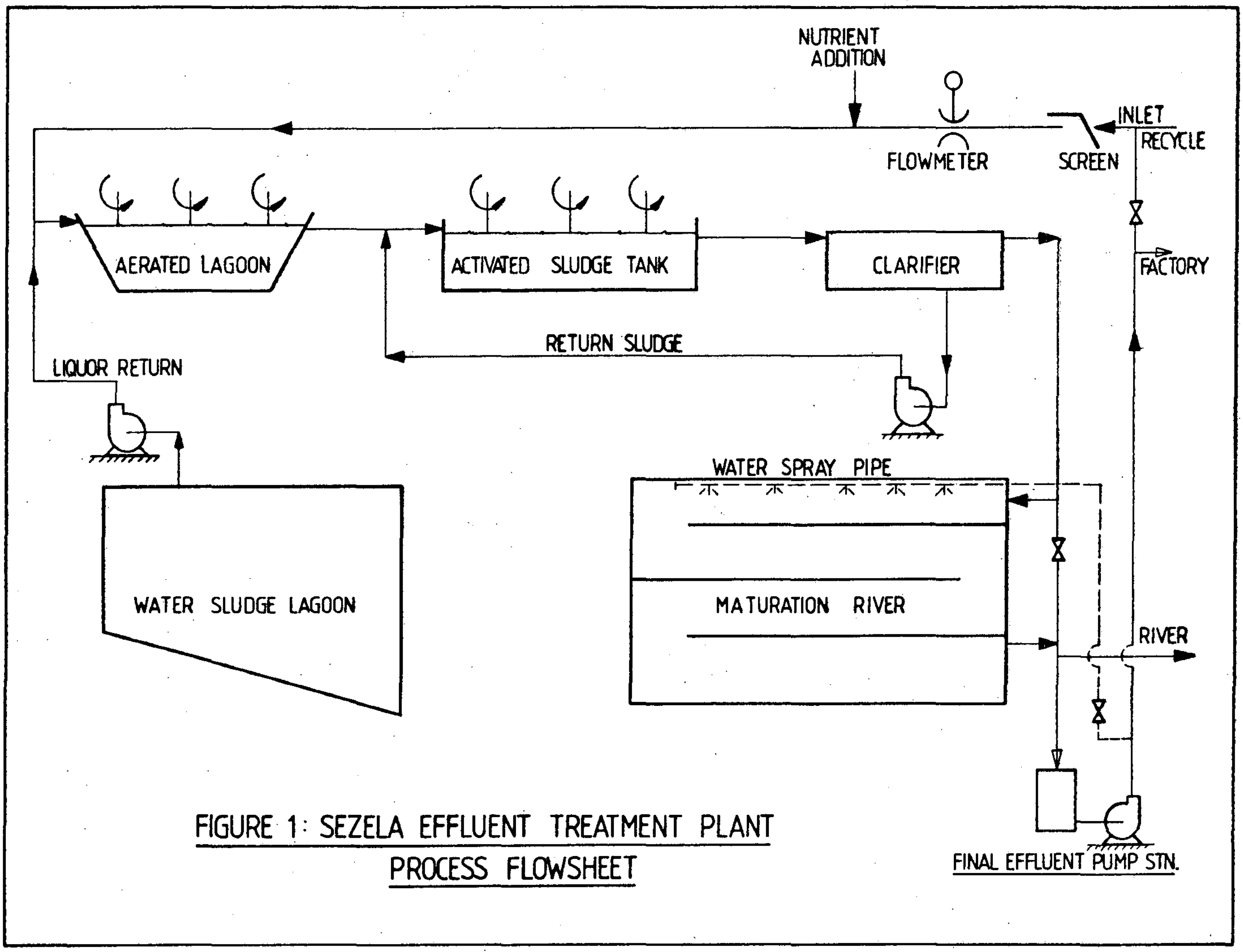


**Figure 1** Sezela effluent treatment plant.

flow rate from the complex is recorded continuously by a Parshall flume arrangement. Provision has been made to add nitrogen and phosphorus in required amounts to balance the nutrient characteristics of the effluent. This is done by adding phosphoric acid and urea solutions by dosing pumps.

*Aerated lagoon*

The aerated lagoon is a rectangular earth-walled pond with a volume of 3250 $m^3$. The pond is equipped with three surface aerators, each capable of injecting 50 kg oxygen/h into the liquid. Aerator speed is reduced to 58 rpm by a direct-mounted gearbox. The aerators are connected to timers which automatically stop and start the units.

*Activated sludge tank*

The activated sludge tank is a reinforced concrete-walled rectangular structure with a volume of 1600 $m^3$ and has three vertical-shaft turbine surface aerators identical to those in the aerated lagoon. At this stage the spontaneous development of micro-organisms takes place. To obtain a high purification efficiency it is necessary to have a high proportion of organisms, relative to the amount of effluent. This is achieved by settling the organisms in a clarifier and returning them to the process upstream of the activated sludge tank.

*Clarifier*

The clarifier is a circular, flat-bottomed reinforced concrete tank with a diameter of 10 m and depth of 3,0 m. A rotating half-bridge, pivoted at the centre of the tank, carries the scrapers and the sludge removal system. The mixture of sludge and effluent passes from the sludge tank to the clarifier, where the activated sludge is settled and the clarified effluent flows to the maturation river. The clarifier underflow (activated sludge) is returned to process at the inlet to the sludge tank by means of vertical-shaft centrifugal pumps. Excess sludge is removed from the clarifier by positive displacement pumps.

*Maturation river*

The maturation river consists of an earth-walled dam with baffles to promote plug flow, and has a volumetric capacity of 1600 $m^3$. Its function is to allow fine suspended solids in the overflow from the clarifier to settle and to provide time for the completion of biological purification reactions initiated in the activated sludge process. This is the final stage at which, through the process of solution from the atmosphere, oxygen is introduced to complete the purification reaction.

## Design parameters

*Hydraulic load*

The plant was designed for the following hydraulic load:

| | | |
|---|---|---|
| Average | 1 200 $m^3$/day | (50 $m^3$/hr) |
| Peak | 1 600 $m^3$/day | (66 $m^3$/hr) |

*Aeration load*

The plant was designed for the following aeration load:

| | | |
|---|---|---|
| Average | 1 920 kg/day BOD | (3 264 kg/day COD) |
| Peak | 2 900 kg/day BOD | (4 930 kg/day COD) |

## Performance of the plant

The average daily hydraulic and COD loading of the plant for the period 1982 to 1990 is shown in Table 1. It can be seen that the hydraulic flow rate exceeded the design value from 1986 to 1990. The high COD loadings in 1983 and 1984 were due to excessive spillage from the flyash disposal system. Increase in hydraulic load is due to the diversion of storm water and domestic sewage to the treatment plant. These are high volume, low COD streams.

**Table 1**

**Average hydraulic and COD loading of the treatment plant**

| Year | Hydraulic load ($m^3$/day) | COD loading (kg/day) |
|---|---|---|
| 1982 | 717 | 2 160 |
| 1983 | 882 | 3 947 |
| 1984 | 802 | 3 938 |
| 1985 | 768 | 2 573 |
| 1986 | 1 637 | 2 764 |
| 1987 | 1 988 | 3 725 |
| 1988 | 2 052 | 3 098 |
| 1989 | 2 112 | 3 367 |
| 1990 | 2 200 | 3 000 |

The suspended solids content of the raw effluent, activated sludge and final effluent is shown in Table 2. Measured value includes both active and inactive suspended solids. The high values for the period 1982 to 1984 were again due to flyash contamination.

**Table 2**

**Average suspended solids content of streams in the process**

| Year | Suspended solids content (ppm) | | |
|---|---|---|---|
| | Raw effluent | Activated sludge | Final effluent |
| 1982 | 1 529 | 7 167 | 36 |
| 1983 | 1 866 | 20 424 | 175 |
| 1984 | 1 576 | 15 499 | 9 |
| 1985 | 769 | 11 908 | 31 |
| 1986 | 515 | 10 307 | 10 |
| 1987 | 604 | 12 394 | 13 |
| 1988 | 579 | 11 869 | 9 |
| 1989 | 455 | 12 737 | 9 |
| 1990 | 542 | 10 266 | 8 |

Quality of final effluent for 1982 to 1990 is shown in Table 3. The high COD values during the early years of operation were due to flyash contamination and lack of understanding of the plant.

**Table 3**

**Final effluent quality for the period 1982 to 1990 (average values)**

| Year | COD (ppm) | TDS (ppm) | pH |
|---|---|---|---|
| 1982 | 219 | – | – |
| 1983 | 596 | 1 257 | – |
| 1984 | 106 | 689 | – |
| 1985 | 109 | 547 | – |
| 1986 | 73 | 597 | 7,3 |
| 1987 | 43 | 600 | 7,0 |
| 1988 | 40 | 545 | 7,0 |
| 1989 | 45 | 572 | 7,0 |
| 1990 | 58 | 489 | 7,0 |

Chemical consumption of the plant from 1982 to 1989 is shown in Table 4. The reduction in chemical consumption during the later years of operation was due to the increased diversion of domestic sewage, with its balanced supply of nutrients, to the effluent plant.

**Table 4**

**Annual chemical consumption of the plant**

| Year | Urea (kg) | Phosphoric acid (kg) |
|---|---|---|
| 1984 | 24 000 | 6 250 |
| 1985 | 18 700 | 4 720 |
| 1986 | 18 450 | 4 683 |
| 1987 | 17 700 | 5 743 |
| 1988 | 13 350 | 4 450 |
| 1989 | 7 800 | 2 140 |
| 1990 | 2 653 | 2 245 |

## Operating the plant

During the processing season all treated effluent is returned to the factory as make-up water for the boiler scrubber system. The maturation river is emptied and used only as an emergency storage for short periods when the treated effluent cannot be returned to the factory due to pump failure or stoppages caused by rain. This prevents the discharge of substandard water into the Sezela river. Excess sludge from the system is pumped into the boiler ash settling ponds and no harmful side effects have been noticed in the past four years. During offcrop, when the ash system is not in use, excess sludge is pumped to a small wasting dam near the effluent plant.

The aerator timers are set to achieve dissolved oxygen levels ranging from 1,0 to 3,0 ppm in both the aerated lagoon and the activated sludge tank. The level of suspended solids in the sludge tank is controlled between 10 000 and 15 000 ppm, depending on the quantity of inactive solids in the system. During periods of high bagasse and flyash contamination it becomes necessary to increase the suspended solids to levels above 15 000. The sludge volume Index (SVI) is controlled between 75 and 100 to give best results.

## Problems experienced

In the first three years of operation contamination of the plant with boiler flyash caused serious malfunctions and resulted in substandard water. The flyash settled in the aeration lagoon, decreasing the effective volume of the plant and causing dead pockets. In the 1984/85 season a new flyash disposal system was commissioned which eliminated all spillages into the effluent system. (Fibrous material causes problems also and it is essential to screen bagasse before the raw effluent enters the plant.) Submersible pumps were used up to June 1990 at the clarifier underflow and at the final effluent station. These pumps were troublesome and very expensive to repair, and are not recommended for future installations.

The submersible pump at the final effluent station has been successfully replaced with a belt-driven centrifugal pump. The submersible pump at the clarifier underflow has been replaced with a vertical shaft-mounted pump that has also proved successful. The initially trouble free aerator gearboxes began to fail after about four years of operation and needed expensive repair. The aerator turbine blades showed wear due to erosion and corrosion, and it is recommended that in future these be manufactured from 3CR12 material.

During the first few years of operation the end of season factory wash down caused excessive hydraulic and COD loadings, and resulted in poor quality final effluent which could not be returned to the factory because of the shutdown. There was no option but to return the water to the river, which caused serious environmental problems. All shutdown washings are now stored in the factory evaporators or product tanks and are released very slowly into the effluent treatment plant. The slow release of high COD wastes may take up to six weeks after shutdown and this rate is successful. During the past two seasons part of the high volume, low COD wastes have been diverted into the flyash system just before offcrop, to lessen hydraulic load on the effluent plant. However, this tends to produce unpleasant odours from the smuts ponds.

Although the treatment plant has been successful in reducing COD to below 75 ppm, it has been unable to decrease the oxygen absorbed (OA) level to below 10 ppm during the season. The reasons for this are not clear, but it is thought that the high hydraulic loading which results in low residence time and the nature of the chemical wastes could be contributing factors. This is not a serious problem during the season because the treated effluent is returned to the plant, and the OA level is normally below 10 ppm when water is discharged into the river during offcrop. Tests using water sprays at the final polishing stage showed that the OA level could be reduced by as much as 20% simply by aerating the treated effluent. Results shown in Table 5 are encouraging, and this system will be evaluated fully next season.

**Table 5**

**OA reduction in treated effluent (October 1990 test)**

| | Average oxygen absorbed (ppm) | |
|---|---|---|
| Test number | Before aeration | After aeration |
| 1 | 20 | 16 |
| 2 | 18 | 14 |
| 3 | 22 | 16 |
| 4 | 17 | 13 |
| 5 | 19 | 15 |
| 6 | 19 | 16 |

## Conclusion

The aerobic activated sludge system has been successful in treating sugar mill, chemical plant and domestic waste. About 40% of the COD loading is from the adjoining chemical plant. The increased diversion of domestic sewage into the plant has resulted in decreased levels of nutrient addition. The plant has worked satisfactorily around the design COD loading, and the design hydraulic load has for long periods been exceeded by as much as 76%. Inactive suspended solids such as fibrous material and flyash caused malfunctions and, on a number of occasions, chemical spillage from the adjoining plant caused complete biological failure from which the system recuperated very quickly. The plant has been unsuccessful in decreasing the OA level to below 10 ppm during the season and the reasons for this are not clear. The spray system will be evaluated during the coming season in order to further reduce the OA level.

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