"DETERMINED LOSS" - A REVIEW OF THE SYSTEM FOR MONITORING SUGAR LOSS IN CONDENSER WATER AT ILLOVO

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Abstract

The system used a Illovo Factory to estimate sugar losses in condenser and dunder water is described and results of a test to check the accuracy of the system are discussed. It is concluded that:

- The system used is effective and reliable.
- A sucrose loss equivalent to 0,1 % of factory throughput causes the sugar concentration in condenser water to increase by 20 ppm per hour.
- There was no evidence of loss being appreciably masked by microbial degradation of sugar in water.
- Abnormal losses via condenser and dunder water should be readily detected by COD analyses of effluent samples collected by the proportional sampler.

Introduction

The weekly calculation of the undertermined loss is sometimes known to be erroneous and is somewhat incomplete because it does not distinguish between chemical and physical losses. For this reason and also to provide a more accurate sucrose balance, all C.G. Smith mills have been fitted with monitoring systems for the estimation of sucrose losses in condenser and dunder water, ie "determined loss". This system provides a useful tool to management for the specific determination and control of physical loss on a continuous basis, rather than the historical results of undetermined loss at the end of the week.

The system involves water flow measurements and proportional sampling for trace sugar analyses at hourly intervals. Confidence in the accuracy of the loss estimates is not complete because of the suspicion that losses can be masked through microbial degradation of sugar within the cooling circuit. This suspicion is reinforced by the observation of microbial slimes in cooling towers and by the fact that water is warm and well aerated and thus seems ideal for microbial growth.

In 1985 a test was carried out with the assistance of the Sugar Milling Research Institute (SMRI) to check the sensitivity of the monitoring system. The check was purposely carried out during a period of low undetermined loss. The objective was to develop (or destroy) confidence in the monitoring system so that the results from the analyses could be really meaningful in future periods of high undetermined loss.

The Condenser and Dunder System

The condenser cooling water system consists of a conventional spray pond with a total holding capacity of 1 200 m^3 situated 450 m from the factory (Figure 1). The hot water is pumped out to the spray pond at an average rate of 38 m^3/min and returned by gravity at a temperature of approximately 30°C before being pumped to the condenser manifold.

Any surplus water in the system is diverted to a canal which takes the water, including the dunder water, to a dam for field irrigation.

All factory floor washing or spillage can be reclaimed and pumped back into the process or pumped out of the factory to the irrigation canal.

Procedure for Testing the Loss Monitoring System

The test strategy involved dosing the condenser water with a stream of B-molasses at a rate equivalent to an undetermined loss of 0,25 % (the actual dose rate achieved was 0,29 %). The molasses was added from drums via a 50 mm valve. Three full drums (200 litres) were added at a constant rate over a 4 h period, giving a dosage rate of 213 kg/h. The molasses had a brix of 81,20 and a pol of 33,30. The fructose content was estimated as 5 % and the pol/sucrose as 0,95 (based on the previous week's analysis of final molasses). The water leaving the factory was dosed and that returning to the factory was analysed.

Existing sampling points and analytical procedures were used to monitor the sugar concentration but the frequency of sampling and analysis was increased from the normal 2 h intervals to 30 min intervals.

Samples of condenser water were drawn continuously through a drip-tube and were collected in a receptacle containing mercuric chloride as preservative. The condenser water flow rate was consistent throughout the test period (indicated by an annubar device).

Effluent samples were hourly catch samples preserved with H_2SO_4 (0,2 % v/v on sample). Effluent flow was measured with a Parshall flume and sonic level detector.

The resorcinol/HCl method was used for measuring sugar in the condenser water. Analyses done by mill staff were checked by retaining samples and repeating the analyses at the SMRI. The SMRI results were generally higher than the mill results by a factor of 1,06 but, even if this factor was applied, the shape and position of the curve in Figure 2 (mill results) would hardly change.

The chemical oxygen demand (COD) analyses were done using a Hach semi-micro COD reactor.

Result and Discussion

The increase in sugar concentration during dosing, and the subsequent decline when dosing ceased, is shown in Figure 2. The average increase over the 4 h dosing period

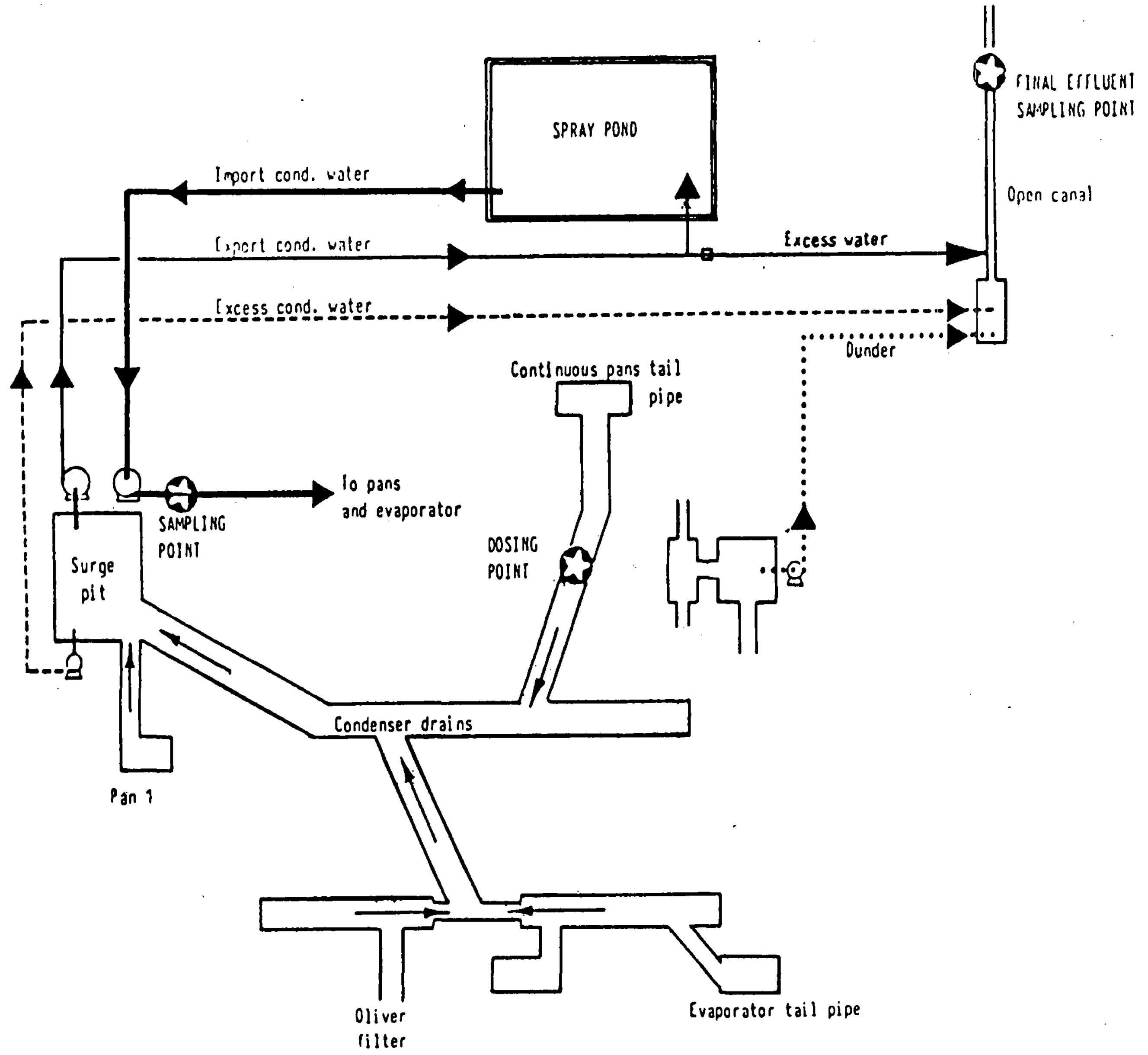

FIGURE 1 Simplified diagram of the condenser water circuit showing dosing and sampling points

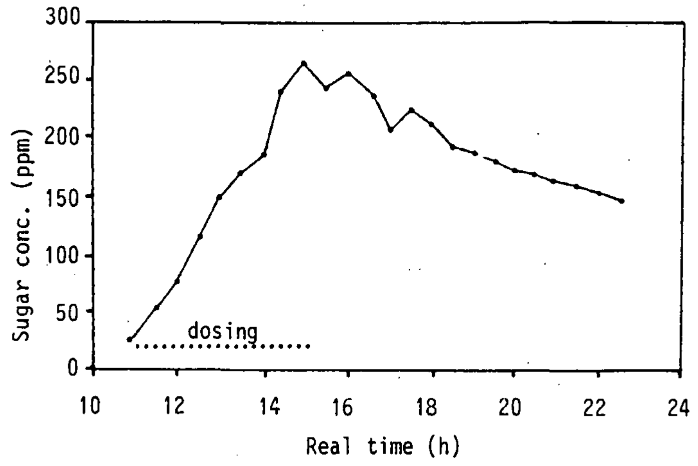

FIGURE 2 Sugar concentrations is condenser water during and after dosing

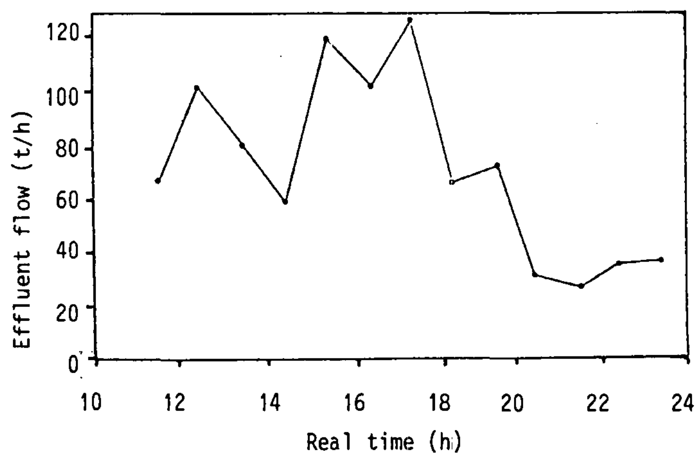

FIGURE 3 Effluent flow rates during the test

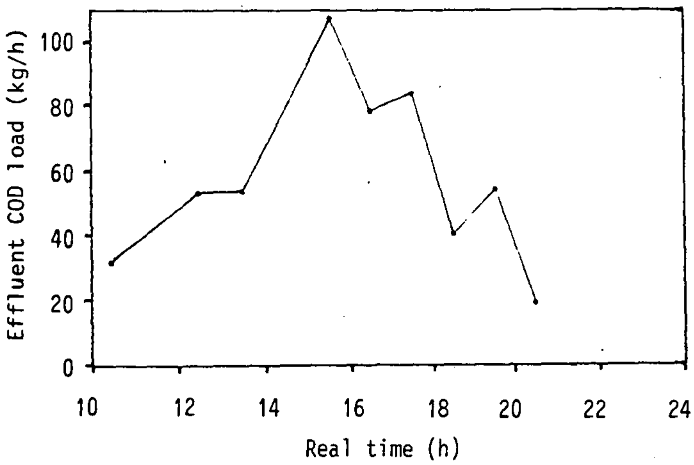

FIGURE 4 Chemical oxygen demand of the final effluent during the test

was 61 ppm/h. The anticipated increase, calculated from dosing rate, system capacity and estimated dilution rate was 65 ppm/h so there was good agreement between the anticipated and measured concentrations.

The shape of the declining curve suggests that dilution, rather than microbial degradation, was the major mechanism through which loss was occurring from the cooling circuit. If microbial degradation was the major cause then the rate of decline would have accelerated as the microbial population increased. Judging from the effluent flow rate (Figure 3), the dilution rate was low after 20h00. From this point onwards the rate of decline averaged 9,6 ppm/h. This represents the maximum possible microbial degradation rate in the cooling system, and is in reasonable agreement with the 5 ppm/h measured when condenser waters from ME and GH were incubated in the laboratory.

The visual appearance of the condenser water changed within 2 hours of the onset of dosing. Unexpectedly, foaming was never severe at any point in the cooling circuit but the water colour changed markedly to reddish/brown. The same colour change was evident in the effluent, which received any overflow of condenser water. Within 20 hours the colour had almost returned to normal.

The COD loading of the effluent changed in apparent response to the dosing (Figure 4). The change was erratic because of the intermittent and inconsistent overflow of condenser water to effluent, but it indicated that severe entrainment to condenser water can be detected by monitoring effluent COD. The recent emergence of a simple semi-micro method for COD analyses[1] makes it possible to do large numbers of COD analyses without undue expenditure on manpower and chemicals.

Between 11h10 and 11h30 a spill occurred from a remelter and could not be reclaimed because the reclaim pump was being serviced. In response to this spill, the effluent COD load for the hour between 11h00 and 12h00 rose to 164 kg/h. This high point has been omitted from Figure 4 because it would have been misleading. It does however confirm the sensitivity of the effluent monitoring system.

Conclusions

This trial has shown that:

- The system used at Illovo (IL) for monitoring sugar losses in condenser water is effective.
- A loss equivalent to only 0,1% of factory throughput causes the sugar concentration in condenser water to increase by about 40 ppm in the 2 h period between sampling, so this loss would be detected within 2 h.
- There is no evidence of loss being appreciably masked by microbial degradation of sugar in the water. (Degradation was estimated to occur at a maximum rate of 9,5 ppm/h, which is equivalent to a loss of about 0,05% of factory throughput.)
- Abnormal losses via condenser water and dunder should be readily detected by COD analyses of effluent samples collected by the continuous proportional sampler at IL. Such losses are unlikely to exceed 0,2% of factory throughput without being detected.

Acknowledgements

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REFERENCE

1. Purchase, BS and Proudfoot, S (1985). An improved method for chemical oxygen demand (COD). *SMRI Technical Report* No. 1420.