EXPERIENCES WITH AN EMERGENCY SPRAY COOLING POND

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Abstract

The design and performance of an emergency spray cooling pond, which was constructed at ML during 1983, are discussed.

Introduction

Spray cooling ponds are not favoured as far as the cooling of condenser water in a sugar factory is concerned. Modern design cooling towers are reputed to be much more efficient but are more expensive. There are times however, when spray cooling ponds have to be built and it is hoped that the experience gained in building such an old-fashioned contraption will serve a useful purpose if a similar situation should arise at other mills.

Problem

Cooling water for condensers at ML is derived from two sources (see Figure 1):

- directly out of the Crocodile river at 2 731 m³/h and
- from a three-cell cooling tower at 1 320 m³/h.

The total quantity of cooling water used is 4 051 m³/h which, under the circumstances, will cater for a crushing rate of 330 tons cane per hour (tch).

At Malelane, the cooling water requirement is thus 12,27 m³/tch under the particular climatic conditions of cooling water temperature at 32°C, out of condenser at 49°C, dry bulb temperatures of 36°C, and wet bulb 25°C. At the coast, conditions would obviously be different.

At Noodsberg, the figure appears to be 14,78 m³/tch and 12,49 m³/tch at Amatikulu which processes raw sugar only.

At the beginning of 1983, the severe drought caused a serious drop in the level of the Crocodile river and by March 1983 there had still not been any rain. Something had to be done very soon or crushing would not be possible. Two thirds of the cooling water supply was no longer available.

Solution

The only practical solution was to build a spray cooling pond which would be available in time. This decision was taken towards the end of March 1983 and the mill was due to start up on 16 May 1983, a little more than seven weeks later.

Technical Details

The system that was designed catered for a water flow of 2 079 m³/h which, with the existing cooling tower of 1 320m³/h, gave a total of 3 399 m³/h which would ensure a cane crushing capacity of 280 tch. ML's normal crushing rate is 325 tch but as a result of the droughts, this was reduced to 280 tch. The system (see Figure 1) consisted of:

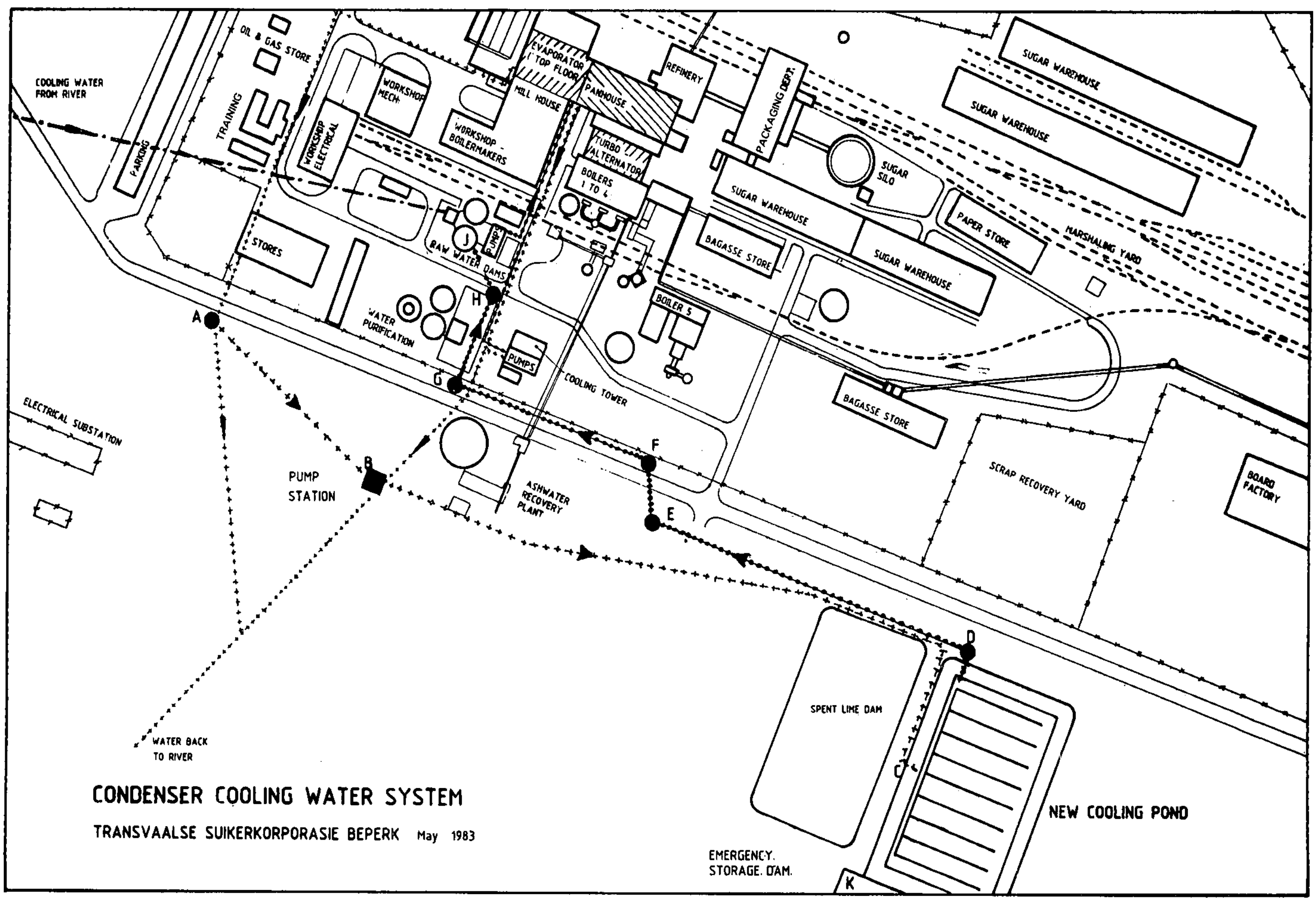

FIGURE 1 Condenser cooling water system, new cooling pond and piping

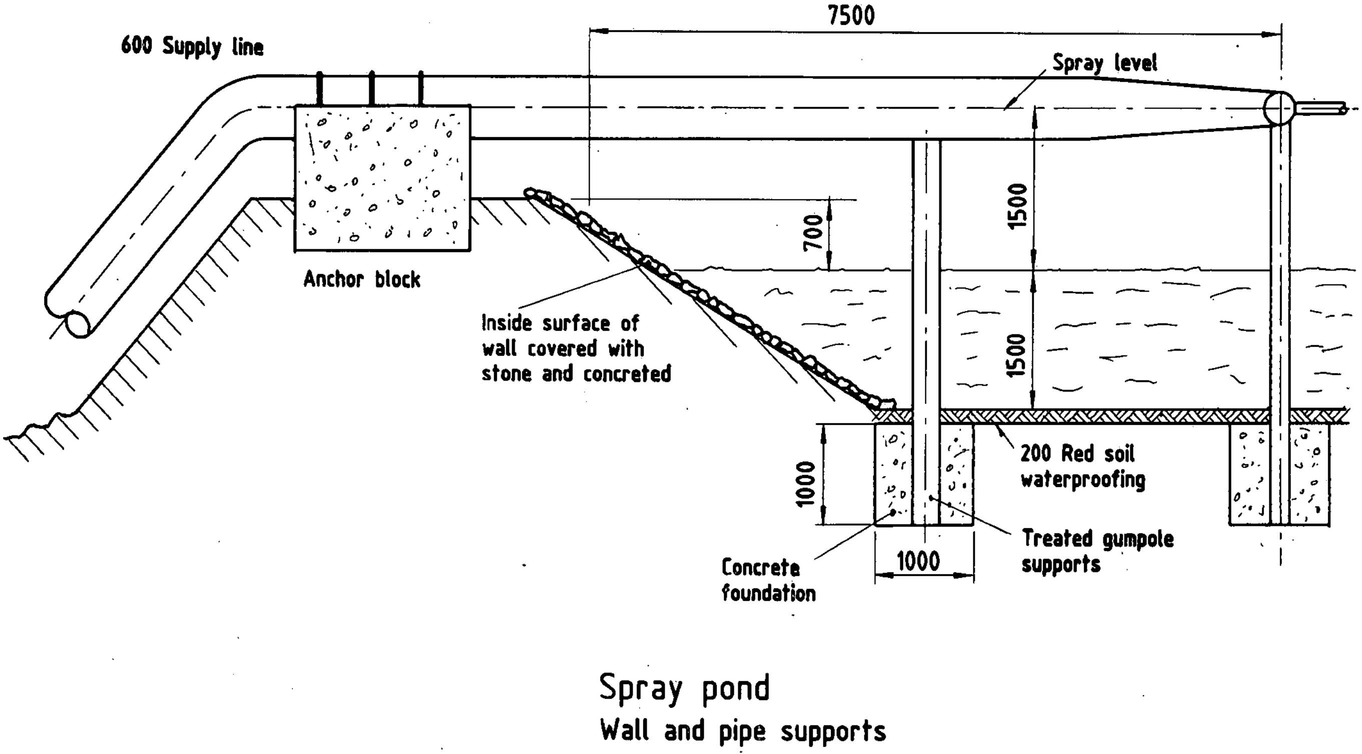

FIGURE 2 Spray pond showing wall and pipe supports

- collecting sump (B) and underground pump station. The sump measured 7 m × 7 m × 3,5 m deep which gave a four minute water holding capacity. The sump was fed through a 600 mm × 120 m asbestos cement pipeline (AB) on the one side with the evaporator condenser water. This pipe had to be built 3 m underground to suit the terrain. The pan condenser water came in through a canal (GB). Pumps were designed for a 20 m head and were driven by two 85 kW motors;
- the delivery pipeline (BC) was 600 mm asbestos cement pipe × 350 m;
- spray dam (C) (see Figures 2 and 3).

The pool measured 105 m × 60 m and was an average 1,5 m deep. The size of the pond can be calculated from the formula in Hugot:[1]

$$\frac{q^2}{s} = 154 \text{ lb/sq ft/h}$$

where q^2 = quantity of hot water in lb/h

s = area in ft^2

If the area is calculated and a 10 m lane is allowed on the sides of the pond to prevent spray loss, the area of the pool is 5 368 m^2.

This was considered to be too small for the local conditions and Mr T. Boast suggested the following formula:

dam cooling capacity = 0,74 kW/m^2/°C

The degrees Celsius is the difference between the hot water and the wet bulb temperature.

Allowance has also to be made for a 10 m lane on the sides for spray loss. The area in this case was 7 038 m^2.

The average of the two areas was taken and the result was a pool of 6 300 m^2.

The measurement of the sides was split in a ratio of approximately 1,0 to 0,6 where 1,0 was the side on which the header would be installed. This was considered to be an economic design ratio for such a dam.

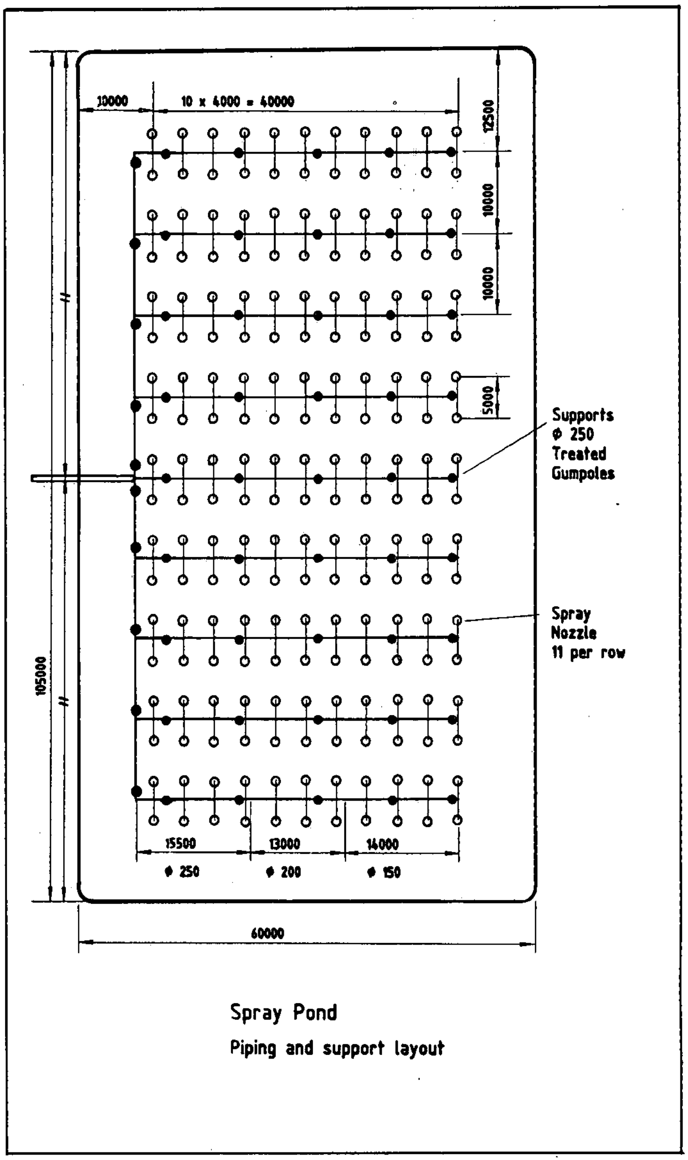

FIGURE 3 Plan of spray pond showing piping and support layout

The depth of the dam was mainly determined by the particular terrain but 1,5 m of water was enough for a retention time of three hours. This could cater for any surges in temperature and volume flow.

Earth walls with the side sloped down to the bottom were packed with stones and covered with concrete which was broomed over. The bottom of the pool was covered with a 200 mm layer of red soil to help with the waterproofing.

Pipes were installed on treated gumpoles with the main header being 400 mm. There were nine distributing lines, from 250 mm down to 150 mm. Each distributing pipe had 22 × 50 mm laterals with sprays. Each spray was equipped with a removable 25 mm diameter nozzle. The number of sprays was calculated according to Hugot:[2]

the capacity of each orifice $q = 25cs\sqrt{2gh}$

where c = constant = 0,45

s = area of orifice in square inches

h = water head in feet

q = cu ft/h

With a head of 23,1 ft (7,04 m) and an orifice diameter of 1 inch (25,4 mm) the number of sprays was 216. Hugot[3] also gives formulae for the spacing of the individual nozzles.

The nozzle units used were fortunately a standard type from a well known manufacturer.

The pond was constructed such that when it was full it would be at the same level as the cooling water pump station feed dam (J) when it was also full. Water could thus flow in either direction in the gravity main (D E F G H J).

- Gravity main (D — J): this pipeline necessitated the use of 900 mm asbestos cement pipes with a total length of 560 m. Two underground road crossings had to be constructed together with four towers at turning points. There was usually a change of level at a turning point. Special bends could not be made in time and thus it was opted for open top towers.
- Emergency storage dam (K): during the design stage it was realized that some storage facility would have to be provided. A disused dam adjacent to the new spray pond was converted into a dam 120 m × 75 m × 5 m deep, giving an 11 hour full reserve.
- The capital cost for the project was approximately R300 000.

Performance

Typical measured figures are given below:

	Design	Actual
water flow m^3/h	2 079	2 079
water inlet temperature °C	49	52
water outlet temperature °C	33	33
Air temperature dry bulb °C	30	33
Air temperature wet bulb °C	26	25

Water losses were taken as being 5%.

Maintenance was not a problem but a number of nozzle blockages occurred as a result of foreign objects and screens on pumps were not very successful due to algae. Algae in the dams was not a serious problem but this was not the case in the feedsumps of the pumps where the water was still relatively hot.

Savings were made in electric power because water was not pumped from the river. The river pumps are 450 kW each whereas the spray pond pumps are only 85 kW. This amounted to a saving of R80 000 per year.

Conclusion

The system was completed in time, on 15 May 1983 when the crushing season started. It was possible to start crushing and continue throughout the year without serious concern because of a lack of cooling water.

REFERENCES

1. Hugot, E. (1960). Handbook of cane sugar engineering. Elsevier Publishing Company p 647.
2. *ibid* p 649.
3. *ibid* p 648.