# CHEMICAL CLEANING OF THE EVAPORATORS AT FELIXTON

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**Abstract**

Chemical cleaning of the first two effects of the Felixton Kestner evaporators has proved more successful than conventional high speed mechanical cleaning. Certain problems and operating conditions have still to be overcome. These include severe tube blockage, a means for effective scale removal from the cleaning solution and sludge disposal. The background to the design and operation is discussed.

## Introduction

The failure of conventional mechanical cleaning to maintain a clean heating surface in first and second effect Kestner evaporators forced us to consider alternate methods. Chemical cleaning with caustic soda and sulphamic acid had been tried at Umfolozi with notable success. A system was designed and installed at Felixton to cater for both spraying and/or boiling of the cleaning solutions. The findings of the work done at Felixton are presented.

## Reason for Chemical Cleaning

In the Felixton Kestner evaporators, conventional mechanical cleaning with high speed cutters was unable to maintain clean heating surfaces, especially the second effects. This was due to (1) the large heating surfaces of the Kestners and (2) the exceptionally hard nature of the scale. This restricted mill throughout and hence extended the 1985/86 season by about one week.

Chemical cleaning does not damage the tubes as does mechanical cleaning, especially when the scale is difficult to remove. Continued use of mechanical cleaning would have led to the replacement of tubes after five years of operation.

## Design

This was done mainly by Felixton personnel, with assistance from the SMRI and AECI. A system was required which would[1] be easy and safe to operate;[2] allow operations on one line to be completely independent of another line;[3] cater for both bagged and bulk handling of chemicals;[4] allow expansion for the future to the 3rd, 4th and 5th effects and/or juice heaters;[5] have the flexibility of being able to spray or boil the caustic and sulphamic solutions, thus allowing the choice of the best method;[6] allow installation to be done on the run with minimal interruption to the plant;[7] minimise pumping and piping;[8] fit into the existing plant without blocking access, with head limitations recognised;[9] allow for the bulk storage of chemicals. (The caustic soda storage tank had to be stress relieved to prevent caustic embrittlement, which occurs when solutions are stored at high temperatures. Thus all welding on tanks had to be stress relieved in Durban, and before erection on site);[10] maximise use of materials from the old Felixton and Empangeni mills, including piping, pumps and tanks, to reduce costs.

Once the requirements had been formulated, a contract draughtsman was employed to put ideas on paper. This was an invaluable aid during the design and later construction.

## Spray or Boil?

*Spraying:*

Spraying reduces the volume of the cleaning solution and heating can be limited to one vessel; flushing and cooling of the vessels is quicker and uses less water than boiling.

*Boiling:*

The boiling point elevation of the caustic solution necessitates additional higher pressure steam connections to vessels; larger chemical volumes are required; boiling sulphamic acid is not desirable due to hydrolysis and the subsequent formation of corrosive sulphuric acid; boiling procedures take longer to execute and thus more time is needed for filling and draining of the vessels.

*Operations*

Felixton evaporator station consists of two quintuple effect sets, the first two vessels in each set being Kestner-type evaporators with separators. The evaporators are cleaned weekly. A basic outline of the procedure is as follows:

After juice liquidation, the vessels are flushed with condenser water to remove the last traces of syrup. Caustic (at ± 30% w/v) is pumped from storage into the Kestner evaporators for circulation. Using a circulating pump, the solution is pumped in parallel from the bottom of the first and second vessels, and sprayed onto the top tube plates. The spray rate is 0,5 ℓ per tube, per minute, or 300 tons per hour at 6 bar absolute. The solution is heated in No. 1 Kestner to ± 114°C. After ± 3,5–4 hours, the solution is transferred back to storage. The vessels are then flushed with condenser water for a few minutes before boiling out with water for one hour. Another water flush is done before the next operation.

## Sulphamic Acid

Inhibited sulphamic acid is used following the same procedure for caustic as described above.

Exceptions are: (1) Concentration ± 1,5% (w/v), (2) Time 1 hour, (3) Temperature ± 70°C.

## Operating Experiences/Problems

Water boiling is an essential part of the caustic flushing phase. Experience has shown that, due to the thixotropic nature of the caustic solution, there is a tremendous advantage to boiling the vessels with water, as opposed to trying to flush by the spray technique. A vast quantity of scale is removed by the agitation of boiling water.

## Spray Nozzles

Figure 2 shows how a spray nozzle was mounted in the top of an evaporator vessel to spray into the heating tubes.

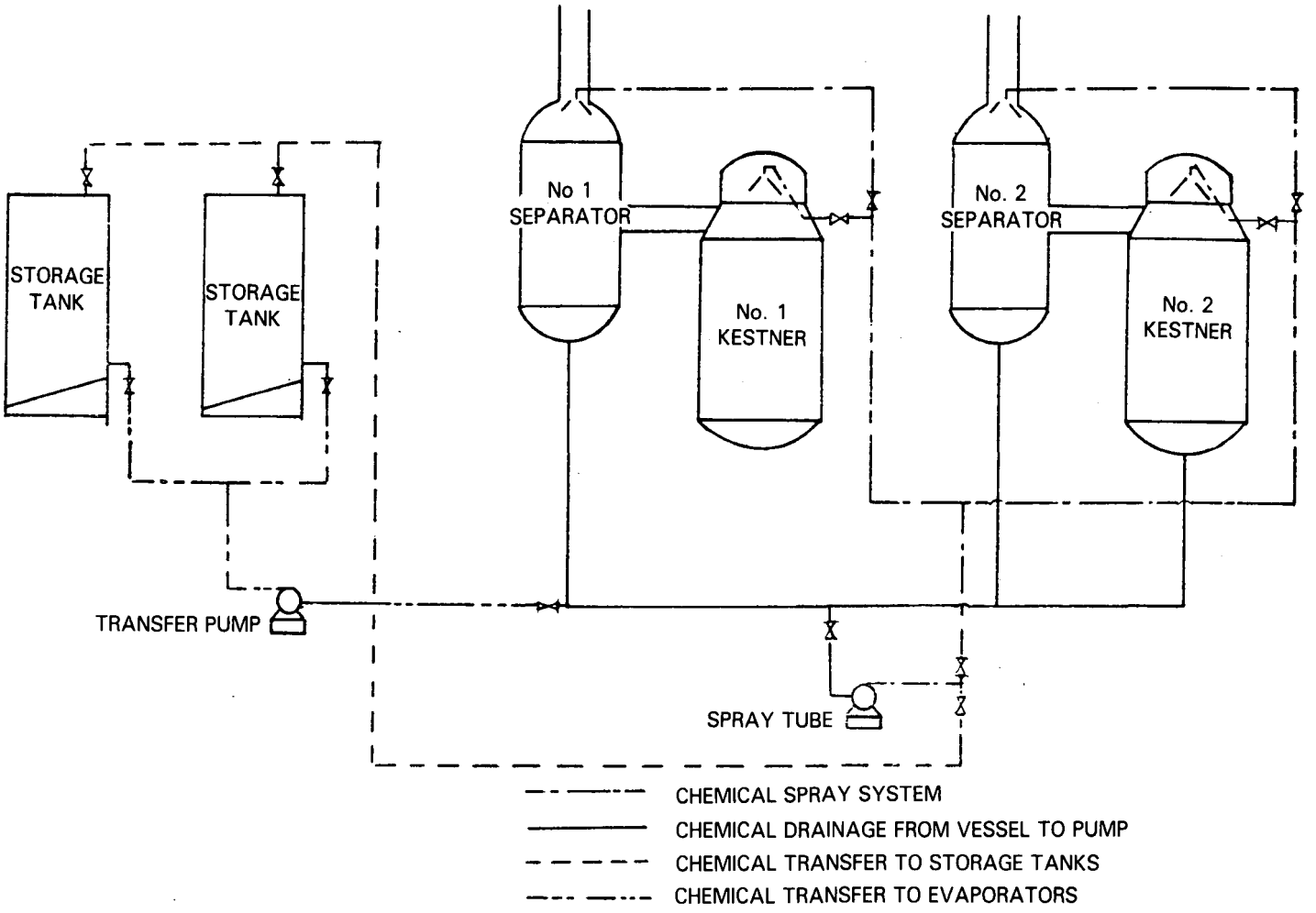


**FIGURE 1** Schematic layout of Felixton chemical cleaning installation.

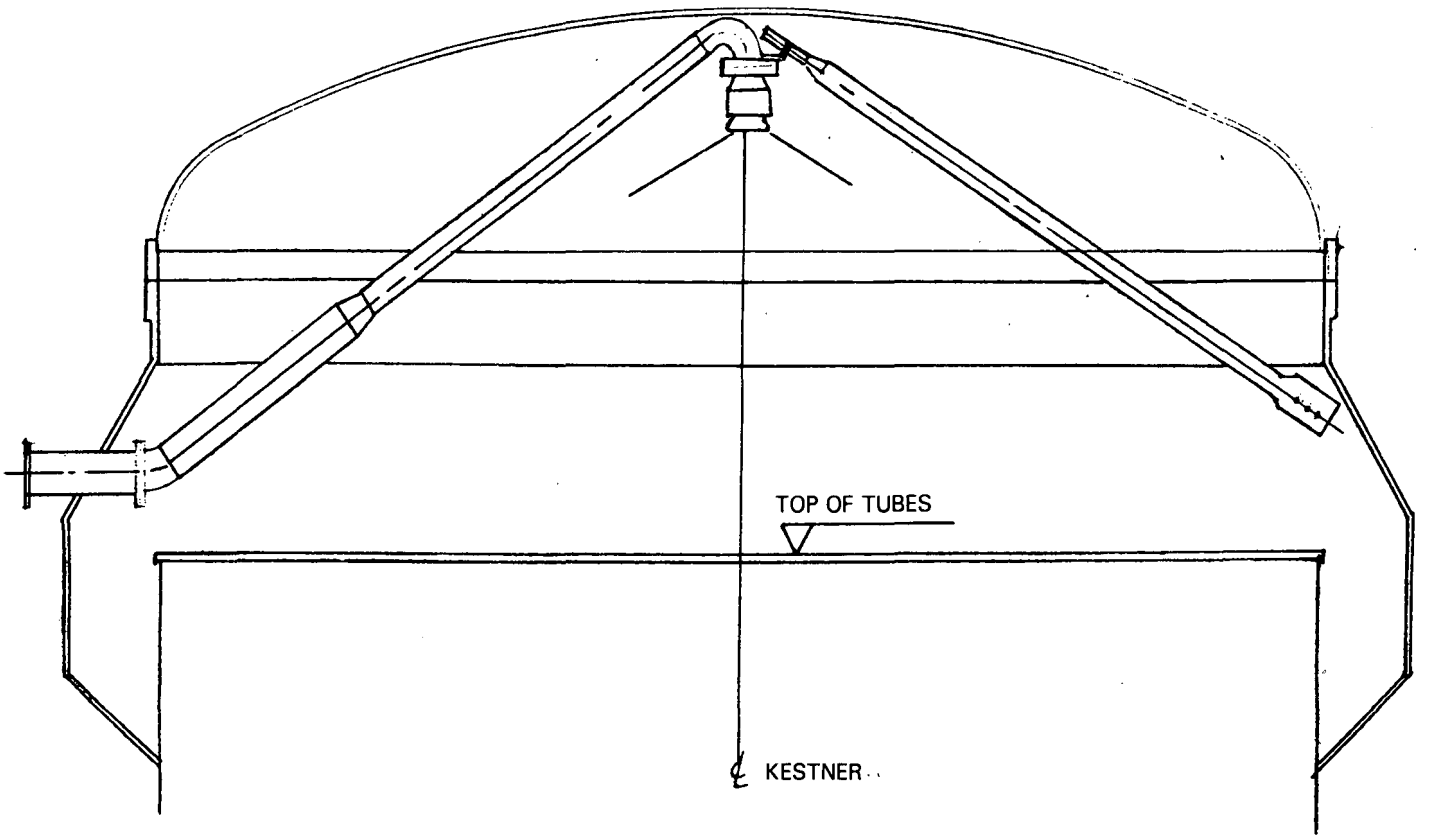


**FIGURE 2** Chemical spray nozzle in Kestner evaporator.

The nozzles which were recommended and installed were not entirely satisfactory. The nozzle is listed as having a 120° spray angle. This refers to the angle at which the liquid emerges, but due to "gravitational droop" the spray reaches only 50% of the tube plate area, and therefore 50% of the heating surface relies on splash and run off. The effect of this situation is being closely monitored.

### Sludge Disposal

There is a need for an effective way to: (1) remove the scale during cleaning, and/or (2) remove sludge from the caustic after cleaning.

After one or two cleanings the caustic thickens to a point where it will not pour when cold.

To assist draining sludge the storage tanks have been equipped with steeply sloping floors. Because this sludge contains a high concentration of caustic there has been a reluctance to waste this, and a tendency therfore to keep the caustic for too long before dumping it to efluent.

### Caustic Source

Caustic is presently obtained in the form of lye from Mondi Board Mills, adjacent to Felixton sugar mill. To do this, a Telecon bin has been modified and stress relieved to transport the lye. The caustic used is diaphragm cell caustic with a chloride content of ± 1%. Tests carried out by the SMRI have shown no detrimental effect to either stainless or mild steel from the caustic or inhibited sulphamic acid.

### Costs

| | |
|---|---|
| Equipment and installation | R213 000 |
| **Chemicals** | **Cents per ton cane** |
| 1986/87 Budget | 8,5 |
| 1986/87 Actual | 9,0 |
| 1987/88 Actual | 7,3 |
| **Mechanical Cleaning** | |
| 1985/86 | 7,3 |

### Safety

It was decided to ask for assistance from NOSA regarding the handling of caustic and sulphamic acid in large quantities. The result was the introduction of a full PVC chemical suit with built-in hood, long gloves, gumboots, chemical goggles and facial visor. This was exceptionally uncomfortable to wear for long periods. Further assistance has been received from AECI and the whole safety clothing issue was reviewed, due to the impracticality and unhygienic conditions, led to complete exhaustion and dehydration if the clothing were worn for the entire operation.

It is however essential to have this equipment available for the initial commissioning and for other occasional needs.

To cope with emergencies safety showers were installed at three strategic points; and each unit is equipped with an eye wash spray.

### Results

Since chemical cleaning started, it has been possible to maintain a clean heating surface without having to reduce milling throughput, as had been necessary in the past.

However, problems are being experienced with severe tube blockages, which occur around the periphery of the second effect vessels; the section nearest the separator blocks first. The blockages appear to start at the top of the tube and, if time permits, can be cleaned fairly easily with the right equipment. A high pressure water pump has been purchased and, operating at a pressure of 400 bar, a rotating nozzle removes the adhering scale. If these tubes are left, they soon block along the entire length and the blockage eventually forms carbon, which is difficult to remove. The cause of the blockage is not entirely clear, as it occurs only in the second effects.

We have recently formed the opinion that it is caused during start up and boil off, when juice flows are very low, and when it is possible to boil the vessels dry. In order to overcome this operating procedures are to be changed.

### The Future

In order to optimise this process, and chemical usage contact has been made with the SMRI. This entails work on: (1) desludging/screening, (2) analysis of cleaning solutions, (3) determination of optimum chemical strength, (4) optimum cleaning times, (5) use of additives.

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