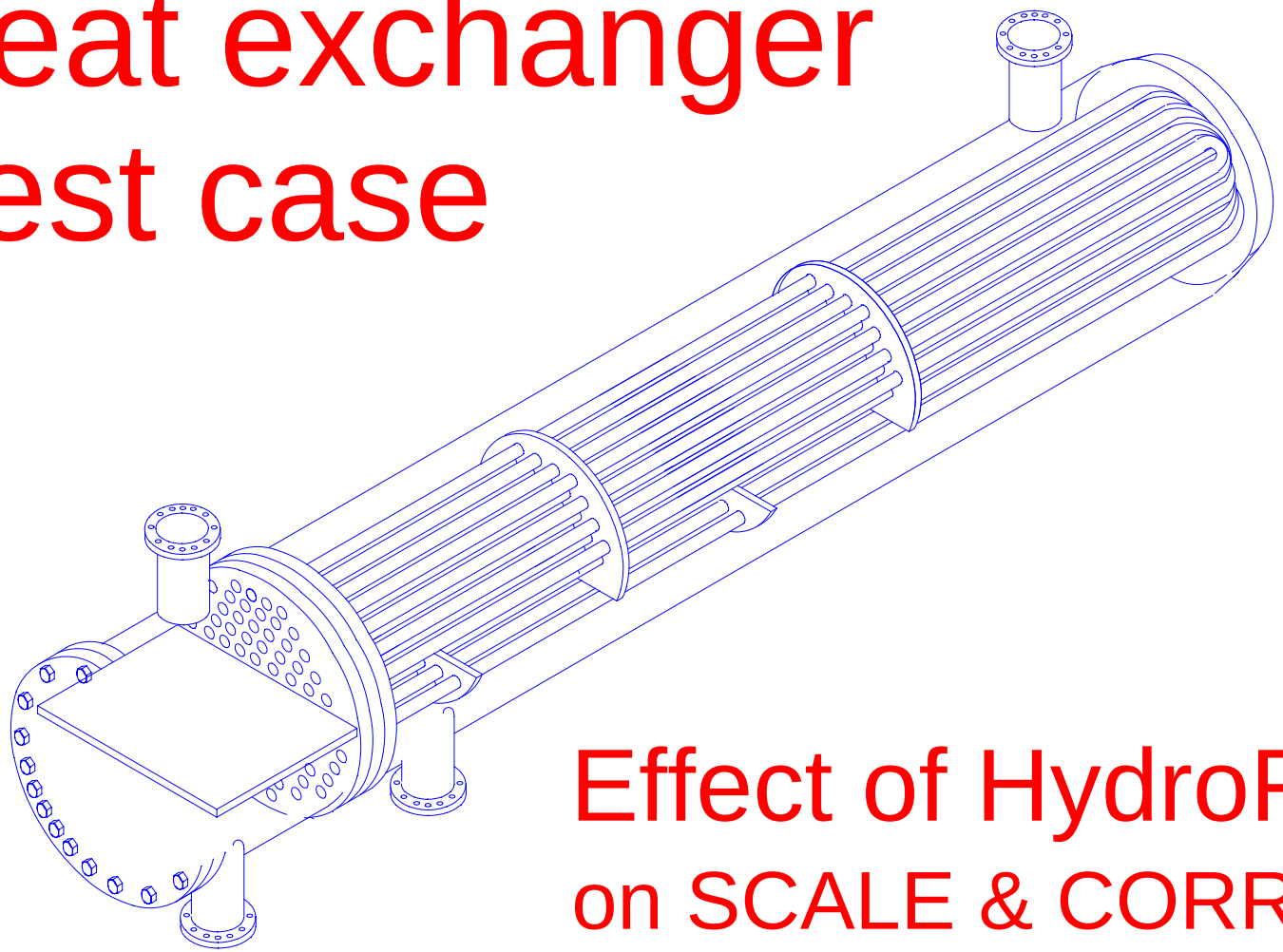
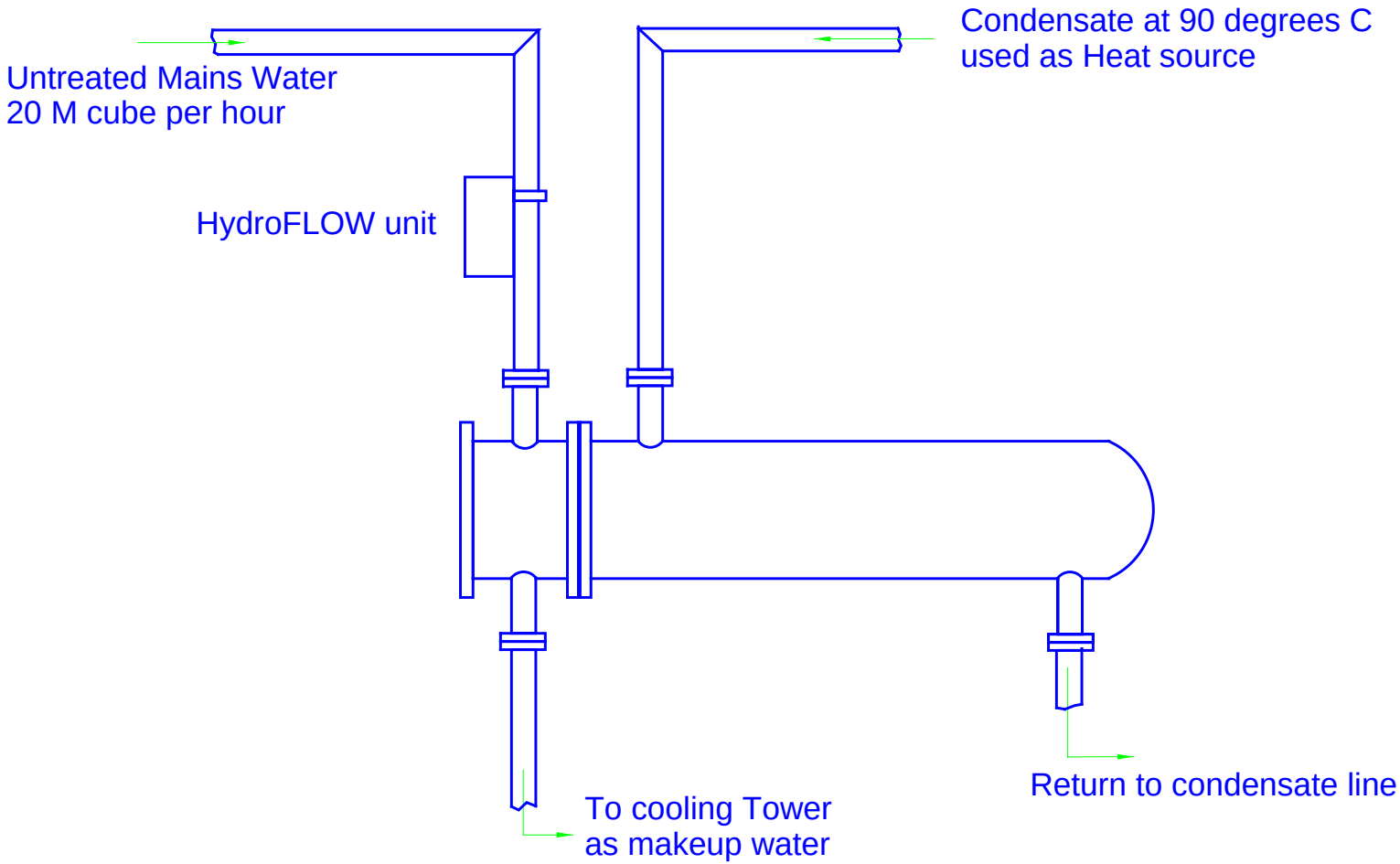
Heat exchanger Test case



Effect of HydroFLOW on SCALE & CORROSION


Untreated Mains Water
20 M cube per hour
HydroFLOW unit
Condensate at 90 degrees C
used as Heat source
To cooling Tower
as makeup water
Return to condensate line

This document is a translation of an internal report produced by an overseas company. The company does not wish to be identified at this stage but employs a large (2500 cm^3) cooling system.
Both the original report and this translation were produced by the company's own engineers for their management and supplied to Hydropath (UK) Ltd for limited distribution.

REPORT OF AN EXPERIMENT USING HYDROFLOW

1. GENERAL

Between 14th June 1994 and 20th October 1994, a semi-industrial experiment was performed using a Hydroflow model C120. The objectives of the experiment were to examine the efficiency of Hydroflow for scale treatment using standard cooling tower water and examine its effect on corrosion rates in heat exchangers and pipes. The implications of the experiment and its results are intended to direct the form of water treatment employed at the plant during the next few years.

2. BACKGROUND

During the last 10 years, the treatment of cooling water at the plant has been based on the use of chemicals.

a. Phosponates and dispersers to prevent non-organic scale, fowling precipitates and other precipitation

b. Chrome and zinc as metallic salts for salts for corrosion prevention. In addition, there is a biological form of treatment to control the growth of algae and bacteria.

The environment lobby has brought pressure to bear and the authorities are imposing ever tougher restrictions on the use of contaminating chemicals and heavy metals in order to reduce environmental damage. The chemical manufacturers have responded by developing formulae using organic based additives that are claimed to be non-contaminating and environment friendly.

The effectiveness of these additives has yet to be established and there are varying opinions to be found among users. One of the main disadvantages is the high price relative to the chemicals they replace.

For these reasons it was decided that an experiment should be conducted at our plant which would examine innovative new methods of electro-physical treatment as a substitute for conventional chemical treatment.

The objectives of the experiment were to:

a. Achieve a reduction in costs compared to chemicals.

b. Reduce the daily maintenance procedures involved in chemical handling by both laboratory staff and engineers.

3. SELECTION OF A SUITABLE DEVICE

Having decided to conduct an experiment, we turned to representatives of various companies manufacturing devices based on both magnetic effects and catalysts. The representatives were invited to familiarise themselves with our application.

The technical, theoretical and operational performances of the devices were studied and examined. In some cases we conducted laboratory tests and we have consulted with other plants who use the devices and are at different stages of experimentation.

After an in depth study of the subject and a careful examination of available devices, our engineering staff reached the conclusion that Hydroflow technology represents a break through that, in our opinion, surpasses any previous attempts to treat water using a physical process.

4. EXPERIMENTAL PROCEDURE

The experiment was conducted using a tube and shell heat exchanger installed specifically for this task. The heat exchanger selected was one that had become severely blocked by scale of all types. The heat exchanger was weighed at both the start and end of the experiment using a special scale to ascertain the weight loss. This demonstrates the capacity of the device to treat existing scale.

The Hydroflow model C120 was installed on the inlet pipe to the heat exchanger which was supplied with untreated water at a rate of 20,000 litres per hour. This caused a temperature increase of approximately 15-20^{o}C.

Temperature and pressure gauges were installed on the inlet and outlet pipes so intended to examine three parameters:

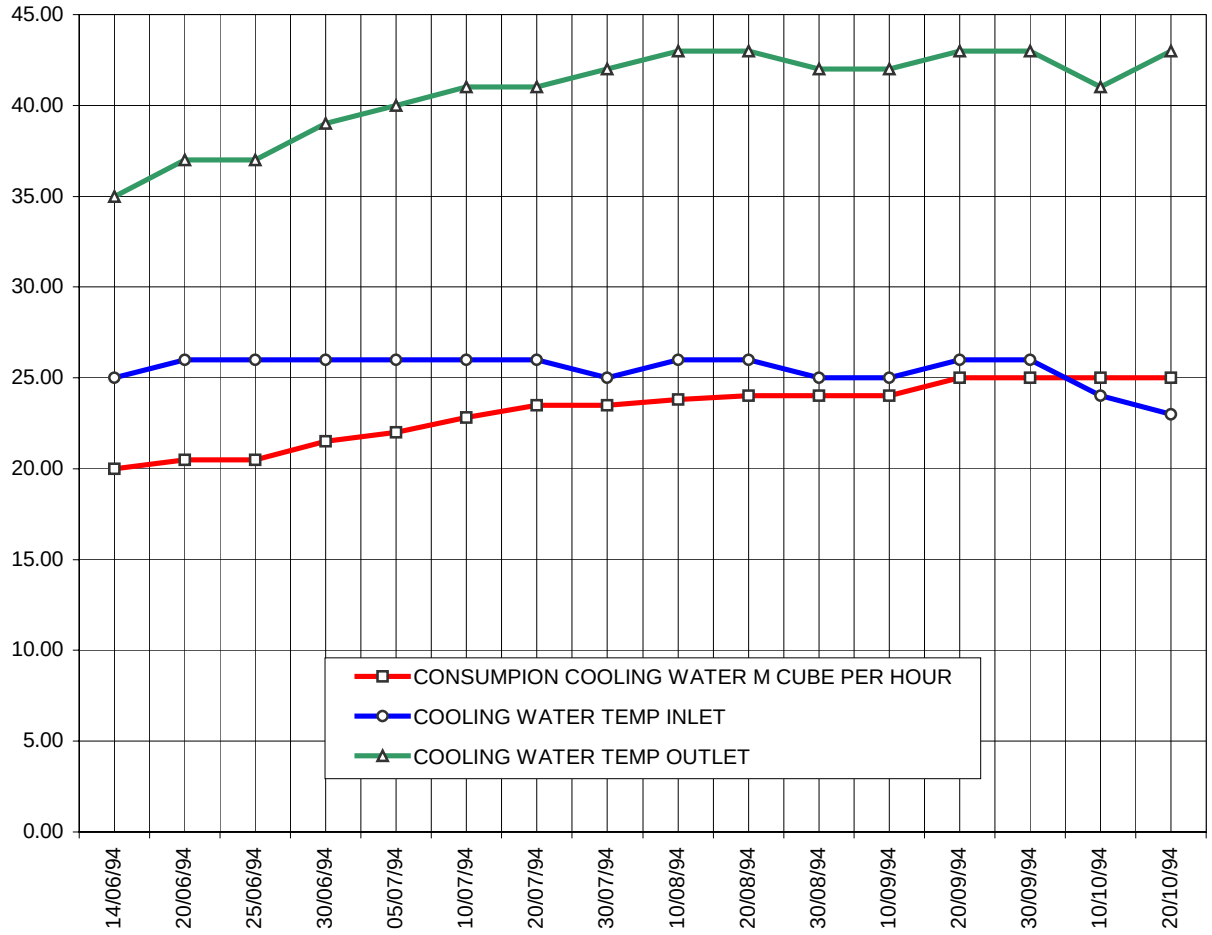
a. The effect of the device on existing scale.

b. Prevention of scale formation from chemically untreated hard water.

c. The ability of the device to reduce the rate of corrosion.

Attached are various tabulations of the results that were supervised and monitored throughout the experiment.

	HARD WATER			CONDENSE WATER USED AS HEAT SOURCE						
DATE	***CONSUMPION COOLING WATER M CUBE PER HOUR***	***COOLING WATER TEMP INLET***	***COOLING WATER TEMP OUTLET***	***CONSUMPION CONDENSE M CUBE PER HOUR***	***CONDENSE WATER TEMP INLET***	***CONDENSE WATER TEMP OUTLET***	***CALCIUM CARBONATE LEVEL (PPM) INLET***	***CALCIUM CARBONATE LEVEL (PPM) OUTLET***	***HEAT TRANSFER (K) KILO CALORIES PER HOUR***	***PRESSURE DROP (ATS)***
14/06/94	20.00	25.00	35.00	10.00	90.00	70.00	170.00	200.00	200.00	1.20
20/06/94	20.50	26.00	37.00	10.00	92.00	69.00	175.00	240.00	225.50	1.00
25/06/94	20.50	26.00	37.00	10.00	92.00	69.50	175.00	260.00	225.50	0.80
30/06/94	21.50	26.00	39.00	10.00	90.00	62.00	180.00	290.00	275.50	0.70
05/07/94	22.00	26.00	40.00	10.00	90.00	61.00	180.00	300.00	308.00	0.60
10/07/94	22.80	26.00	41.00	10.00	92.00	58.00	170.00	320.00	342.00	0.60
20/07/94	23.50	26.00	41.00	10.00	94.00	59.00	180.00	340.00	352.50	0.50
30/07/94	23.50	25.00	42.00	10.00	93.00	53.00	190.00	380.00	399.50	0.50
10/08/94	23.80	26.00	43.00	10.00	93.00	53.00	180.00	370.00	404.60	0.40
20/08/94	24.00	26.00	43.00	10.00	95.00	55.00	175.00	360.00	408.00	0.40
30/08/94	24.00	25.00	42.00	10.00	90.00	50.00	190.00	320.00	408.00	0.40
10/09/94	24.00	25.00	42.00	10.00	90.00	50.00	180.00	290.00	408.00	0.30
20/09/94	25.00	26.00	43.00	10.00	92.00	50.00	200.00	270.00	425.00	0.30
30/09/94	25.00	26.00	43.00	10.00	92.00	50.50	190.00	240.00	424.00	0.30
10/10/94	25.00	24.00	41.00	10.00	92.00	50.00	180.00	220.00	425.00	0.30
20/10/94	25.00	23.00	43.00	10.00	90.00	40.00	188.00	195.00	500.00	0.30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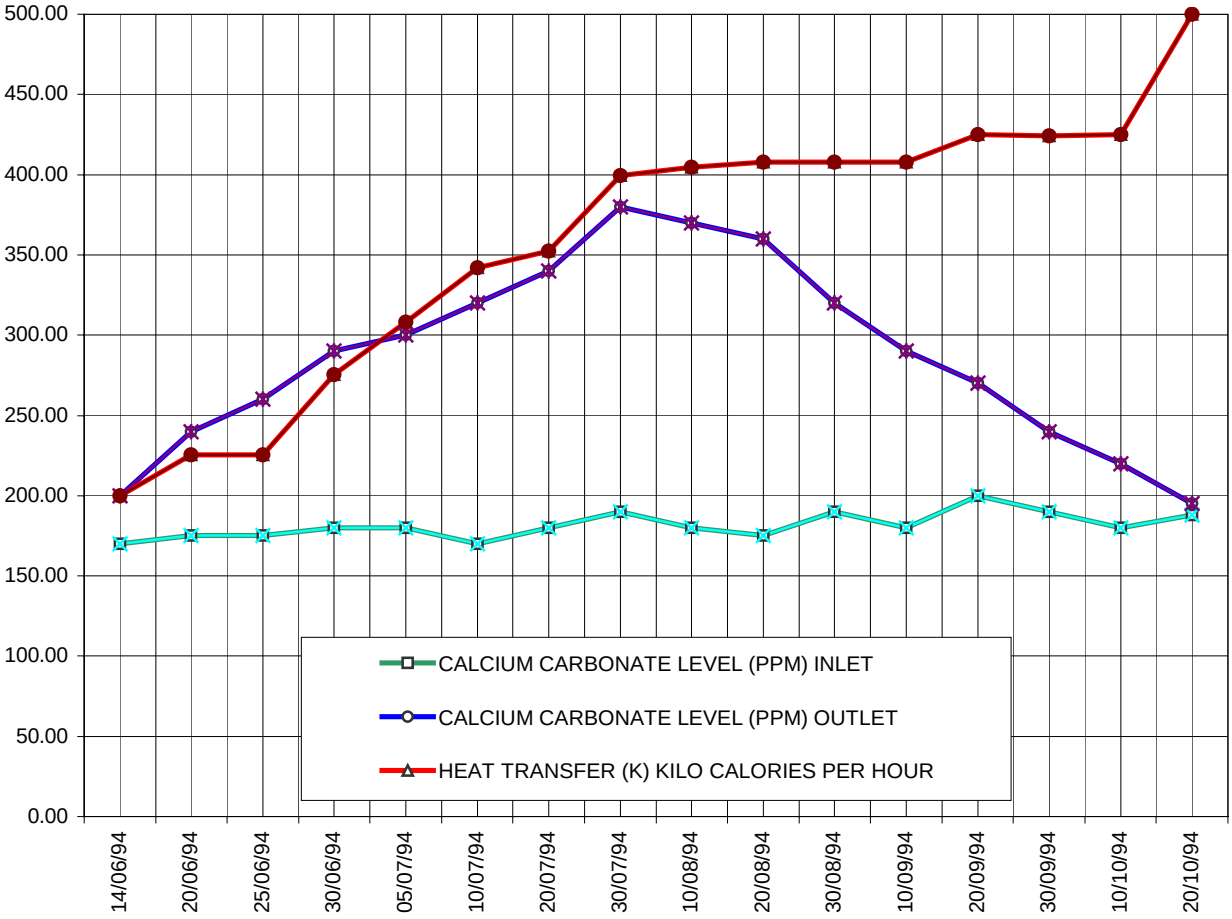
CONSUMPION COOLING WATER M CUBE PER HOUR
COOLING WATER TEMP INLET
COOLING WATER TEMP OUTLET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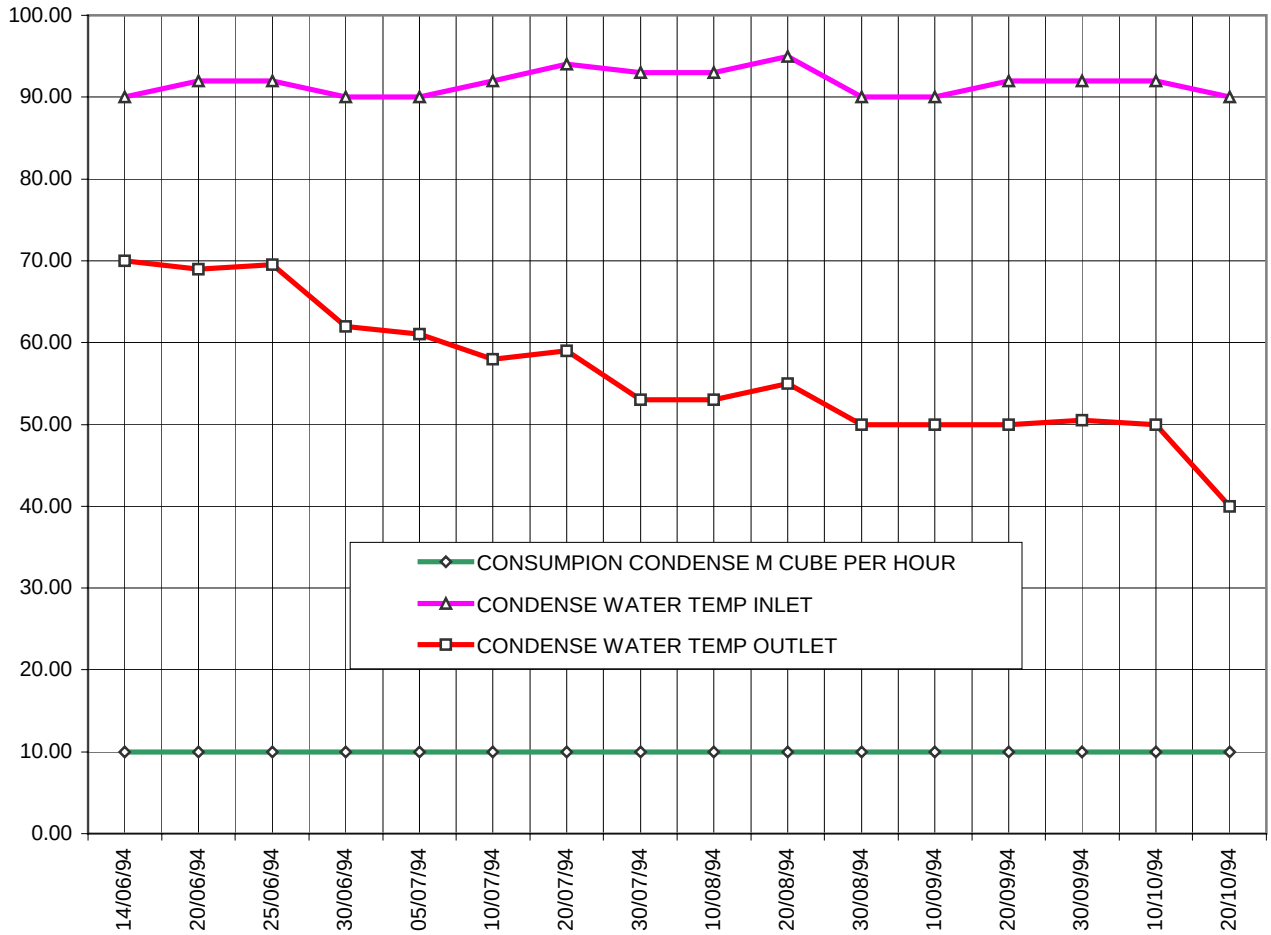
CALCIUM CARBONATE LEVEL (PPM) INLET
CALCIUM CARBONATE LEVEL (PPM) OUTLET
HEAT TRANSFER (K) KILO CALORIES PER HOUR



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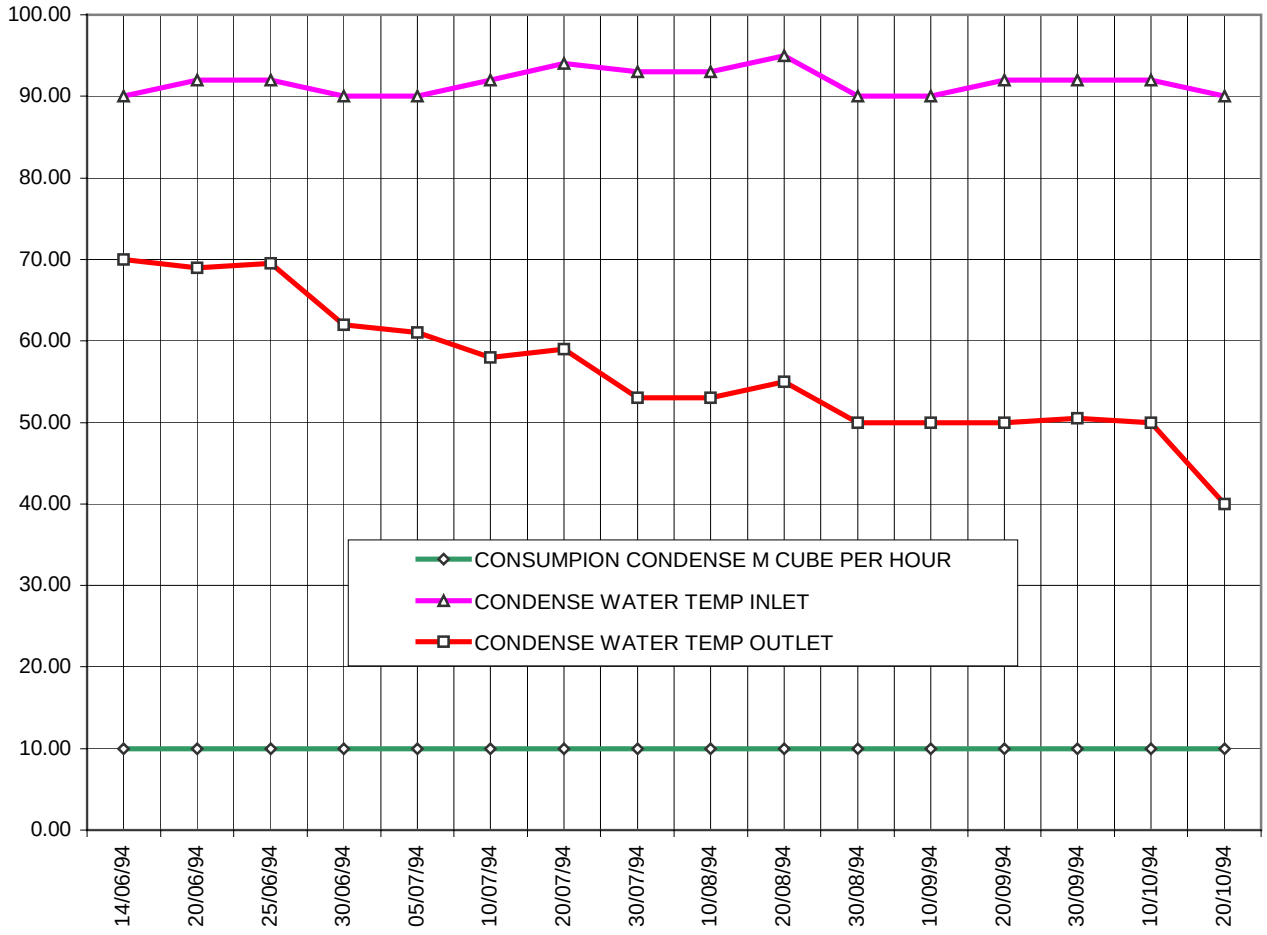


5. RESULTS

The experiment has been running for 5 months and the following data has been established:-

a. The level of calcium (Ca++) expressed as CaCO3 initially increased in the outlet water flow. As the experiment continued this reduced and, towards the end of the experiment, there was a significant decrease down to the same level as the incoming water. This enabled us to determine the quantity of calcium released from the heat exchanger.

b. In parallel with the reduction of calcium, there was a gradual and consistent increase in the temperature of coefficient between the inlet and the outlet pipes. This indicated a more efficient heat transfer.

c. A gradual decrease in the pressure drop was observed on the side of the tubes.

On 14th June 1994 we were satisfied by our monitoring of the experiment that Stabilisation of the calcium levels between the inlet an outlet flows had been Achieved. At this time we opened the heat exchanger and were able to make the following observations

- The tubes were completely clean with no sign of any scale deposits.
- The lids of the heat exchanger were completely clean with no sign of any scale deposits.
- Black spots were seen on some of the tube sheets. These indicated a trend towards inhibition of corrosion through the creation of an oxidising film over the metal. This film comprised Gamma Feffic Oxide.

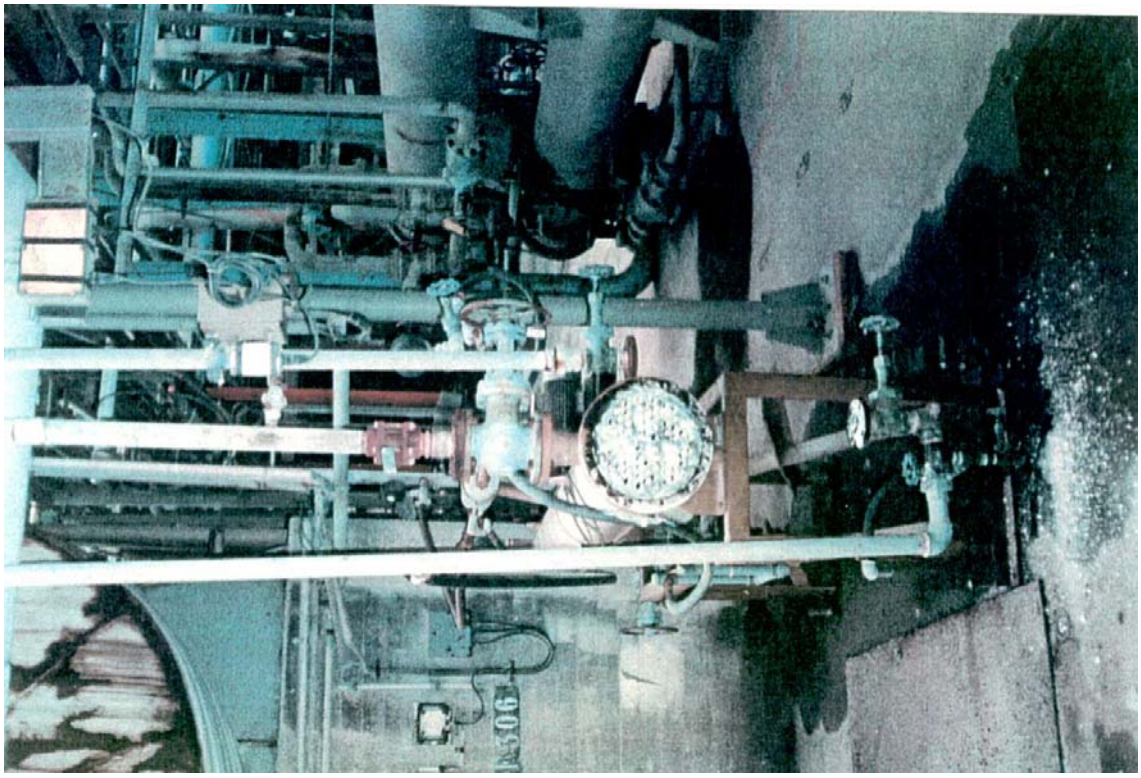
Stage three of the experiment started on 1st November 1994 and concerns a determination of the efficiency of the device in suppressing the rate of corrosion. To do this, we have installed coupons in the outlet flow from the heat exchanger. These are examined every 30 days and the results to date are encouraging. The M.P.Y. values (the index of corrosion) have been stable at a level between 2.0 and 2.5 M.P.Y. The experiment will conclude by March 1995 when the full results will be reported.

6. CONCLUSION

The analytical results of the experiment provide categorical evidence that Hydroflow devices act dramatically on existing scale in heat exchangers and pipes and that they prevent the formation of new scale.

Against any criteria, the results of the experiment are good and Hydroflow has enabled proper and continuous operation while significantly suppressing the process of precipitation.

Before



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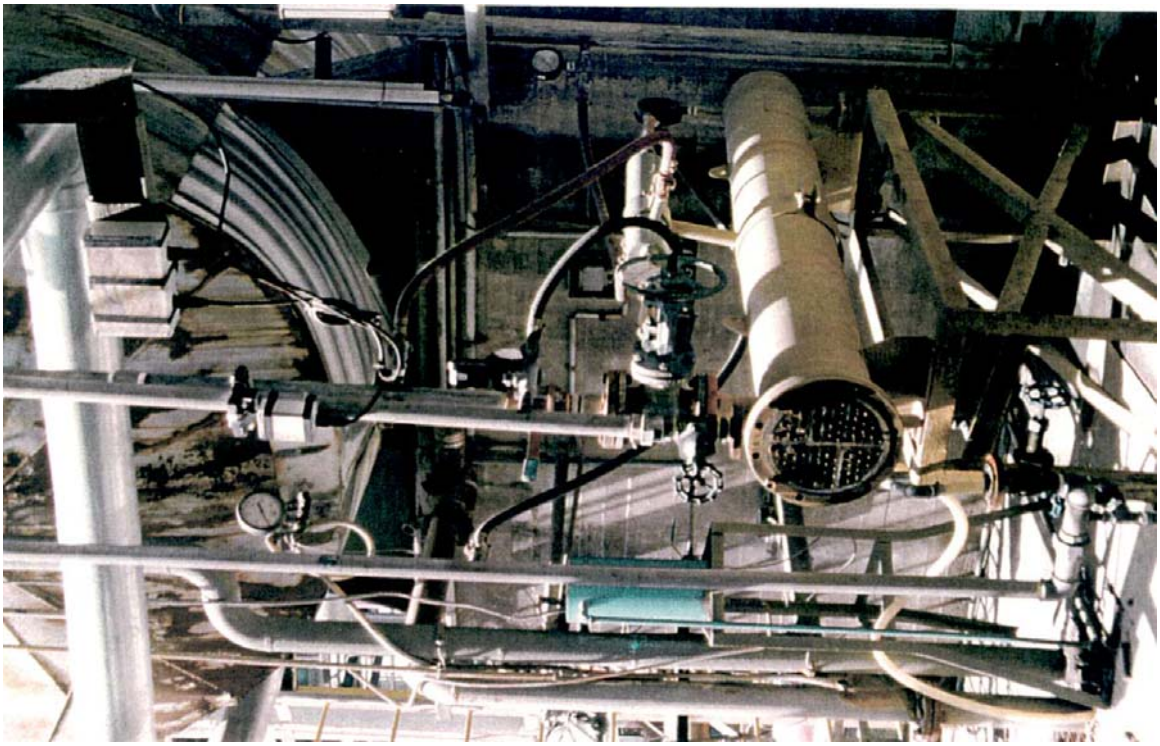

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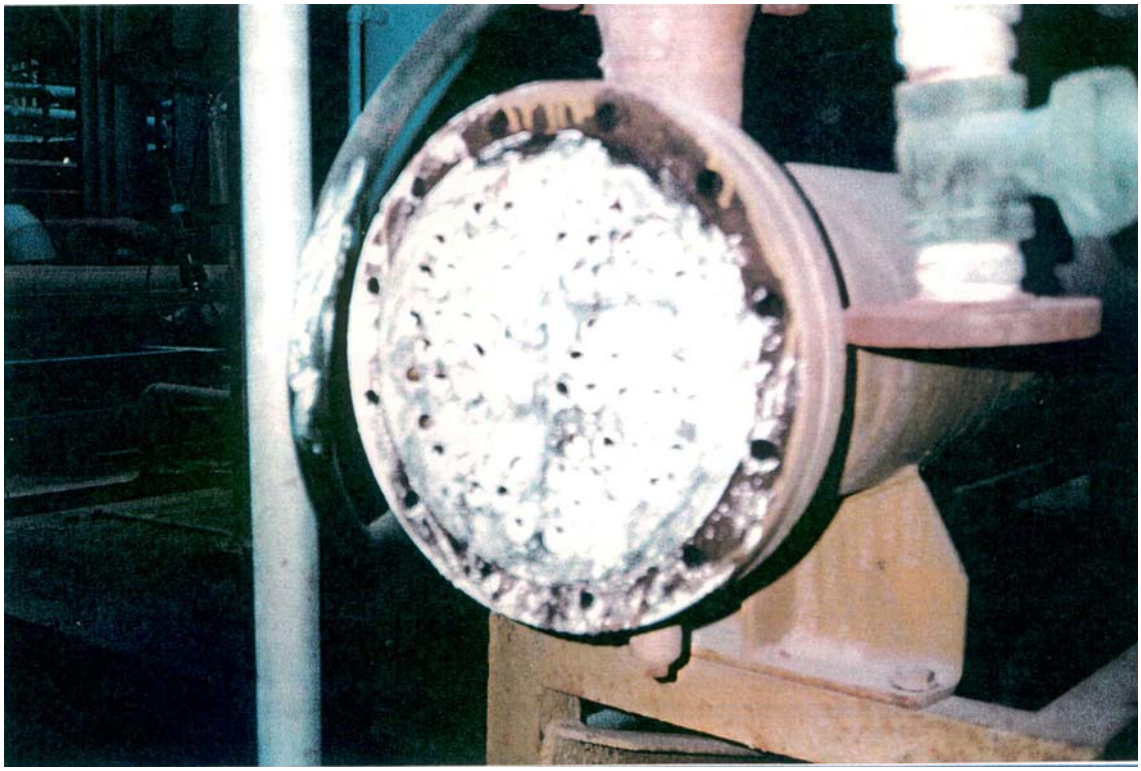

After