TEST SERIES 1

This series of tests evaluated the effect of a C-A-T on four batches of synthetic water, each with a different hardness level. The water analyses obtained at Fluid Dynamics are shown in Fig. 5-B. The test parameters used are outlined on Fig 5-A. The test results are shown on Fig 5-C.

The percentage weight drop is calculated by averaging result 1 and result 3 for a test. Then taking this average as 100%, the weight drop is determined by comparing with the weight drop in result 2.

The Test procedure used with the experimental flow system is as follows :

(1) A filament is prepared and weighed.

(2) Two litres of deionized water are placed in the sample jar and this is flushed through the system for twenty minutes. No power input is used on the filament. This ensures that no previous test has an effect on the system. The deionized water is then removed from the system.

(3) The actual sample to be tested is placed in the system. It is run through the system for five minutes prior to testing. A flow rate of 150 ML/min. is established and a power input of 744W is used. The test is run for one hour.

(4) The system is again washed out as in No. 2. A sample is placed in the sample jar as in No. 3. However, a C-A-T stirrer is also placed in the sample jar and rotated.

(5) The system is again prepared as in No. 2. A sample is tested as in No. 3 but no C-A-T stirrer is used.

After each sample above is tested, the filament is removed, dried, weighed, cleaned, redried and replaced in the flow system. The results are than compared and any weight differences are noted.

In earlier tests the water analyses were carried out in Fluid Dynamics Laboratory. In the next tests, the water was also analysed at the Microanalysis Department, University College Dublin, Belfield complex. This allowed a more accurate analysis and a greater range of tests to be carried out.

Electron microscopy was also carried out on the scale formed in a test. The scale formed when no C-A-T was used and the scale formed when a C-A-T was used were examined. This allowed the scale formation pattern to be examined in much greater detail than was possible with optical microscopy.

The microstructure of two C-A-T stirrers were examined. Two C-A-T stirrers were cast from the same metal mix on the same day. One was examined as cast. The other was examined after it had been used to treat the water in a number of tests.

PARAMETERS OF OPERATION FOR THE EXPERIMENTAL FLOWSYSTEM

FLOWRATE	150 ML/MIN	+ 5 ML/MIN −
WATER INLET TEMPERATURE	18 C	+ 1 C −
WATER OUTLET TEMPERATURE	84 C	+ 1 C −
POWER INPUT	744 W	+ 3 W −
VOLTAGE	62 V	+ 1 V −
CURRENT	12 A	+ 0.5 A −
STIRRER SPEED	550 RPM	+ 20 RPM −
TEST DURATION	1 HOUR	

FIGURE 5A

SAMPLE ANALYSES FOR TEST SERIES 1

BATCH 7	TOTAL HARDNESS	190 ppm
	CALCIUM HARDNESS	190 ppm
	TOTAL DISSOLVED SOLIDS	325 ppm
	PH	7.35
BATCH 8	TOTAL HARDNESS	220 ppm
	CALCIUM HARDNESS	220 ppm
	TOTAL DISSOLVED SOLIDS	375 ppm
	PH	7.12
BATCH 9	TOTAL HARDNESS	270 ppm
	CALCIUM HARDNESS	270 ppm
	TOTAL DISSOLVED SOLIDS	500 ppm
	PH	7.20
BATCH 10	TOTAL HARDNESS	325 ppm
	CALCIUM HARDNESS	290 ppm
	TOTAL DISSOLVED SOLIDS	600 ppm
	PH	7.61

FIGURE 5-B

TEST SERIES 1 - RESULTS

Treatment	Total hardness	Pre Test weight	Weight of scale formed	% weight drop
Batch 7				
None	190	33.3865	0.6mg	
CAT	190	33.3707	0.3	57.1
None	190	33.3641	0.8	
Batch 8				
None	220	33.3411	12.3	
Cat	220	33.3423	10.6	8.5
None	220	33.3392	10.9	
Batch 9				
None	270	34.8145	17.6	
Cat	270	34.8043	9.8	43.0
None	270	34.8001	16.8	
Batch 10				
None	325	33.6348	15.8	
Cat	325	33.6052	8.4	50.6
None	325	33.6031	18.2	

FIGURE 5C

TEST SERIES 2

A 10L Batch of water, Batch 11, was made up. All the tests in this test series used this water. The water analysis appears below (Fluid Dynamics). The same filament was used for all tests. The test parameters are as outlined on Fig. 5-A. The test results appears on Fig. 5-D.

BATCH 11 WATER ANALYSIS

TOTAL HARDNESS	280 ppm
CALCIUM HARDNESS	270 ppm
TOTAL DISSOLVED SOLIDS	530 ppm
P.H.	7.45

TEST SERIES 2 - RESULTS

TREATMENT	TOTAL HARDNESS	PRE-TEST FILAMENT WEIGHT	SCALE WEIGHT MG	% WEIGHT DROP
TEST 1				
NONE	280	33.7309	35.6	
TEST 2				
C-A-T	280	33.6312	19.3	46.2
TEST 3				
NONE	280	33.6277	37.9	
TEST 4				
C-A-T	280	33.6098	22.4	37.6
TEST 5				
NONE	280	33.5988	34.2	

SAMPLE VOLUME - 1 LITRE

FIGURE 5-D

SAMPLE ANALYSES - TEST SERIES 3 - 4

COCA-COLA WATER (UNTREATED)	TOTAL HARDNESS	320 ppm
	CALCIUM HARDNESS	320 ppm
	TOTAL DISSOLVED SOLIDS	375 ppm
	P.H.	7.35
COCA-COLA WATER (TREATED)	TOTAL HARDNESS	300 ppm
	CALCIUM HARDNESS	270 ppm
	TOTAL DISSOLVED SOLIDS	300 ppm
	P.H.	7.28
NORTH DUBLIN (UNTREATED)	TOTAL HARDNESS	290 ppm
	CALCIUM HARDNESS	240 ppm
	TOTAL DISSOLVED SOLIDS	200 ppm
	P.H.	7.41
NORTH DUBLIN (TREATED)	TOTAL HARDNESS	270 ppm
	CALCIUM HARDNESS	230 ppm
	TOTAL DISSOLVED SOLIDS	200 ppm
	P.H.	7.43

FIGURE 5-F

TEST SERIES 3

This series of tests was carried out on water from Coca-Cola, Tuam, Co. Galway, where a C-A-T is installed and works well. The water was analysed before and after treatment at Fluid Dynamics and in the Microanalysis Department, Belfield. The Fluid Dynamics analysis appears on Figure 5-F. Two filaments were used in this test series, one for when no C-A-T was used and one for when a C-A-T was present. These two filaments were sent for electron microscopy of the scale formed.

The parameters of operation are as in Figure 5-A. The results of the test series are as on Figure 5-G. The sample volume was 1 litre.

TEST SERIES 3 - RESULTS

TREATMENT	TOTAL HARDNESS	PRE-TEST FILAMENT WEIGHT	SCALE WEIGHT mg	% WEIGHT DROP
TEST				
NONE	320	35.6609	119.4	
TEST 2				
C-A-T	320	32.9297	42.8	64.6
TEST 3				
NONE	320	35.6451	122.3	

**TWO DIFFERENT FILAMENTS USED TO FACILITATE ELECTRONMICROSCOPY.

FIGURE 5-G

TEST SERIES 4

This test series used North Dublin water as samples. This water is the type of water used in some C-A-T applications, and the C-A-T works quite well in most of these applications. The water analysis obtained at Fluid Dynamics is shown on Figure 5-F. The same filament was used in all tests of this test series. The parameters of operation were as outlined in Figure 5-A. It was noted that an organic substance, possible lubricating oil was floating on the surface of the specimen when it was opened. There was also a strong odour of petrol from the container. The test results appear on Figure 5H. The sample volume used was one litre.

TEST SERIES 4 - RESULTS

TREATMENT	TOTAL HARDNESS	PRE-TEST FILAMENT WEIGHT	SCALE WEIGHT mg	% WEIGHT DROP
TEST 1				
NONE	290	32.8681	20.5	
TEST 2				
C-A-T	290	32.8611	15.2	25.5
TEST 3				
NONE	290	32.8339	19.8	
TEST 4				
C-A-T	290	32.8248	16.1	21.1
TEST 5				
NONE	290	32.8201	20.9	

FIGURE 5-H

CONCLUSION

If the experimental flow system in its present form or slightly modified was to be used as a testing process, more analyses of water for applications where the performance of the C-A-T is known should be carried out. A good spread of data would thus be compiled, allowing the effectiveness of the system to be proven conclusively. The results to date have been encouraging but they are too few and the differences too varied to allow anything more than an indication of the performance of the C-A-T. With more data, statistical methods could be applied.

The following modifications of the flow system would reduce the bulk of the rig, allow it to be more portable, and also increase its' accuracy.

(1) Stabilization of flow using a better pump. A pump delivering a constant flow rate; a metering pump could be used. This would also dispense with the need for a flow meter.

(2) A straight - through flow, taken directly from water to be treated. This would dispense with the sample jar. The water would then flow straight to waste, dispensing with the cooling coil. Because no recycling would take place, the drop in hardness level due to repeated passes over the filament would not occur. If a small, portable flow system was evolved, the water to be tested could flow to the flow system via a tube connected directly to the metering pump. Therefore, the amount of tubing needed in the actual system would be reduced.

DIAGRAM OF FLOW