

ENVIRONMENT DIVISION

SCALEHAMMER PERFORMANCE TESTS

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Final Report

Mr. Steve Castegan
VKI TECHNOLOGIES INC.
3200, 2e Rue
Saint-Hubert (Quebec) J3Y 8Y7

GUY GENEST, ENG.
INDUSTRIAL CONSULTANT

LINE JAULIN, M.Sc.A.
PROJECT REPRESENTATIVE
ENVIRONMENT DIVISION

MARIE-JOSÉE HARDY, MICROBIOLOGIST
ASSISTANT DIRECTOR
ENVIRONMENT DIVISION

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This report was translated in English at the client's request. In case of incompatibility between the French and the English version, the French one will prevail.

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1. CONTEXT

Performance validation tests were performed on electronic scale treatment units: the Scalehammer. The Scalehammer's function is to replicate the magnetic fields and induce them in water. These calibrated waves prevent molecular attraction of scale particles. These particles then remain freely suspended and no longer adhere to pipe walls. These units are used to prevent scaling of hot water pipes of coffee vending machines, for example.

2. OBJECTIVES

VKI TECHNOLOGIES INC. mandated the CRIQ to expose the Scalehammer's action on prevention of scale deposits in water supply pipes.

More specifically, the tests sought to measure the Scalehammer's effect on scale deposits. The monitoring was performed on 4 hot water lines on which a Scalehammer unit had been installed. For test purposes, hot water was used to accelerate scale formation in the pipes.

3. DESCRIPTION OF THE WORK

An experimental setup was installed to perform these tests. The detailed diagram of the test installation is presented in Figure 1.

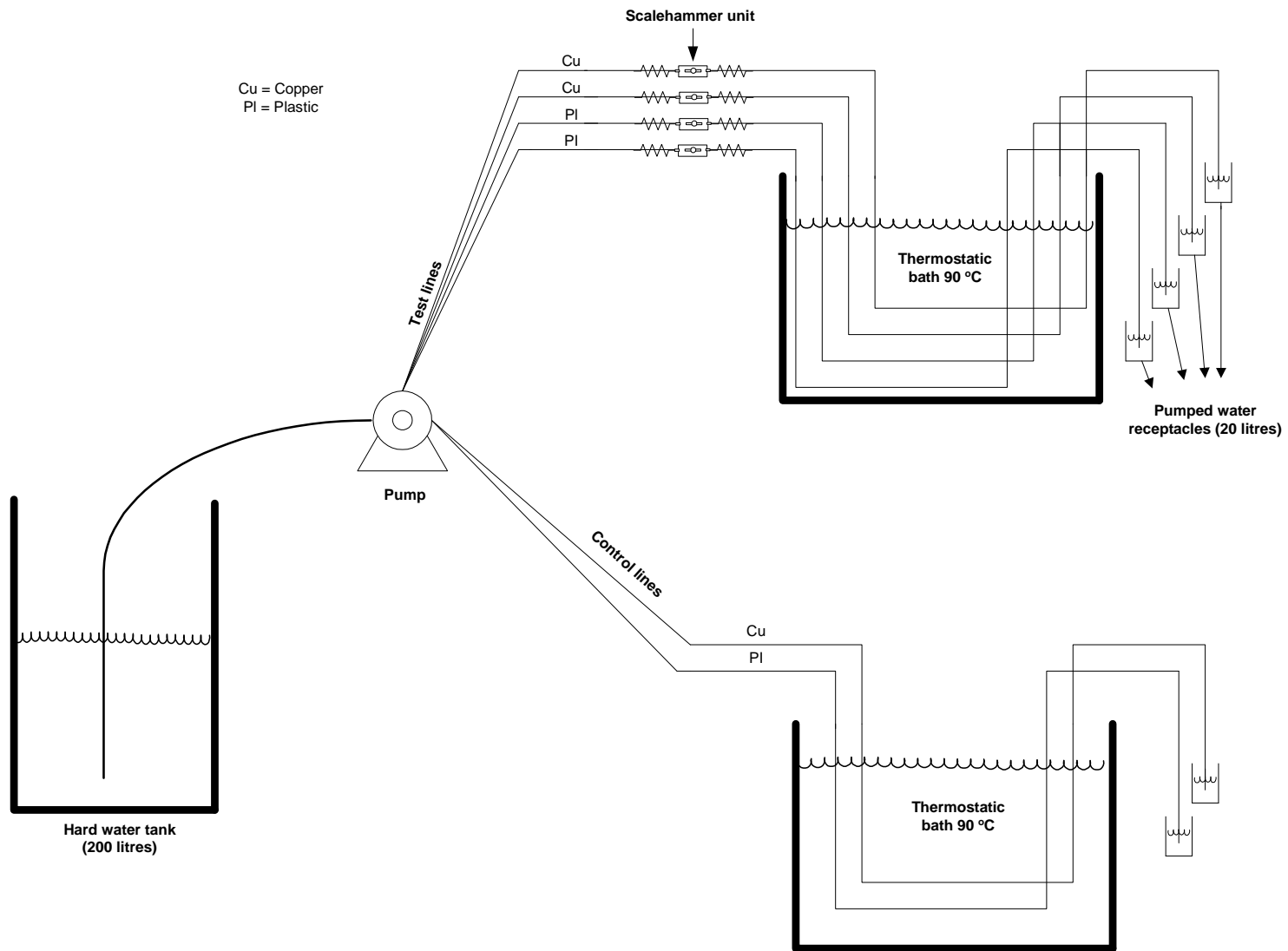


Figure 1 Test Setup Diagram

The photos of the installation set up to test the Scalehammer unit are presented below.



Photo 1: Scalehammer installed on the water lines

As Photo 1 shows, a Scalehammer unit was installed on each of the four water lines 1.27 cm in diameter, two copper and two CPVC. Each water line was supplied with standardized hard water (see appended table).

Every day, 14 litres of hard water were prepared according to the protocol described in method ONGC 2-11-94. Method 31.2. The hard water had a hardness of 300 ppm and circulated in a pipe submerged in a thermostatic bath of diethylene glycol maintained at 90°C. The water, after circulating in each pipe, was collected in individual containers.

Control lines of the same diameter (1.27 cm), one copper and one CPVC were also fed during the same period at the same frequency to compare the Scalehammer effect.



Photo 2: Water line synthetic water supply systems

Hard water was supplied to the lines by a peristaltic pump at a rate of 1.2 litre/hour (see Photo 2).

Three test series were performed. The first test series consisted of supplying the system with standardized hard water for 5 consecutive days.

The flow was maintained for a period of 12 successive hours, then stopped for 12 hours. During this shutdown period, the electrostatic bath was not heated. This feed sequence was maintained for 5 days. At the end of this first test series, the pipes were dried in an oven and weighed.

During the first 5 days of supply, a water sample was taken at each pipe outlet in receptacles. Water samples were collected for analysis. The characterization parameters were:

- “M” and “P” alkalinity (APHA 2320);
- Conductivity (APHA 2510);
- pH (APHA 4500);
- Solids in suspension (APHA 2540);
- Dissolved solids (APHA 2540);
- Calcium (APHA 3120);
- Magnesium (APHA 3120).

The second test series was performed with pipes scaled in advance. Standardized hard water was supplied for 10 days according to the same feed sequence as before. The electrostatic bath temperature was increased to 105°C to favour scale formation. Given the small quantities of scale present, the characterization was performed only by weighing the pipes to show the reduction of scale.

During the two test series, the control pipes were supplied in the same way.

Finally, for the third test series, a Scalehammer unit was installed on each of the two control lines and a supply of standardized hard water was maintained for 8 consecutive days according to the same feed/stop sequence as before.

4. DESCRIPTION AND ANALYSIS OF RESULTS

First test series

The characterization results of the recovered water, obtained during the first test series, are presented in the appended table.

Given the small quantities of scale involved during the test period, we did not observe significant changes in the chemical properties of the water before and after treatment.

The growth of scale deposits was monitored by periodic weighing of the dried pipes. The weighing results obtained are presented in the appended table.

TABLE I: RESULTS OF WEIGHINGS IN THE FIRST TEST SERIES

	Copper pipe 1	Copper pipe 2	Copper control pipe	Plastic pipe 1	Plastic pipe 2	Plastic control pipe
Initial weight (g) t = 0	384.72	385.38	313.22	91.85	91.46	91.96
Weight (g) t = 3 d	384.74	385.38	313.23	91.93	91.65	91.98
Weight (g) t = 5 d	384.72	385.37	313.22	91.84	91.47	92.00

The weight variations observed are minimal and do not really allow a conclusion on the Scalehammer's effectiveness.

Second test series

To reveal the Scalehammer effect, we proceeded with artificial scaling of the pipes. For this purpose, each pipe was filled with standardized hard water and then put in the oven at 90°C. This procedure was monitored for a week until a significant scale deposit was obtained in the pipes.

A second test series began. We followed the same supply procedure as for the first test series. The electrostatic bath temperature was increased to 105°C in order to accelerate scale deposit. The flow of water supplied to the pipes was maintained at 1.2 litre/hour. The pipe supply sequence lasted 10 days. Weighings were performed at different intervals during this period. The results obtained are presented in Table II.

TABLE II: RESULTS OF WEIGHINGS IN THE SECOND TEST SERIES

	Copper pipe 1	Copper pipe 2	Copper control pipe	Plastic pipe 1	Plastic pipe 2	Plastic control pipe
Initial weight (g)	384.72	385.38	313.22	91.85	91.46	91.96
Weight after scaling (g) t = 0	384.96	385.63	313.54	91.93	91.54	92.05
Weight (g) at t = 3 d	384.83	385.44	313.65	91.91	91.51	92.15
Weight (g) at t = 5 d	384.72	385.40	313.82	91.85	91.46	92.27
Weight (g) at t = 8 d	384.72	385.40	314.06	91.86	91.46	92.36
Weight (g) at t = 10 d	384.71	385.41	314.13	91.82	91.46	92.42

The results obtained clearly show the effect of the Scalehammer unit on the scale deposits. Indeed, after 3 days of operation, we observed respective copper pipe weight reductions of 54% (pipe 1) and 76% (pipe 2), while the weight of the copper control pipe increased by 34%. This shows that scale continued to deposit in the control pipe while in the lines equipped with a Scalehammer unit, the scale was dissolved by its action. After 5 days of operation, the scale deposits initially present in the copper pipes totally disappeared in copper pipe 1, while the deposit in the control pipe continued to grow. Figures 2 and 3 present the growth of scale deposits observed in the copper pipes and in the plastic pipes.

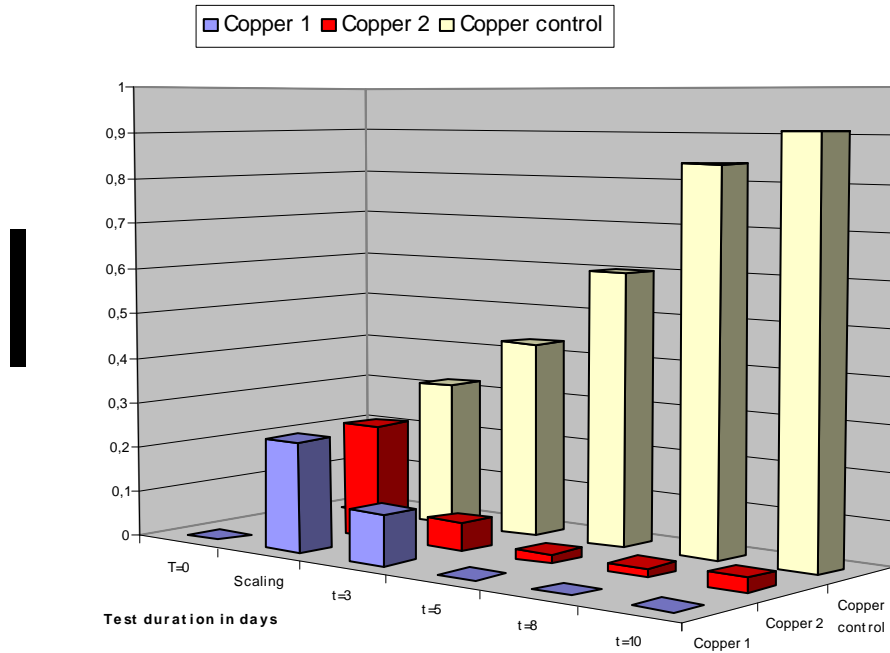


Figure 2 Scalehammer Effect on Copper Pipes

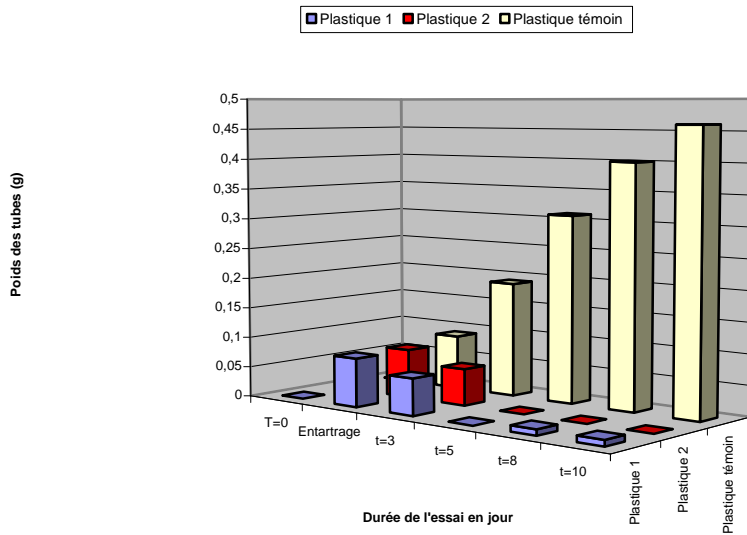


Figure 3 Scalehammer Effect on CPVC Pipes

Third test series

This last test series consisted of working on the two control lines on which the scale deposits had continued to increase during the second test series. A Scalehammer was installed on each of these two lines and a supply of standardized hard water was applied for 8 days with the same frequency as before. The feed was maintained at 1.2 litre per hour and the electrostatic bath temperature at 105°C. The weight of the pipes was monitored. The results obtained are presented in Table III.

TABLE III: RESULTS OF WEIGHINGS IN THE THIRD TEST SERIES

	Copper control pipe	CPVC control pipe
Initial weight of the pipes (g)	313.22	91.96
Weight at restart (g) t = 0	314.13	92.42
Weight at t = 4 d	313.39	92.19
Weight at t = 6 d	313.27	92.02
Weight at t = 8 d	313.24	91.98

The initial scale deposit in the pipes was greater than in the previous test series. In the copper pipe the deposit was 0.91 g and in the plastic pipe 0.46g. After 4 days of operation, weighing the pipes showed us that the weight of the scale in the two pipes decreased by 81% for the copper pipe and 50% for the plastic pipe. This reduction continued in the following days. The weight loss progression is illustrated in Figure 4.

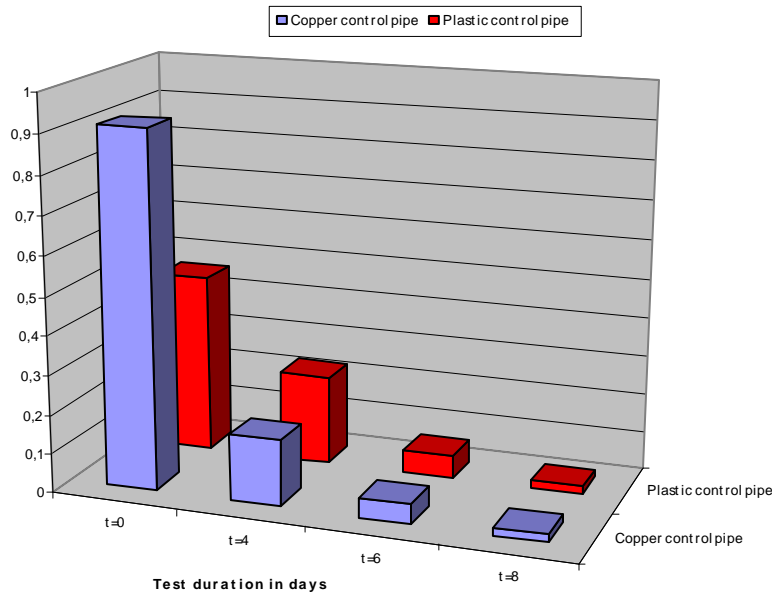


Figure 4 Scalehammer Effect

5. CONCLUSION AND RECOMMENDATION

These tests showed the effect of the Scalehammer unit on prevention of scale deposits in a hot water line. Indeed, following the three test series performed over 23 days, it was observed that the Scalehammer, which induces a magnetic field in the water, makes it possible to eliminate the scale deposits initially present after a certain number of days of operation. The efficiency of this unit was observed both for copper pipes and for CPVC pipes, because in both cases pipes returned to their initial weight before scaling after 5 days of operation in the second test series.

The third test series confirmed these observations, because the Scalehammer effect was observed in papers with greater initial scale deposits. Indeed, the reduction of the scale deposit was observed within the first few days of operation and continued for the subsequent days. After 8 days of operation, the observed scale reduction was 98% for the copper pipe and 96% for the plastic pipe.

To complete the Scalehammer evaluation, it would be interesting to monitor an installed unit over a period of about 6 months to ensure the durability of its action.

APPENDIX

**RECOVERED WATER CHARACTERIZATION RESULTS, OBTAINED IN
THE FIRST AND SECOND TEST SERIES**

TABLE: RECOVERED WATER CHARACTERIZATION RESULTS, OBTAINED IN THE FIRST AND SECOND TEST SERIES

Sample description	Sampling date	Reaction time (d)	pH	Conductivity (mS/cm)	Total hardness (mg CaCO ₃ /L)	SIS	Dissolved solids (mg/L)	"M" alkalinity (mg CaCO ₃ /kg)	"P" alkalinity (mg CaCO ₃ /kg)	Ca (mg/L)	Mg (mg/L)
Cu 1	2006-02-22	1	7.82	0.863	402	< 3.5	361	72	0	102	35.77
Cu 2		1	8.07	0.856	401	< 3.5	4334	71	0	102	35.59
Control Cu		1	7.97	0.836	406	< 3.5	422	73	0	103	36.09
Plast. 1		1	7.86	0.85	406	< 3.5	493	70	0	104	35.44
Plast. 2		1	7.92	0.862	400	< 3.5	359	70	0	102	35.25
Control plast.		1	7.89	0.843	387	< 3.5	451	69	0	98.04	34.59
Feed		1	7.7	0.836	397	< 3.5	387	69	0	101	35.1
Cu 1	2006-02-23	2	7.93	0.835	394	4	530	68	0	98.89	35.79
Cu 2		2	8.1	0.838	399	3	580	68	0	99.71	36.36
Control Cu		2	8.05	0.827	392	5	650	67	0	97.25	36.13
Plast. 1		2	7.93	0.844	391	< 3	610	67	0	98.51	35.15
Plast. 2		2	7.91	0.848	388	< 3	540	67	0	97.25	35.33
Control plast.		2	7.89	0.852	391	< 3	620	66	0	98.39	35.37
Feed		2	7.69	0.84	388	4	560	65	0	97.35	35.17
Cu 1	2006-02-24	3	7.91	1.01	396	5	610	68	0	99.83	35.6
Cu 2		3	8.17	1.03	376	5	590	69	0	94.76	33.74
Control Cu		3	8.11	1.02	391	5	550	67	0	98.94	34.96
Plast. 1		3	8.08	1.03	361	4	440	67	0	90.52	32.72
Plast. 2		3	8.05	0.96	380	4	620	67	0	96.04	34.13
Control plast.		3	8.01	1	396	< 3	570	65	0	100	35.5
Feed		3	7.8	0.97	392	< 3	580	65	0	99	35.07
Cu 1	2006-02-27	4	8.06	0.939	426	< 3	710	69	0	108	37.88
Cu 2		4	8.12	0.959	419	< 3	550	69	0	106	37.51
Control Cu		4	8.04	0.966	421	4	600	68	0	106	37.85
Plast. 1		4	8.06	0.949	412	< 3	660	67	0	104	36.7
Plast. 2		4	8.14	0.96	427	< 3	640	68	0	108	38.29
Control plast.		4	8.06	0.952	419	< 3	640	67	0	106	37.43
Feed		4	7.81	0.931	407	< 3	620	66	0	103	36.48

TABLE: RECOVERED WATER CHARACTERIZATION RESULTS, OBTAINED IN THE FIRST AND SECOND TEST SERIES (CONTINUED)

Sample description	Sampling date	Reaction time (d)	pH	Conductivity (mS/cm)	Total hardness (mg CaCO ₃ /L)	SIS	Dissolved solids (mg/L)	"M" alkalinity (mg CaCO ₃ /kg)	"P" alkalinity (mg CaCO ₃ /kg)	Ca (mg/L)	Mg (mg/L)
Cu 1	2006-02-28	5	8.11	0.904	420	< 3.5	441	64	0	107	37.02
Cu 2		5	8.23	0.895	416	< 3.5	428	63	0	106	36.75
Control Cu		5	8.13	0.884	415	< 3.5	393	62	0	106	36.6
Plast. 1		5	8.04	0.875	412	< 3.5	389	62	0	105	36.38
Plast. 2		5	8.11	0.849	409	< 3.5	525	62	0	104	36.33
Control plast.		5	8.02	0.85	409	< 3.5	368	62	0	104	36.17
Feed		5	7.74	0.883	405	< 3.5	489	60	0	103	35.78
Scaling period											
Cu 1	2006-03-16	3	8.24	0.906	368	---	530	64	0	93	33
Cu 2		3	8.17	0.910	365	---	540	63	0	91	32.15
Control Cu		3	8.12	0.896	365	---	540	63	0	96	33.38
Plast. 1		3	7.87	0.886	365	---	540	62	0	88	30.38
Plast. 2		3	8.04	0.898	364	---	530	63	0	103	35.14
Control plast.		3	8.03	0.895	388	---	530	63	0	88	31.85
Feed		3	7.55	0.870	362	---	510	60	0	100	34.85
Cu 1	2006-03-20	5	7.86	0.913	411	---	550	63	0	105	36.16
Cu 2		5	7.95	0.913	413	---	530	62	0	103	36.51
Control Cu		5	7.88	0.925	411	---	530	63	0	105	37.24
Plast. 1		5	7.43	0.901	409	---	510	62	0	103	35.57
Plast. 2		5	7.65	0.913	400	---	570	59	0	99	36.57
Control plast.		5	7.83	0.909	397	---	530	61	0	99	36.26
Feed		5	7.57	0.870	391	---	530	60	0	100	34.89
Cu 1	2006-03-23	8	7.73	0.863	510	---	380	59	0	95	34.66
Cu 2		8	7.74	0.861	510	---	384	59	0	97	35.57
Control Cu		8	8.02	0.875	510	---	394	60	0	101	36.98
Past. 1		8	7.80	0.874	490	---	402	59	0	100	36.27
Plast. 2		8	7.83	0.871	510	---	388	59	0	90	33.70
Control plast.		8	7.86	0.890	520	---	376	59	0	99	36.70
Feed		8	7.62	0.848	500	---	385	60	0	92	33.57

TABLE: RECOVERED WATER CHARACTERIZATION RESULTS, OBTAINED IN THE FIRST AND SECOND TEST SERIES (CONTINUED)

Sample description	Sampling date	Reaction time (d)	pH	Conductivity (mS/cm)	Total hardness (mg CaCO ₃ /L)	SIS	Dissolved solids (mg/L)	"M" alkalinity (mg CaCO ₃ /kg)	"P" alkalinity (mg CaCO ₃ /kg)	Ca (mg/L)	Mg (mg/L)
Cu 1	2006-03-27	10	7.75	0.913	500	---	407	59	0	102	36.87
Cu 2		10	7.88	0.948	510	---	405	58	0	101	36,45
Control Cu		10	7.85	0.954	550	---	405	60	0	103	37,08
Plast. 1		10	7.86	0.897	500	---	407	57	0	100	36,46
Plast. 2		10	7.89	0.9	520	---	402	59	0	100	37,05
Control plast.		10	7.71	0.899	520	---	397	59	0	97	35,88
Feed		10	7.8	0.878	510	---	385	56	0	96	34,58