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AN INVESTIGATION ON THE RATE OF "CORROSION OF COOLANT IRON PIPE" IN TREATED AND UNTREATED POPLAR CREEK WATER

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AN INVESTIGATION ON THE RATE OF CORROSION OF COOLANT IRON PIPE IN TREATED AND UNTREATED POPLAR CREEK WATER

H.A. Bernhardt, H.W. Bishop, J.P. Brusie

I. Introduction

This investigation was undertaken to determine the rate of corrosion of coolant iron pipe in treated and untreated Poplar Creek water in order to estimate the life of the pipe. Since the water flowing through the iron pipe in the plant is at an elevated temperature and contains dissolved gases, the rate of corrosion will be higher than would be the case if coolant water free of dissolved gases were being used. Not only did it seem desirable to determine the rate of corrosion, but it was also desirous to determine whether the corrosion resulted in the pitting of the pipe surface or whether it was an all-over type of corrosion.

II. Samples

The iron pipes used in these experiments were cleaned by pickling in a dilute HCl solution, after which they were washed with distilled water and degreased in trichlorethylene. The pipe samples were then measured so that the total apparent surface area could be calculated, and all samples were weighed on a mass balance to the nearest tenth of a milligram. Spectrographic analysis of iron pipe used in Run 1 through Run 6:

Fe	very strong	Ni	0.01%
Cu	0.01 - 0.1%	Si	0.01%
Mn	0.1 - 1.0%	C	0.13%

III. Apparatus

Two water baths of 66 liters capacity each were used and were maintained at a temperature of 60° C. During the tests, air was bubbled through the water. The corrosion inhibitors tried were Calgon and potassium dichromate. The water was analyzed before each run and the analyses are shown in Table I. The samples of pipe were suspended in the baths by means of pieces of cotton cord.

IV. Experimental Procedures

During each run, five pieces of pipe were placed in each bath and on an average one piece of pipe was removed from each bath every 48 hours. The samples, after being removed from the baths, were cleaned

of the rust particles that were adhering to the surface by means of a wire brush. The samples were then dried and reweighed on the mass balance to the nearest tenth of a milligram. The loss in weight of the samples was taken as a measure of the rate of corrosion. The rate of corrosion of the samples was calculated in milligrams per square decimeter per day (m d d) and the results are listed in Table II. In Run 5 analyses were made each day for "Calgon", and the necessary amount of "Calgon" to keep the concentration about 10 p.p.m. was added. The "Calgon" analyses from day to day on Run 5 are given in Table III. Photographs were taken of samples before and after treatment and are included at the end of the report.

V. Discussion of Results

It can be seen from Table II that the rate of corrosion is greater in the case of untreated Poplar Creek water than in the case of Poplar Creek water containing "Calgon", but in both cases the rate is much greater than in water containing dichromate.

The corrosion in all cases was of a pitting nature, as clearly shown in plate No. 22-A.

It can be seen from Table III, that the "Calgon" is used up very rapidly. These tests show that if the "Calgon" concentration is kept at about 10 p.p.m. the corrosion rate is much less than in untreated Poplar Creek water, but in no case does the "Calgon" treatment compare with the dichromate treatment. It will probably be worth while in the near future to see just how small a concentration of dichromate can be used and still keep the rate of corrosion to a minimum.

TABLE I

Analysis (in ppm) of the water used in each run

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
pH	7.80	8.1	7.52	9.10	7.1	7.30
NaCl	16	33	24	4	32	3.2
Al	0	0	-	0	-	3.0
Ts	246	263	315	401	232	228
$PO_4^{\equiv}$	None	1.2	10.1	2	0.4	-
Fe(Total)	3	-	10	-	1.24	1.9
TDS	145	154	210	115	194	191
Hardness	131	108	-	114	-	126
Fe (Dissolved)	0.5	0.17	-	0.1	0.08	0.8
Suspended solids	101	-	-	-	38	37
$SO_4^{=}$	50.9	6.6	39.5	48	11.7	47
SiO_2 (Total)	40.4	-	6.4	-	-	22
"P" (alk.)	1.4	0	0	2.4	14	None
"M" (alk.)	85.4	84	82	78	110	126
Ca	28	42	22	14.6	34	41
SiO_2 (dissolved)	5.2	-	-	-	1.1	-
Mg	8.9	8.6	9	16.9	15	16
Cu	0	0.4	0.3	0.1	-	None
SiO_2 (filtered)	-	-	-	3.2	-	-
Al_2O_3	-	-	-	-	8.4	-
HCO_3^-	-	84	-	-	-	-
SiO_2 (unfiltered)	-	27	-	144	-	-
PO_3 (Calgon)	-	-	14.3	7.5	0.1	-

TABLE II

Rate of Corrosion

Hours of Immersion	Run 1 mdd	Run 2 mdd	Run 3 mdd	Run 4 mdd	Run 5 mdd	Run 6 mdd
48	467	0	310	0	76	50
96	497	-	314	0	55	-
144	-	-	266	0.9	36	50
164	-	0	-	-	-	-
192	413	0	271	0	45	35
216	-	-	-	-	38	-
240	361	-	-	-	-	37
264	-	-	280	-	-	-
288	320	-	-	-	-	-

Run 1 - Untreated Poplar Creek water
Run 2 - Poplar Creek water treated with 200 ppm of $Na_2Cr_2O_7$
Run 3 - Wet well water
Run 4 - Wet well water treated with 200 ppm of $Na_2Cr_2O_7$
Run 5 - Poplar Creek water maintained at a constant concentration of 10 ppm of Calgon
Run 6 - Poplar Creek water +50 ppm of Calgon (No extra Calgon added during run)

TABLE III

Run V

Day	Calgon ppm	Day	Calgon ppm
1	10.0	7	7.2
2	6.0	Calgon added	
Calgon added		8	9.0
3	10.5	Calgon added	
5	4.0	9	8.0
Calgon added		10	8.0
6	5.4		
Calgon added			

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Plate No. A-17
Sample No. 0
Mag.: 15X
Remarks: Pipe before exposure.

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Plate No. A-18
Sample No. 2
Mag.: 15X
Remarks: Sample cleaned with fine wire brush after exposure to Poplar Creek water treated with dichromate (200 pts./million) - Time of exposure - 48 hours

Plate No. A-19
Sample No. 3
Mag.: 15X
Remarks: Sample pipe cleaned with fine wire brush after exposure to untreated Poplar Creek water - Time of exposure 48 hours.

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Plate No. A-42
Sample No. 10-13
Mag.: 1X
Remarks: Sample exposed to wet well water. Uncleaned after exposure. Time of exposure - 11 days.

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