

ABC COMPANY STIMULATION FLUID CORROSIVITY



Job# 16-000

Revision Comments	Date	Author	Reviewed by
Initial Draft	April 00, 0000		

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1 INTRODUCTION

Company ABC requested testing of stimulation fluids for corrosion rate testing. The XXX solution was evaluated in the stirred autoclave apparatus at two concentrations over an exposure period of one day. Testing was performed according to the protocol discussed with ABC Company using a Nitrogen gas cap and electrodes made from L80 grade steel.

2 CHEMICAL SAMPLES

The following table lists the product received from ABC Company for evaluation.

Product	Concentration
XXX	50% & 75%

Table 1: Products Received

The product was not purged to deaerate the solution prior to use in the test. The pH of the fluids pre & post-test was measured via pH meter and pH test strips. Post-test fluids were retained for visual analysis.

3 AUTOCLAVE TEST PARAMETERS

3.1 Gas Composition

A 2000 kPa nitrogen gas charge was added to the autoclave cells. The inert gas charge is to prevent boiling of the fluids at the elevated test temperature.

3.2 Test Temperature

The sealed autoclaves were placed inside individual heating mantles and heated to the prescribed temperature of 150°C. Proportional temperature controllers accurate to +/- 2°C are used to maintain the set temperature.

4 AUTOCLAVE TEST APPARATUS

The autoclaves used by Cormetrics Limited are constructed of Hastelloy 276-C and have a capacity of approximately 300mL. The test was carried out with 180 mL of synthetic hydrochloric acid replacement product in the cell.

A Teflon sleeve was inserted into the base of the autoclave and the synthetic acid was then poured into this Teflon cup. A three-electrode assembly was suspended from the lid of the autoclave, keeping the bottom clear for a Teflon-coated magnetic stir-bar. Configuration of the electrodes is a closely spaced equilateral triangle, with each cylindrical electrode having a 6.3 ϕ x 38 mm geometry. Reference electrodes are made from

Hastelloy 276-C, while working and counter electrodes are L80 carbon steel. Electrodes are solvent rinsed and weighed prior to the commencement of the test period. A surface area of 7.92 cm² has been used throughout for corrosion rate calculations. Weight loss corrosion rates are reported as an average of the working and counter electrodes based on total exposure time.

The temperature of the fluid in the autoclave is sensed by a thermistor probe, held at the center of the cell by a Hastelloy sleeve. Charging of the autoclave is by means of an offset Hastelloy tube, fitted with a pressure gauge and sour-service valve. Each cell is also equipped with a pressure relief valve that is used when venting excess pressure.

LPR measurements were obtained at 30-minute intervals by connecting each cell to a Gamry PC4-300 potentiostat and controller, via a Gamry ECM8 multiplexer. Data acquisition was by means of Gamry's DC105 software package. LPR measurements were initiated after cell pressuring to include corrosion data during heating phase.

5 AUTOCLAVE DATA AND DISCUSSION

Appendix I contains graphs of the Linear Polarization Resistance (LPR) corrosion rate measurements. Weight loss corrosion rates and electrode photographs are located in Appendix II. The following tables summarize the autoclave test data.

Cell	Initial LPR (mm/yr)	Final LPR (mm/yr)	Weight Loss (mm/yr)	Weight Loss (lb/ft ²)*
XXX #1	5.20	0.01	1.11	0.005
XXX #2	3.62	0.09	1.74	0.008

Table 2: Autoclave Evaluation Corrosion Rate Summary

* Weight loss in lb/ft² is over the test exposure period of 24 hours

5.1 pH Data

Cell	Initial pH	Final pH
XXX #1	0.32	7.96
XXX #2	0.16	8.19

Table 3: Meter pH Values

pH values were measured using an Oakton All in 1 pH5 meter.

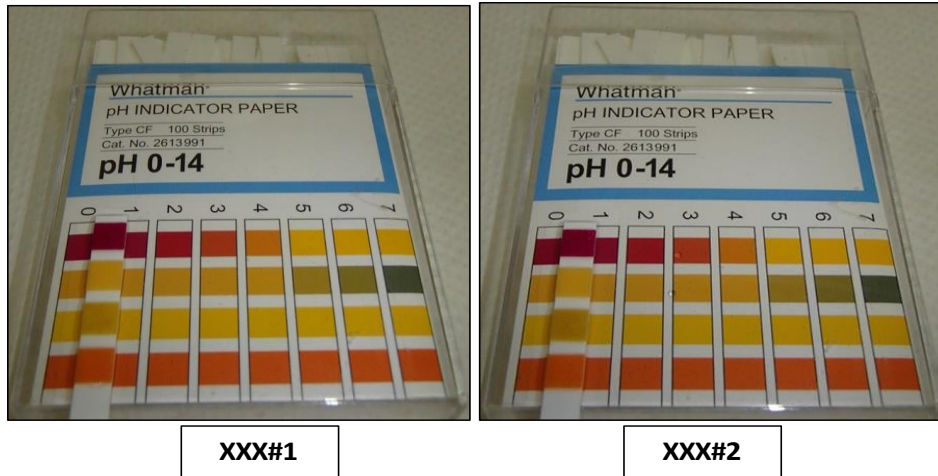


Figure 1: Pre-Test pH

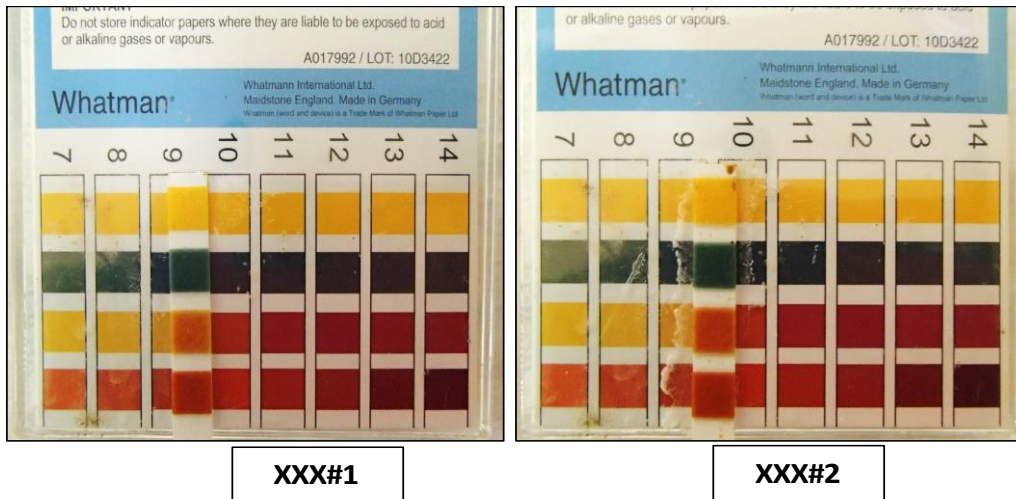


Figure 2: Post-Test pH (24 Hour Exposure)

5.2 AUTOCLAVE TESTING

The XXX#1 product displayed a peak LPR corrosion rate of 15.66 mm/yr observed after ~3-hour exposure. The corrosion rate was initially erratic and then fell to below 0.1 mm/yr after 4 hours. This coupled with the slightly alkaline post-test fluids indicate the fluid was likely spent after 4 hours' exposure. The weight loss was 18.90 mg with the electrode displaying an overall moderate etching attack.

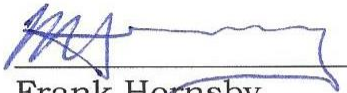
The XXX #2 solution had a higher weight loss at 29.60 mg with a longer duration of high corrosion activity. After 10 hours the corrosion rate stabilised around 0.1 mm/yr; indicating the acidity of the fluids was spent. No localised corrosion activity was visible on the electrode surface.

6 CONCLUSION

The XXX #2 solution was more corrosive due to a higher weight loss and an extended activity versus the XXX #1 solution. Results demonstrate the XXX #1 solution was spent after 4 hours' exposure while the XXX #2 solution remained active until 10 hours' exposure. Both solutions had large increases in pressure likely due to corrosion activity and breakdown of the solution at the elevated test temperatures. All post-test fluids were spent with a slightly alkaline pH and a distinct bleach odor.

Sincerely,

Cormetrics Limited



Frank Hornsby

President

Cormetrics Limited

Please note, all inhibitor samples and electrodes are stored for 6 months prior to disposal.

APPENDIX I – LPR DATA

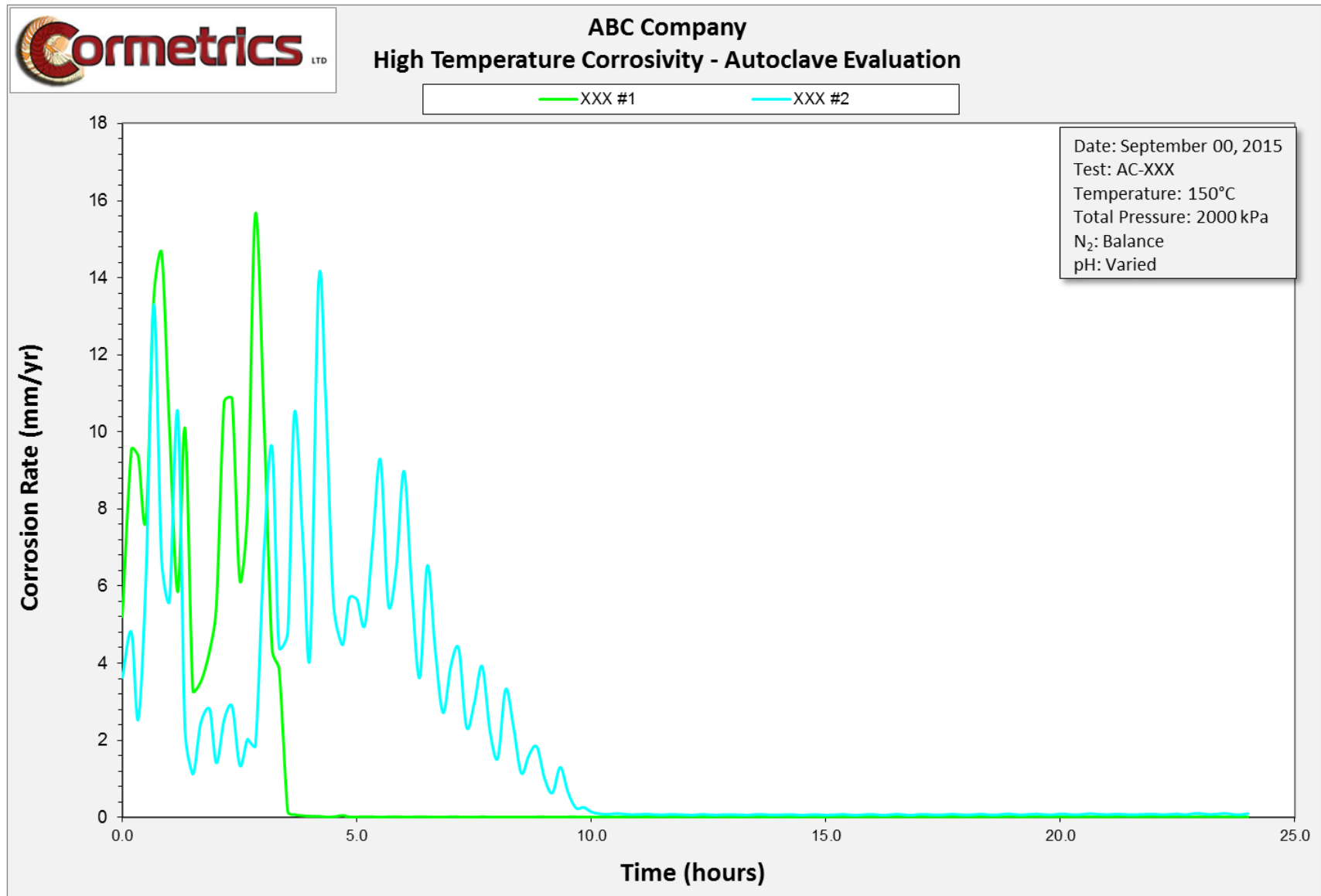


Figure 3: LPR Data; 24 Hour Exposure

APPENDIX II – WEIGHT LOSS & VISUAL DATA


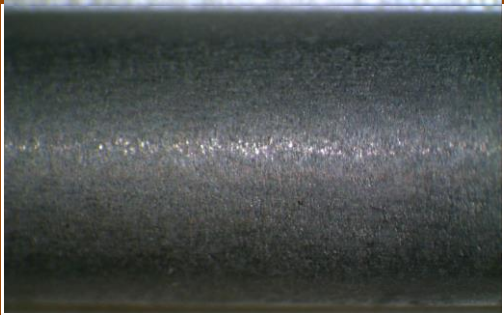

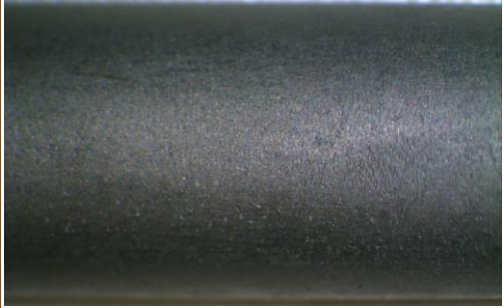
Inhibitor	Weight Loss		Visual Description	Electrode Photo	
	(mg)	(mm/yr)		(Full)	(Close-Up)
XXX #1	18.90	1.11	Overall moderate surface etch.		
XXX #2	29.60	1.74	Overall moderate surface etch.		

Table 4: Weight Loss Data & Electrode Photographs (24 Hour Exposure)



Figure 4: Post-Test Fluids