

# Coiled Tubing Tested in 50% Oil Safe AR® at 420°F

Project Number E0493

Prepared for:

Heartland Energy Group Ltd.

December 18, 2012



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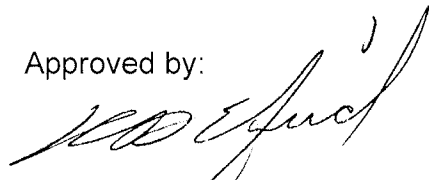
**Heartland Energy Group Ltd.**

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## TABLE OF CONTENTS

**TABLE OF CONTENTS** ..... iii

**LIST OF TABLES** ..... iii

**LIST OF FIGURES**..... iii

**EXECUTIVE SUMMARY** ..... iv

**INTRODUCTION**.....1

**EXPERIMENTAL PROCEDURE** .....1

    TEST MATERIAL.....1

    ENVIRONMENT .....1

    TEST APPARATUS .....1

    TEST PROCEDURE.....2

**RESULTS** .....2

**CONCLUSIONS** .....4

## LIST OF TABLES

Table 1. Results of corrosion test.....3

## LIST OF FIGURES

Figure 1. Schematic diagram of the autoclave test cell.....2

Figure 2. Carbon steel coiled tubing after testing in 50%vol Oil Safe AR® at 420°F for 24 hours before (left) and after (right) cleaning.....3

Figure 3. Slight pitting on carbon steel coiled tubing samples after testing in 50%vol Oil Safe AR® at 420°F for 24 hours. Original magnification at 20X.....3

## EXECUTIVE SUMMARY

The objective of this project was to evaluate carbon steel coiled tubing in an acidizing environment at elevated temperature. The material was tested in 50%vol Oil Safe AR® at 420°F. A twenty four hour exposure was used to determine the effect of the acidizing environment on the corrosion rate and morphology of the alloys. The conclusions are as follows:

- The carbon steel coiled tubing had an average mass loss of 0.078 kg/m<sup>2</sup> (143 mpy) in the 50%vol Oil Safe AR® environment at 420°F after 24 hours.
- The carbon steel coiled tubing had very slight pitting visible at 20X magnification after 24 hours in the 50%vol Oil Safe AR® environment at 420°F.

## INTRODUCTION

The objective of this project was to evaluate carbon steel coiled tubing in an acidizing environment at elevated temperature. The material was tested in 50%vol Oil Safe AR® at 420°F. A twenty four hour exposure was used to determine the effect of the acidizing environment on the corrosion rate and morphology of the alloys.

## EXPERIMENTAL PROCEDURE

### Test Material

The machined carbon steel test coupons, approximately 3" x 1/2" x 1/8", were supplied by Schlumberger and were machined from a sample of coiled tubing. Mechanical properties and the chemistry of the carbon steel tubing were not supplied.

### Environment

The test environment was Oil Safe AR® in distilled water to give a 50%vol solution. The solution was allowed to mix for at least 30 minutes prior to use in the test. The autoclaves were overpressured with 300 psig of ultra pure (UP) nitrogen to prevent boiling. The test temperature was 420°F. For timing purposes, the test was considered to be at test temperature at 420°F.

### Test Apparatus

The corrosion tests were conducted in one-liter autoclaves. The test cell and its internals (thermowell, etc.) are constructed of alloy 316L, as diagrammed in Figure 1. Omega heating tapes and controllers were used to maintain the test temperature.

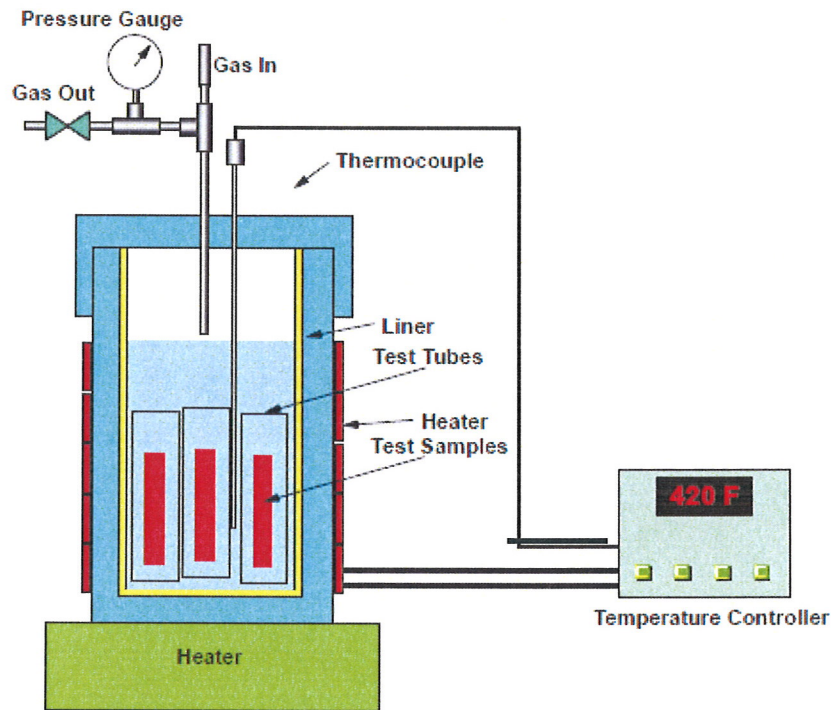


Figure 1. Schematic diagram of the autoclave test cell.

## Test Procedure

Triplicate coupons were placed in test tubes in the autoclave, and the test tubes and autoclave were filled with 50%vol Oil Safe AR®. The autoclave was pressured to 300 psig N<sub>2</sub> and heated to 420°F. The test duration was 24 hours based upon the time at temperature.

After testing, the coupons were cleaned according to ASTM G1. The coupons were weighed and examined for localized corrosion (pitting and/or crevice corrosion) and photographed.

## RESULTS

Table 1 gives the mass loss and the corrosion rate data of the carbon steel coiled tubing in 50%vol Oil Safe AR® at 420°F for 24 hours. Figure 2 shows the coupons before and after cleaning. Figure 3 shows the slight pitting that occurred on the carbon steel. Although not evaluated in this test protocol, the author's experience with inhibited HCl acidizing treatment tests, corrosion rate of approximately 800-2000 mpy is typical. This product had a significantly lower corrosion rate than typically seen with minor pitting on the carbon steel

surface. It should also be noted that any aerated solution containing chloride at 420°F would result in pitting of carbon steel.

Table 1. Results of corrosion test.

Average Mass Loss (kg/m <sup>2</sup> )	0.078
Minimum Mass Loss (kg/m <sup>2</sup> )	0.074
Maximum Mass Loss (kg/m <sup>2</sup> )	0.083
Average Corrosion Rate (mpy)	143.0
Minimum Corrosion Rate (mpy)	134.8
Maximum Corrosion Rate (mpy)	150.8

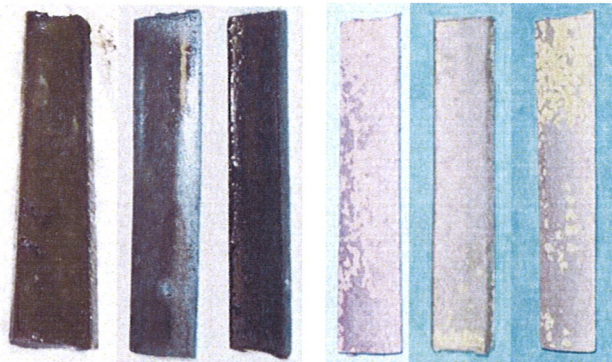


Figure 2. Carbon steel coiled tubing after testing in 50%vol Oil Safe AR® at 420°F for 24 hours before (left) and after (right) cleaning.



Figure 3. Slight pitting on carbon steel coiled tubing samples after testing in 50%vol Oil Safe AR® at 420°F for 24 hours. Original magnification at 20X.

## CONCLUSIONS

- The carbon steel coiled tubing had an average mass loss of  $0.078 \text{ kg/m}^2$  (143 mpy) in the 50%vol Oil Safe AR® environment at 420°F after 24 hours.
- The carbon steel coiled tubing had very slight pitting visible at 20X magnification after 24 hours in the 50%vol Oil Safe AR® environment at 420°F.