Alloy G3 and 718 Tested in 50% Oil Safe AR® at 420°F

Project Number E0466

Prepared for:

Heartland Energy Group Ltd.
626 Valley Ridge Court
Grain Valley, MO 64029

July 3, 2012

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EXECUTIVE SUMMARY

The objective of this project was to evaluate two nickel based alloys in an acidizing environment at elevated temperature. The materials were alloy G3 (UNS N06985) and alloy 718 (UNS N07718). The alloys were tested in 50%vol Oil Safe AR® at 420°F. Twenty four hour exposures were used to determine the effect of the acidizing environment on the corrosion rate and morphology of the alloys. The conclusions are as follows:

- Both the alloy G3 (UNS N06985) and alloy 718 (UNS N07718) had low corrosion rates and showed no pitting in the 50%vol Oil Safe AR® environment at 420°F.
- The average corrosion rates in the 50%vol Oil Safe AR® environment at 420°F are:

Material	Average Mass Loss	Average Corrosion Rate (mpy)	
	kg/m^2	Based on Time at Temperature	Based on Total Time in the Solution
Alloy G3	0.01060	19.96	15.93
Alloy 718	0.00843	15.78	12.82

INTRODUCTION

The objective of this project was to evaluate two nickel based alloys in an acidizing environment at elevated temperature. The materials were alloy G3 (UNS N06985) and alloy 718 (UNS N07718). The alloys were tested in 50%vol Oil Safe AR® at 420°F. Twenty four hour exposures were used to determine the effect of the acidizing environment on the corrosion rate and morphology of the alloys.

EXPERIMENTAL PROCEDURE

Test Material

The test coupons, approximately 2" x 3/4" x 1/8", were supplied by Metal Samples. Table 1 gives the chemistry of the two nickel based alloys tested.

Table 1. Chemical analysis of alloys tested.

Alloy	C	S	P	Mn	Fe	Si	Cu	Ni	Cr	Co	Mo	W	Al	Ti	Nb
G3	0.004	<0.001	0.016	0.77	19.40	0.21	1.77	46.41	21.72	1.86	6.73	0.89			
718	0.030	0.001	0.006	0.04	18.20	0.02	0.03	53.32	18.64	0.02	3.03		0.57	0.96	5.12

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 temperature at 400°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.

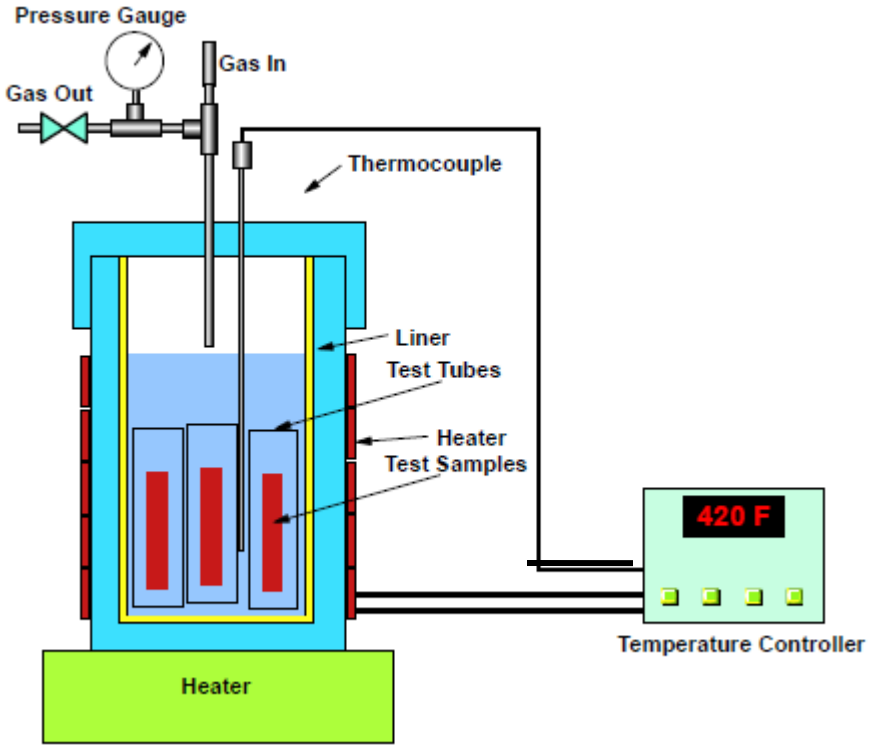

Figure 1. Schematic diagram of the autoclave test cell.

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_2 and heated to 420°F. The test duration was 24 hours based upon the time at temperature. Care was taken to insure that the heating and cooling periods were approximately the same for all tests.

After testing, the coupons were cleaned by glass bead blasting, a process that removes corrosion products or films but not the base metal. The coupons were weighed and examined for localized corrosion (pitting and/or crevice corrosion) and photographed. An alloy 718 blank (an untested coupon) was also cleaned and weighed to determine the mass loss due to the cleaning process. This was then subtracted from the mass loss of the tested coupons to determine an accurate corrosion rate.

RESULTS

Figure 2 shows the average mass loss. Figures 3 and 4 show the average corrosion rate in the 50% Oil Safe AR® environment at 420°F, based upon the time at temperature or the total time in solution, respectively. Figures 5 and 6 show the coupons before and after cleaning. All coupons had low corrosion rates and contained no pits or localized attack.

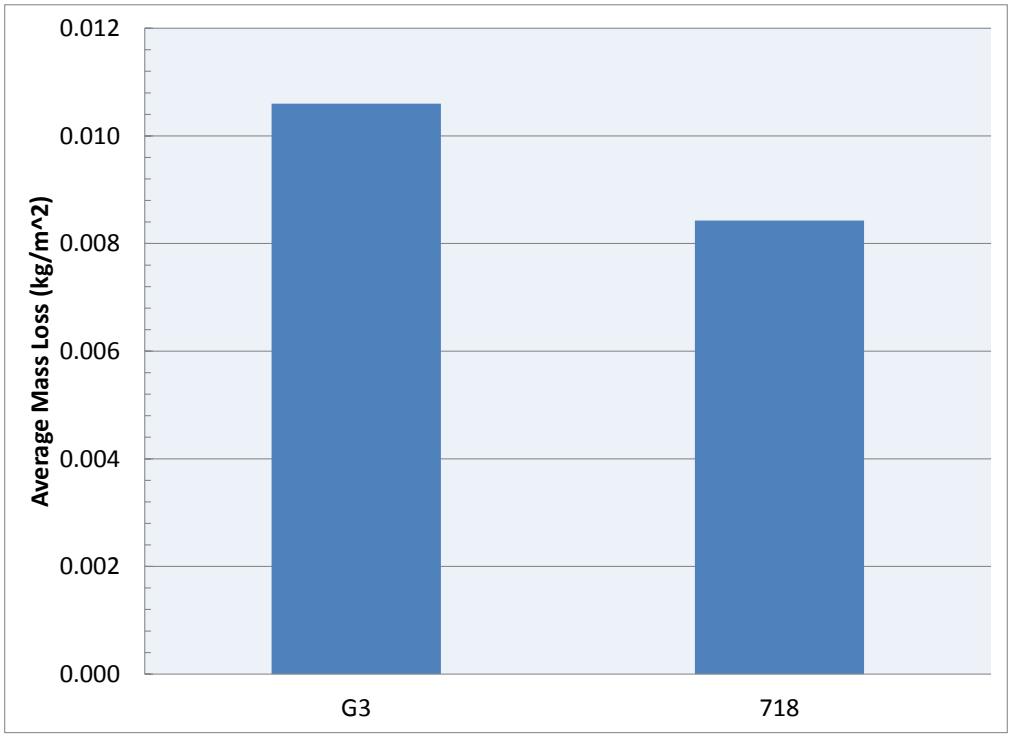

Figure 2. The average mass loss in the 50%vol Oil Safe AR® environment at 420°F.

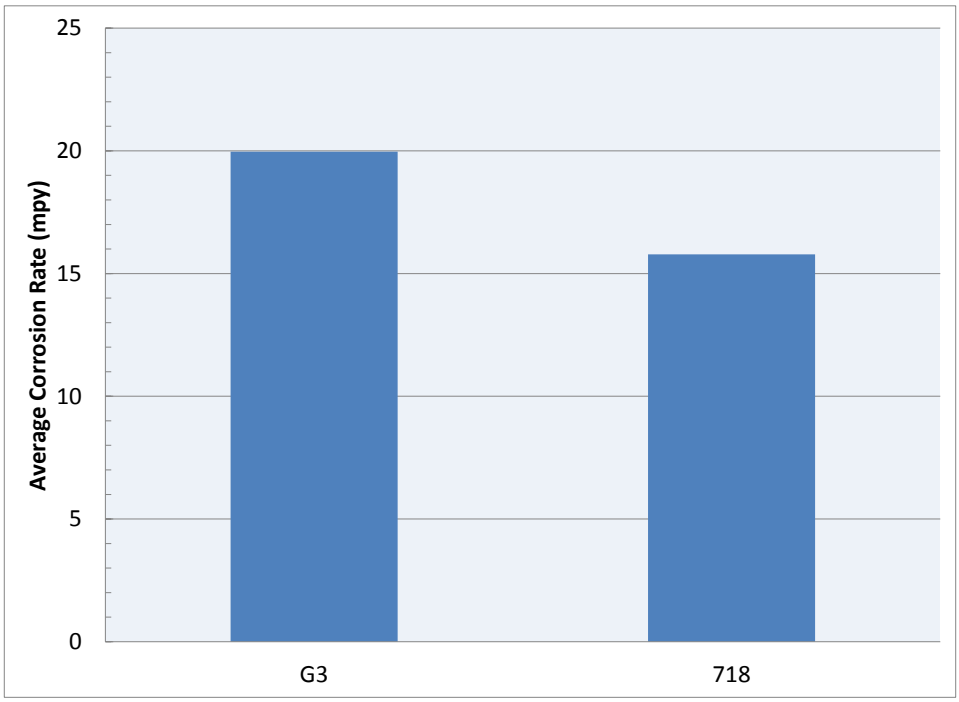

Figure 3. The average corrosion rate based on time at temperature in the 50%vol Oil Safe AR® environment at 420°F.

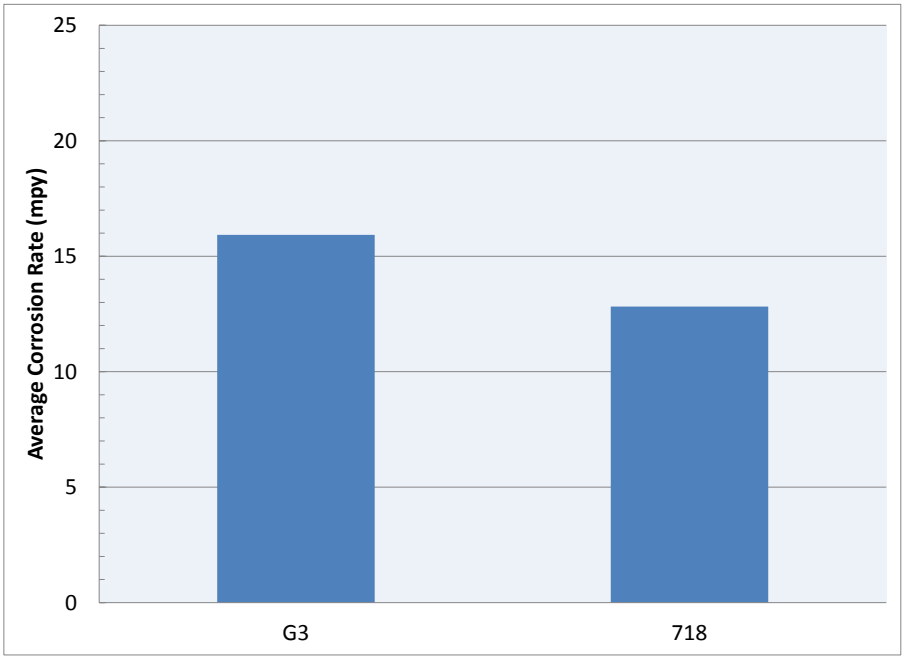

Figure 4. The average corrosion rate based on total time in solution in the 50%vol Oil Safe AR® environment at 420°F.

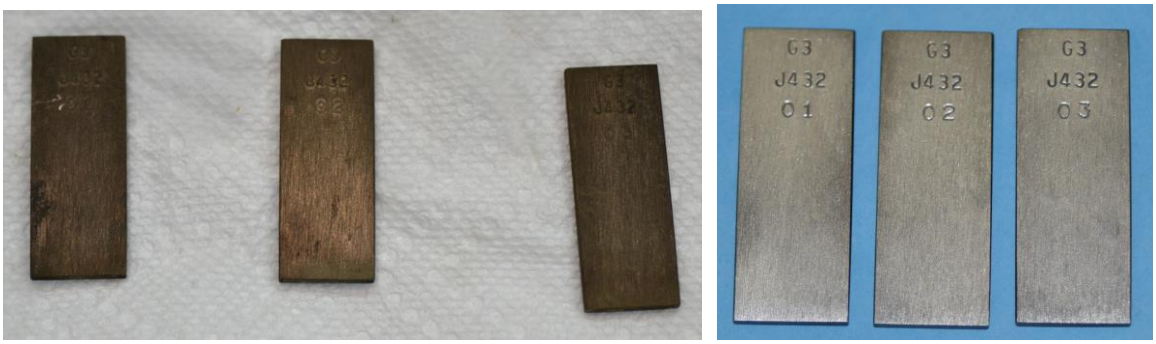

Figure 5. Alloy G3 after testing in 50%vol Oil Safe AR® at 420°F before (left) and after (right) glass bead blasting.

Figure 6. Alloy 718 after testing in 50%vol Oil Safe AR® at 420°F before (left) and after (right) glass bead blasting.

CONCLUSIONS

- Both the alloy G3 (UNS N06985) and alloy 718 (UNS N07718) had low corrosion rates and showed no pitting in the 50%vol Oil Safe AR® environment at 420°F.
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