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# CORROSION TESTS ON FERRULES FOR TUBE CONNECTIONS IN THE 1300 AREA SEMI-WORKS

by

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# CORROSION TESTS ON FERRULES FOR TUBE CONNECTIONS IN THE 1300 AREA SEMI-WORKS


## Abstract:

The corrosion characteristics of nitrided and work hardened stainless steel ferrules for use in the Parker Ferrulok tube fittings for the 1300 Area Semi-Works project were studied.

These tests showed that the nitrided ferrules are not suitable for use with solutions containing nitric acid, and that the work hardened ferrules are not attacked to an appreciable extent.

These tests also reaffirmed the fact that stainless steel even in the nitrided condition is not appreciably attacked by strong caustic in concentrations around 4 N NaOH.


## Problem:

To compare the corrosion characteristics of nitrided and work hardened ferrules for use in Parker Ferrulak stainless steel tube fittings. These tests were to be run in the solutions encountered in the 1300 Area Semi-Works operation.

## Specimens:

The ferrules were treated in the condition as received from the company. The coupling of the ferrules with 316 stainless steel was accomplished by sliding the ferrule down over a solid cylinder of 316 tapered to fit the inside taper of the ferrule and thus give intimate contact. All 316 cylinders were cleaned prior to testing by degreasing, 20 minute immersion in 25% by volume $HNO_3$, scrubbed under running water with a surgical brush, followed by a rinse in acetone and then alcohol.

All specimens were weighed prior to immersion in the corroding solutions.

## Testing Procedure:

A. The corroding media for these tests were:

| | | |
|---|---|---|
| Group I | $Th(NO_3)_4$ | 1.24M |
| | $HNO_3$ | 0.97M |

[redacted]

Testing Procedure (Con't.)

| | | |
|---|---|---|
| Group II | $NaAlO_2$ | ~ 2.7M |
| | Free NaOH | ~ 3.5M |
| | $NaNO_3$ | ~ 1.2M |

B. All tests were operated for a period of thirty (30) days under static conditions in the temperature range 95 - 100°C.

C. The solution volume for each test was four (4) liters.

D. On completion of the thirty (30) days testing time, the samples were removed from the solution, rinsed in running water, alcohol, dried, and weighed. Coupled tests were separated only after drying and just prior to weighing. The specimens were then given a microscopic inspection.

The defilming of all specimens was accomplished by a 15 minute immersion in a 10% by weight $HNO_3$, 2% by weight HF solution held at 65°C. They were then scrubbed with a surgical brush under running water, rinsed in acetone and alcohol, dried, weighed, and again inspected microscopically.

Results:

A. Tabulation:



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## GROUP I

| Material | Contact Area ($cm^2$) | Total Area ($cm^2$) | Initial Wt. (grams) | Corrected Wt. Loss (mgs) |
|---|---|---|---|---|
| Ferrule(1)<br>316 | 2.3<br>2.3 | 5.4<br>14.3 | 2.6143<br>26.1926 | 59.4<br>8.6 |
| Ferrule(1)<br>316 | 2.3<br>2.3 | 5.4<br>14.3 | 2.5996<br>26.6258 | 135.4<br>8.0 |
| Ferrule(1) | - | 5.4 | 2.5421 | 69.0 |
| Ferrule(1) | - | 5.4 | 2.6147 | 92.5 |
| Ferrule(2)<br>316 | 2.3<br>2.3 | 5.4<br>14.3 | 2.5987<br>27.0927 | 5.5<br>4.3 |
| Ferrule(2)<br>316 | 2.3<br>2.3 | 5.4<br>14.3 | 2.5667<br>26.5363 | 14.6<br>5.1 |
| Ferrule(2) | - | 5.4 | 2.5790 | 10.3 |
| Ferrule(2) | - | 5.4 | 2.6041 | 13.9 |

## GROUP II

| | | | | |
|---|---|---|---|---|
| Ferrule(1)<br>316 | 2.3<br>2.3 | 5.4<br>14.3 | 2.6470<br>26.9656 | 83.8(3)<br>.8 |
| Ferrule(1)<br>316 | 2.3<br>2.3 | 5.4<br>14.3 | 2.6076<br>26.7263 | 90.6(3)<br>+ .6(4) |
| Ferrule(1) | | 5.4 | 2.5925 | 161.9(3) |
| Ferrule(1) | | 5.4 | 2.5416 | 83.6(3) |
| Ferrule(2)<br>316 | 2.3<br>2.3 | 5.4<br>14.3 | 2.5355<br>26.7925 | 3.6<br>+ 6.5(4) |
| Ferrule(2)<br>316 | 2.3<br>2.3 | 5.4<br>14.3 | 2.5691<br>27.2500 | + 3.3(4)<br>.7 |
| Ferrule(2) | | 15.1 | 6.7480 | 5.8 |
| Ferrule(2) | | 15.1 | 6.7852 | 8.8 |



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[redacted]

(1) These ferrules have been case hardened by a nitriding process.

(2) These ferrules have been hardened by cold working.

(3) These values are not considered as being dependable because they are chiefly due to the attack of the nitrided surfaces by the defilming solution.

(4) The gain in weight of these specimens was caused by the failure of even the strong defilming solution used to remove the deposited $Al(OH)_3$.

B. Observations:

There was no pitting of any of the surfaces but there was a definite evenly distributed concentration of attack in the contact area on the 316 stainless steel cylinders coupled with the nitrided ferrules, and a slight concentration of attack with the work hardened ferrules in Group I.

The nitrided surface of all such ferrules in Group I was completely removed.

Prior to defilming, the nitrided ferrules in Group II were apparently unattacked.

Surface hardness on both types of ferrules was tested in the as-received condition. They both had a Rockwell "C" hardness of 41.

Conclusions:

From the results of these tests the following conclusions can be drawn:

(1) From the corrosion standpoint the nitrided ferrules, which are recommended by the company for use in their fittings, are definitely not suitable.

(2) There is indication that it would be bad practice to use these tube fittings in combination with 316 stainless steel tubing.



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Conclusions (Con't.)

(3) There is no indication that the strongly caustic solution from the jacket removal process will affect either the nitrided or the work hardened ferrules.



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