Instrument Valve & Manifold Fugitive Emissions Tests

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INSTRUMENTATION VALVE & MANIFOLD FUGITIVE EMISSIONS TEST

1.0 INTRODUCTION

1.1 Test Purpose and Objective

The Clean Air Act Amendments of 1990 provide fugitive emissions control requirements for volatile organic compounds emitted by valve stem seals. To test the stem sealing capabilities of standard instrument valves and manifolds, Parker PGI contracted H.O. Mohr Research and Engineering, Inc. of Houston, Texas to perform a series of fugitive emission tests. The objective of the testing was to determine the fugitive emission leak resistance of leading stem seal designs under various simulated field conditions. Mohr provided test equipment and personnel, and all testing was done in accordance with EPA test Method 21 as found in part 40 of the Code of Federal Regulations.

2.0 SUMMARY

The standard valves of two (2) different manufacturers were tested:

- Parker PGI
- Competitor

The Parker PGI and Competitor valves were tested under three (3) different test conditions. These conditions were simulated by the following test procedures:

- Mechanical cycling at ambient temperature
- Heat cycle testing
- Modified heat cycle testing

The Parker PGI valves successfully completed all testing requirements for the three different test conditions.

The Competitor valves were not successful in meeting any test requirements and failed all three test conditions.

3.0 VALVES TESTED

3.1 Parker PGI

PTFE Pressure-Core® Stem Seal
1/2" NPT Valve
10,000 PSI WP @ ambient 8,000 PSI WP @ 450° F

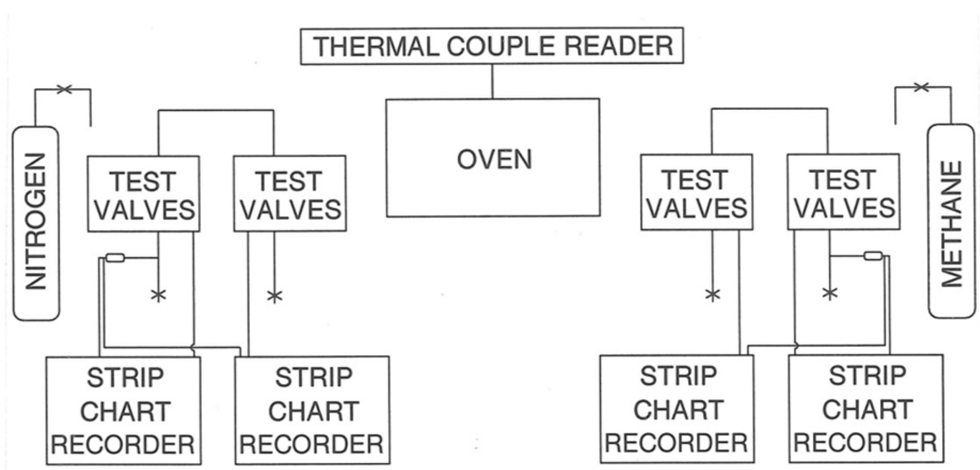
3.2 Competitor

Adjustable PTFE Stem Seal Packing
1/2" NPT Valve
10,000 PSI WP @ ambient 8,000 PSI WP @ 500° F

Low Emissions Graphite Stem Seal Packing
1/2" NPT Valve
6,000 PSI WP @ ambient 1,500 PSI WP @ 850° F

4.0 TEST SET-UP

4.1 Test Set-up Schematic Drawing



4.2 Test Set-up Descriptions

The test design incorporated three separate tests: mechanical cycling at ambient temperature, heat cycle and modified heat cycle testing. The set-up for the different tests is described below.

4.2.1 Mechanical Cycling at Ambient Temperature

The test valves were assembled into a tubing loop to facilitate pressurization with methane. The pressure was maintained at 1000 PSI methane throughout the cycling procedure and was monitored with a Sensotec 0-5000 PSI stain gauge transducer. All data on mechanical cycles and fugitive emission leak rates were manually recorded. A 98% pure CP grade bottle of methane with its respective regulator and shutoff valves was used to pressurize the test valves for all fugitive emission leak rate tests.

4.2.2 Heat Cycle and Modified Heat Cycle Testing

Each test valve was attached to tubing and fittings such that the test valves could be inserted into an oven to accomplish the heat portion of the test while the block valves and pressure transducer for each valve pair remained outside the oven. This was accomplished by a barrier of Marinite insulating board which was used as the oven door and heat barrier. A type J thermocouple was welded to each test valve on the valve body. The position was adjacent to the bonnet nut. The thermocouples were read by digital thermal coupler reader/amplifiers and recorded on an Omniscribe two-pen strip chart recorder.

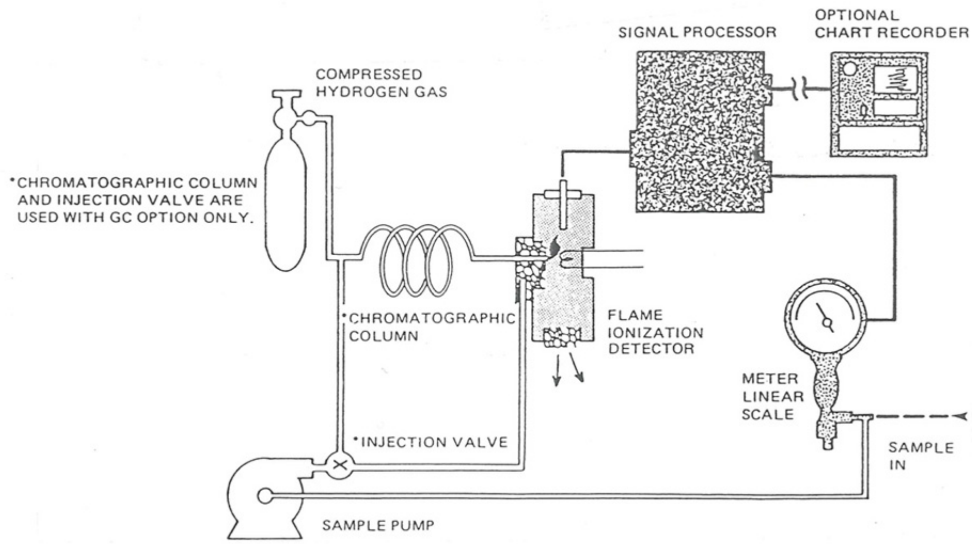
The oven was a manually controlled laboratory oven capable of 500° F maximum. A shielded Type J thermocouple and reader were used to monitor the oven air temperature.

The pressure was monitored with a Sensotec 0-5000 PSI strain gage transducer and a Daytronics digital strain gage indicator/amplifier conditioned the signal to be recorded on the strip chart recorder. Temperature and pressure for each valve was recorded during testing.

A bottle source of dry nitrogen with its respective regulator and shut off valves was used as the pressure medium for all heating cycles.
A 98% pure CP grade bottle of methane was used to pressurize the test valves for all fugitive emission leak rate tests.

5.0 INSTRUMENTATION UTILIZED

5.1 Instrumentation Schematic Drawing



5.2 Instrumentation Description

The Organic Vapor Analyzer (OVA) used during all testing was a Foxboro Model 128 dual mode analyzer. The instrument was used only in survey mode (Mode 1) which provides continuous operation for screening an area for total organics and reporting the values directly in parts per million (PPM) methane equivalent.

In the survey mode, the OVA 128 uses a flame ionization detector to monitor the presence of organic vapors. The internal signal processor then converts and displays the results constantly to a hand held sample probe and meter. Sample gathering at the sniffer tube is accomplished by a small diaphragm air pump contained in the instrument.

Calibration of the instrument is accomplished by introducing two known concentrations of certified calibration gases, with an adjustment of the instrument's potentiometer providing the necessary accuracy. The two (2) gases furnished with this instrument consist of zero gas for properly setting the instrument zero and a 95 PPM methane for setting concentration and range readings.

Complete calibration of the instrument was performed prior to testing and at the conclusion of the test program. A change of less than 3 PPM was noted during the final calibration.

A daily calibration check was made prior to each test using the recommended procedure in the instrument operating manual.

6.0 TESTING DETAILS & RESULTS

6.1 Mechanical Cycling at Ambient Temperature Test

6.1.1 Test Procedure

At ambient temperature, pressurize test valves to 1000 PSI methane, cycle valve full open to full close 20 times and then sniff area of the valve stem and seal within 1/2" of stem using the Organic Vapor Analyzer (OVA).

6.1.2 Failure / Test Completion Criteria

A reading of 1000 PPM or greater is considered failure criteria. An adjustment of the bonnet seal gland nut may be made on any valve that reaches a 1000 PPM leak rate. Repeat cycling procedures until 2000 cycles have been completed or until the valve cannot be further adjusted to bring it within the 1000 PPM leak rate.

6.1.3 Test Results: Parker PGI PTFE Pressure-Core® Seal

CYCLES	LEAK RATE PPM	COMMENTS
250	0	
500	0	
750	0	
1000	10	
1250	10	
1500	1	
1750	0	
2000	0	End of test

6.1.4 Test Results: Competitor Adjustable PTFE Packing

CYCLES	LEAK RATE PPM	COMMENTS
40	>1000	Tighten gland 1/4 turn
70	>1000	Tighten gland 1/8 turn
92	>1000	Stopped test

6.1.5 Test Summary

A. Parker PGI Pressure-Core® Seal

The Pressure-Core® Seal completed 2000 mechanical cycles (full open to full close), at which time the testing was stopped. The leak rate throughout the 2000 cycles never exceeded 10 PPM.

Operation of the valve was smooth and the force required to turn the stem was minimal.

B. Competitor Adjustable PTFE Packing

The adjustable PTFE seal failed at the 40th, 70th and 92nd mechanical cycle. The gland nut had to be readjusted after each failure. The test was aborted at cycle 92 since the valve was showing a pattern of failure.

This valve was more difficult to turn from the onset, and got progressively worse as the gland nut was adjusted.

6.2 Heat Cycle Test

6.2.1 Test Procedure

Purge the valves using dry nitrogen and then pressurize valves to 1000 PSI nitrogen with the stem in the 1/2 open position. Heat the valves to 400° F in the oven, remove and let air cool to ambient. Purge the nitrogen from the system with methane and then pressurize to 1000 PSI with methane. Sniff the area of the valve stem and bonnet seal within 1/2" of the stem using the OVA. Cycle the valve open and closed five (5) times and repeat the OVA sniffing procedure.

6.2.2 Failure / Test Completion Criteria

A reading of 1000 PM or greater is considered failure criteria. An adjustment of the bonnet seal gland nut may be made on any valve that reaches 1000 PM leak rate. Repeat the above procedures until ten (10) heat cycles have been completed or until the valve cannot be further adjusted to bring it within the 1000 PPM leak rate.

6.2.3 Test Results: Parker PGI Pressure-Core® Seal

MECH. CYCLES	HEAT CYCLES	LEAK RATE PPM
0	1	30
5	1	8
5	2	30
10	2	15
10	3	5
15	3	10
15	4	10
20	4	6
20	5	5
25	5	5
25	6	30
30	6	30
30	7	10
35	7	5
35	8	20
40	8	45
40	9	10
45	9	4
45	10	0
50	10	0

6.2.4 Test Results: Competitor Adjustable PTFE Packing

MECH. CYCLES	HEAT CYCLES	LEAK RATE PPM	COMMENTS
0	1	>1000	Tighten gland ¼ turn
5	1	0	
5	2	>1000	Tighten gland ¼ turn
10	2	0	
10	3	>1000	Stopped test

6.2.5 Test Summary

A. Parker PGI Pressure-Core® Seal

The Pressure-Core® Seal completed all 10 thermal cycles and 50 mechanical cycles. The leak rates encountered ranged from 0 to 45 PPM over the duration of the test.

Operation of the valve was smooth throughout all cycles.

B. Competitor Adjustable PTFE Packing

The adjustable PTFE seal was tightened prior to heating and tested to assure no leakage was present. The valve was then heated for the first cycle. At the first test point after cooling, the leak rate exceeded the 1000 PPM threshold. The gland was again tightened. Five (5) mechanical cycles were then performed with a zero leak rate. The valve was subjected to two (2) additional heat cycles with the results being identical to the first heat cycle. The repeated failure pattern was enough evidence to abort the test after the third cycle.

The operation of the valve was initially smooth but as the gland nut was adjusted, the force to turn the valve increased considerably.

6.3 Modified Heat Cycle Test

6.3.1 Test Procedure

Purge the valves using dry nitrogen and then pressurize valves to 1000 PSI nitrogen with the stem in the 1/2 open position. Heat the valves to 400° Fin the oven, remove and let air cool to ambient. Purge the nitrogen from the system with methane and then pressurize to 1000 PSI methane. Sniff the area of the valve stem and bonnet seal within 1/2" of the stem using the OVA. Cycle the valve open and closed fifty times (50) times and repeat the OVA sniffing procedure every 10 cycles.

6.3.2 Failure I Test Completion Criteria

The failure criteria for this test was reduced to **100 PPM** or greater. An adjustment of the bonnet seal gland nut may be made on any valve that reaches 100 PPM leak rate. Repeat the above procedures until the valve cannot be further adjusted to bring it within the 100 PPM specified leak rate.

6.3.3 Test Results: Parker PGI Pressure-Core® Seal

0/C CYCLES	HEAT CYCLES	COMMENTS
50	1	OK
100	2	OK
150	3	2 PPM leak rate
200	4	OK
250	5	OK
300	6	OK
350	7	OK
400	8	OK
450	9	OK
500	10	OK
550	11	OK
600	12	2 PPM
650	13	OK
694	13	10 PPM Stem frozen 1/2 open; test discontinued

6.3.4 Test Results: Competitor Low Emissions Graphite Seal

0/C CYCLES	HEAT CYCLES	COMMENTS
50	1	OK
89	2	Fail - Tightened gland 1/4 turn
139	3	OK
144	4	Fail - Tightened gland 1/4 turn
200	5	OK
250	6	OK
255	7	Fail - Tightened gland 1/8 turn
300	8	OK
350	9	30 PPM leak rate
350	10	Fail - Tightened gland 1/8 turn
400	11	2 PPM
450	12	10 PPM
500	13	20 PPM

6.3.5 Test Summary

A. Parker PGI Pressure-Core® Seal

A total of 694 mechanical cycles and 13 heat cycles were achieved. At that point, the stem froze at the 1/2 open position due to galling of the threads. The leak rate at that cycle was 10 PPM. Prior to that, 2 PPM had been the maximum leak rate recorded.

B. Competitor Low Emissions Graphite Seal

The Competitor valve used in this portion of the test included a low emissions graphite stem seal. This packing is warranted against leaks for three (3) years from the date of shipment at a level of less than 100 PPM. Maximum temperature is 1,000° F.

This valve received a total of 500 mechanical cycles and 13 heat cycles. During that time the valve failed four (4) times requiring an adjustment to the gland nut after each failure. The initial operation of this valve was smooth. As the gland was tightened, the force to turn increased to a point that one man could not perform more than a few cycles without stopping to rest. At this point two technicians were assigned to trade off in order to complete the test.