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Accession No. 12152

COMPARATIVE EVALUATION OF GASKET MATERIAL IN ACID SERVICE

Prepared by:
J. E. Preiser

ABSTRACT

Nine types of gasket material were tested under controlled conditions in 60% HNO_3 and 98% H_2SO_4 acid service at 210°F to investigate their chemical resistance and mechanical characteristics. The report is intended as an aid in the selection of gasket material for this service.

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COMPARATIVE EVALUATION
OF
GASKET MATERIAL IN ACID SERVICE

I. SUMMARY

PURPOSE

To obtain comparative performance data on various gasket materials in sulfuric and nitric acid service at elevated temperatures. This information will be used as a guide in gasket selection for process applications.

SCOPE

Nine types of gasket material were tested in 98% sulfuric and 60% nitric acids at 210°F and 45 psig operating pressure. Periodic inspections were made during the tests for leaks. Comparative evaluation of performance was made in an engineering workshop following the test program. G. F. Hickey, E.S.D. Maintenance Engineering Consultant, assisted in the gasket selection, test design and comparative evaluation phases.

RESULTS AND CONCLUSIONS

1. A summary of comparative performance data is shown in Table I.
2. Virgin Teflon® and glass-filled "Teflon" showed some evidence of creep under test operating conditions. Creep is aggravated with increased temperature and pressure and may lead to failure when temperatures exceed 300°F.

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3. The Duriron "Task Line" gasket (Teflon®-stainless steel) showed no noticeable evidence of creep under temperatures and pressures encountered in the test. Company operating experience has shown this material to be suitable in temperatures up to 400°F.
4. The envelope gasket made of "Teflon" with compressed asbestos insert (Garlock 8547) showed no evidence of creep in either of the test programs. Field installations in other services as high as 550°F have given satisfactory service.
5. The blue asbestos impregnated with "Teflon" (Johns Manville Chempac 92) was outstanding in its performance. Field experience has demonstrated successful applications of this material in high temperature, high pressure service (440°F-500 psi).
6. Test results show the Mosite Rubber Co. envelope gasket of Viton® fluoroelastomer to be satisfactory in 98% sulfuric acid service. However, severe degradation occurred in 60% HNO₃ after 800 hours' exposure.
7. The Klinger Acidit material became brittle after exposure to the test acids. System mechanical stresses could lead to ultimate failure.
8. Armalon PDX7700 gasket material performed well in both services. The recommended 15 foot-lb. bolts torque makes it an excellent candidate for use in glass-lined or plastic pipe systems. Retorquing of flange bolts due to gasket relaxation will be necessary to maintain a leak-free system.
9. Satisfactory leak-free gaskets can be formed using the Crane "Zip Joint" material; however, installation difficulty between vertical flange faces will restrict its use.

RECOMMENDATIONS

1. Use test results and other data sources as a guide in selecting gasket material for specific process application.
2. Consider temperature limitations and related creep problems in the application of products made of "Teflon" as gaskets.

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3. Consider gasket face loading requirements in glass lined or plastic pipe systems as stress induced from flange bolts could cause pipe failure.
4. Compare cost and performance of various gasket materials in selecting the most suitable material for process systems.

Noted by:

G. F. Hickey
G. F. Hickey
Engineering Service Division

Prepared by:

J. E. Preiser
J. E. Preiser
Engineering Service Division
Engineering Test Center

Submitted by:

L. R. Millett
L. R. Millett
Engineering Service Division
Engineering Test Center

Approved by:

E. M. Homan
E. M. Homan
Engineering Service Division
Engineering Test Center

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II. DISCUSSION

TEST DESCRIPTION

A flow loop operating at 210°F and pressure of 45 psig was used for the testing of gasket materials in acid service. Gaskets were installed using torques recommended for the specific material. Two sets of similar materials were tested. One set was subjected to 98% H₂SO₄ for 1500 hours. A second set was subjected to 60% HNO₃ for 800 hours. Observations were made during the test for leaks, extrusion and other external evidence of failure. Qualitative evaluation of performance was determined in an engineering workshop at the conclusion of physical testing.

ENGINEERING EVALUATION

Task Line (The Duriron Co.)

This gasket is made of molded virgin Teflon® with a perforated stainless steel core. Performance in both the HNO₃ and H₂SO₄ tests was excellent. Inspection following testing showed no deformation or tendency to creep at the temperatures and pressures encountered.

Garlock Co. 8547

Construction of this gasket (Du Pont Code G58) consists of an envelope made of "Teflon" molded over a Grey SBR Bonded compressed white asbestos core. Performance under conditions of both tests was excellent. No creep or deformation was evident in the inspection which followed the test program.

Dore Inc. - Glass-Filled "Teflon"

A glass-filled sheet of "Teflon" was used to cut gaskets of the appropriate size for the tests. Performance in both acids was excellent and no problems were encountered. Inspection following the tests revealed some evidence of creep on the inner circumference of the gasket. This should not become a problem, based on plant experience, unless temperatures in excess of 300°F are encountered.

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Virgin Teflon®

Material was purchased in 1/16" sheet form and gaskets of the appropriate size were cut for the tests. The material remained both leak- and maintenance-free for the duration of each test. Inspection at the conclusion of the tests revealed more extensive creep of "Teflon" than that encountered with the glass-filled material. Operation at higher temperatures would have required retorquing of flange bolts.

Armalon PDX7700 - Du Pont - Fabrics & Finishes Department

Armalon is a felt made of "Teflon" impregnated with "Teflon". The material is available in sheet form and gaskets are cut to the required size. This material offers the advantage of low seating stress and should be considered for use with glass-lined or plastic pipe. While slight leakage occurred after 20 hours in the nitric acid test and 216 hours in the sulfuric acid test, leaks were easily stopped by retorquing bolts to the original 15 foot-lb. loading. Inspection following testing revealed some signs of porosity. Seating stress imposed was low and porosity would have been much less with a higher loading. Porosity noted, however, was not judged harmful to the material's overall performance.

Zip Joint - John Crane Packing Co.

This material is string made of virgin "Teflon" 3/32" in diameter. The appropriate length of material is pulled from a can dispenser for installation. The manufacturer suggests that a single strand, with ends overlapped, is sufficient for sealing the joint. Leaks resulted when the recommended installation procedure was followed. Leak-free operation was achieved using several strands of the material and a bolt torque of 130 ft.-lbs. Installation of the material between flanges in the vertical position was difficult. For this reason, testing was limited to the nitric acid service. Leak-free joints can be obtained with this material. Its use as an emergency gasket, rather than a standard gasket, is recommended.

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Chempac 92 - Johns Manville

Basic material for this sheet gasket is woven blue asbestos cloth impregnated with "Teflon". Processing includes a press compaction and resintering operation. Performance in the nitric and sulfuric acid services was excellent. Inspection following the tests showed no deformation, porosity, embrittlement or other evidence which would indicate the possibility of future failure.

Klinger Acidit - Richard Klinger, Inc.

This gasket is compressed white asbestos with a polyvinyl chloride binder. Performance during both tests was excellent with no external signs of failure. Inspection following testing revealed that exposure to each acid had caused material embrittlement. The material cracked when subjected to a slight bending stress and flakes of material could be chipped off easily with the fingernail. Its use in a system subjected to rapid heating and cooling or vibration could result in mechanical failure.

Envelope of Viton® - Mosites Rubber Co.

Gasket construction consisted of an envelope of "Viton" molded over a 316 stainless steel core. Performance of this gasket in sulfuric acid service for 1500 hours was excellent. Inspection following this test revealed no degradation or swelling of "Viton". Exposure of the material to 800 hours' nitric acid service, however, produced unsatisfactory results. While leaks did not occur during the test period, relatively few additional test hours would have resulted in failure. Inspection revealed severe degradation of "Viton" and erosion with scarcely $\frac{1}{4}$ " of unattached material on the circumference of the gasket maintaining a seal.

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GASKET MATERIALS IN ACID SERVICE

TYPE	MANUFACTURER	COMPOSITION	BOLT (1) TORQUE (FT-LBS)	APPROX. (2) PRICE PER GASKET	HOW PURCHASED	PERFORMANCE				GASKET CONDITION AFTER TESTING		
						98% H ₂ SO ₄	60% HNO ₃	98% H ₂ SO ₄	60% HNO ₃	98% H ₂ SO ₄	60% H ₂ SO ₄	60% HNO ₃
ZIP JOINT	John Crane Packing Co.	Rope of Virgin Teflon®	130	\$.25	Can con- taining 50' of 3/16 rope	Not Tested	Good (3)	-	-	-	-	Good
TASK LINE	Duriron Co.	Virgin "Teflon" with S/S insert	130	1.46	Precut gaskets	Good	Good	Good	Good	Good	Good	Good
ARMALON PDX 7700	Du Pont Fabrics & Finishes Dept.	"Teflon" impreg- nated "Teflon" cloth	15	4.50	Precut gaskets	(4)	(4)	Good	Good	Good	Good	Good
8547	Garlock	Envelope of "Teflon" over compressed asbestos	30	1.90	Precut gaskets	Good	Good	Good	Good	Good	Good	Good
CHEMPAC 92	Johns Manville	Pressed and re- sintered woven blue asbestos with impregnant of "Teflon"	110	1.44	Sheet	Good	Good	Good	Good	Good	Good	Good
GLASS- FILLED "TEFLON"	Dore Inc.	Glass-filled "Teflon"	130	1.21	Sheet	Good	Good	(5)	(5)	(5)	(5)	(5)
VITON® ENVELOPE	Mosites Rubber Company	Envelope of "Viton" over S/S insert	10	5.40	Precut gaskets	Good	Good	Good	Good	Good	Good	(6)
KLINGER ACIDIT	Richard Klinger Inc.	Compressed white asbestos with PVC binder	35	.53	Precut gaskets	Good	Good	(7)	(7)	(7)	(7)	(7)
VIRGIN "TEFLON"	-	Virgin "Teflon"	80	.58	Sheet	Good	Good	(5)	(5)	(5)	(5)	(5)

- (1) Figures shown for each gasket represent that minimum torque which experience has shown is necessary to sufficiently seal the minute surface imperfections on flange faces. The torque is related to the hardness of each material. Flanges were 2" ASA 150#.
- (2) Exact prices should be obtained at each location. Price is for 2" 150# ring gaskets.
- (3) Leakage occurred when material was used according to manufacturer's specifications. See Engineering Evaluation.
- (4) Leakage occurred initially. Retorquing corrected the condition.
- (5) Some cold flow of "Teflon" apparent.
- (6) Severe degradation was evident.
- (7) Gaskets were hard and brittle.

TABLE I

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