

TWR- 19968

FINAL REPORT FOR  
THE EVALUATION OF A METERED MIXER FOR RTV  
SILICONE FOR RSRM NOZZLE BACKFILL OPERATIONS

SEPTEMBER 1989

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
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SPACE OPERATIONS

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FINAL REPORT  
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THE EVALUATION OF A METERED MIXER FOR RTV SILICONE  
FOR RSRM NOZZLE BACKFILL OPERATIONS

SEPTEMBER 1989

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REFERENCES

TWR-18306 EFFECT OF LOW TEMPERATURE AND HIGH HUMIDITY ON THE CURE OF STW5-2813 SEALANT

TWR-18115 THE EFFECT OF TEMPERATURE AND HUMIDITY ON RSRM NOZZLE BACKFILL OPERATIONS

PEI-846 ELIMINATING ENTRAPPED AIR IN THE RSRM NOZZLE BACKFILL JOINT

STW5-2813 SEALANT, SILICONE, ROOM TEMPERATURE VULCANIZING

ETP-0442 THE EVALUATION OF A METERED MIXER FOR RTV SILICONE FOR SRM NOZZLE BACKFILL OPERATIONS

Process Engineering Technical Report Categories

- Adhesives
- Bond and Void Problems
- Nozzles
- Rubber, Silicone
- Sealant
- Semco Cartridge
- Void

## 1.0 INTRODUCTION AND SUMMARY

Manufacturing Engineering requested that Process Engineering investigate metered mixing specifically for the RSRM backfill operation. Projected advantages were the elimination of waste RTV silicone produced in the operation and the elimination of entrapped air during the mix.

Although metered mixing proved to be a viable method for mixing the Dow Corning DC 90-0006 rubber with its catalyst, applying the technology to the RSRM backfill operation has several disadvantages that are decisive. Use of a metered mixer would increase the amount of material that was being scraped for each backfill and increase the amount of time required to clean up the equipment after each operation. Therefore, use of metered static mixers is not recommended for use in the RSRM nozzle backfill operations.

This report documents only the investigation of metered mixers for use in the backfill operation. Because metered mixers proved to have significant disadvantages other methods of mixing and dispensing the RTV during the backfill operation are being investigated, and will be reported in a separate document.

## 2.0 CONCLUSIONS

1. Tests results show that the metered mixers produced material with good physical characteristics and eliminated entrapped air.
2. Currently, approximately two backfill operations are performed per month, approximately 12 pounds of RTV rubber are mixed for each operation.
3. Metered mixers capable of mixing the RTV rubber and dispensing it into the nozzle joint at the required pressure need approximately 6 pints or 7.2 lb of catalyst to prime the system. This would mix with 72 lb of base material on a ten to one ratio.
4. Storage requirements limit maximum cumulative exposure time out of controlled storage to 30 days.
5. Use of a metered mixer would require cleaning the equipment at best once per month and at worst after every backfill. At the vendor sight, after our tests, cleaning of the metered mixer demanded 8 man-hours.

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6. Use of the metered mixer to perform the RSRM backfill would produce excessive amounts of waste material and increase the amount of time required to clean up the mix equipment after the operation.

### 3.0 RECOMMENDATION

It is recommended that metered static mixers not be used to perform the RSRM nozzle backfill operation.

### 4.0 DISCUSSION AND RESULTS

#### 4.1 Problem Under Investigation

Process Engineering recommended that metered mixers be investigated as a possible method to mix the Dow Corning DC 90-006 base RTV silicone rubber with its catalyst (see PEI 846). Another projected benefit was that the metered mixer could inject the mixed solution directly into the nozzle joint; thus, eliminating the Semco loading tube operation. Metered mixers were also seen as a possible means of eliminating any possibility of entrapping air in the joint.

Manufacturing Engineering requested that we take a closer look at metered mixers as a method to perform the backfill operation (Work Request I89052). An Engineering Test Plan (ETP-0442) was written and the tests performed as outlined in the test.

#### 4.2 Objectives of Investigation

Test objectives outlined in ETP-0442 are listed as follows.

1. To determine if the metered mixer is suitable for the RSRM nozzle backfill operations.
2. To determine what optional equipment is necessary to perform a successful backfill operation.
3. To determine optimum operating parameters for a successful backfill operation using the metered static mixer.

#### 4.3 Plan of Investigation and Results

Tests to determine if metered mixing was suitable for the RSRM backfill operations were performed at two vendor sights; Liquid Control Corporation of North Canton, Ohio and Sealant Equipment and Engineering of Oak Park, Michigan.

Dow Corning 90-006 RTV Silicone rubber was the material tested in the metered mixers. It was tested at a ten to one weight ratio of base to catalyst.

##### Sealant Equipment and Engineering

Sealant Equipment and Engineering was the first vendor to be visited. Their equipment used double action cylinders which could be adjusted to various ratios by means of a lever drive arm. The material was fed into a static mixing tube which consisted of 32 mixing elements. These elements divided the RTV into 2 raised to the 32<sup>nd</sup> power times. The ratios were adjusted until a 10:1 weight ratio was achieved. Flow rates were taken and sample cups were shot. Shore A hardness readings were taken and the average was 42.2, which is an acceptable level according to Material Specification STW5-2813c.

The equipment used at Sealant Equipment and Engineering was sensitive to pressure loss in the lines when the cylinders cycled. Also, the proper flow rates were difficult to obtain at the beginning of the test due to residual contamination in the catalyst reservoir left there from a former test. This contamination caused the catalyst to coagulate; consequently flow problems arose.

A Lexan joint was used to simulate the phenolic nozzle joint. A flat nozzle was used to inject the RTV into the Lexan joint. The RTV flowed well into the joint all the way to the O-ring. No problems were observed with flow, or the ability of the system to inject the RTV.

##### Liquid Control Corporation

Liquid Controls Inc, provided the equipment for the second set of tests. The system tested used two single-action cylinders and a single drive plate. Weight ratios are maintained by cylinder volume ratios. This system maintained line pressure by a fast return stroke of the drive plate. Mixing of the catalyst occurred at the gun; thus, eliminating material hardening in the

pumps. Shore A hardness of samples produced by the liquid control system averaged 37.9 which is well above the limit of 25.

Additional tests were run to determine the minimum number of mixer elements to mix the RTV. Use of six mix elements showed visible signs of unmixed catalysts. The cured RTV separated at the unmixed locations. Shore A hardness of the mixed regions was above the acceptable limit.

Eight elements mixed the material with no visible signs of unmixed catalysts. The standard number of elements for the Liquid Control system is 24. Therefore, use of 24 mix elements provides a substantial element of safety, ensuring proper mix of base material with catalyst.

Of the two systems tested, Liquid Control's system provided better control of material mixing and dispensing for our application. However, both systems required large amounts of base material and catalyst to prime the system. For the mixture to remain airless, the system must have sufficient material to maintain a minimum amount in the base and catalyst reservoirs until after the operation has been completed. Both systems tested would require a minimum of six pints of catalyst to prime the pumps and allow a small amount in the reservoir. Currently, a backfill operation requires approximately one pint of material to perform an entire backfill operation.

It would be possible to build a system to suit the backfill operations. Such a system would have smaller reservoirs and would feed directly from the pump to the static mixer and then to a Semco tube. This type of system would not allow us to perform a backfill operation directly from the metered mixer. It would still require a minimum of one pint of catalyst and two pints of base material to prime the system.

Both of the metered systems we tested would require large amounts of time to clean the equipment after the backfill was complete. Liquid Control Corporation had one man spend an eight-hour day to clean the metered mixer after our demonstration. Both systems would increase the amount of waste material that is produced as part of the process. For these reasons, metered static mixers are not recommended for use in the RSRM backfill operation.

In an attempt to document the work completed, a copy of the report from Liquid Controls Corporation is included as Attachment I. It includes test specifics and comments of the vendor on our application.

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ATTACHMENT I. Liquid Control Corporation Demonstration Report

TM

*Manufacturers of Precision Liquid Control Equipment*  
7575 Franklin Avenue, N.W. • P.O. Box 2747 • North Canton, Ohio 44720-0747  
Phone (216) 494-1313 • Telex 6502337513 • Fax (216) 494-6307

July 5, 1989

Mr. Brian K. Perry  
MORTON THIOKOL, INC.  
Wasatch Operations  
Space Division, M/S 415  
Box 524  
Brigham City, UT 84302

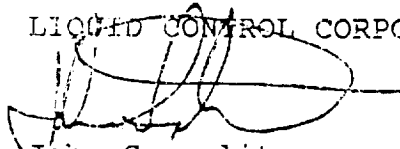
Dear Brian:

Enclosed is the report generated during the demonstration conducted at our facility.

If you have any questions or desire any additional information, please feel free to contact our West Coast Regional Sales and Marketing Manager, Mac Larsen, or me.

Very truly yours,

LIQUID CONTROL CORPORATION



John Scopelite  
Senior Applications Engineer

JS/chk  
Enclosure  
cc: Mac Larsen, LCC-WEST

Space Operations  
ATTACHMENT I. Liquid Control Corporation Demonstration Report (Continued)  
DEMO REPORT

DEMO NO. 1049 DATE 6-20-69 BY \_\_\_\_\_

CUSTOMER: Morton Thiokol  
Box 524  
Brigham City, UT 84302

APPLICATION: Material injected into a joint as a thermal barrier to protect  
O-ring

MACHINE TYPE: PR 25.946-10

DRIVE ASSEMBLY: Twin 6" dia. air cylinders  
POWER FACTOR: 46:1

MAXIMUM OUTPUT PER CYCLE: 45.96 cc's  
MINIMUM OUTPUT PER CYCLE: 6.89 cc's

MATERIAL FEED METHOD: A 5 gal. ASME with pressure  
B 1 gal. P.E.

METERING PUMPS: A 25.846mm stainless steel  
B 10mm stainless steel

OUTLET CHECK VALVE: A SIZE \_\_\_\_\_ SEAT \_\_\_\_\_  
B SIZE \_\_\_\_\_ SEAT \_\_\_\_\_

MATERIAL OUTLET HOSES: A 1" ID + 3/4" ID x 5 teflon lined, stainless steel braided  
B 1/4" ID x 20' teflon lined stainless steel braided

MATERIAL INFORMATION

MANUFACTURER: Dow Corning

TYPE: Silicone

PRODUCT NO.	<u>90-006A</u>	<u>90-006B</u>
VISCOSITY @	<u>1,000,000 cps</u>	<u>100,000 cps</u>
SPECIFIC GRAVITY	<u>*1.46</u>	<u>.98</u>
VOLUME RATIO	<u>12.27</u>	<u>1</u>
WEIGHT RATIO	<u>10</u>	<u>1</u>

MIXED SPECIFIC GRAVITY: \_\_\_\_\_  
POT LIFE: 2 hrs. @ RT  
CURE TIME: 24 hrs. @ RT

RATIO RESULTS

	HIGH VOL.	LOW VOL.	RATIO	SETTING
1	<u>61.38</u>	<u>6.59</u>	<u>9.31:1</u>	
2	<u>58.72</u>	<u>5.97</u>	<u>9.84:1</u>	
3	<u>28.27</u>	<u>2.87</u>	<u>9.85:1</u>	

COMMENTS: \* As checked by Don Strauss at attended demo

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ATTACHMENT I. Liquid Control Corporation Demonstration Report (Continued)

MIX RESULTS

INJECTION BLOCK: Over under block hi flow

MIXER: 1/2" pipe mixer 24 element

DISPENSE VALVE: Flow gun

FLOW RATES: @ ~~40~~ PSI. 15 PSI 318.18 gr/min/ 333.34 gr/min/ 337.98 gr/min.  
@ ~~60~~ PSI. 20 PSI 534.24 gr/min/ 739.54 gr/min/ 697.56 gr/min.  
@ 80 PSI.

ADDITIONAL INFORMATION: Whip hose from pipe mixer to flow gun 3/8 nylon hose by 4'

MIX SAMPLE TYPE: Tins and butterfly samples

CURE SCHEDULE: Overnight at RT

MIX RESULTS: Material mixed well and samples came out fine

CUSTOMER SAMPLE: Filled customer's joint mock up and material completely filled cavity

FILLING PROCEDURE: Injected material with customer's special nozzle

CURE SCHEDULE: Overnight at room temp.

SUMMARY, CONCLUSION, AND SPECIAL RECOMMENDATIONS:

A machine with a single 6" air cylinder will do the job. After testing for mix, we determined a 5/8" x 12 and 3/8" x 24 will mix this material very well.

In this demo we also tried a mini over/under attached to the flow gun with a 3/8" x 24 disposable mixer on the flow gun. This worked well. The Dow material as a lot of pigment in the "A" side and cleanup is extremely time consuming.

The tanks on this machine should be teflon coated because the silicone reacts with the galvanizing and causes it to cure.

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