



HELIUM EXPANSION ENGINE DYNAMIC O-RING TEST PROGRAM

C.B. Pallaver
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INTRODUCTION

The Koch Wet and Dry Expansion Engines use Dynamic O-rings at the warm end (crosshead) of a plunger type piston to seal the low temperature gas to atmosphere.

Each piston uses two O-rings and two grease impregnated felts that supply lubrication during operation.

These engines each have two cylinders which run 180° out of phase. For more information about these expanders see "Fermilab's Satellite Refrigerator Expansion Engines" by Tom Peterson, in Advances in Cryogenic Engineering, Vol. 29, 1984.

METHOD USED

An existing spare wet engine was used to test the crosshead O-rings. This engine was driven by a DC Drive controlling the speed at 250 RPMS.

With the four engine cylinder valves propped open and the inlet and outlet bayonet valves closed, a trapped volume of Helium gas was transferred back and forth within the two cylinders.

A high pressure Helium bottle supplied makeup gas the condition of the O-rings was determined by the loss of Helium gas. One thousand hours of continuous operation was selected as inspection time.

CONCLUSIONS

TEST 4: With Houghton Cosmolube Grease: Cylinders O-rings, and felts looked very good. Had a sort of slippery feel and very little grease migrated down walls of the cylinders.

TEST 6: Which lost a remarkable only 100 psi proved planned or accidental mixing of greases have no effect on wear. One important area not measured after each test was finish of cylinder walls.

NOTE: This test program and all test data where a result of an interested engine technical group particularly Tom Peterson, Ernest Ramirez, Mark Gilmour and Jeff Spencer.

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TEST RESULTS

| TEST | ¹ 'O' RING | ² FELTS | ³ 'O' RING GREASE | CROSS HEAD GREASE | ³ CROSS HEADS | HOURS | ⁴ HELIUM LOSSES | INSPECTION | REMARKS |
|------|-----------------------|-------------------------------|------------------------------|-------------------------|------------------------------|-------|----------------------------|--|--|
| 1 | #7507 | BOOTH | CITGO PREM EP2 | EXXON LIDOK EP1 | SLEEVED | 946 | 2000 PSI | 'O' RING WEAR, TOP SIDE FELTS LIMITED WEAR | |
| 2 | #7507 | BOOTH | CITGO PREM EP2 | EXXON LIDOK EP1 | SLEEVED | 1,079 | 5,545 PSI | 'O' RINGS WEAR, TOP SIDE FELTS LIMITED WEAR | SMALL 'BACK UP' 'O' RINGS WERE USED ON #1 CYLINDER TO PREVENT STANDARD 'O' RING FROM MOVING |
| 3 | #7507 | BOOTH | HONGHTON COSMOLUBE | HONGHTON COSMOLUBE | SLEEVED | 69 | 1,200 PSI | CHIPPED 'O' RINGS #1 SIDE | #1 CYLINDER BACK-UP RINGS USED #2 CYLINDER STANDARD |
| 4 | #7507 | BOOTH | HONGHTON COSMOLUBE | HONGHTON COSMOLUBE | SLEEVED | 980 | 2,094 PSI | 'O' RINGS AND FELTS NO APPRECIABLE WEAR | |
| 5 | #7507 | 3- BOOTH SEE REMARKS | MIXED SEE REMARKS | MIXED SEE REMARKS | STANDARD CHROME PLATED | 143 | 350 PSI | #2 CYLINDER FELTS SHOWED APPRECIABLE WEAR | #1 CYLINDER-CITGO PREM EP2 ON 'O' RINGS AND FELTS, EXXON LIDOK EP1 ON CROSS HEAD #2 CYLINDER-MIXED CITGO PREM EP2 AND EXXON LIDOK AND USED ON 'O' RINGS AND FELTS #1 CYLINDER-PLACED A THIRD FELT ABOVE 'O' RINGS AS A WIPER FELT |
| 6 | #7507 | 3- BOOTH | MIXED | MIXED | STANDARD CHROME PLATED | 1,001 | 100 PSI | #1 AND #2 'O' RINGS AND FELTS SHOWED NO APPRECIABLE WEAR | SAME AS TEST #5 |

¹ 'O' RINGS- PRECISION RUBBER PRODUCTS, LEBANON TENN.,.210 DIA. NITRILE, 70 DUROMETER ,HAND BUFFED

² FELTS-BOOTH FELT CO.,CHICAGO,ILL. TYPE BDF 1/4' SQUARE 30 DEGREE BEVEL

³ CROSS HEADS AND SLEEVES- CARBON STEEL .0002 CHROME PLATE 12 RMS FINISH.

⁴ HIGH PRESSURE BOTTLE 213 SCF AT 2200 PSI