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ISSUE DATE: 31 May 2017

REPORT No.: 103048791COL-001

# TEST REPORT

REPORT No.: 103048791COL-001

RENDERED TO:

Company: EcoCool World 10012 N Dale Marby Hwy Suite, B-107 Tampa, Fl 33618 USA

Contact: Mr. Don Bryan

#### GENERAL

This report gives the results of an evaluation of the lubricant additive IceCOLD, O-ring 33-1175, and Gasket 33-2513 with R-410A and POE, R-407C and POE, R-134a and PAG, and R-404A and ThermoKing compressor oil per ANSI/ASHRAE 97 Issue: 2007/06/27 Sealed Glass Tube Method to Test the Chemical Stability of Material for Use within Refrigerant Systems. A wear test with IceCOLD and R-410A was also conducted per ASTM D3233-93(2014) Method A. Samples of IceCOLD, ThermoKing compressor lubricant, O-rings and gaskets were provided by EcoCool World and received on 28 April 2017 in good condition and given the unique identification numbers COL1704281446-001 – COL1704281446-008. Testing occurred at the Intertek Columbus facility at 1717 Arlingate Lane, Columbus, Ohio 43228 between 16 May 2017 and 31 May 2017.

#### ASHRAE 97 TEST DESCRIPTION

Glass tubes and syringes were cleaned and rinsed, placed into an oven to evaporate the solvent, then removed to let cool. Copper and steel coupons were sanded to a dull shine. All coupons were rinsed with toluene, placed into an oven to evaporate the solvent, then removed to let cool. One copper, steel, and aluminum coupon was added to each tube. A piece of O-ring and gasket were cut and added to each tube. A syringe was flushed with the appropriate lubricant. 0.5 mL of lubricant was added to each tube: Control tubes contained neat lubricant while Test tubes contained 10% w/w IceCOLD mixed with lubricant. Tubes were constricted and placed on a manifold. The manifold was flushed with the proper refrigerant then evacuated to less than 200 millitorr. Tubes were chilled with liquid nitrogen. The pressure of refrigerant. The sample port valve was opened to add the proper amount of refrigerant. After all tubes were filled and frozen the manifold was evacuated. Sample port valves were opened to pull out non-condensable gases. When the vacuum was below 200 millitorr, the tubes were cut and sealed. Tubes were placed in an oven at 175  $\degree \pm 5^\circ$  C for 14 days.TAN was analyzed per Modified ASTM D974-12, modification due to small sample size. Dissolved metals were analyzed by ICP-OES per ASTM D5185-13e. Refrigerant was analyzed per AHRI 700-2016 Appendix C & D-2012 and GCMS





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to identify and quantify breakdown components. Hardness of the O-rings and gaskets was measured with a Shore M durometer.

Table 1 ASHRAE 97 Tube Descriptions				
Tube ID	Tube Description	Lubricant Volume (ml)	Refrigerant Volume (ml)	
ECW410A Control	R-410A / 32-3MAF POE Metal Coupons O-ring and Gasket	0.5	0.5	
ECW410A Test	R-410A / 10% IceCOLD 32-3MAF POE Metal Coupons O-ring and Gasket	0.5	0.5	
ECW407C Control	R-407C / 32-3MAF POE Metal Coupons O-ring and Gasket	0.5	0.5	
ECW407C Test	R-407C / 10% IceCOLD 32-3MAF POE Metal Coupons O-ring and Gasket	0.5	0.5	
ECW404A Control	R-404A / ThermoKing Metal Coupons O-ring and Gasket	0.5	0.5	
ECW404A Test	R-404A / 10% IceCOLD ThermoKing Metal Coupons O-ring and Gasket	0.5	0.5	
ECW134a Control	R-134a / ACDelco PAG 46 Metal Coupons O-ring and Gasket	0.5	0.5	
ECW134a Test	R-410A / 10% IceCOLD ACDelco PAG 46 Metal Coupons O-ring and Gasket	0.5	0.5	







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	Table 2 Calibrated Equipment				
Item	Equipment Type	Equipment #	Cal. Due Date		
1	Digital Manometer	CE 2524	8/3/2017		
2	Manifold	CE 2398	Initial Calibration Only		
3	Syringe	CE 2314	Reference Only		
4	Oven	CE 2435	Reference Only		
5	Data Logger	CE 2413	8/3/2017		
6	Thermometer	CE 2557	8/2/2017		
7	ICP	CE2100	Verify Before Use		
8	Analytical Balance	CE 1017	8/17/2017		
9	Karl Fisher	CE 1112	Verify Before Use		
10	GC	CE 1114	Verify Before Use		
11	GC	CE1104	Verify Before Use		
12	GC	CE1110	Verify Before Use		
13	Burette	CE 2458	Initial Calibration Only		
14	Barometer	CE 1109	Initial Calibration Only		
15	КОН	Lot 051017TE	Exp. 11/10/2017		
16	Indicator	Lot B00Q1909	Exp. 7/1/2020		
17	Toluene	Lot 170804	Exp. 2/1/2017		
18	IPA	Lot C796337	Exp. 1/1/2023		
	Micro Hardness				
19	Durometer	CE2619	11/2017		
	Micro Hardness				
20	Verification Discs	RS 285	11/2017		
21	R-410A	T-3916	N/A		
22	R-407C	T-105	N/A		
23	R-404A	T-5183	N/A		
24	R-134a	T-107152	N/A		
25	GC Mass Spec.	CE 2585	Verify Before Use		
26	КОН	Lot C689875	7/13/2017		

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#### CONCLUSION

This concludes the evaluation of the lubricant additive IceCOLD, rubber O-ring, and a gasket with R-410A and POE, R-407C and POE, R-134a and PAG, and R-404A and ThermoKing compressor oil per ANSI/ASHRAE 97 Issue: 2007/06/27 Sealed Glass Tube Method to Test the Chemical Stability of Material for Use within Refrigerant Systems and a wear test with IceCOLD and R-410A per ASTM D3233-93(2014) Method A. The results from this evaluation are outlined in the following tables.

Test Performed by:

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Tyler Eaton Associate Engineer Analytical Laboratory

Report Approved by:

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John Senediak Senior Chemist Analytical Laboratory







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#### ASHRAE 97 RESULTS

Table 3 Pre-exposure Analysis of Lubricants					
MoistureTotal Acid NumberLubricant(ppm)(mgKOH/g)					
32-3MAF POE	93	0.01			
ACDelco PAG 46	102	0.01			
ThermoKing Compressor Lubricant	105	0.02			

Table 4           Post-exposure Properties of Lubricants						
Tube ID	Tube Description	Dissolved Fe (ppm)	Dissolved Al (ppm)	Dissolved Cu (ppm)	Total Acid Number (mgKOH/g)	Refrigerant Decomposition* (mass %)
ECW 410A Control	R-410A / POE Metal Coupons O-ring, Gasket	3812	39.4	14.1	14.5	<0.05
ECW 410A TEST	R-410A / POE 10% IceCOLD Metal Coupons O-ring, Gasket	5555	17.6	21.0	14.8	<0.05
ECW 407C Control	R-407C / POE Metal Coupons O-ring, Gasket	2043	17.9	11.6	14.7	0.13
ECW 407C TEST	R-407C / POE 10% IceCOLD Metal Coupons O-ring, Gasket	2904	20.7	27.0	15.0	0.13
ECW 404A Control	R-404A / ThermoKing Metal Coupons O-ring, Gasket	1113	8.9	19.2	20.6	<0.05
ECW 404A TEST	R-404A / ThermoKing 10% IceCOLD Metal Coupons O-ring, Gasket	423.4	4.9	42.9	10.6	<0.05
ECW 134a Control	R-134a/ PAG Metal Coupons O-ring, Gasket	10.2	<0.1	68.2	0.55	<0.05
ECW 134a TEST	R-134a/ PAG 10% IceCOLD Metal Coupons O-ring, Gasket /MS Analysis on followi	11.5	<0.01	68.2	0.48	<0.05

\*See GC/MS Analysis on following page

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Tables

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# Table 5 GC/MS Analysis of ASHRAE 97 Tubes

IUbe	Tube Description	Trace Contaminants Not Present in Control Tube
ECW 410A TEST	R-410A / POE 10% IceCOLD Metal Coupons O-ring, Gasket	None detected
ECW 407C TEST	R-407C / POE 10% IceCOLD Metal Coupons O-ring, Gasket	None detected
ECW 404A TEST	R-404A / ThermoKing 10% IceCOLD Metal Coupons O-ring, Gasket	None detected
ECW 134a TEST	R-134a/ PAG 10% IceCOLD Metal Coupons O-ring, Gasket	None detected

Table 6           Change in Hardness of Gasket and O-ring: After vs. Before Exposure				
Tube ID	Tube Description	Change in Gasket Hardness (Shore M)	Change in O-ring Hardness (Shore M)	
ECW 410A Control	R-410A / POE Metal Coupons, O-ring, Gasket	< <del>±</del> 2	<±2	
ECW 410A TEST	R-410A / POE 10% IceCOLD Metal Coupons, O-ring, Gasket	< <u>+2</u>	<±2	
ECW 407C Control	R-407C / POE Metal Coupons, O-ring, Gasket	<±2	-2.1	
ECW 407C TEST	R-407C / POE, 10% IceCOLD Metal Coupons, O-ring, Gasket	< <u>+2</u>	<±2	
ECW 404A Control	R-404A / ThermoKing Metal Coupons, O-ring, Gasket	<±2	-4.6	
ECW 404A TEST	R-404A / ThermoKing 10% IceCOLD Metal Coupons, O-ring, Gasket	<±2	-2.4	
ECW 134a Control	R-134a/ PAG Metal Coupons, O-ring, Gasket	<±2	<±2	
ECW 134a TEST	R-134a/ PAG , 10% IceCOLD Metal Coupons, O-ring, Gasket	< <del>±</del> 2	< <u>±2</u>	

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(	Table Change in Volume% of Gasket and C	-	xposure
Tube ID	Tube Description	Change in Gasket Volume* (%)	Change in O-ring Volume* (%)
ECW 410A Control	R-410A / POE Metal Coupons, O-ring, Gasket	27.5 - 30.7	14.6 – 18.8
ECW 410A TEST	R-410A / POE 10% IceCOLD Metal Coupons, O-ring, Gasket	32.6 - 40.6	18.9 – 20.9
ECW 407C Control	R-407C / POE Metal Coupons, O-ring, Gasket	21.7 – 24.7	15.7 – 28.6
ECW 407C TEST	R-407C / POE, 10% IceCOLD Metal Coupons, O-ring, Gasket	20.4 - 28.2	16.1 – 30.2
ECW 404A Control	R-404A / ThermoKing Metal Coupons, O-ring, Gasket	12.8 - 33.0	14.7 – 18.5
ECW 404A TEST	R-404A / ThermoKing 10% IceCOLD Metal Coupons, O-ring, Gasket	14.8 – 23.9	19.9 – 33.4
ECW 134a Control	R-134a/ PAG Metal Coupons, O-ring, Gasket	1.4 – 8.5	6.4 – 11.2
ECW 134a TEST	R-134a/ PAG , 10% IceCOLD Metal Coupons, O-ring, Gasket	2.6 - 5.0	7.0 - 10.2
*Panga of 2 cam			

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\*Range of 3 samples







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Table 8           ASHRAE 97 Results, Visual Inspections					
Tube ID	Tube Description	Visual Inspection of Liquid Phase	Visual Inspection Fe Coupon	Visual Inspection Cu Coupon	Visual Inspection Al Coupon
ECW410A Control	R-410A / 32-3MAF POE Metal Coupons O-ring, Gasket	2b	3	1	0
ECW410A Test	R-410A / 10% IceCOLD 32-3MAF POE Metal Coupons O-ring, Gasket	2b	3	1	0
ECW407C Control	R-407C / 32-3MAF POE Metal Coupons O-ring, Gasket	2b	3	2	0
ECW407C Test	R-407C / 10% IceCOLD 32-3MAF POE Metal Coupons O-ring, Gasket	1b	3	2	0
ECW404A Control	R-404A / ThermoKing Metal Coupons O-ring, Gasket	2b	3	2	0
ECW404A Test	R-404A / 10% IceCOLD ThermoKing Metal Coupons O-ring, Gasket	1b	3	2	0
ECW134a Control	R-134a / ACDelco PAG Metal Coupons O-ring, Gasket	1a	1	2	0
ECW134a Test	R-410A / 10% IceCOLD ACDelco PAG Metal Coupons O-ring, Gasket	1a	1	2	0

Liquid Phase Visual Inspection Legend

0 =No change 1 = Slight darkening 2 = Moderate darkening 3 = Extreme darkening 4a = Opaque

a = clear b = cloudy

 Steel Coupon Visual Inspection Legend

 0 =No change
 1 = Slight darkening
 2 = Slight discoloration
 3 = Moderate copper plating
 4 = Heavy copper plating

 0 =No change
 1 = Slight tarnish
 2 = Moderate Tarnish
 3 = Slight corrosion
 4 = Heavy corrosion

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 Table 9

 ASHRAE 97 Tube Observations, Post Exposure

Tube ID	Tube Description	Observations*
ECW	R-410A / POE	Single yellow cloudy layer. White insoluble / particulate matter. Fe coupon moderate
410A	Metal Coupons	copper plating. Cu coupon slight tarnish. Aluminum coupon unchanged. Gasket shows
Control	O-ring, Gasket	darkening. O-ring appears unchanged. Foul odor.
ECW	R-410A / POE	Single yellow cloudy layer. White insoluble / particulate matter, black particulates. Fe
410A	10% IceCOLD	coupon moderate copper plating. Cu coupon slight tarnish. Aluminum coupon
-	Metal Coupons	unchanged. Gasket shows darkening. O-ring appears unchanged. Foul odor.
TEST	O-ring, Gasket	unchanged. Casket shows darkening. Ching appears unchanged. I bur bubi.
ECW	R-407C / POE	Single yellow cloudy layer. White and brown insoluble / particulate matter. Fe coupon
407C	Metal Coupons	moderate copper plating. Cu coupon moderate tarnish. Aluminum coupon unchanged.
Control	O-ring, Gasket	Gasket shows darkening. O-ring appears unchanged. Foul odor.
ECW	R-407C / POE	
-	10% IceCOLD	Single yellow cloudy layer. White and brown insoluble / particulate matter. Fe coupon
407C	Metal Coupons	moderate copper plating. Cu moderate slight tarnish. Aluminum coupon unchanged.
TEST	O-ring, Gasket	Gasket shows darkening. O-ring appears unchanged. Foul odor.
ECW	R-404A / ThermoKing	Single yellow cloudy layer. White insoluble / particulate matter. Fe coupon moderate
404A	Metal Coupons	copper plating. Cu coupon moderate tarnish. Aluminum coupon unchanged. Gasket
Control	O-ring, Gasket	shows darkening. O-ring appears unchanged. Foul odor.
	R-404A / ThermoKing	
ECW	10% IceCOLD	Single yellow cloudy layer. White insoluble / particulate matter. Fe coupon moderate
404A	Metal Coupons	copper plating. Cu coupon moderate tarnish. Aluminum coupon unchanged. Gasket
TEST	O-ring, Gasket	shows darkening. O-ring appears unchanged. Foul odor.
ECW	R-134a/ PAG	Single clear pale yellow layer. Brown insoluble / particulate matter. Fe coupon slight
134a	Metal Coupons	copper plating. Cu coupon moderate tarnish. Aluminum coupon unchanged. Gasket and
Control	O-ring, Gasket	O-ring appear unchanged. Foul odor.
	R-134a/ PAG	
ECW	10% IceCOLD	Single clear pale yellow layer. Brown insoluble / particulate matter. Fe coupon slight
134a	Metal Coupons	copper plating. Cu coupon moderate tarnish. Aluminum coupon unchanged. Gasket and
TEST	O-ring, Gasket	O-ring appear unchanged. Foul odor.
*See Phot	os in Appendix A	

\*See Photos in Appendix A

# WEAR TEST RESULTS

<u>······</u>	Table 10 Wear Test Results
R-410A, POE	R-410A, 10% IceCOLD in POE
Range of Pin Mass-loss(g)	Range of Pin Mass-loss(g)
0.0385 - 0.0493	0.0163 – 0.0182
Range of Wear-Scar (mm)	Range of Wear-scar (mm)
0.6 - 0.8	0.5 – 0.8







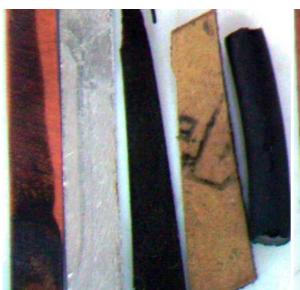
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#### **APPENDIX A: PHOTOS**

ASHRAE 97 Metal Coupons, Gaskets, and O-Rings, Post Exposure



R-410A Control: Cu, Al, Fe, Gasket, O-Ring



R-410A Test: Cu, Al, Fe, Gasket, O-Ring



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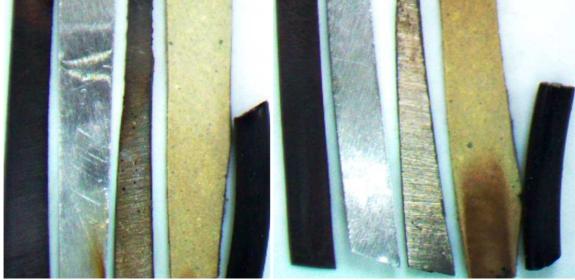
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R-404A Control: Cu, Al, Fe, Gasket, O-Ring

R-404A Test: Cu, Al, Fe, Gasket, O-Ring



R-134a Control: Cu, Al, Fe, Gasket, O-Ring

R-134a Test: Cu, Al, Fe, Gasket, O-Ring

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**ASHRAE 97 Tubes Post Exposure** 



R-410A Control





R-407C Control

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R-407C Test

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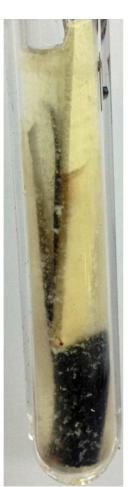


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R-404A Control

R-404A Test

R-134a Control

R-134a Test

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O-ring

Gasket

Samples

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