FINWORKS 709N/709NBH

Product Development

Finworks 709N/709NBH

*Finworks 709N is produced in the United States

*Finworks 709NBH is produced outside of the United States

Both products are chemically identical, the name difference is only to differentiate where the material was produced.

PRODUCT DEVELOPMENT AND LABORATORY EVALUATIONS

Test methods

- Hydrolytic Stability
- Plastics and Elastomers compatibility
- Water Contact Angle
- ASHRAE 97 sealed glass tube testing/Refrigerant Compatibility

Hydrolytic Stability Testing

- Method
  - The hydrolytic stability of lubricants is typically evaluated by heating 90 grams of lubricant and 10 grams of water to reflux in the presence of 1 gram of alumina. After heating for 48 hours, an additional 90 grams of water is added to the test container, and the contents are vigorously mixed to extract water soluble species. After separation of the lubricant and water phase in the test container, the water phase is analyzed by ion chromatography (IC) for the presence of carboxylates [such as acetate (acetic acid) and formate (formic acid)] implicated in producing formicary corrosion of copper.
- Results

Sample	Acetate (ppm)	Formate (ppm)
Finworks 709N/709NBH	<1	<1

Plastics compatibility with Finworks 709N/709NBH

- Plastic dumbbell shaped strips were wrapped in the center with cheesecloth and saturated with 709N/709NBH. Strips were put onto the test apparatus, which produced a strain of 4.13%. Results are after 15 days.

Plastic	Results
Noryl	broke in 4 hours
LDPE	no change in 2 weeks
Delrin	no change in 2 weeks
Polycarbonate	after cheesecloth removed, small crazing – 1 mm in length was observed
Teflon	no change in 2 weeks
ABS	no change in 2 weeks
Nylon	no change in 2 weeks
Polypropylene	no change in 2 weeks

Elastomer compatibility with Finworks 709N/709NBH

O rings were measured and weighed. They were put in aluminum weigh dish and covered with 709N/709NBH. The O rings were measured and weighed after 15 days

	(mm) before	(mm) after	weight (g) before	weight (g) after	% Diff. of Measurements	% Diff. of Mass
					Column1	Column2
FEP w/ silicone core	1.77	1.77	0.1515	0.1523	0.00	0.35
Buna N	1.58	1.57	0.111	0.1134	0.42	1.42
EPDM	1.79	1.77	0.1058	0.1584	0.75	24.89
Teflon	1.73	1.76	0.1969	0.1972	1.15	0.10
Kalrez	1.48	1.52	0.1738	0.1743	1.79	0.19
Hytrel	1.18	1.22	0.0703	0.0736	2.23	3.03
Neoprene	1.53	1.62	0.1342	0.1419	3.85	3.68
Viton	1.78	1.63	0.1655	0.166	5.78	0.20
Silicone	1.77	1.6	0.1257	0.1322	6.61	3.33
Fluorosilicone Rubbe	1.63	1.44	0.1322	0.1333	8.09	0.55
Polyurethane	1.73	1.49	0.1113	0.1126	9.70	0.77
HNBR	1.71	1.36	0.1202	0.1019	14.64	11.30
Natural Rubber	1.13	1.7	0.0638	0.0888	28.79	20.71

Water Contact Angle

- ASTM D7334
  - Discussion:
  - Coated Aluminum coupons of Finworks 709N/709NBH with a residual coating weight of 60 mg/sqft were evaluated for long term wettability using contact angle measurement. Contact angle is the angle formed at the interface between the liquid drop and the solid surface. A small contact angle is measured when the drop spreads across the solid surface. The contact angles of distilled water on each substrate were measured using a Rame-Hart Contact Angle Goniometer model 190-U1 with DROPimage CA v 2.5.
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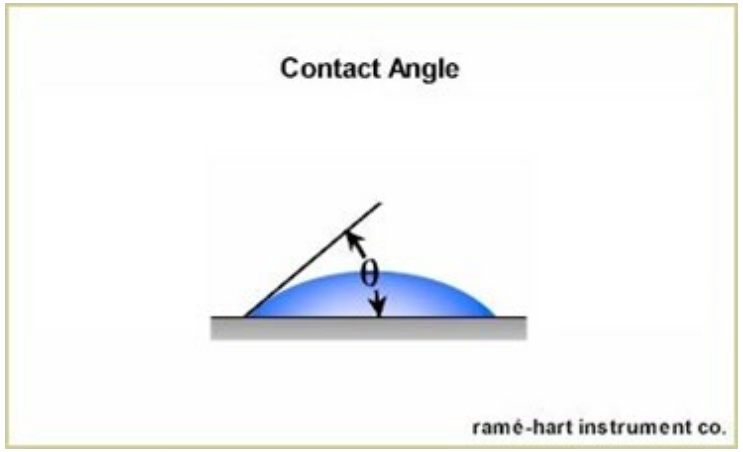
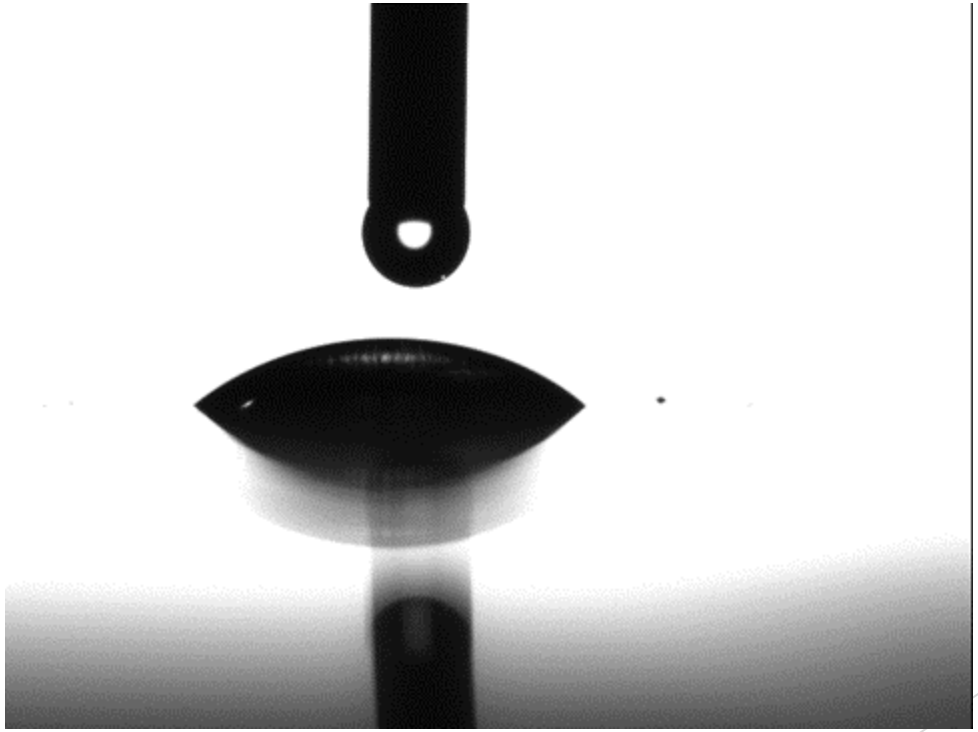


Water Contact Angle - Results

Sample	Average
Finworks 709N/709NBH #1 at 60 mg/sqft	30



ASHRAE 97/Refrigerant Compatibility with Finworks 709N/709NBH

- **EXPERIMENTAL METHOD:**

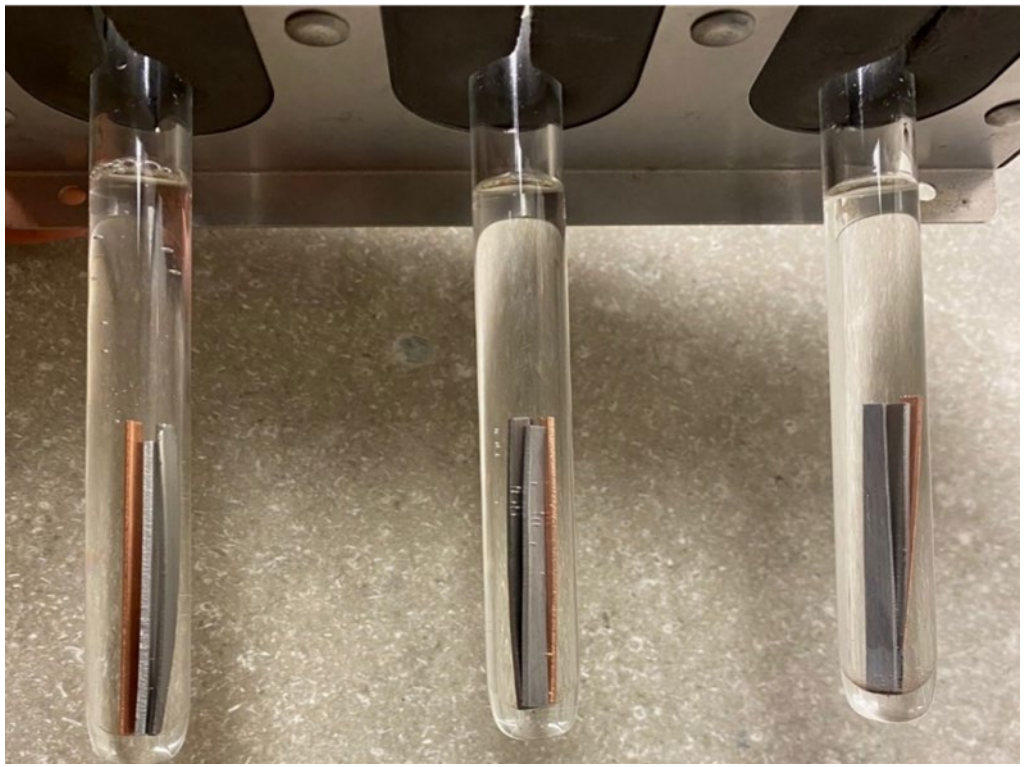
The process chemical was tested at a 0.5 weight/percent concentration. Steel, aluminum, and copper coupons were added to the glass tubes. After addition of the metal catalysts, lubricant/process chemical mixtures were added to the tubes. The PC/Lubricant mixture was dried down to a water content of 16 ppm as measured by Karl Fischer. The tubes were then connected to the vacuum/refrigerant charging manifold and a 200-micron vacuum was applied to the tubes. Refrigerant was added to each tube and then heat sealed under vacuum. The tubes were placed inside the testing chamber at 175^0 C for 14 days and removed from the chamber. After aging, the tube contents were visually examined for change in lubricant color, cloudiness in the lubricant, floc or particulate formation, corrosion of metal coupons, and copper plating on the steel surfaces. The tube contents were also analyzed for Total Acid Number (TAN) and by Inductively Coupled Plasma (ICP).

ASHRAE 97 – Results

	Table 2: Analytical Results of Sealed Tubes After Aging (with Finworks 709NBH)													
Refrigerant/Lubricant	Process Chemical Concentration	Pre-TAN mg KOH	Post TAN mg KOH/g	Inductively Coupled Plasma (ICP) Results ppm									
				Fe	Al	Pb	Cu	Si	B	Na	P	Zn	Mg
Control Tube /Standard	----	0.03	0.34	<1	<1	<1	2	2	<1	<1	<1	<1	<1
R410A/32-3 MAF	-----	-----	-----	---	---	---	---	---	---	---	---	---	---
	0.5wt%	0.00	0.44	<1	<1	<1	3	<1	<1	<1	<1	<1	<1
		Sample size of 2.0 g was used for both Standard and Process chemical tubes post TAN											

	Table 5: Metal Coupon Weights Before and After Aging (with Finworks 709NBH)							
Refrigerant/Lubricant	Process Fluid Concentration	Weight, g						
		Before			After			
		Cu	Al	Steel	Cu	Al	Steel	
	-----	-----	-----	-----	-----	-----	-----	
R410A/32-3 MAF	709NBH tube 1	2.0818	0.5886	2.116	2.0823	0.5891	2.1163	
	709NBH tube 2	2.0066	0.3002	1.9529	2.0069	0.3003	1.9536	
	709NBH tube 3	2.1577	0.2795	1.9707	2.1578	0.2798	1.9708	
	709NBH tube 4	1.8474	0.406	1.7675	1.8474	0.406	1.7674	

ASHRAE 97 - Results



Photograph of sealed tubes with 32-3MAF/R410A (CONTROL) left, 0.5 wt. /% right Finworks 709N/709NBH with 32-3MAF/R410A after aging