VRHCXXXX

REFRIG HEAL+H CHECK™

Intelligent Refrigerant Analysis

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bsi. ISO 9001 Quality Management FS 605178 | ISO 14001 Environmental Management EMS 605177 | AS/NZS 4801 Occupational Health & Safety Management OHS 605179

Customer Supplied Information

Sampling Date	01/01/2023	Unique Analysis	VRHCXXXX
Refrigerant Health Check **Purity, Composition, Moisture, Acidity, High Boiling Residue, Chloride, Oil Analysis, Particulates, Non-Condensable Gases**			

Customer Information			
Company Name			
Collection Address			
Contact/Sampler Name		**Contact Number**	
Email Address			
Sample Site/Site Number			

System Information			
System Type	Low Temperature Rack	**Equipment Name**	System 1 Low Temperature
Unit Manufacturer	Frigrite	**Model Number**	Protocol Rack
System Serial Number	1234	**Refrigerant Capacity (kg)**	1000kg
Gas Type to be Tested	R404a	**Asset Number**	
System Age	2009	**Ambient Temp**	24
System Comments: (i.e. Problems experienced, etc): Pre-Works Testing			

Refrigerant Test Information (Non-Condensable Analysis)	
System Temperature	28 Celsius
System Pressure	150 PSI
Total Unit Hours	

Oil Test Information			
Oil Type/Oil Name	BSE-32	**Hours on Oil**	
System Oil Capacity		**Date of Last Oil Change**	
Total Unit Hours			

Certificate of Analysis

Refrigerant Analysis Results					
Identified Refrigerant	R404A				
Characteristics	AHRI700 Limits		Result		Diagnosis
Purity - %W	99.5		100.00		**PASS**
Composition - % W	R125	42.0-46.0	R125	48.2	**FAIL**
	R143a	51.0-53.0	R143a	50.5	
	R134a	2.0-6.0	R134a	1.3	
Moisture by Karl Fisher - ppm	10		42		**FAIL**
High Boiling Residue = %W	0.01		0.04		**FAIL**
Acid – PPMW as HCl	1		<1		**PASS**
Chloride	No Visual Turbidity		PASS		**PASS**
Particulates/Solids	Visually Clean		PASS		**PASS**

Vapour Sample

Non-Condensable Gas - %v/v	1.5	1.76	**FAIL**

Refrigerant Diagnosis	**UNSATISFACTORY**

Refrigerant Analysis Comments
The refrigerant sample provided did not conform to AHRI700 standard for composition. A system running on gas that is out of composition spec may struggle to reach temperature and will be less efficient. It is recommended that the gas be removed from the system and replaced with a fresh charge. (Sample also failed on specifications for NCG, moisture and high boiling residue. No leak was detected during NCG testing - Temperature/Pressure were within range).

Oil Analysis Results			
Physical Properties		**Wear Metals (ppm, mg/L)**	
KF Moisture ppm (ASTM D6304)	426	**Iron (Fe)**	<1
Viscosity @40oC cST (ASTM D445)	32.9	**Chromium (Cr)**	<1
Oxidation Index (JOAP)	218	**Copper (Cu)**	3
PQ Index (OM019)	6	**Lead (Pb)**	<1
TAN mg KOH/g (ASTM D974)	0.18	**Tin (Sn)**	<1

Contaminants D5185 (ppm, mg/L)		**Additives D5185 (ppm, mg/L)**	
Silicon (Si)	17	**Calcium (ca)**	<1
Aluminium (Al)	<1	**Zinc (Zn)**	<1
Sodium (Na)	<1	**Phosphorus (P)**	<1
Particle Count		**Oil Diagnosis**	
ISO Code (ISO4406)	**19/16/11**	**SATISFACTORY**	

Oil Analysis Comments
Initial results are generally satisfactory. Wear levels are within limits. Viscosity is typical of an ISO 32 grade oil. Compartment is free from external contaminants. Continue sampling to monitor and establish trends.

Prepared By	Tony Trinh	**Date:**	02/03/2023
	Quality Assurance Chemist		
Authorised By	Simon Djordjevic	**Date:**	02/03/2023
	Laboratory Supervisor		

END OF REPORT

DISCLAIMER

1. **This Report is provided by A-Gas to the customer whose details appear on page 2 of this Report (Customer). The purpose of this Report is to provide general guidance to the Customer about the quality of the relevant refrigerant(s) and/or oil(s) used by the Customer in an operating HVAC system.**
2. **The Customer is solely responsible for ensuring that correct sampling procedures were followed in collecting the samples of the refrigerant(s) and/or oil(s) that are the subject of this Report. A-Gas does not accept any responsibility for ensuring that correct sample procedures were followed. The Customer acknowledges that not following correct sample procedures can significantly affect the results obtained from analysis.**
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      ii. **the ongoing operation of the relevant HVAC system or any part of it.**
   b. **A-Gas does not guarantee that the technical advice or recommendations made in this Report are correct, or adequate for the Customer's purposes.**
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GLOSSARY OF TERMS

Oil Analysis

The comments section of the Certificate of Analysis will identify any areas of concern found in the oil analysis. This section is intended to explain what analysis has been carried out and identify parameters in the oil that may be a cause for concern.

Moisture %

This test identifies the moisture content in the oil sample in ppm (parts per million). New oil tends to have a moisture content of 20-50ppm and low oil moisture content is desirable as it can have a destabilising effect on oil structure. Synthetic oils such as POE are hygroscopic and actively absorb moisture from the atmosphere, on taking an oil sample and allowing the refrigerant to boil out, absorption of moisture into the oil is unavoidable; it is therefore an expectation that synthetic oil samples will have elevated moisture levels

Viscosity @ 40oC

This test measures oil kinematic viscosity in centistokes (cSt) and is a measure of how 'thick' the oil is. Viscosity controls the ability of the oil to coat and protect the moving parts of machinery, as a general rule slow moving machinery normally uses more viscous oil, fast moving parts less viscous oil. In HVAC application the operating temperature of the equipment is taken into account as temperature affects viscosity. Different refrigeration oils are designed to have different viscosity, if the oil type is specified on the RHC information return sheet it allows easy comparison of viscosity against what it is supposed to be.

Oxidation Index

The Oxidation Index measures the degree of oxidation the oil has suffered. Generally, when oils are heated to high temperatures they oxidise and produce acidic compounds, in HVAC application, compressors that have burnt out or suffered very high discharge temperatures will have high oxidation index readings on the oil. Synthetic oils due to their chemical structure show a very high oxidation index when analysed using FTIR. In this instance, the TAN needs to be checked to verify if the oil is really oxidised; if oxidation index is high but TAN is low then this identifies that the oil is synthetic and not oxidised. As a guide a healthy mineral oil would be expected to have an oxidation index of around 15.

PQ Index

The PQ Index is a particle quantification specifically measuring magnetic debris (ie ferrous material). The PQ Index ranges from 1 to 9999 and is a good measure of machine wear, it however does not measure particle size and also won't pick up aluminium which is a component of most HVAC compressors. As a rough guide, if a PQ Index reading is over 200 this is a cause for concern and will be raised in the oil comments section of the Certificate of Analysis.

TAN

The TAN is the total acid number for the sample and should be used in conjunction with the Oxidation Index to determine whether oil has been exposed to high temperatures causing oxidation and acid creation. A new oil would be expected to have a TAN of around 0.01 to 0.02.

Wear Metals

The wear metals analysis uses ICP-OEMS to identify the presence of iron, chromium, copper, lead and tin in the oil sample (to a max particle size of <10µm). The elevated presence of these metals (over 13ppm as a guide) indicates that the system is experiencing wear; this should be viewed in conjunction with the PQ Index and particle count. Lead and tin are suggestive of bearings wear.

System wear will occur whatever the condition of the oil, so the number of hours the system has been running on the oil should be considered. Wear is a particular problem when particulates in the oil have a 'sandpaper' effect on the moving parts or if the oil viscosity is wrong or in HVAC application if the system is suffering poor oil return to the compressor.

Contaminants

Contaminants analysis uses ICP-OEMS to identify Silicon, Aluminium and Sodium concentrations in the oil sample. Silicon and Sodium are generally an indicator of dirt/ dust in the oil but can also be associated with sealing compounds. In HVAC application, Aluminium can be an indicator of wear as it is used in compressors.

Additives

This section is not relevant in HVAC oils; Calcium, Zinc and Phosphorous are important additives in engine oil, hydraulic fluid and turbine oil application but should not be present in oil used in HVAC application

Particle Count

The particle count is expressed by 3 numbers (for example: 23/22/18) which represents the number of particles of different sizes in a fixed volume of sample; particle size includes 4 micron/ 6 micron/ 14 micron. Particulates in the 4 micron region can be the most damaging to a system as they can act like sandpaper in the oil increasing wear. In oil removed from HVAC systems it is possible that tiny bubbles of refrigerant boiling out of the oil can be mistakenly identified as particulates by the analytical equipment, checking the oil filter is therefore advised before changing the oil. For reference, new oil would be expected to have a particle count of around 12/10/9.

Some Reference values for new commercially available oils;

Synthetic Refrigerant Oil	Emkarate® RL32H	Emkarate® RL68H	Emkarate® RL170H
Viscosity 40 C (cSt)	33.7	72.3	170
Pour Point C	-46	-39	-25
Density @20 C (g/ml)	0.977	0.977	0.968
Flash Point (COC) (C)	270	270	290
Total Acid Number (mgKOH/g)	0.02	<0.02	<0.02
Water Content (ppm)	<50	<50	<50

Mineral Refrigerant Oil	Suniso® 3GS	Suniso® 4GS	Suniso® 5GS
Viscosity 40 C (cSt)	29.5	54.9	94.6
Pour Point C	-40	-35	27.5
Density @20 C (g/ml)	0.909	0.915	0.921
Flash Point (COC) (C)	178	188	208
Total Acid Number (mgKOH/g)	0.01	0.01	0.01
Water Content (ppm)	20	20	20

Reference: Supplier Datasheets

GLOSSARY OF TERMS

Refrigerant Analysis

The refrigerant analysis section of the Certificate of Analysis shows the test results against AHRI 700:2014 specifications. This standard specifies acceptable maximum levels of contaminants in HFC/HCFC refrigerants, it is usually applied to recycled refrigerant but is also used for virgin (new) refrigerant. Testing to AHRI700 includes (but is not limited) to the following:

Purity

Refrigerant purity is tested using Gas Chromatography and identifies whether gases have been mixed creating a blend that a system has not been designed to work on. Mixing of refrigerants usually happens inadvertently through poorly labelled equipment or inadequately evacuated cylinders. Refrigerant with purity lower than 99.5% generally results in the system working poorly and having lower energy efficiency; it can however lead to over pressurisation and the system cutting out on the high pressure switch or gas being lost through the Pressure Relief Device.

Composition

400 and 500 series refrigerants (eg R404A, R407C etc) are blends of 2 or more components in a specific percentage composition range listed in the ASHRAE 34 standard. 400 series refrigerants are zeotropic and in the event of a leak in the vapour phase can 'fractionate' meaning that certain components can leak proportionately more than others changing their percentage composition in the blend. A fractionated gas will normally be depleted in the higher pressure components of the blend meaning it will have reduced volumetric capacity. Systems with fractionated gas may struggle to reach temperature and will have reduced energy efficiency.

Moisture

Moisture is a major contaminant in an HVAC system, in high quantities it can lead to icing and blockages of TX valves. In smaller quantities it can react with HFC and HCFC refrigerants to create acidic by-products including hydrochloric and hydrofluoric acid.

Acidity

Acidity in an HVAC system can be caused through moisture contamination or through thermal decomposition of HCFC and HFC gases generally as a result of the high temperatures created in a compressor burnout. The strong acids produced attack seals, motor windings and discharge valves especially in the compressor where temperatures are elevated. Acids also react with refrigerant oils to create sludge, this reduces lubrication properties causing increased wear in the compressor.

Non Volatile Residue (NVR)

NVR is the refrigerant oil that is added to an HVAC system to lubricate the compressor. HVAC systems are open meaning that the oil and refrigerant interact together, this is important in ensuring oil return to the compressor from the system. NVR is included in the AHRI 700 specification and requires removal as oil can harbour contaminants (especially moisture) that detract from refrigerant quality. When testing a working system it is expected that NVR will fail every time and no action will be required to remediate this.

Particulates

Particulates in an HVAC system generally include mill scale (copper oxides) from unshielded brazing of pipework but can also include thread sealing (PTFE) tape and other debris. It is easily removed by system filters and is a simple fix should it be detected in a sample.

Chloride

The chloride test establishes the presence of hydrochloric acid or metal chlorides in the refrigerant sample. Chlorides can occur due to acid formation from HCFCs or can be as a result of poor manufacturing practice when the refrigerant was first made. Chlorides are corrosive and damaging to HVAC systems.

Non Condensable Gases (NCG)

The presence of non condensable gases such as CO_2 in a system may cause an increased head pressure and discharge temperature as well as a decrease in overall system efficiency. Testing for non condensable gases in a system requires a vapor sample.

Returned to Branch	Received by A-Gas	A-Gas Signed Off
2/9/2023	2/15/2023	3/2/2023