

M5-011 HYDROCARBON AS NATURAL REFRIGERANT

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Abstract

In the globalization era, we need the clean refrigerant for clean environmental. Hydrocarbon is the one of the natural refrigerant. Propane, butane and ethane are the most popular hydrocarbon for refrigerant. Because of we need the performance of those refrigerant, a blending refrigerant is the solution, for example : Propane + iso butane, propane + ethane .

In Indonesia, we knew a many hydrocarbon refrigerant, like HyChill (Australia), EnvironSave (Netherland), RedTek (Canada,USA), Petrozone, MusiCool (Indonesia), HyCool(Indonesia),DuraCool (USA), Autocool (USA), MacFreeze (Australia) etc. The hydrocarbon refrigerant is a natural organic refrigerant, so it is save for ozone and perfect "drop in" solution for systems which previously used gases such as conventional refrigerant (CFC R12, HFC R134a, HCFC R22, R502, R11 and others).Resulting the research using hydrocarbon, that ensures exceptional energy efficiency, dispersing heat much more effectively than fluorocarbon equivalents and substantial cost savings for long term operation are achievable by replacing fluorocarbon refrigerants.

Some system examples: Vehicle Air Conditioning ,Refrigerated Containers and Transports, Domestic Refrigerators and Freezers, Drink Dispensers, Supermarket Cool Units and Displays, Industrial Cool Rooms and Freezers, Agricultural Chillers and Vats, Domestic and Commercial Air Conditioning Systems

Like most organic materials, hydrocarbon refrigerant is flammable, but its ignition temperature is 1585°F at both 5 psi and 0 psi.

Key word: hydrocarbon, clean refrigerant, blending.

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Pendahuluan

Hidrokarbon merupakan refrigeran organik alamiah, yang sejak 1926 telah dinyatakan oleh Albert Einstein, akan menjadi refrigerant yang sangat populer pada tahun dua ribuan. Peraturan yang mengikat dalam masalah “aman lingkungan hidup” terdapat pada : Montreal Protocol, Vienna Treaty, Kyoto Protocol, Keppres 1992, Kepmen Deperindag 1998, SNI 06-6500/65011/65012 -2000, NZS 1677 (USA), BS 4434/1995 (England). Pengikisan ozon (depletion ozone) sebagai penyebab problema kesehatan terhadap manusia, hewan dan tanaman di bumi harus dikurangi bahkan

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dihapuskan. Lapisan ozon yang digunakan sebagai penahan dan pemantul sinar ultra violet, dapat terkikis dengan adanya zat chlor yang ada pada jenis refrigerant konvensional (Freon) serta bahan2 (Halon, PVC) lain.

Hydrocarbon mempunyai sifat flammable, perlu teknik terhadap bahaya kebakaran yang mungkin terjadi, terutama bila memenuhi di atas ambang batas 38 gr/m³ untuk Lower Flammability Level dan 171 gr/m³ untuk Upper Flammability Level.

Produk Refrigeran

Refrigeran dari hidrokarbon banyak diproduksi oleh beberapa faktori dari dalam maupun luar negeri Indonesia. Indonesia dalam hal ini Pertamina membuat refrigerant dari hidrokarbon dengan nama: Petrozon, HyCool dan MusiCool. Tetangga kita dari Australia memproduksi refrigerant dari hidrokarbon dengan nama : HyChill (HR), MacFreeze, produksi dari Eropa dengan nama Enviro Safe (ES) , produksi dari Amerika/Canada dengan nama: RED TEK. Dura Cool , AutoCooldll.

Product	MusiCool 12	HyChill 12	Env.Safe 12	RED TEK® 12a	R12	R134a
Chemical Type	HC	HC	HC	HC	CFC	HFC
Composition	Prop.isobutane	Propane,isobutane	zeotrope	zeotrope	pure	pure
G.W.P (CO ₂ =1, 100yr ITH)	3	3	4(CO ₂ =0.5)	3	10,600	1,600
O.D.P.	0	0	0	0	0.9	0
Atmospheric Life	< 1 year	< 1 year	< 1 year	< 1 year	130 years	16 years
Thermal Performance	+12 - +32%	+12 - +32%	+12 - +32%	+12 - +32%	0	-8%
Oils	both	both	both	both	mineral	synthetic
Leak Detection	hydrocarbon	hydrocarbon	hydrocarbon	hydrocarbon	halide	halide
Boiling Point (C)	-32.9	-31	-30.4(F)	-31	-30	-26
Autoignition (F)	473(C)	1385	1585	1385	n/a	1385
Latent Heat (1.0 bar, abs)	314 KJ/kg(RE)	367 KJ/kg	367 KJ/kg	367 KJ/kg	145 KF/kg	189 KJ/kg
Refrigerant Mass Charge	33%	33%	30%	33%	100%	90%

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Size (R12=100%)						
Toxic Thermal Decomposition	None	None	None	None	Phosgene Gas	Hydro Flouride Gas

Tabel I : Komparasi refrigerant hidrokarbon .

Komposisi

Refrigeran hidrokarbon terdiri atas campuran satu atau dua jenis hidrokarbon dengan komposisi tertentu. Sebagai contoh refrigerant pengganti Freon-12 (R-12) atau HFC134a, beberapa merk refrigerant menggunakan campuran (azeotrope) propan (R290) dan iso-butan (R600a) dengan komposisi 50%: 50%. Sedang untuk pengganti Freon 22 (R-22) digunakan campuran (azeotrope) jenis hidrokarbon propan (R290) dan etana (C₂H₆) dengan komposisi 95%:5%. Refrigeran untuk suhu rendah dapat menggunakan hidrokarbon tunggal (pure) misalnya iso-butane(R600a) 100%(3metyl-methane), juga dapat menggunakan propan (R290- C₃H₈) 100%.

Beberapa merk dagang dari refrigeran hidrokarbon dapat dilihat dari nomor produk tersebut.

Misalnya:

Freon/CFC,HFC	MusiCool	HyChill	EnvironSave	Red Tek
R-12 / R-134a	MC-12	HR-12	ES-12	RedTek-12a
R-22 /R-502	MC-22	HR-22	ES-22	RedTek502

Seperti diketahui bahwa Freon dan HFC sesuai sifat kimianya merupakan bahan yang "toxic" dan dapat merugikan lingkungan maupun kesehatan orang. Misalnya :

R-12 (CFC)	R-134a (HFC)	MusiCool	EnvironSave	HyChill. etc
Phosgen Gas	Hydro Fluoride Gas	Hydrocarbon Azeotrope	Hydrocarbon Azeotrope	Hydrocarbon Azeotrope
ToxicThermal decomposition	Toxic Thermal Decomposition	None	None	None

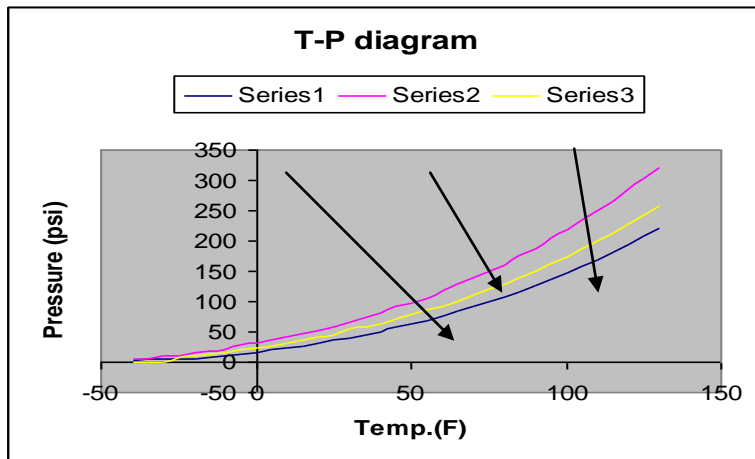
Sifat "mudah terbakar" (flammable) menjadi bahan pertimbangan dalam memilih refrigeran.

Misalnya :

R-12 (CFC)	R-134a (HFC)	MusiCool	EnvironSave	HyChill. etc	RedTek 502
Non flammable	Flammable	Flammable	Flammable	Flammable	Flammable
safe	1385 ⁰ F	473 ⁰ C	1585 ⁰ F	1385 ⁰ F	800 ⁰ F

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Series 1 untuk R-290 , Series 2 = R-22, dan Series 3 = R-12

Diagram di atas menunjukkan perbedaan tekanan pada operasi temperature refrigerasi.

Critical Temperature: ($^{\circ}\text{C}$)

Freon	Petrozon	MusiCool	Freon	Petrozon	MusiCool	HFCs	Petrozon	MusiCool
R-12	Rosy12	MC-12	R-22	Rosy22	MC-22	HFC134	Rosy34	MC134
111,5	(--)	115,5	96	(--)	96,77	101	(--)	113,8

Critical Pressure: (psia)

Freon	Petrozon	MusiCool	Freon	Petrozon	MusiCool	HFCs	Petrozon	MusiCool
R-12	Rosy12	MC-12	R-22	Rosy22	MC-22	HFC134	Rosy34	MC134
599,9	565,9	588,6	723,7	617,4	616,0	588,7	573,4	591,8

Liquid Viscosity ($37,8^{\circ}$): (uPa-s)

Freon	Petrozon	MusiCool	Freon	Petrozon	MusiCool	HFCs	Petrozon	MusiCool
R-12	Rosy12	MC-12	R-22	Rosy22	MC-22	HFC134	Rosy34	MC134
166,5	(--)	103,6	143,1	(--)	84,58	102,5	(--)	101,6

Parameter Lingkungan.

Parameter	Freon-12	Freon-22	HFC 134a	RedTek	MusiCool
ODP	1,0	0,055	0,0	0,0	0,0
GWP	4000	1700	1300	3	3
Life Time (year)	120	14	15	< 1	<1
Self Ignition $^{\circ}\text{C}$	1100	1385 F	800	1385 F	473

Product	RED TEK® 12a	R12	R134a
Chemical Type	HC	CFC	HFC
Composition	zeotrope	pure	pure

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G.W.P (CO ₂ =1, 100yr ITH)	3	10,600	1,600
O.D.P.	0	0.9	0
Atmospheric Life	< 1 year	130 years	16 years
Thermal Performance	+12 - +32%	0	-8%
Oils	both	mineral	synthetic
Leak Detection	hydrocarbon	halide	halide
Boiling Point (C)	-31	-30	-26
Autoignition (F)	1385	n/a	1385
Latent Heat (1.0 bar, abs)	367 KJ/kg	145 KF/kg	189 KJ/kg
Refrigerant Mass Charge Size (R12=100%)	33%	100%	90%
Toxic Thermal Decomposition	None	Phosgene Gas	Hydro Flouride Gas

Tabel 2: komparasi refrigerant REDTEK terhadap R12 dan R 143a .
 Dari tabel 2 di atas dapat dilihat perbedaan yang menolok dari latent heat, atm.life, oil dll.

SECTION 4 - INGREDIENTS

Hazardous Ingredients	%	CAS Number	L C50	P.E.L.	ACGIH TLV
Dimethyl Methane	30-60	74-98-6	n/a	800 ppm	800 ppm
Methylethyl Methane	40-70	106-97-8	202,000 ppm (mouse, 4 hr.) 276,000 ppm (rat, 4hr.)	n/a	800 ppm
Isopentane	.1-1	78-78-4	140,000 ppm (mouse, 2 hr.)	n/a	600 ppm
Dimethyl	.1-1	74-84-0			
Non Hazardous Ingredients	> 1	n/a	n/a	n/a	n/a

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Pembahasan

Hidrokarbon sebagai refrigerant, dengan berbagai komposisi, dapat menjadikan penyelesaian masalah terhadap pencemaran lingkungan, terutama terhadap pengikisan ozon dll. Tetapi problem baru muncul, di antaranya sifat mudah terbakar, menjadikan penggunaan refrigerant ini menjadi terbatas.

Dari kenyataan yang diperoleh dari aplikasi, terjadinya *temperature glide* akibat blending dari beberapa jenis hidrokarbon, menjadikan perhitungan dan pembahasan teoritis jadi agak sulit. Apa lagi bila puritas dari hidrokarbon tersebut kurang baik.

Temperatur glide terjadi pada operasi di condenser dan juga di evaporator.

Kesimpulan

Dari uraian tersebut di atas dapat disimpulkan, sebagai berikut

1. Refrigeran hidrokarbon merupakan refrigerant yang layak digunakan pada mesin refrigerasi
2. Sifat dari refrigerant hidrokarbon sangat tergantung dari puritas hidrokarbon campurannya
3. Sifat terhadap pencemaran lingkungan GWP dan ODP lebih dapat dipertanggung jawabkan.
4. Ditinjau dari harga, maka refrigerant hidrokarbon lebih dapat bersaing.
5. Perlu perhatian khusus dalam penggunaan, akibat sifat mudah terbakar.
6. Hidrokarbon dari minyak bumi, sehingga Indonesia dapat membuat sendiri refrigerant hidrokarbon tsb.(Petrozon*, MusiCool, HyCool dll)
7. Retrofit refrigerant conventional (R12,R134a) dengan refrigerant hidrokarbon perlu syarat tertentu.

Penutup

Pada kesempatan ini kami ucapkan terima kasih kepada **Bapak Wiwid Andi,ST staff PT Pertamina** Jakarta dan **Bapak Ir. JC.Singgih Wibawanto** PT Petraguna yang banyak memberikan informasi, juga tidak lupa kepada **Bapak Ir.Prajitno,MT** dosen Pesawat Pendingin dan Pemanas di Jurusan Teknik Mesin Fakultas Teknik Universitas Gadjah Mada Yogyakarta yang banyak membantu dalam penulisan makalah ini. Juga Kepada staf redaksi journal ilmiah Teknik Mesin dan Teknik Industri , serta semua pihak yang ikut membantu saya ucapkan banyak terima kasih.

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WWW.HyChill.com

WWW.viron-safe.com

Lampiran

Products

HR12 (50% propane/R290, 50%iso butane/R600a)

HR12 is a blend of R600a and R290, two naturally occurring hydrocarbon refrigerant gases and is perfect for use in automotive air-conditioning systems and in refrigeration applications. (**lube: HyChill ERG 1000 oil=any lbe oil**)

HyChill HR12 is derived from uniquely pure natural gas sources, and manufactured to the strictest quality controls.

HR12 is efficient and safe to use, requiring no modification to air conditioning systems and minimal modification to most refrigeration systems.

HyChill HR12 ensures exceptional energy efficiency, dispersing heat much more effectively than fluorocarbon equivalents.

Substantial cost savings for long term operation are achievable by replacing fluorocarbon refrigerants with HR12.

Products

HR22 [95% propane/R290(C₃H₈), 5% etana(C₂H₆)]

On a hot day, the air conditioner is the biggest consumer of power in a building. By switching to HR22/502, power bills can be dramatically reduced, and the wear and tear on the air conditioning system can also be minimised.

HyChill HR22/502 is the Natural Organic solution for low temperature refrigeration and air-conditioning systems previously charged with HCFC R22 or CFC R502.

HR22/502 is a direct replacement, which means no new parts or equipment (retro-fitting) are required when changing refrigerant gases other than general service items.

An air conditioner or refrigeration system charged with HR22/502 uses up to 20% less power than HCFC-based refrigerants. Because hydrocarbon refrigerant is more efficient, it can cool a room down to the temperature set by the thermostat in less time. In hot weather, this can result in substantial energy savings.

Products

HR290 (100% propane: C₃H₈)

Pure hydrocarbon refrigerant with a singular molecule and no temperature glide used in medium to low temperature refrigeration systems. It is also suitable for

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transport refrigeration and static cool room applications.

HR290 produces similar performance results to ammonia and could be used as a substitute in some applications

Products

HR600a (100% CH(CH₃)₃ = 3 methyl methane=iso butane)

Highly efficient natural hydrocarbon refrigerant used in state-of-the-art light commercial and domestic refrigeration.

Current research indicates HR600a is most suitable for production line installation, however it has no 'drop-in' application.

Please review the [Ecofrig manual](#) for further technical information regarding European **Isobutane** use in domestic refrigerators.

RED TEK® 12a, a HC-based refrigerant from Thermofluid Technologies, is a blend of environmentally safe hydrocarbon fluids designed as a direct replacement and retrofit refrigerant option for replacing R134a and R12 refrigerants in automotive air conditioning and refrigeration systems. 12a operates at lower head pressures and offers improved cooling properties and performance versus R134a and R12.

BENEFITS

- **Operation:** RED TEK® 12a possesses similar volumetric refrigerating effects to R12 or R134a refrigerants. Operates at lower head pressures and offers improved cooling properties, performance and energy efficiency versus R12 or R134a. Can be used effectively in R12 or R134a refrigeration systems without major "retrofitting."
- **Lower Cost:** Less expensive than R12 refrigerant and R134a "retrofits". Energy savings up to 30%.
- **Compatibility:** Compatible with most common refrigeration materials and lubricants including R134a, R12, metal components, mineral and synthetic (Ester and PAG) lubricants, seals, gaskets, hoses, compressors, and o-rings.
- **Environment:** 100% natural organic refrigerant, non-ozone depleting, non-global warming. 12a is in full compliance with the UN Montreal Protocol.

Safety: Does not become caustic when contaminated with moisture or oxygen. Non-toxic, non-carcinogen, autoignition temperature above 1385F. No long term health risks have been attributed to RED TEK® 12a refrigerant.

RED TEK® 22a Hydrocarbon Refrigerant

Replaces R22

SECTION 1 - IDENTIFICATION

Manufacturer: Thermofluid Technologies, Inc.

Address: 2413 East Broadway, 141

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Maryville, TN 37804

Phone: (865) 983-1633

Fax: (865) 983-0068

Product Name: RED TEK® 22a™

Proper Shipping Name: Petroleum Gases Liquefied

UN Number: 1075

Hazardous Goods: 2.1

Uses: Refrigeration Systems

WHMIS CLASS A; CLASS B; DIVISION 1

Classification:

TOLL FREE 24 HOUR EMERGENCY TELEPHONE NUMBER

1 (888) 676-9380

SECTION 2 - PHYSICAL PROPERTIES

APPEARANCE: Colourless gas; pine odour

ODOUR THRESHOLD: N/A

COEFF. WATER/OIL: N/A

DIST:

FREEZING POINT: -267 F

VAPOR DENSITY: (est.) 1.76

VAPOR PRESSURE: (PSIG) 70@ 70 F

PHYSICAL STATE: Gas/Liquid

SPECIFIC GRAVITY: 0.540

EVAPORATION RATE: Rapid

BOILING POINT: -30.4 F

pH: N/A

SECTION 3 - FIRE OR EXPLOSIVE HAZARD

AUTO-IGNITION TEMPERATURE: 1110 F

FLASHPOINT: Not Available

LOWER FLAMMABLE LIMIT (LEL): 1.9%

UPPER FLAMMABLE LIMIT (UEL): 8.5%

EXTINGUISH MEDIA: If possible, stop flow of gas. Use water to cool fire - exposed tanks, surroundings and to protect personnel working on shutoff. Water spray, dry powder, or carbon dioxide can be directed at flame area to reduce fire intensity. Do not extinguish flames unless leak can be stopped.

HAZARDOUS COMBUSTION PRODUCTS: Normal combustion forms oxides of carbon.

SENSITIVITY TO STATIC DISCHARGE: Vapor may ignite if exposed to static discharge.

EXPLOSION DATA: Sensitivity to impact. Mixture is not sensitivity.

FIRE AND EXPLOSION HAZARD: Flammable vapor may form if allowed to mix with air. Accumulation of gas is an ignition hazard. Vapors are heavier than air and may travel to an ignition source.

SECTION 5 - REACTIVITY DATA

CHEMICAL STABILITY: This material is chemically stable.

CONDITIONS TO AVOID: Propellant is flammable, avoid ignition source.

INCOMPATIBLE MATERIALS: Strong oxidizers.

DECOMPOSITION PRODUCTS: Burning of this product can produce oxides of carbon.

HAZARDOUS POLYMERIZATION: Will not occur.

POLYMERIZATION TO AVOID: None known.

SECTION 6 - HEALTH HAZARD

AS WITH MOST FLAMMABLE PRODUCTS: Do not expose to flames , sparks, torches, welding area.

INHALED/ASPHYXIAN: This product may cause irritation of the respiratory tract. May also cause headaches or dizziness at moderate exposures. Heavy exposure may cause anemia and irregular heart rhythm, respiratory arrest and death at elevated exposures.

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EYE CONTACT: Irritating if the liquid gets into eyes, with a possible hazard from freezing due to rapid evaporation. Extremely high vapor concentration may also be irritating.

SKIN CONTACT: Exposure to rapidly expanding gas or vaporizing liquid may cause frost bite damage to tissue . Prolonged contact may irritate the skin and cause dermatitis
CHRONIC: Prolonged exposure to this product may cause central nervous system disorder and/or damage.

SECTION 7 - FIRST AID

INHALED: In emergency situations, use proper respiratory protection and immediately remove the victim to fresh air. Administer artificial respiration if breathing has stopped. Seek medical attention promptly in serious cases of over exposure.

EYES: Flush eyes with tepid water for 15 minutes . Seek medical advice immediately.

SKIN: Avoid skin contact with the liquid . Remove contaminated clothing and wash the exposed area with soap and water.

FROSTBITE: Obtain medical assistance. If medical assistance is not available , place person in a warm area as soon as possible and allow the injured area to warm gradually. DO NOT WARM EXPOSED AREA TO EXCESS HEAT OR COLD.

INGESTION: Unlikely to be a problem , this should not occur.

SECTION 8 - SAFE HANDLING

SPILLS: Shut off ignition source and source of leak. Evacuate all non essential personnel from the area. If possible , ventilate the area. If mechanical ventilation is used, equipment must be explosion proof. Use water spray to disperse vapors. Isolate and ventilate area until gas has dispersed . If the incident is significant seek assistance from local fire, police, and other relevant authorities.

WASTE DISPOSAL METHOD: Dispose of product in accordance with local, county, provincial/state, and federal regulations.

STORAGE AND SHIPPING: Store in a cool , well ventilated area. Store away from strong oxidizing agents, chlorine dioxide, excessive heat and /or static discharge.

OTHER PRECAUTIONS: Empty containers may contain flammable or combustible vapors. Do not use without adequate precautions.

SECTION 9 - PERSONAL PROTECTION

ENGINEERING CONTROLS: Use only in a well ventilated area! Ensure there is good ventilation. If additional ventilation is needed use auxiliary ventilation equipment ensuring that all systems are well grounded and spark proof.

EYES: Wear chemical safety glasses with side shields and/or goggles.

GLOVES: Use thermal, chemical resistant gloves when handling this product.

OTHER PROTECTIVE CLOTHING: Long sleeves, pants and closed toe shoes.

RESPIRATORY PROTECTION: If ventilation of the area is not adequate use a jointly approved NIOSH/MESA respirator for organic vapours, to prevent overexposure by inhalation.

SECTION 10 - PREPERATION

Thermofluid Technologies, Inc. : 2413 E. Broadway, 141 , Maryville, TN 37804 865-983-1633

Prepared by Missy Simpson January, 1 2002

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RED TEK® 502a Hydrocarbon Refrigerant ,Replaces R502

RED TEK® 502a, a HC-based refrigerant from Thermofluid Technologies, is a blend of environmentally safe hydrocarbon fluids designed as a direct replacement and retrofit refrigerant option for replacing R502 refrigerants in commercial air conditioning and refrigeration systems. 502a operates at lower head pressures and offers improved cooling properties and performance verses R502.

BENEFITS

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- **Operation:** RED TEK® 502a possesses similar volumetric refrigerating effects to R502 refrigerants. Operates at lower head pressures and offers improved cooling properties and performance versus R22 and R502. Can be used effectively in R502 refrigeration systems without major "retrofitting."
 - **Lower Cost:** Less expensive than R502 refrigerant. Increased energy savings up to 30%.
 - **Compatibility:** Compatible with most common refrigeration materials and lubricants including R22, R502, metal components, mineral and synthetic(Ester and PAG) lubricants, seals, gaskets, hoses, compressors, and o-rings.
 - **Environment:** 100% natural organic refrigerant, non-ozone depleting, non-global warming. 502a is in full compliance with the UN Montreal Protocol.
 - **Safety:** Does not become caustic when contaminated with moisture or oxygen. Non-toxic, non-carcinogen, autoignition temperature above 800 F. No long term health risks have been attributed to RED TEK® 502a refrigerant.
-