GMC MOTORHOMES INTERNATIONAL

Air Conditioning & Duracool

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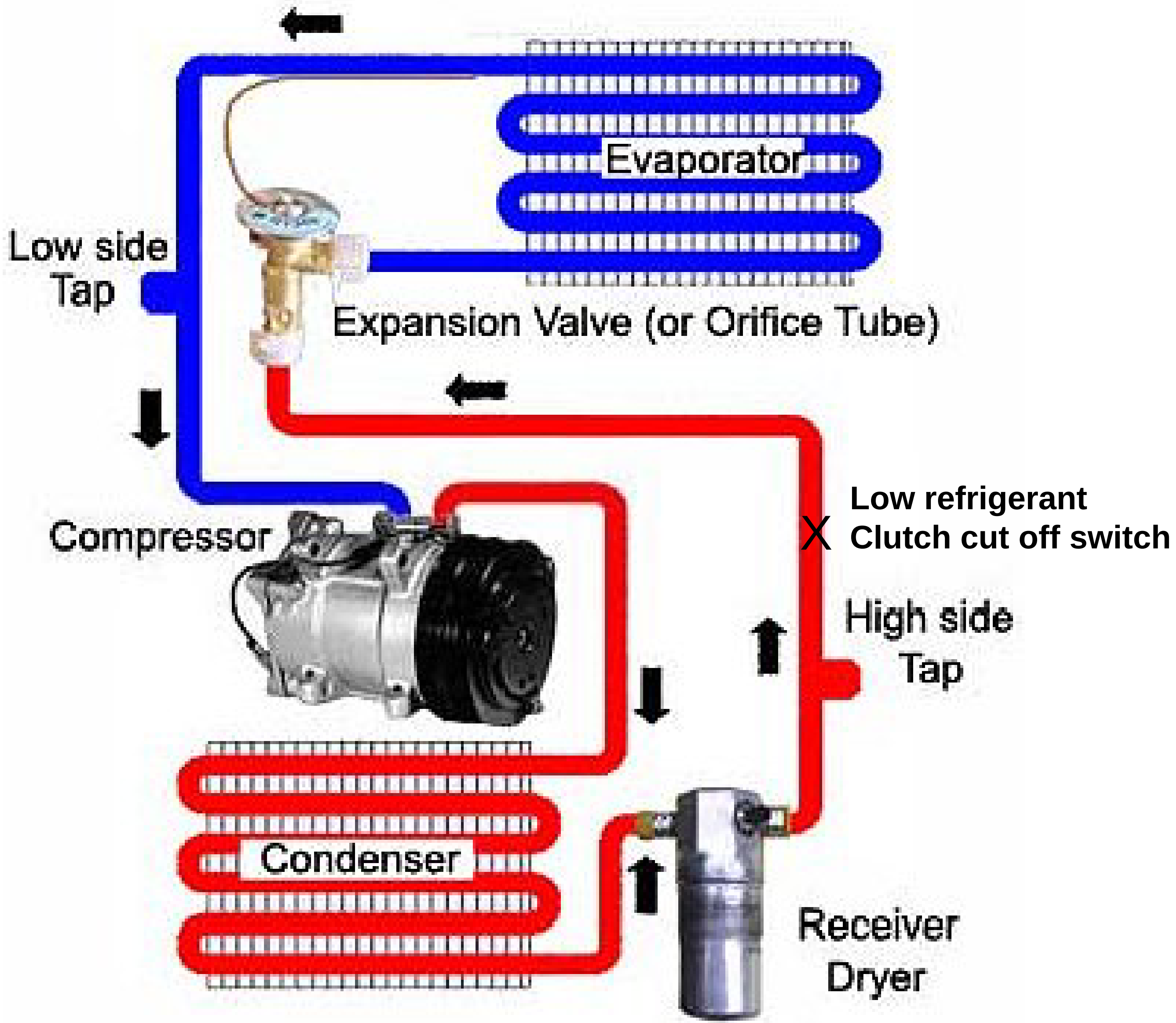
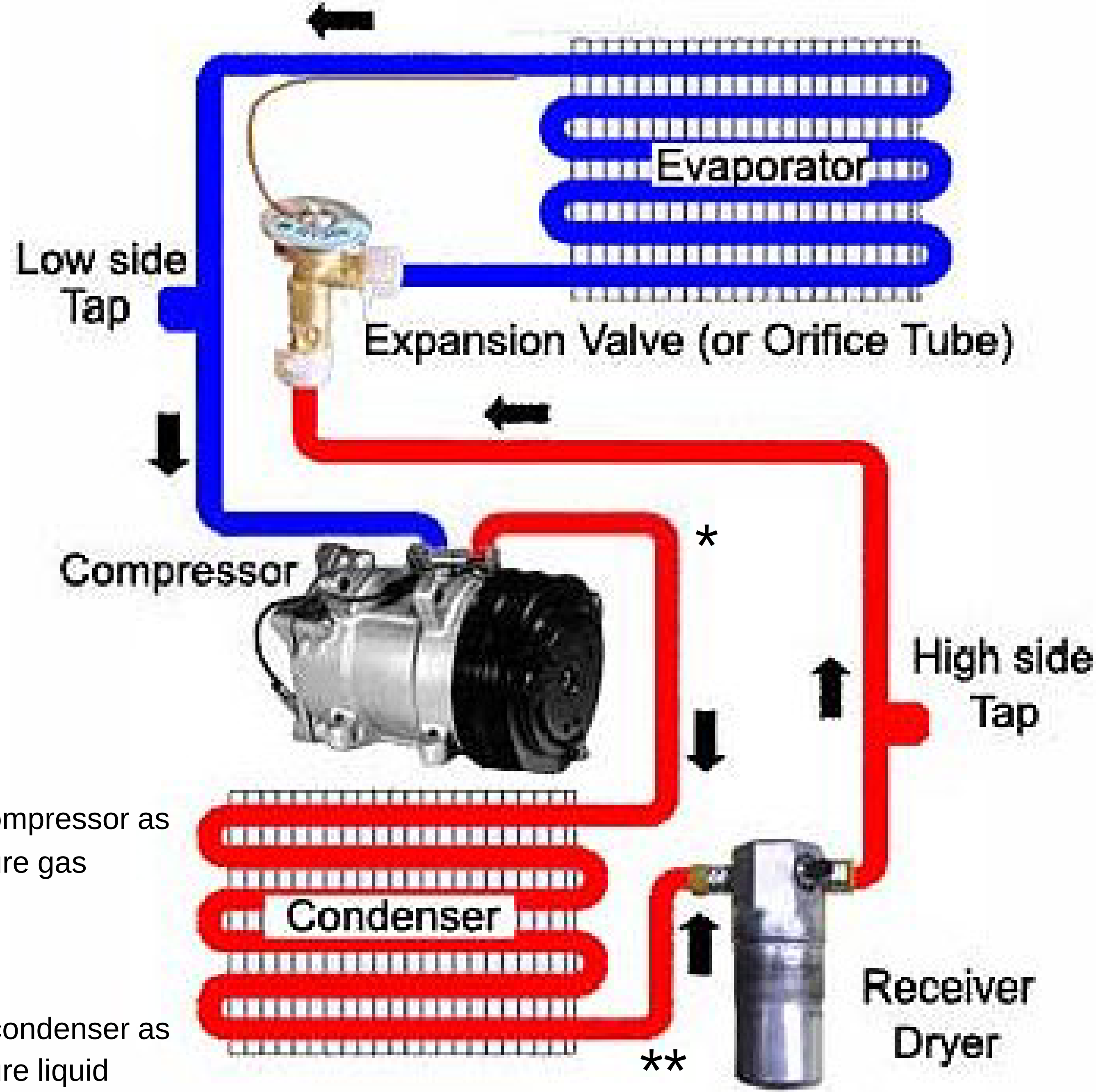
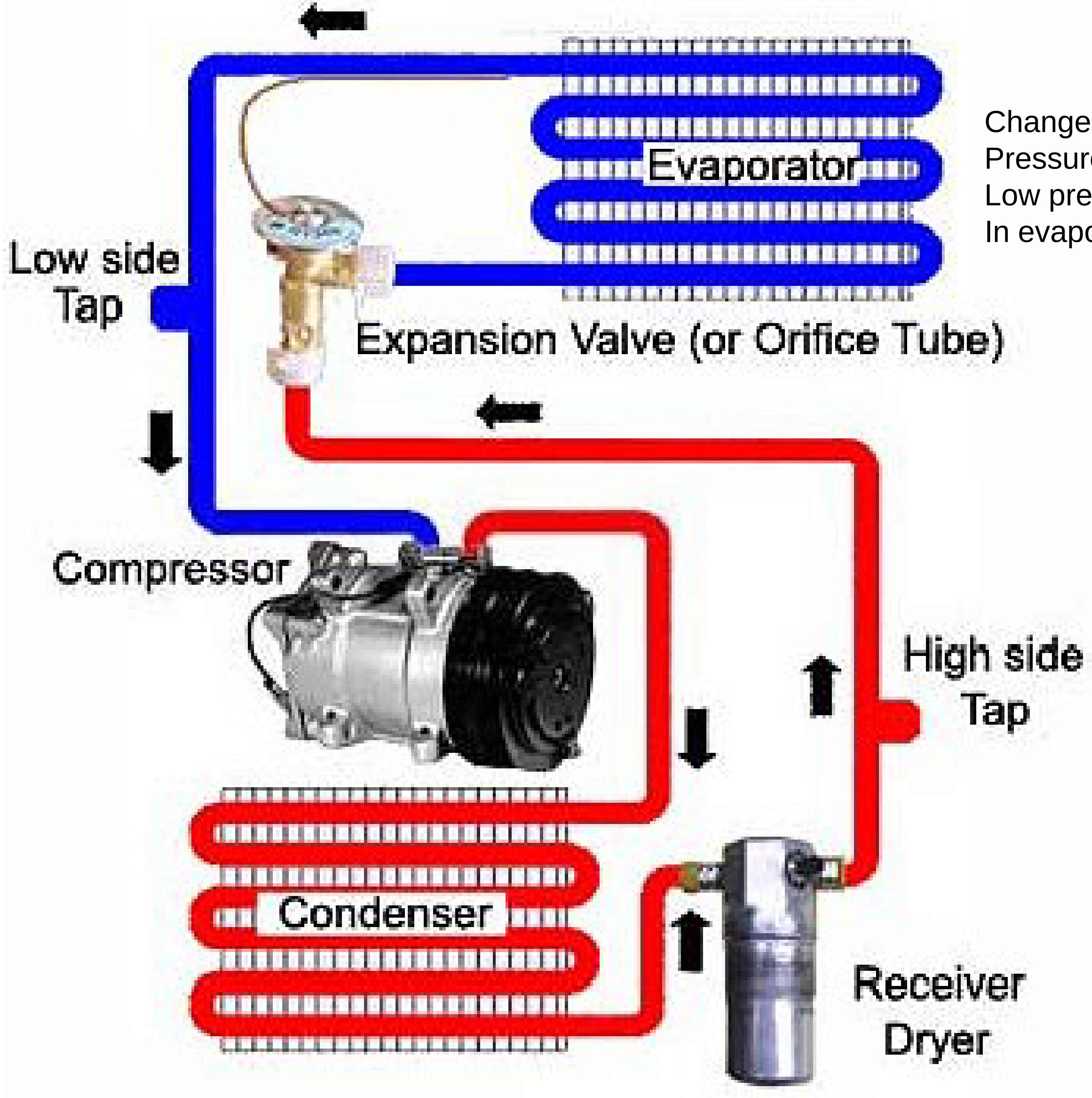


Evaporator
Low side
Tap
Expansion Valve (or Orifice Tube)
Compressor
Low refrigerant
Clutch cut off switch
X
High side
Tap
Condenser
Receiver
Dryer



*Leaves compressor as High pressure gas

**Leaves condenser as High pressure liquid



Changes from a high
Pressure liquid to a
Low pressure gas
In evaporator.

Now that you've seen how it works -------

The question is:

Why does it work?

Latent Heat of Vaporization

Latent = Hidden

Vaporization = changing from a liquid to a gas

Example:

When you boil water on a stove it stays at 212 degrees F. (at sea level) until it is completely boiled away.

Where is the heat going?

It takes energy to change from a liquid to a gas. This is in the form of Latent Heat.

Likewise when changing from a gas to a liquid it gives up heat.

So, when you pass the high pressure liquid through an orifice (or expansion valve) it “boils” or changes from a liquid to a gas.

While doing this it absorbs a lot of heat from its surroundings to effect the change in state from a liquid to a gas. (Latent Heat)

This occurs in the evaporator.

When blowing air through the fins of the evaporator it absorbs heat from the air and the cool air is blown into your motorhome.

Remember the condenser which is in front of your radiator?

The opposite thing is happening there. The air going through the fins of your condenser absorbs heat and cools the hot vapor inside the condenser so that it condenses into a liquid.

The net result is that you have transferred the heat from the inside of your GMC to the outside air, even if the outside air is much hotter than the inside of the GMC.

This is all possible through the
Latent Heat of Vaporization.

What Makes a Good Refrigerant?

Historical Introduction of Refrigerants

year	refrigerant / absorbant	chemical formula or makeup
1830s	caoutchoucine	distillate of india rubber
1830s	sulfuric (ethyl)ether	$CH_3CH_2\text{-}O\text{-}CH_2\text{-}CH_3$
1840s	methyl ether (R-E170)	$CH_3\text{-}O\text{-}CH_3$
1850	sulfuric acid / water	H_2SO_4 / H_2O
1856	ethyl alcohol	$CH_3\text{-}CH_2\text{-}OH$
1859	ammonia / water	NH_3 / H_2O
1866	chymogene	petrol ether and naphtha
1866	carbon dioxide	CO_2
1860s	ammonia (R-717)	NH_3
1860s	methyl amine (R-630)	$CH_3(NH_2)$
1860s	ethyl amine (R-631)	$CH_3\text{-}CH_2\text{-}(NH_2)$
1870	methyl formate (R-611)	$HCOOCH_3$
1875	sulfur dioxide (R-764)	SO_2

1878	methyl chloride (R-40)	CH_3Cl
1870s	ethyl chloride (R-160)	CH_3-CH_2Cl
1891	sulfuric acid with hydrocarbons	H_2SO_4, C_4H_{10}, C_5H_{12}, $(CH_3)_2CH$-CH_3
1900s	ethyl bromide (R-160B1)	CH_3-CH_2Br
1912	carbon tetrachloride	CCl_4
1912	water vapor (R-718)	H_2O
1920s	isobutane (R-600a)	$(CH_3)_2CH$-CH_3
1920s	propane (R-290)	CH_3-CH_2-CH_3
1922	dielene (R-1130)	CHCl=CHCl
1923	gasoline	hydrocarbons
1925	trielene (R-1120)	$CHCl{=}CCl_2$
1926	methylene chloride (R-30)	CH_2Cl_2
1940s	chlorofluorocarbons	$C_xF_yCl_z$

Composition of Commonly Available Refrigerants

Type	% R-22	% R-124	% R-142b	% R-134a	% HC	
FRIGC		39		59	2	
Freezone			19	79		
GHGX4 Autofrost Chill-it	51	28.5	18.5		4	
Hot Shot	50	39	9.5		1.5	
Freeze-12			20	80		

In Europe currently it is intended that HCFC be phased out by 2015. Several European countries have decided on earlier dates. R134a and similar products have not been a universal success. Apart from having a very high Global Warming potential, they have proved to be excessive energy consumers in most applications; poor performers in high ambient conditions; and are particularly dangerous when exposed to moisture or a heat source causing degradation. They are easily replaced with a hydrocarbon product such as Duracool (HC12a), a hydrocarbon product or with CO_2.

In Australia they have been using hydrocarbon products for years. HyChill has distributed many tons of HR12 since late 1995, enough to charge hundreds of thousands of vehicles, and not one safety or flammability incident has been reported. However, four car air conditioning fires have been reported - one with R12 and three with R134a, supposedly non-flammable refrigerants! The point is that all refrigerants become flammable due to the oil entrained with the gas being discharged from systems.

In the USA, the EPA is still ignoring the potential problem. Lobbyists???

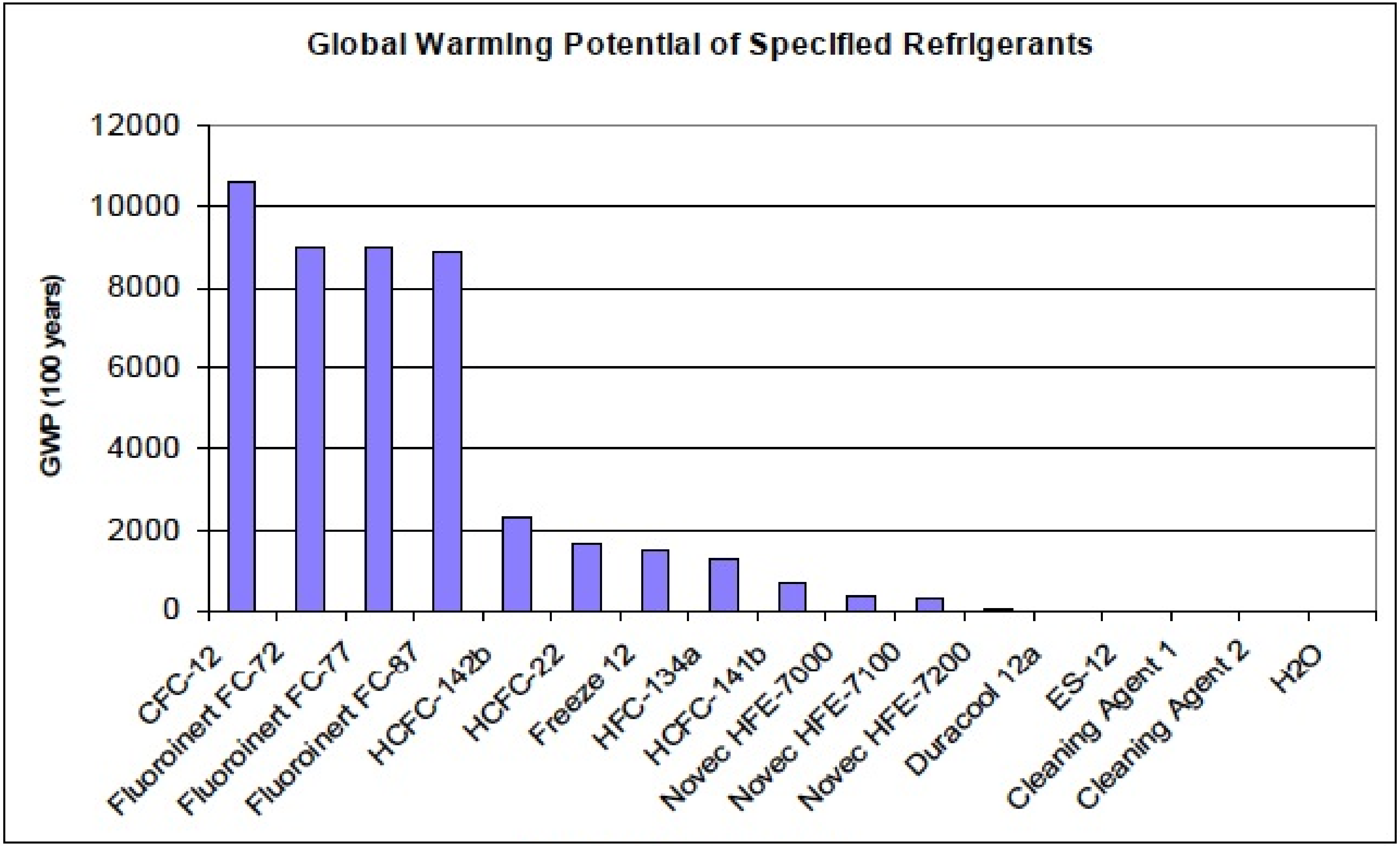


Fig. 2. Refrigerant GWP.

A Good Refrigerant:

1. Safe to use.

2. A boiling point below the desired inside target temperature.

3. A high Latent Heat of Vaporization.

4. Non-corrosive.

5. Reasonable operating pressures.

Name	Boiling Point F	Latent Heat BTU/#	High Side Pressure PSI	Corrosion	Safety
SO2	-14	166		Very High	Poison
Methyl Format	+32	112		Low	Irritant
CO2	-109	246	1800	Low	Safe
R12	-22	71	200+	Mod.	Safe
R134a	-16	92	300+	High	?
Duracool	-25	172	~150	None	?

How does Duracool compare?

Properties	R-12	R-134a	Duracool
Atmospheric Lifetime Year	130	16	less than 1
Thermal Performance	0	-8%	+12-32%
Oils Compatibility	Mineral	Synthetic	Both
Components, changes and/or wear	No	Yes	No
Potential Corrosion	Yes	Yes	No
Toxic Thermal Decomposition	Phosgene Gas	Hydrogen Fluoride Gas	None
Long Term Health Effects	None	Tumors on testicles	None
Short Term Health Risks	None	May cause death	None
Leak Detection	Halide	Halide	Hydrocarbon
Boiling Point (f)	-21	-15	-30.4
Latent Heat BTU/#	71	91	172
Auto-ignition (f) 0 psi	Nonflammable	1411	1585
Auto-ignition (f) 5 psi	Nonflammable	368	1585

Let’s Discuss Flammability

There are Eminent Risk Assessment Reports, prepared in Europe, Australia, the United Kingdom and USA documenting the safety of hydrocarbon refrigerants in motor vehicle air-conditioning systems. Arthur D. Little, in a detailed UK-based study, estimated the risk of an ignited refrigerant leak in the passenger compartment of a motor vehicle as being in the order of 3 in 10 million. Their findings, from a local perspective, mean that if every car in the USA (some 50 to 60 million vehicles) were to use a Hydrocarbon Refrigerant such an accident might occur once in every 50 years.

Is it Flammable?

It is possible for a hydrocarbon refrigerant to ignite, but the probability is very remote. Duracool is safer than R134a: the Ignition point is higher than R134a; Duracool will extinguish itself quickly. R134a will continue burning until its source is eliminated. Duracool is nontoxic. R134a will release a toxic fume when burning (Mustard Gas).

In terms of an "impact", it is important to recognize that we use less than 18 ounces of Duracool. If there were a full amount leak into the passenger compartment and it ignited, it would theoretically create a "flash" which would last 1-1.5 seconds. R134a has about 4 times as much in the system.

HC REFRIGERANT (propane) IS ONLY FLAMMABLE BETWEEN 2 AND 10% VOLUME CONCENTRATION IN AIR.

It is non-flammable inside the refrigerant circuit where the concentration is always above 10%. HC refrigerants have a high leak and low flame velocity so an ignited leak tends to blow itself out. HC refrigerants have a lower density so the charged mass is only one fourth of HFC 134a. If this small charge leaked from the evaporator into the passenger cabin, the surrounding air would keep it non-flammable by preventing the concentration from exceeding 2%.

Has anyone actually seen or even heard of an actual fire?

I feel it is a matter of personal choice as to one's aversion to risk. 1 in 50 million might be acceptable odds to some but might be unacceptable to others. I personally feel that 0.00000002 is sufficiently close to zero. So, the benefits of using HC refrigeration in my GMC far outweigh any fire risk in my mind. You have to make up your own mind on this, though.

The EPA, in its infinite wisdom, has refused to recognize HC refrigerants as a DIRECT SUBSTITUTE for R12 due to its being flammable.

They have apparently ignored the fact that R134a is also flammable.

They also ignore the 50 gallons of gasoline we are sitting on. We also have several gallons of propane in our rear tank.

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However, it is perfectly legal to install a HC refrigerant to replace R134a in a system.

SO, convert to R134a and then convert to Duracool

However, the following states prohibit the use of flammable refrigerants in automobile air conditioners: Arkansas, Arizona, Connecticut, Florida, Idaho, Iowa, Indiana, Kansas, Louisiana, Maryland, North Dakota, Oklahoma, Texas, Utah, Virginia, Washington, Wisconsin, and the District of Columbia.

In some cases this only applies to licensed installers or service people.

How do you convert?

- To convert to R134a you must replace all O rings, replace the drier and some recommend replacing all the hoses. The system must be flushed of all mineral oil and new synthetic (ester) oil put in. Install new fittings, evacuate and install R134a.

- To convert to Duracool, just take out all remaining R12 or R134a and put in the Duracool. It is compatible with either mineral oil or ester oil. Evacuate only if you have had a leak. R134a fittings optional unless required by law.

Cost

- R12 is still available but very high cost.
- R134a about 6 cans at $6 to $12 / can = $36 to $72.   Plus cost of conversion and parts.
- Duracool (HC12a) about 3 cans at $6 to $8 / can = $18 to $24.

- If you still have pressure from R12 or R134a in you system it is not necessary to evacuate your system. Just bleed off the gas.
- Actually you can add Duracool to the existing R12 or R134a but it will not cool as well as straight Duracool.
- If your system has a leak and is empty you will have to evacuate the system.
- First find and fix the leak.
- A quick way is to pressurize your system with nitrogen or with air from an air compressor. Then test for leaks with a bubble solution just as you do for a propane leak.

- Once you repair the leak you have to evacuate the system with a vacuum pump.
- To install the Duracool attach the can hose to either your gauge set or directly to the low pressure side fitting (the one without the clutch pressure cut off switch)
- Put in one 6 oz. can. Point the fitting of the can down when filling.
- Then start the engine and turn on the air conditioner to high or Max.
- Put in another can.
- If you are using gauges, have someone hold the gas pedal to 1500 rpm.

- Start putting in the 3rd can until you have approx. 20 psi on the gauge. If you are not using gauges put in the 3rd can and then bleed off a little until you feel you have cold enough air coming from your outlets. About 40 deg. below outside temperature.
- If you have too much of a charge it will not be as cold.
- If you have less charge it will be colder but in humid areas you could get ice forming on the evaporator fins which will block air from blowing into your GMC.

- On a car or smaller system you might need a higher pressure to prevent icing.
- On a GMC I have found through trial and error that 20 psi is about right most of the time.
- Note that if you don’t want to buy gauges you can buy a pressure gauge which is like a tire gauge but with a much larger opening to fit the low pressure fitting on the GMC.
- THAT’S IT!

The Decision Is Yours

Duracool gives better performance, the larger molecule means less leakage and the lower pressure means less wear on the compressor and less engine load, BUT

Cost, Flammability and Regulations are up to you.


It's Cool
in Here
with
Duracool
QuickTime™ and a
decompressor
are needed to see this picture.

That's all, folks!

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