TOXALERT™
INTERNATIONAL, INC.

Refrigerant Gas Paper
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Toxalert provides a refrigerant leak monitor model TOX-REFRIG. This paper has a purpose of putting some details down for any and all to either refresh your memory or to provide original knowledge about REFRIGERANTS and its chemicals. The following information has been distilled from research papers and news articles and some government items including Wikipedia, International Institute of Refrigeration, Industrial Resources Group, Inc., EPA and ASHRAE and others.

A compound of gases when heated changing to a liquid state and then returning to a gas in a mechanism that allows cooling is a refrigerant. The compounds are used within the equipment to air condition space, cool a production process or medical applications, refrigerate various items including foods or run a freezer containing any variety of items including making ice. Everyone most often thinks of the home refrigerator and freezer, vehicle or workspace air conditioners.

Chlorofluorocarbons (CFC's) are considered to deplete the earth's ozone at 100% and hydrochloroflurocarbons (HCFC's) are also considered to deplete the ozone but not as readily. Some of the CFC compounds are considered to be hazardous waste. We will not spend a lot of space here talking about the Montreal and Kyoto Protocols other than to remind you that it calls for the phase out of CFC's and HCFC's and that the United States signed the protocols. The conference held in 2007 reduced most ozone-depleting gases but not HCFC-22 which is big in China and India. The European Union phased it out in 2004 and the US must by 2020. There are other chemicals (refrigerants) that could be used to avoid harm to the ozone layer but environmentalists contend that chemical companies and air-conditioner manufacturers are too slow to embrace the other refrigerants, like ammonia or carbon dioxide. They may pose technical challenges but could be better for the ozone layer and reduce global warming. So getting to a, noncorrosive, good thermodynamic properties and then safe, product that is financially effective to replace the ozone killers is the world goal.

Anyone around refrigerants has seen the "R" identifier for the different compounds. The Dupont Company developed the R-# numbering system to systematically identify the molecular structure of refrigerants made with a single halogenated hydrocarbon. In the Toxalert Data Sheet under Table 1 many of the refrigerants are listed. Within Group A1 see R-134a then the Dupont system says 4 fluorine atoms, 2 hydrogen atoms, 2 carbon atoms and the suffix a indicates that the isomer is unbalanced by one atom. Now see under the word Name is 1, 1, 1, 2-tetrafluoroethane and the code defines the meaning from Dupont system as:

Rightmost digit : Number of fluorine atoms per molecule.
Tens digit : One plus number of hydrogen atoms per molecule.
Hundreds digit : The number of carbon atoms minus one. Omitted for methyl halides, which have only one carbon atom.
Thousands digit: Number of double bonds in the molecule. Omitted when zero and is rarely used, since most of these compounds are unstable.
Suffix with B : Indicates the number of bromine atoms, when present but rarely used.

Remaining bonds not accounted for are occupied by chlorine atoms.

Suffix of a, b or c: Indicates increasingly unbalanced isomers.

ASHRAE assigns the right most digit on special cases like R-400 and R-500.
Also there are differences for aerosol spray propellants because of the regulatory differences among these types.
Early refrigeration systems used sulfur dioxide or anhydrous ammonia and sulfur dioxide being very toxic was put aside and Freon became the choice. Wikipedia says purified liquid propane is gaining favor to be in place of R-12, R-22 and R-134a. You will see, again, in the Toxalert Data Sheet under Group A3 Propane is R-290. Propane is often referred as not being a large toxic because of the odorant that is added and thereby "tells" people it is present. However, the lack of oxygen always needs to be addressed. Propane refrigerators can be as much as 15% more energy efficient. It should be noted here that propane as a fuel is gaining with on-road vehicles. Around the world such propane is known as autogas and an estimate of 9 million vehicles are in operation.

Ammonia is still the product used in many of the really large commercial operations. Anhydrous Ammonia seeks water and when absorbed becomes ammonium hydroxide which is a component of lye. When both it and a human are in the same space it seeks the moisture of eyes, throat, lungs and skin resulting in caustic burns and possible suffocation. It has a distinct odor and people can detect it in concentrations as small as 5 parts per million. Industrial uses mostly are in high concentrations and brief exposure to 2,500 ppm or more can result in death. The following is a list of FACTS AND MYTHS about ammonia refrigeration.

FACTS:	Anhydrous Ammonia is a dangerous refrigerant.
	Trapped ammonia liquid is very dangerous.
	Ammonia smells bad.
	Safety engineering is the key to ammonia safety.
	Ammonia refrigeration has not changed much in the last 50 years.
	Ammonia is more energy efficient as a refrigerant.
	Ammonia based systems require more preventive maintenance.
MYTHS:	Ammonia systems have more leaks than Freon based systems.
	Ammonia systems operate differently than Freon systems.
	Ammonia based systems are not as safe as Freon systems.
	Ammonia as a refrigerant is being phased out.

Both the Montreal and Kyoto Protocols get after the concern of greenhouse gases and then makes the world look for replacements to be used in refrigeration that are less toxic and less flammable. Carbon dioxide then is being proposed mainly because of its non flammability. See Toxalert Data Sheet again under Table 1, Group A1 is R-744. Advantages of carbon dioxide other than flammability are in the science. That is the gas cooler pressure and temperatures are not linked. The high side pressure greatly affects the compressor work and efficiency and high temperatures can be achieved with reasonable compressor power. High vapor pressure leads not only to a low pressure ratio with the advantage of high compressor efficiency, but also to high heat-transfer coefficients and low relative pressure losses. So, despite the lack of efficiency of the theoretical transcritical cycle, the CO2 supercritical refrigeration cycle may still compete with the vapor compression cycle using other refrigerants. A further advantage related to the use of CO2 is its higher volumetric capacity due to its high working pressures enabling small equipment components and small-diameter lines to be used. The fact that one is not forced to recover, reclaim or recycle the CO2 refrigerant means that CO2 appears to be very attractive in certain applications where the infrastructure is poor or too expensive. According to the International Institute of Refrigeration

it is environmentally benign and locally safe, but needs a breakthrough enabling mass production of the necessary components in order to be cost-competitive compared with conventional refrigeration.

This review only scratches the surface of the refrigerant chemicals information but Toxalert will continue to up-date or renew the information that comes along as often as possible.

Bob Bittle