Refrigeration Service Engineers Society
1666 Rand Road
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REFRIGERANT 410A

Information compiled by Frank Prah, CMS

INTRODUCTION

Recently a new refrigerant, R-410A, has been formulated and currently is being used in the HVAC/R industry. It was developed primarily because the production of R-22 is scheduled to stop soon. The phaseout schedule for R-22, as mandated by the Environmental Protection Agency (EPA), will be discussed in more detail at the end of this article. Although R-410A is specifically intended for use in new air conditioning applications that traditionally would have used R-22, other applications are also possible, including low- and medium-temperature refrigeration systems.

At first glance, the most notable difference between R-410A and R-22 is the higher operating pressures (approximately 50% higher on both the discharge side and the suction side). For example, a high-efficiency condensing unit using R-22 typically operates with a suction pressure of about 68 psi and a discharge pressure of about 250 psi at an outdoor temperature of 95°F. With R-410A, the same unit will operate under the same conditions with a suction pressure of 118 psi and a discharge pressure of 400 psi, as shown in Figure 1 on the next page. (Note that in most cases, equipment designed for R-22 cannot use R-410A because of this difference in operating pressures, so retrofitting an existing R-22 system is normally not an option.)

When R-22 was first introduced as a replacement for R-12 in residential air conditioning applications, manufacturers and service technicians had to familiarize themselves with the characteristics of this "new" refrigerant. (R-22 operated at higher pressures and was more efficient than R-12, but did not return oil as well.) In time, R-22 became widely used and now has served the HVAC/R industry well for over 50 years. Today R-410A (which has had to pass strict safety guidelines that R-12 and R-22 did not have to pass) is becoming more popular, both because it is an HFC (hydrofluorocarbon), and because its greater efficiency allows for the design and use of smaller air conditioning equipment.

R-410A is an azeotropic mixture of HFC-32 and HFC-125. It has been developed as a long-term replacement for R-22 in a variety of new air conditioning and cooling equipment. R-22 is an HCFC, or hydrochlorofluorocarbon, which means that it contains chlorine, an element that is damaging to the ozone layer. Because R-410A contains no chlorine at all, its ozone depletion potential (ODP) is zero. R-410A comes in rose-colored cylinders. The "rose" color is PMS (Pantone Matching System) 507.

R-410A is expected to find widespread use in coming years. Its benefits include significantly higher cooling capacities and pressures. At 77°F, its density is 50% greater than that of R-22, and its vapor pressure is 58% greater. Other advantages include a low toxicity level, and recognition by Underwriters' Laboratory (UL) that it is virtually nonflammable (although it may be combustible at elevated pressures, as discussed later).

As with any refrigerant, there are certain safety precautions that the technician needs to understand and observe. This article describes typical applications, recycling/recovery procedures and equipment, and precautions applicable to this new refrigerant product.

TYPICAL APPLICATIONS

Major applications for R-410A include unitary air conditioning equipment, chillers, and commercial refrigeration systems. In new unitary residential and light commercial systems, R-410A has demonstrated a 5 to 6% higher energy efficiency rating (EER) than

R-22. Its higher cooling capacity permits smaller, more compact units to be used.

Because of the significantly higher pressures associated with R-410A, a typical compressor designed for R-22 cannot be used with R-410A. As noted previously, this fact—along with other components in the system that would need to be changed—renders the refrigerant inappropriate for retrofit of existing R-22 systems.

Another important issue is the compatibility of the compressor lubricant with the azeotropic R-410A mixture. To ensure satisfactory operation and durability, a polyolester-based lubricant that is miscible with the refrigerant is recommended. Compressor manufacturers are continuing to test and recommend specific lubricants for use with R-410A. It is therefore important to contact the compressor and/or equipment manufacturer to review system lubricant requirements. It is also important to review materials with which the refrigerant will come in contact, including motor windings in hermetic and semi-hermetic compressors, gaskets, etc., for compatibility.

R-410A and R-22 are chemically compatible—which means that they will not react or form other compounds if accidentally mixed—but they will form a mixture that can be difficult to separate. At this time, separation cannot be accomplished by any known on-site recovery device or in the facilities of most off-site reclaimers. Disposal of the mixture by incineration is recommended.

RECOVERY OF R-410A

The capability and compatibility of recovery and reclamation equipment are equally important considerations for the service technician. Despite R-410A's negligible impact on the ozone, reclamation and recycling are mandatory, and disposal must be conducted in accordance with national, state or provincial, and local regulations.

First and foremost, R-410A's higher vapor pressures mean that careful attention must be paid to the design pressure rating of handling and storage equipment, including recovery and storage cylinders. For R-410A, a working pressure capability of at least 400 psi is recommended (this includes recovery cylinders). Standard DOT recovery cylinders rated for 350 psi should *not* be used. Use *only* DOT recovery cylinders rated for 400 psi or higher when recovering R-410A.

Compatibility of the recovery equipment with the components that make up R-410A also is vital. In addition to the guidelines provided by the manufacturer of the refrigerant, make sure you consult the compatibility data supplied by the recovery equipment manufacturer.

Extra precautions are required during storage and handling. An important handling practice is the use of *liquid charging* (rather than vapor charging) to minimize compositional changes. Refrigerants in the -400 and -500 ASHRAE classification series should be

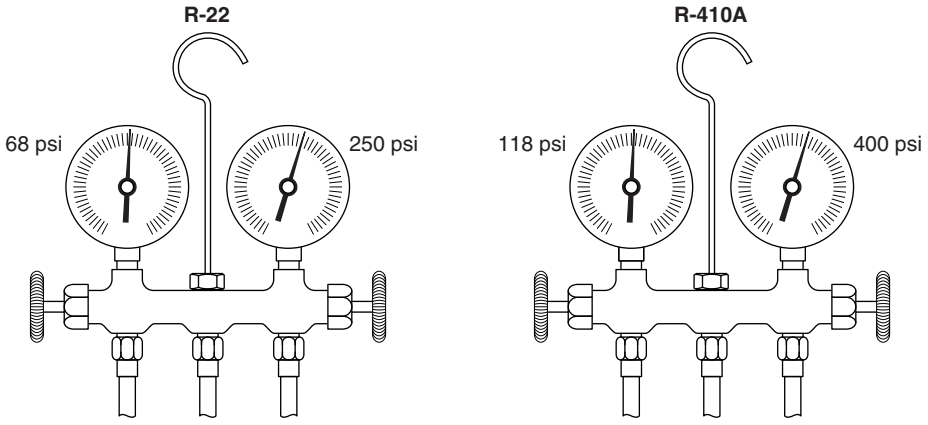

Figure 1. Typical operating pressures

charged (put into the system) in a liquid state. Not all manufacturers equip their cylinders with dip tubes. Without a dip tube, the cylinder must be in the inverted position (turned upside down) for liquid charging. If you are charging on the high side, refrigerant can enter the system as a liquid, since there is no danger of the refrigerant reaching the compressor in liquid form and causing "slugging" damage. If you are charging on the low side, meter the refrigerant as it enters the system to vaporize before it reaches the compressor.

In order to prevent the damage to equipment that can be caused by charging with contaminated refrigerant, *cross contamination* (the mixing of R-410A with other refrigerants) should be avoided during recovery and recycling. Recovery equipment includes not only the recovery/recycling machine itself, but also all equipment that comes into contact with the refrigerant during recovery and reclamation. This may include hoses, storage cylinders, vacuum pumps, manifold gauges, and scales.

To eliminate the possibility of cross contamination, the technician should use recovery/recycling devices with self-purging or evacuation features. Such equipment contains special valves that work with internal compressors to remove refrigerant by creating a partial vacuum in the tanks and hoses, thus allowing for the complete removal and diversion of materials into the recovery cylinder. Hoses, cylinders, and manifold gauges should either be dedicated to R-410A or evacuated after each recovery job. All equipment should be clearly marked to indicate the formulation for which it can be used, and all new cylinders should be evacuated prior to the first use.

Proper maintenance of vacuum pumps, used to remove non-condensable gases and moisture from a system, is equally important. New (clean) oil specifically formulated for vacuum pumps should be used at the start of each procedure. The oil should be changed at intervals as recommended by the manufacturer, or more frequently if it takes on a milky or cloudy appearance. An isolation valve is an absolute necessity for checking system integrity. In addition, worn O-rings and hoses should be replaced to ensure minimal manifold leakage during evacuation. Vacuum pumps should be capable of pulling a vacuum of 300 to 500 microns.

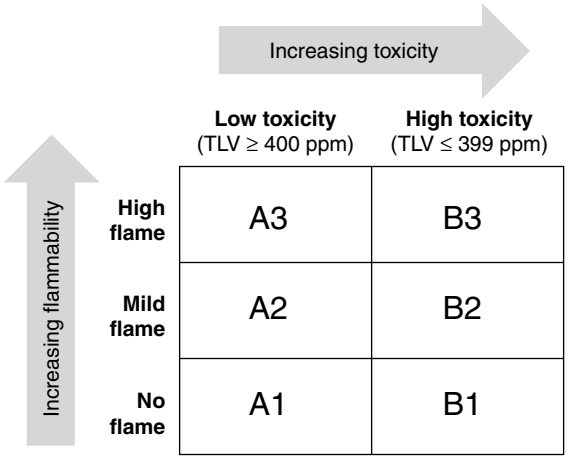

Figure 2. Safety matrix

Scales are sometimes used during recovery to prevent tank overfilling. If the scale is equipped with an automatic solenoid shutoff, it must be purged prior to each use.

SAFETY PRECAUTIONS

ASHRAE has designated R-410A as A1/A1 on the safety matrix shown in Figure 2. As you can see, the "A1" rating denotes the safest refrigerants to handle.

In addition to the procedures discussed above regarding the proper use of equipment and the importance of avoiding cross contamination, there are a few other safety precautions that the service technician should note.

An R-410A system may be operating at over 600 psi and not have the high-pressure safety switch open. Carrier has a unit with the high-pressure switch set at 610 psi. It resets at about 420 psi. The same model has a loss-of-charge liquid-line switch that opens at about 20 psi and resets at about 45 psi. Low-pressure switches are also found on the suction side. Low-pressure switches on Carrier equipment using R-410A are usually set to open at about 50 psi and close at about 100 psi.

Note: Heat pumps operating in the heating mode also may have a vapor switch that cycles the outdoor fan when the pressure is about 400 psi, and resets when the pressure drops to about 310 psi.

Because it is heavier than air, R-410A vapors can accumulate at ground level. If a large release of vapor occurs, the vapor may displace the oxygen available for breathing, resulting in suffocation. Although smaller leaks pose no acute health hazards, exposure to levels of more than 1,000 parts per million (the same limit as R-22) can be harmful. Symptoms of exposure to dangerous levels of R-410A include dizziness, headache, confusion, cardiac irregularities, and loss of consciousness in extreme cases. If a leak is present or suspected, a suitable leak detector should be used to determine the need for ventilation or respiratory protection.

R-410A expands significantly when heated. Exposure of a container to direct sunlight or other heat source can cause it to burst, resulting in serious injury. Allied Signal recommends that its cylinders not be allowed to exceed 125°F (52°C). Care also should be taken to avoid damage to containers that could cause them to leak or rupture. Storage near corrosive chemicals or fumes or on damp floors should be avoided.

Although R-410A is not flammable, it may become combustible at elevated pressures in the presence of large quantities of air. Containers and recovery/recycling equipment should not be exposed to welding, brazing, open flames, or high temperatures until thoroughly purged of all traces of liquid and vapor. Recovery and recycling systems with self-purging capabilities are invaluable for this purpose.

Other commonsense precautions for storing and handling R-410A include:

- using personal protective equipment (e.g., side shield glasses and safety shoes) when handling containers
- avoiding skin contact, which may cause frostbite
- protecting containers from damage, and hoses from cuts or abrasions
- storing containers under a roof to protect them from weather extremes
- never attempting to repair or alter containers or valves.

As stated previously, the energy efficiency of R-410A is allowing the design of smaller, more efficient air conditioning equipment. By following the procedures and noting the precautions provided in this article, the technician can readily service systems using this increasingly popular refrigerant.

R-22 PHASEOUT

The schedule for the phaseout of R-22 has been previously published, but may be accelerated at some point. Currently the schedule is:

- 2010: New equipment designed for use with R-22 will no longer be manufactured.
- 2020: End of production of R-22 (after 2020, the use of reclaimed and stockpiled R-22 may be permitted).

SUMMARY

The following is a quick review of some of the most important points to remember when you are working with R-410A:

- *Never* vent R-410A (or any other refrigerant) to the atmosphere.
- R-410A is to be used with “new equipment design” only (that is, it is not to be used in retrofits). If the cost of R-22 rises, R-407 may be used in some cases to retrofit R-22 systems.
- Use good piping practices when installing units with R-410A. (Piping practices are similar to those recommended for R-22 systems.)
- R-410A operates at pressures 50 to 70% higher than those of R-22. Be certain that servicing equipment and replacement components are designed to operate with this refrigerant.
- R-410A cylinders are rose-colored (PMS 507).
- Recovery cylinders must be rated at 400 psi or higher (DOT 4BA400 or BW 400).
- Charge systems with liquid refrigerant to avoid fractionation.

- Manifold sets should be at 750 psi (high side) and 200 psi (low side), with a 500-psi low-side retard.

- Use hoses with a 750-psi service pressure rating.

- Leak detectors should be of the HFC type.

- R-410A is compatible with POE oils. POE oils absorb moisture rapidly. Do not expose the oil to the atmosphere. Keep all components sealed until the time of installation/brazing.

- A liquid-line filter-drier is required on all units, or per the manufacturer's directions. Do not use liquid-line filter-driers with working pressures rated at less than 600 psi.

- Do not use an R-22 TXV valve.

- Braze joints (do not use soft/low-temperature solder).

Note: A pressure-temperature chart for R-410A is included on page 6.

Technical sources:
DuPont Suva Technical Information Bulletin H-65905-2
Carrier Installation and Start-Up Instructions for the 38YXA Heat Pump (023-813)

psig	°F	psig	°F	psig	°F	psig	°F	psig	°F	psig	°F
12	–37.7	114	37.8	216	74.3	318	100.2	420	120.7	522	137.6
14	–34.7	116	38.7	218	74.9	320	100.7	422	121.0	524	137.9
16	–32.0	118	39.5	220	75.5	322	101.1	424	121.4	526	138.3
18	–29.4	120	40.5	222	76.1	324	101.6	426	121.7	528	138.6
20	–36.9	122	41.3	224	76.7	326	102.0	428	122.1	530	138.9
22	–24.5	124	42.2	226	77.2	328	102.4	430	122.5	532	139.2
24	–22.2	126	43.0	228	77.8	330	102.9	432	122.8	534	139.5
26	–20.0	128	43.8	230	78.4	332	103.3	434	123.2	536	139.8
28	–17.9	130	44.7	232	78.9	334	103.7	436	123.5	538	140.1
30	–15.8	132	45.5	234	79.5	336	104.2	438	123.9	540	140.4
32	–13.8	134	46.3	236	80.0	338	104.6	440	124.2	544	141.0
34	–11.9	136	47.1	238	80.6	340	105.1	442	124.6	548	141.6
36	–10.1	138	47.9	240	81.1	342	105.4	444	124.9	552	142.1
38	–8.3	140	48.7	242	81.6	344	105.8	446	125.3	556	142.7
40	–6.5	142	49.5	244	82.2	346	106.3	448	125.6	560	143.3
42	–4.5	144	50.3	246	82.7	348	106.6	450	126.0	564	143.9
44	–3.2	146	51.1	248	83.3	350	107.1	452	126.3	568	144.5
46	–1.6	148	51.8	250	83.8	352	107.5	454	126.6	572	145.0
48	0.0	150	52.5	252	84.3	354	107.9	456	127.0	576	145.6
50	1.5	152	53.3	254	84.8	356	108.3	458	127.3	580	146.2
52	3.0	154	54.0	256	85.4	358	108.8	460	127.7	584	146.7
54	4.5	156	54.8	258	85.9	360	109.2	462	128.0	588	147.3
56	5.9	158	55.5	260	86.4	362	109.6	464	128.3	592	147.9
58	7.3	160	56.2	262	86.9	364	110.0	466	128.7	596	148.4
60	8.6	162	57.0	264	87.4	366	110.4	468	129.0	600	149.0
62	10.0	164	57.7	266	87.9	368	110.8	470	129.3	604	149.5
64	11.3	166	58.4	268	88.4	370	111.2	472	129.7	608	150.1
66	12.6	168	59.0	270	88.9	372	111.6	474	130.0	612	150.6
68	13.8	170	59.8	272	89.4	374	112.0	476	130.3	616	151.2
70	15.1	172	60.5	274	89.9	376	112.4	478	130.7	620	151.7
72	16.3	174	61.1	276	90.4	378	112.6	480	131.0	624	152.3
74	17.5	176	61.8	278	90.9	380	113.1	482	131.3	628	152.8
76	18.7	178	62.5	280	91.4	382	113.5	484	131.6	632	153.4
78	19.8	180	63.1	282	91.9	384	113.9	486	132.0	636	153.9
80	21.0	182	63.8	284	92.4	386	114.3	488	132.3	640	154.5
82	22.1	184	64.5	286	92.8	388	114.7	490	132.6	644	155.0
84	23.2	186	65.1	288	93.3	390	115.0	492	132.9	648	155.5
86	24.3	188	65.8	290	93.8	392	115.5	494	133.3	652	156.1
88	25.4	190	66.4	292	94.3	394	115.8	496	133.6	656	156.6
90	26.4	192	67.0	294	94.8	396	116.2	498	133.9	660	157.1
92	27.4	194	67.7	296	95.2	398	116.6	500	134.0	664	157.7
94	28.5	196	68.3	298	95.7	400	117.0	502	134.5	668	158.2
96	29.5	198	68.9	300	96.2	402	117.3	504	134.8	672	158.7
98	30.5	200	69.5	302	96.6	404	117.7	506	135.2	676	159.2
100	31.2	202	70.1	304	97.1	406	118.1	508	135.5	680	159.8
102	32.2	204	70.7	306	97.5	408	118.5	510	135.8	684	160.3
104	33.2	206	71.4	308	98.0	410	118.8	512	136.1	688	160.8
106	34.1	208	72.0	310	98.4	412	119.2	514	136.4	692	161.3
108	35.1	210	72.6	312	98.9	414	119.6	516	136.7	696	161.8
110	35.5	212	73.2	314	99.3	416	119.9	518	137.0		
112	36.9	214	73.8	316	99.7	418	120.3	520	137.3		

Table 1. Pressure-temperature chart for R-410A

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