SUVA®

REFRIGERANTS

ART-15

Retrofit Guidelines for SUVA® HP81

INTRODUCTION

SUVA® HP81 is a commercially available refrigerant designed to replace R-502 in applications where a 5.6–11.1°C (10–20°F) increase of compressor discharge temperature is acceptable. For applications where compressor discharge temperature is a limitation, SUVA® HP80 is the retrofit refrigerant of choice for R-502. Reference ART-9 for information on retrofit guidelines with SUVA® HP80.

Either as a result of a decision to stop using CFCs or following the phaseout of CFC-based refrigerants, existing R-502 equipment will need to be retrofitted to alternative refrigerants to extend the equipment's useful life. SUVA® HP81, a blend of HFC-125, HC-290 (propane), and HCFC-22, has been developed by DuPont as a retrofit refrigerant for many R-502 systems. Using the retrofit guidelines summarized below, most R-502 systems using positive displacement compressors (i.e., reciprocating, rotary, screw, and scroll) can be easily and economically retrofitted for use with HP81. This allows the equipment to operate safely and efficiently even after R-502 is no longer available.

PROPERTIES AND SAFETY

HP81 offers improved environmental properties versus R-502, with significantly lower ozone depletion potential (ODP) and global warming potential (GWP). Refer to DuPont Technical Bulletins P-HP (H-47122) and ARTD-35 (H-35815) for more detailed information on properties and performance characteristics of HP81. Refer to the Material Safety Data Sheets (MSDS) for safety information on the use of HP81.

LUBRICANTS

Lubricant selection is based on several factors, which can include oil return to the compressor, lubricity, and materials compatibility.

In ice machines, mineral oil has been demonstrated as an acceptable lubricant for use with HP81. The equipment arrangement and the operation of ice machines (harvest cycles, hot gas defrost, etc.) aid in the return of lubricant to the compressor. The positive results of SUVA® HP81 and mineral oil in ice machines may mean HP81/mineral oil can be used in other small hermetic systems which exhibit good lubricant return to the compressor. Consult your compressor manufacturer for their lubricant recommendation in your system.

In larger systems (i.e., supermarket stationary equipment), the evaluation of lubricants is still underway. Potential candidate lubricants are mineral oil and alkylbenzene/mineral oil mixtures for systems in which lubricant miscibility is not required for lubricant return. For systems which require greater lubricant miscibility for oil return or to solve heat transfer problems, candidate lubricants would include alkylbenzenes and polyol ester lubricants. To date, all of these lubricant options have shown satisfactory performance in commercial refrigeration systems. The compressor manufacturer should be consulted for specific lubricant recommendations. Other sources for lubricant information include DuPont Distributors, lubricant manufacturers, system manufacturers and/or refrigeration contractors. As new information is generated, DuPont will communicate any changes in lubricant recommendations through its Distributors.

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SELECTION OF REFRIGERANT

SUVA® HP81 is the recommended alternative for R-502 applications where an increase in compressor discharge temperature of 5.5–11.1°C (10–20°F) is acceptable. Applications which have been demonstrated as most suitable for use with HP81 are ice machines, ice cream machines, vending machines, open drive compressor systems, water-cooled condensing units, and compressors operating in low ambient temperatures.

SYSTEM MODIFICATION

The composition of SUVA® HP81 has been selected to provide an increase in refrigeration capacity and energy efficiency versus R-502. Minimal system modifications are anticipated when retrofitting R-502 systems to HP81.

Retrofits of R-502 systems with other alternative refrigerants such as HCFC-22 or HFC-125 may require more extensive system modifications (compressor replacement to multistage compressors, use of liquid injection, etc.). For some systems, this cost may be prohibitive. SUVA® HP81 provides the service contractor and equipment owner with a cost-effective way to retrofit an existing R-502 system.

It is important to note, however, that SUVA® HP81 was not designed for use in conjunction with other refrigerants (i.e., topping off an existing R-502 charge with HP81). This will yield a nonreclaimable mixture.

OVERVIEW OF RETROFIT PROCESS

Retrofit of an existing R-502 system with SUVA® HP81 can be accomplished using service practices and service equipment commonly used by trained mechanics or service contractors in the field.

The key steps involved in the retrofit are:

- Collect baseline data of system while still running with R-502
- Recover R-502 charge from system
- Remove existing lubricant and replace with selected lubricant when necessary
- Replace filter drier with new drier compatible with HP81
- Charge system with SUVA® HP81
- Start up system and adjust charge and/or controls to achieve desired operation
- Label components in system with SUVA® HP81 and lubricant type

For the majority of systems, the compressor lubricant change and a filter drier change will be the only required system modifications for a retrofit to SUVA® HP81. Some systems with expansion valves may require adjustment to the superheat setting. For systems which are still under warranty, we recommend contacting the equipment or compressor manufacturers prior to performing the retrofit. Some equipment or compressor warranties may be impacted by a change from the refrigerant or lubricant originally specified for the system or compressor.

EQUIPMENT AND SUPPLIES NEEDED FOR RETROFIT

- Safety Equipment (Gloves, Glasses)
- Refrigeration manifold Gauges
- Thermocouples
- Vacuum Pump
- Leak Detection Equipment
- Scale
- Recovery Unit
- Recovery Cylinder
- Container for Recovered Lubricant
- Replacement/Approved Lubricant (if necessary)
- Replacement Refrigerant
- Replacement/Approved Drier

RETROFIT PROCEDURE

Summarized below is a more detailed discussion of the recommended procedures for retrofitting an R-502 system with SUVA® HP81. Prior to the retrofit, review the Material Safety Data Sheet safety information for SUVA® HP81 and consult the compressor manufacturer to check for compatibility of SUVA® HP81 with the materials of construction of the system.

1. **Baseline data with R-502.** For service contractors performing their initial retrofits with HP81, it is recommended that system performance data be collected while R-502 remains in the system. This baseline of temperatures and pressures at various points in the system (evaporator, condenser, compressor suction and discharge, expansion device, etc.) at normal operating conditions will be useful when optimizing operation of the system with HP81. A System Data Sheet is attached for recording these baseline data.

2. **Remove R-502 Charge.** R-502 should be removed from the system and collected in a recovery cylinder using a recovery device capable of pulling 10–20 in. Hg vacuum (34–67 kPa, 0.34–0.67 bar). If the recommended R-502 charge size for the system is not known, weigh the amount of refrigerant removed, as the initial quantity of HP81 charged in the system will be determined from this figure.

3. **Drain Lubricant from the System.** Whether or not an oil change is necessary is very much system-dependent and consultation with the equipment manufacturer is recommended.

   In the cases where a lubricant change is necessary, the oil in the system will need to be removed. In small hermetic systems, this will often require the physical removal of the compressor from the system if the compressor has no oil drain port. The lubricant can then be drained from either the suction or discharge line of the compressor (depending on the internal configuration of the compressor). In most small systems, 90–95% of the lubricant will be removed from the system during this compressor drain.

   For semi-hermetic and open drive compressors, a drain port is often accessible and the lubricant can be drained from the compressor at that point.

   In larger systems, review the system arrangement to determine if there are any points in the system where lubricant may accumulate. If this is the case, additional drainage or system flushes may be necessary to remove a sufficient amount of the lubricant to allow acceptable performance with HP81. In systems with oil separators or accumulators, any lubricant present in these devices should also be drained.

   In all cases, measure the amount of lubricant removed from the system. Compare to the compressor/system specifications to ensure that the majority of lubricant has been removed from the system. Record on the attached Retrofit Checklist the amount of lubricant removed, as this will be needed in the next step.

4. **Charge Compressor with Chosen Lubricant.** In systems where the lubricant is removed, the same volume of new lubricant should be charged into the system. The viscosity of new lubricant should be similar to that removed from the system (150 SUS or 32 cSt is typical for R-502 systems).

5. **Reinstall Compressor** (if removed from system in step 3). Use normal service practices.

6. **Replace Filter Drier.** It is recommended to replace the filter drier following system maintenance. There are two types of filter driers commonly used in low and medium temperature R-502 equipment:

   a. Loose fill driers, which contain only the molecular sieve desiccant

   b. Solid core driers, in which the molecular sieve desiccant is dispersed within a solid core binder.

   For both types of driers, consult the drier manufacturer for their recommended drier in use with HP81. Currently, ALCO's ADK and Sporlan's Catch-All solid core driers are acceptable with HP81. Others may also be acceptable; again, consult the manufacturer.

7. **Reconnect System and Evacuate.** Use normal service practices. To remove air or other non-condensables in the system, it is recommended that the system be evacuated to as close to full vacuum as possible (approach 30 in. Hg vacuum/ 0 kPa/0 bar).

8. **Leak Check System.** Use normal service practices. Evacuate system following leak check with any gas.

9. **Charge System with HP81.** SUVA® HP81 is a near-azeotropic mixture; therefore the vapor composition in the cylinder is different from the liquid composition. To ensure that the proper refrigerant composition is charged in the system, it is important that liquid only be removed from the charging cylinder. Cylinders of HP81 are equipped with **dip tubes**, allowing liquid to be removed from the cylinder when the cylinder is in the **upright** position. The proper position is indicated by arrows on the cylinder and cylinder box. Once removed from the cylinder, HP81 can be charged to the system as vapor as long as all of the refrigerant removed from the cylinder is transferred to the system.

   Due to the liquid density difference of SUVA® HP81 vs R-502, the refrigeration system will require less weight of HP81 than R-502. The optimum charge will vary depending on the operating conditions, size of the evaporator and condenser, size of receiver (if present), and length of pipe or tubing runs in the system. For most systems, the optimum charge will be 90–95% by weight of the original R-502 charge. It is recommended that the system be initially charged with about 90% by weight of the original R-502 charge.

   Add the initial charge to the high pressure side of the system with the compressor not running. When the

system and cylinder pressures equilibrate, load the remainder of the refrigerant into the suction line of the system. In this step, the compressor will be running. Some compressors may be damaged if liquid refrigerant enters the suction side of the compressor. Since liquid must be removed from the charging cylinder, it is important to charge the refrigerant slowly into the suction line to allow it to vaporize before it enters the system. A throttling valve may be used to cause the refrigerant to vaporize.

10. **Start up System and Adjust Charge.** Start up the system and let conditions stabilize. If the system is undercharged, add additional HP81 in small amounts (still removing liquid from the charging cylinder) until the system conditions reach the desired levels. (SUVA® HP81 is more sensitive to charge size than R-502. Therefore, system performance will change more quickly if the system is not optimally charged with HP81 and it is important not to overcharge the system).

    In order to determine the appropriate suction pressure for HP81, the suction pressure with R-502 must be determined. The evaporator temperature with R-502 can be determined by using an R-502 pressure/temperature (P-T) chart. Once the R-502 evaporator temperature is determined, add 0.6°C (1°F) to it and determine the appropriate suction pressure for HP81 with this new temperature.

    Example:

    Step 1: Determine R-502 evaporator temperature.

    Suction pressure w/R-502 is 41 psig (384.5 kPa, 3.845 bar); this pressure corresponds to an evaporator temperature of –12.2°C (10°F).

    Step 2: Add 0.6°C (1°F) to R-502 evaporator temperature.

    –12.2°C + 0.6°C = –11.6°C (10°F + 1°F = 11°F).

    This temperature is the saturated vapor temperature of HP81 necessary to achieve an equivalent average evaporator temperature as R-502.

    Step 3: Determine compressor suction pressure for SUVA® HP81 at this saturated vapor temperature from P-T chart.

    11°F on the Engineering units P-T chart corresponds to a 43 psig suction pressure.

    –11.6°C on the SI units P-T chart corresponds to a 390 kPa (3.90 bar) suction pressure.

    For low temperature evaporator applications (–40°F or –40°C), the suction pressure with HP81 will be approximately the same as R-502's suction pressure. At medium temperature evaporator conditions (10°F or –12.2°C), the suction pressure with HP81 will be approximately 2 psi (13.8 kPa, 0.138 bar) higher than with R-502. HP81 will have approximately 15 psi (103.4 kPa, 1.034 bar) higher discharge pressure and approximately 11.1°C (20°F) higher discharge temperature than R-502.

11. **Label Components and System.** After retrofitting the system with HP81, label the system components to identify the type of refrigerant (SUVA® HP81) and lubricant in the system, so that the proper refrigerant and lubricant will be used to service the equipment in the future. Identification labels are available from DuPont.

SUMMARY

With the phaseout of CFCs, existing refrigeration equipment will need to be replaced with new equipment or retrofitted with alternative refrigerants. Using the procedures described above, existing R-502 refrigeration systems can be retrofitted for use with SUVA® HP81, allowing them to continue in service for the remainder of their useful life.

Attached is a Retrofit Checklist and System Data Sheet and Pressure-temperature charts for HP81 to assist you in the retrofit process.

TABLE 1
Pressure–Temperature Chart
SUVA® HP81 Saturation Properties
(Engineering Units)

Pressure (psig)	SUVA® HP81 Saturated Vapor Temperature, °F[1]	R-502 Saturated Vapor
0	–49	–50
2	–44	–45
4	–39	–40
6	–35	–36
8	–32	–32
10	–28	–29
12	–25	–25
14	–22	–22
16	–19	–19
18	–16	–16
20	–13	–13
22	–11	–11
24	–8	–8
26	–6	–6
28	–4	–3
30	–1	–1
32	1	1
34	3	3
36	5	5
38	7	7
40	8	9
42	10	11
44	12	13
46	14	15
48	16	16
50	17	18
52	19	20
54	20	21
56	22	23
58	23	24
60	25	26
62	26	28
64	28	29
66	29	30
68	31	32
70	32	33
72	33	34
74	34	36
76	36	37
78	37	38
80	38	40
85	41	43
90	44	46
95	47	49
100	50	51
105	52	54

[1] Saturated Vapor Temperature (Dew Point)—The temperature (at a given pressure) at which the last drop of liquid HP81 has boiled. It is also the temperature (at a given pressure) where condensation begins. Above this temperature (at the same pressure), the refrigerant is superheated vapor.

NOTE: For HP81, the mean evaporator temperature where a change of state occurs is approximately 1°F below the saturated vapor temperature. For example, at a saturated vapor temperature of 11°F, the mean evaporator temperature is approximately 10°F.

TABLE 2
Pressure–Temperature Chart
SUVA® HP81 Saturation Properties
(SI Units)

Pressure (kPa)	SUVA® HP81 Saturated Vapor Temperature, °C[1]	R-502 Saturated Vapor
100	–45	–46
110	–43	–44
120	–41	–42
130	–40	–40
140	–38	–38
150	–36	–37
160	–35	–35
170	–33	–34
180	–32	–32
190	–31	–31
200	–30	–30
210	–28	–29
220	–27	–27
230	–26	–26
240	–25	–25
250	–24	–24
260	–23	–23
270	–22	–22
280	–21	–21
290	–20	–20
300	–19	–19
310	–18	–18
320	–18	–17
330	–17	–17
340	–16	–16
350	–15	–15
360	–14	–14
375	–13	–13
400	–11	–11
425	–10	–9
450	–8	–8
475	–6	–6
500	–5	–4
525	–3	–3
550	–2	–1
575	–1	0
600	1	1
625	2	3
650	3	4
675	5	5
700	6	7
725	7	8
750	8	9
775	9	10
800	10	11
825	11	12
850	12	13

[1] Saturated Vapor Temperature (Dew Point)—The temperature (at a given pressure) at which the last drop of liquid HP81 has boiled. It is also the temperature (at a given pressure) where condensation begins. Above this temperature (at the same pressure), the refrigerant is superheated vapor.

NOTE: For HP81, the mean evaporator temperature where a change of state occurs is approximately 0.6°C below the saturated vapor temperature. For example, at a saturated vapor temperature of –11°C, the mean evaporator temperature is approximately –11.6°C.

CHECKLIST FOR SUVA® HP81 RETROFIT

_____ 1. Establish baseline performance with R-502. (See data sheet for recommended data.)

_____ 2. Consult the original equipment manufacturer of the system components for their recommendation on the following:
- Plastics compatibility.
- Elastomers compatibility.
- Lubricant (viscosity, manufacturer, additives).
- Retrofit procedure to sustain warranty.

_____ 3. Remove R-502 charge from system.
(Need 10–20 in. Hg vacuum [34–67 kPa/0.34–0.67 bar] to remove charge).
- Use recovery cylinder/*Do Not Vent to Atmosphere.*
- Weigh amount removed (if possible): _____

*4. Drain lubricant charge from the refrigerant system (unless a compatible lubricant is already in the system).
- Remove 90–95% of lubricant from the system.
- Measure amount of lubricant removed and record. _____

_____ 5. Charge compatible lubricant.
- Recharge with amount equivalent to amount removed in *Step 3.*

_____ 6. Reinstall compressor (if removed).

_____ 7. Replace filter drier with new drier approved for use with SUVA® HP81.
- Loose fill driers: use XH7 or XH9 desiccant or equivalent.
- Solid core driers: check with drier manufacturer for recommendation.

_____ 8. Reconnect system and evacuate with vacuum pump. (Evacuate to full vacuum [approach 30 in. Hg vacuum/0 kPa/0 bar]).

_____ 9. Leak check system. (Reevacuate system following leak check).

_____ 10. Charge system with SUVA® HP81.
- Initially charge 90% by weight of original equipment manufacturer specified R-502 charge.
- Amount of refrigerant charged: _____

_____ 11. Start up equipment and adjust charge until desired operating conditions are achieved.
- If low in charge, add in increments of 2–3% of original R-502 charge.
- Amount of refrigerant charged: _____

Total Refrigerant Charged (add 9 and 10) _____

_____ 12. Label components and system for type of refrigerant (SUVA® HP81) and lubricant.

_____ 13. *Conversion is complete!!*

* If using flushing technique repeat steps 3-4-5, 7-8 three times operating the system with R-502. Filter/drier need not be replaced during the flushing procedure.

SYSTEM DATA SHEET

Type of System/Location: _____

Equipment Mfg.: _____
Model No.: _____
Serial No.: _____
R-502 charge size: _____

Compressor Mfg.: _____
Model No.: _____
Serial No.: _____
Original Lubricant:
Type/mfg: _____
Charge size: _____
New Lubricant:
Type/mfg: _____
1st Charge size: _____
2nd Charge size: _____
Additional Charge size: _____

Drier Mfg.: _____
Model No.: _____

Drier type (check one):
Loose fill: _____
Solid core: _____

Condenser cooling medium (air/water): _____

Expansion Device (check one):
Capillary tube: _____
Expansion valve: _____

If Expansion valve:
Manufacturer _____
Model No.: _____
Control/set point: _____
Location of sensor: _____

Other System Controls (ex.: head press control), Describe: _____

(circle units used where applicable)

Date/Time				
Refrigerant				
Charge Size (lb, oz/grams)				
Ambient Temp. (°F/°C)				
Relative Humidity				
Compressor:				
Suction T (°F/°C)				
Suction P (psig, psia/kPa, bar)				
Discharge T (°F/°C)				
Discharge P (psig, psia/kPa, bar)				
Box/CaseT (°F/°C)				
Evaporator:				
Refrigerant Inlet T (°F/°C)				
Refrigerant Outlet T (°F/°C)				
Coil Air/H,O In T (°F/°C)				
Coil Air/H,O Out T (°F/°C)				
Refrigerant T @ Superht. Ctl. Pt. (°F/°C)				
Condenser:				
Refrigerant Inlet T (°F/°C)				
Refrigerant Outlet T (°F/°C)				
Coil Air/H,O In T (°F/°C)				
Coil Air/H,O Out T (°F/°C)				
Exp. Device Inlet T (°F/°C)				
Motor Amps				
Run/Cycle Time Comments: _____				