Application Bulletin

R410A “A” and “B” Series
Compressor Application Guidelines

Bristol compressors

Application Bulletin

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Subject: R410A “A” and “B” Series Compressor Application Guidelines

- ***This Application Bulletin is for air-to-air air conditioning and heat pump applications only. For other applications or deviations from this Bulletin, please call Bristol’s Applications Engineering Department at (276) 466-4121.***
- ***Refer to Bulletin No. 121 “Compressor Application Guidelines” for additional information on compressor operation limits.***

Bristol’s family of R410A compressors are virtually the same machines as our proven R22 products, except for the following:

1) Thicker housing (shell)
2) Smaller displacement
3) Polyolester lubricant (Mobile 32BC)
4) Higher pressure relief valve setting
5) Larger bearing surfaces

R410A compressors inherently have lower efficiency than R22 compressors at high condenser temperatures like 130°F and roughly the same efficiency at low condenser temperatures like 100°F. For system performance, R410A has better heat transfer and pressure characteristics.

R410A compressors are identified by the number 8 in the second digit of the model number (example: H89B283ABCA). The following guidelines were developed for single and three-phase compressors through actual system and laboratory testing.

1.0 R410A Refrigerant

R410A is a non-ozone depleting, hydrofluorocarbon (HFC) refrigerant. It is a near-azeotropic blend of two refrigerants with the following composition:

R32	50%
R125	50%

2.0 Safety Consideration

R410A systems operate at 50% - 60% higher pressures than R22. R22 service equipment should not be used with R410A refrigerant. Refer to the attached pressure temperature chart (page 9) for comparison. The compressor housing thickness has been increased to compensate for the higher operating pressures.

3.0 Lubricant and Exposure to Moisture

R410A compressors are factory charged with Mobil 32BC polyolester (POE) lubricant which is the only approved oil for use with these products. In the unlikely event that a Bristol HFC compressor requires an oil re-charge, only Mobil 32BC should be used. Substitutes can have an adverse effect on system performance and long term reliability of the compressor. Improper oil charging of the compressor voids the Bristol Compressors warranty. POE lubricant is highly hygroscopic (i.e., it readily absorbs water). POE lubricants can absorb 15 times as much water as mineral oil or an alkylbenzene lubricant. When installing a compressor, it is very important not to leave the compressor exposed to the atmosphere for more than 15 minutes. Tubing should be prepared and the system ready to accept the compressor before the compressor plugs are removed.

Loss of Charge

When a system in the field has lost the refrigerant charge and has been exposed to moisture, the lubricant must be removed from the compressor and replaced. In order to properly replace the lubricant, the compressor must be removed from the system so the lubricant can be drained out via the compressor suction fitting. If the amount of lubricant removed from the compressor is not within 5% of the recommended recharge, the system will need flushing to remove the remaining lubricant. Check with your local wholesaler on the amount of lubricant needed for recharge. The filter driers should be replaced after flushing.

If a loss of charge switch or low-pressure safety switch prevents the system from operating below atmospheric pressure, then the lubricant and filter drier will not need to be replaced. A loss-of-charge switch or low-pressure safety switch is highly recommended.

4.0 Internal Pressure Relief Valve

A redesigned internal pressure relief valve limits the maximum operating pressure of the compressor. The valve will open between 550 and 600 psig (39-42 kg/cm^2) pressure differential. With a suction pressure of 142 psig (10 kg/cm^2) the internal relief will open at 692 to 742 psig (49-52 kg/cm^2). If the internal relief is used to protect the system, the following test must be performed: (1) Operate the system at the highest outdoor and indoor ambient that the system will experience; (2) Simulate a failed condenser fan motor by disconnecting the fan motor. Heat pumps will require simulating the outdoor units' motor failure in cooling and the indoor unit motor failure in the heating mode. It is recommended that all commercial installations incorporate low and high pressure manual reset safety switches.

5.0 Critical Pressure

The critical pressure for R410A is 677 psig (48 kg/cm^2), and the critical temperature is 158°F (70.0°C). R410A compressors have a rapid decrease in performance as the condenser temperature approaches

150°F (65.5°C) and above. The critical temperature of R410A is much lower than other R22 alternatives such as R407C, which has a critical temperature of 187°F (86.1°C).

6.0 Filters/Driers

The proper selection of a filter/drier is very important. The filter/drier must be rated for the higher working pressures. Use filters with no more than 25% activated alumina. Some filter driers may not be suitable for R410A and POE lubricant. Therefore, check with the original equipment manufacturer to ensure that all components are compatible.

7.0 Power Terminal Cover

Only the Bristol Compressors approved power terminal cover/retainer should be used unless written approval is provided by Bristol for an alternative.

8.0 Crankcase Heater

A crankcase heater is not required on systems when the total system charge is below the specified compressor charge limit. Refer to the individual model specification summary sheets for the “refrigerant charge limit”. Total charge includes the allowance for the tube size and length plus the tolerance of the charging equipment. Insertion type crankcase heaters are available for “A” and “B” compressors. To increase the longevity of the compressor bearings, a crankcase heater is recommended to prevent liquid refrigerant from migrating into the compressor sump. Liquid refrigerant can dilute the oil, causing excessive bearing wear. Refer to Application Bulletin 135, Crankcase Heaters.

9.0 Accumulators

R410A will require an accumulator specifically designed for this refrigerant. Oil trapping can occur in standard accumulators.

All heat pump systems require an accumulator. Other systems should be tested per Application Bulletin 101, to determine if an accumulator will be required. Cooling-only systems with a total charge less than the compressor charge limitation normally will not require an accumulator. A double-sided see-through sight glass, installed in the suction line of a test compressor will assist the system designer in making this decision.

Large volumes of liquid refrigerant repeatedly flooding back to the compressor during the off-cycle, defrost cycle or excessive floodback during steady operation can dilute the oil to the point that the bearings are inadequately lubricated, causing excessive bearing wear.

10.0 Excessive Continuous Liquid Floodback Tests

1) Heating Mode Excessive Continuous Liquid Floodback Test (Section 11)
2) Cooling Mode Excessive Continuous Liquid Floodback Test (Section 12)
3) Excessive Liquid Floodback Cycling Test (Section 13)

The following tests are for all systems including those designed with an accumulator. These tests are used to confirm appropriate system design. **Bristol testing has indicated that adding an accumulator as the only solution to excessive flooding, in most cases, is inadequate.**

Two excessive liquid floodback tests are required on heat pumps: one for the heating mode and one for the cooling mode. Air conditioners require only the cooling test. The test set up is the same for heat pumps and air conditioners.

Before starting the test, thermocouples should be attached to the suction and discharge lines approximately 6 to 8 inches (15.24cm to 20.32cm) from the compressor. A thermocouple should also be attached to the sump of the compressor (as close to bottom center as possible, all TCs must be insulated). The system charge for this test should be 20% greater than design specifications using a 25 foot (7.62m) line set. The 20% overcharge simulates commonly found overcharge in the field. For split system testing, the evaporator should be elevated 5 feet (1.52m) above the condensing unit. Should you have any questions, please contact Bristol's Applications Engineering Department.

11.0 Heating Mode Excessive Continuous Liquid Floodback Test

The defrost control must be disconnected to prevent unit from defrosting. Outdoor ambient must be 17°F DB (-8.3°C), 15°F WB (-9.4°C) and indoor ambient 70°F DB (21.1°C), 60°F WB (15.6°C) maximum. Outdoor unit fan motor must be disconnected. Run unit until pressures and temperatures are stabilized.

Discharge **superheat** should be 35°F (19.4°C) higher than the saturated temperature equivalent of the discharge pressure.

Example: For R410A at 274-psig (19.3 kg/cm^2) discharge, the saturated condensing temperature is 90°F (32.2°C)

Example No. 1:
Assume actual discharge temperature of 125°F (51.6°C)
Discharge superheat = 125°F (51.6°C) - 90°F (32.2°C) = 35°F (19.4°C) Therefore **no system design change** is required.

Example No. 2:
Assume actual discharge temperature of 120°F (48.9°C)
Discharge superheat = 120°F (48.9°C) - 90°F (32.2°C) = 30°F (16.7°C)
Therefore **system design change** is required

If discharge superheat temperature is less than 35°F (19.4°C), the system design must be changed.

Sump **temperature** should be 30°F (16.7°C) higher than the saturated temperature equivalent of the suction pressure.

Example: For R410A at 34-psig (2.4 kg/cm^2) suction, the saturated evaporator temperature is -12°F (-24.4°C)

Example No. 1:
Assume actual sump temperature of 28°F (-2.2°C)
Δ temperature = 28°F(-2.2°C) - -12°F (-24.4°C) = 40°F (22.2°C)
Therefore **no system design change** is required

Example No. 2:
Assume actual sump temperature of 15°F (-9.4°C)
Δ temperature = 15°F (-9.4°C) - -12°F(-24.4°C) = 27°F (15.0°C)
Therefore **system design change** is required

If sump Δ temperature is less than 30°F (16.7°C), system design must be changed.

12.0 Cooling Mode Excessive Continuous Liquid Floodback Test

Operate the system for 1 hour; outdoor unit must be in 95°F (35.0°C) DB, 75°F (23.9°C) WB ambient and indoor unit at 67°F (19.4°C) DB, 57°F (13.9°C) WB with evaporator air flow reduced to 50% to simulate dirty return air filters.

Discharge **superheat** should not be less than 35°F (19.4°C).

Example: For R410A at 4l8-psig (29.4 kg/cm^2) discharge, the saturated condensing temperature is 120°F (48.9°C)

Example No. 1:
Assume actual discharge temperature of 155°F (68.3°C)
Discharge superheat = 155°F (68.3°C) - 120°F (48.8°C) = 35°F (19.4°C) Therefore **no system design change** is required

Example No. 2:
Assume actual discharge temperature of 150°F (65.6°C)
Discharge superheat = 150°F (65.6°C) - 120°F (48.9°C) = 30°F (16.7°C) Therefore **system design change** is required

If discharge superheat is less than 35°F (19.4°C), system design must be changed.

Sump **temperature** should be 30°F (16.7°C) warmer than the saturated temperature equivalent of the suction pressure.

Example: For R410A at 118-psig (8.3 kg/cm^2) suction, the saturated evaporator temperature is 40°F (4.4°C)

Example No. 1:
Assume actual sump temperature of 70°F (21.1°C)
Δ temperature = 70°F (21.1°C) - 40°F (4.4°C) = 30°F (16.7°C)
Therefore **no system design change** is required

Example No. 2:
Assume actual sump temperature of 65°F (18.3°C)
Δ temperature = 65°F (18.3°C) - 40°F (4.4°C) = 25°F (13.9°C)
Therefore **system design change** is required

If Δ temperature is less than 30°F (16.7°C), system design change is required.

13.0 Excessive Liquid Floodback Cycling Test

This test is run to determine how much liquid actually returns to the compressor during system on/off cycles. To complete this test, the compressor must be weighed or sight tube used to determine liquid refrigerant quantity. The evaporator should be elevated 5 (1.52 meters) feet higher than the condenser. System charge should be 20% greater than design specifications using a 25 ft. (7.6 meters) line set. Operate the system in the cooling mode for 1 hour before testing at each of the ambient temperatures indicated in Table 1. Shut condenser off (compressor and fan). Keep evaporator blower running. System on/off time and number of cycles is different for each of the tests shown in Table 1. Monitor the amount of liquid refrigerant (height or weight) at the start of each on cycle. If the compressor slugs or makes a slugging sound at start- up, system design change is required.

Test	No. 1	No. 2	No. 3
Indoor Ambient (°F)	70	70	70
Outdoor Ambient (°F)	85	95	105
System On-time (Minutes)	7	14	54
System Off-time (Minutes)	13	8	6
Number of On/Off	5	5	4

Table 1

14.0 Motor Protection

As with all A and B model Bristol compressors, internal line break motor protection is provided.

15.0 Starting Characteristics (single phase)

Most Bristol products do not require start components on systems with equalized pressure start up. However, products with a "C" or "B" in the 8th digit of the model number require, at least, a PTCR with equalized pressure starting. With a pressure differential at start up, a start capacitor and potential relay are required. PTCR and start component values are published in the individual compressor specification sheets.

16.0 Hard Start Component Elimination

An innovative starting concept has been developed by Bristol Compressors that eliminates the compressor hard start components (start capacitor/relay) required for systems using non-bleed type expansion valves. This optional feature is available on select "H89B" models with capacity ratings of 22K and below. They are identified by the letter "B" in the seventh character of the model number (H89B**B). These compressors are designed to internally equalize by utilizing an external check valve in conjunction with a non-bleed type TXV. This technique will help maintain system operating pressures during the off-cycle, thus improving the SEER performance by decreasing C_D. The internal equalization is transparent to the customer and requires no special attention. For this application, an external check valve is required. Bristol advises the use of a high quality non-positional check valve designed for near zero leak rate. It must be UL/CSA certified for use as a high side component for the intended refrigerant application. Ball-type check valves should not be used.

The recommended sources for the check valve are:

A1 Components
Part numbers MS-887 or MSM-11 (for 1/2" connection)
625 West 18th Street
Hialeah, FL 33010
Phone: (800) 759-9299
Fax: (800) 759-2872
Web: www.a-1components.com

Superior Refrigeration Products / Sherwood
Part number 900MA-8S (for 1/2" connection)
2111 Liberty Drive
Niagara Falls, NY 14304
Phone: (716) 505-4800
Web: www.sherwoodvalve.com

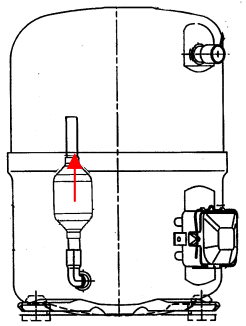

Figure 1

The check valve should be located in the discharge line near the compressor discharge outlet tube as illustrated above in Figure 1. **A heat sink is required to prevent internal damage to the check valve**

during brazing. Properly installed, this method is effective for reliable starting without a start capacitor/relay at all expected system differentials. The required time for internal compressor equalization depends on the specific pressure differential when the compressor cycles off. System testing at Bristol indicates a three minute minimum off-time will ensure complete equalization at all operating differential pressures.

R22 and R410A Pressure / Temperature Tables

Sat	R22		R410A	
°F	psia	psig	psia	psig
-20	24.9	10.2	41.1	26.4
-19	25.5	10.8	42.0	27.3
-18	26.1	11.4	42.9	28.2
-17	26.7	12.0	43.9	29.2
-16	27.3	12.6	44.9	30.2
-15	27.9	13.2	45.9	31.2
-14	28.6	13.9	46.9	32.2
-13	29.2	14.5	47.9	33.2
-12	29.9	15.2	49.0	34.3
-11	30.6	15.9	50.1	35.4
-10	31.2	16.5	51.2	36.5
-9	31.9	17.2	52.3	37.6
-8	32.6	17.9	53.4	38.7
-7	33.4	18.7	54.5	39.8
-6	34.1	19.4	55.7	41.0
-5	34.8	20.1	56.9	42.2
-4	35.6	20.9	58.1	43.4
-3	36.4	21.7	59.3	44.6
-2	37.1	22.4	60.5	45.8
-1	37.9	23.2	61.8	47.1
0	38.7	24.0	63.1	48.4
1	39.6	24.9	64.4	49.7
2	40.4	25.7	65.7	51.0
3	41.2	26.5	67.0	52.3
4	42.1	27.4	68.4	53.7
5	43.0	28.3	69.7	55.0
6	43.9	29.2	71.2	56.5
7	44.8	30.1	72.6	57.9
8	45.7	31.0	74.0	59.3
9	46.6	31.9	75.5	60.8
10	47.5	32.8	77.0	62.3
11	48.5	33.8	78.5	63.8
12	49.5	34.8	80.0	65.3
13	50.5	35.8	81.6	66.9
14	51.5	36.8	83.1	68.4
15	52.5	37.8	84.7	70.0
16	53.5	38.8	86.4	71.7
17	54.6	39.9	88.0	73.3
18	55.6	40.9	89.7	75.0
19	56.7	42.0	91.4	76.7
20	57.8	43.1	93.1	78.4
21	58.9	44.2	94.9	80.2
22	60.0	45.3	96.6	81.9
23	61.2	46.5	98.4	83.7
24	62.3	47.6	100.3	85.6
25	63.5	48.8	102.1	87.4
26	64.7	50.0	104.0	89.3
27	65.9	51.2	105.9	91.2
28	67.1	52.4	107.8	93.1
29	68.4	53.7	109.8	95.1
30	69.7	55.0	111.7	97.0
31	70.9	56.2	113.7	99.0
32	72.2	57.5	115.8	101.1
33	73.5	58.8	117.8	103.1
34	74.9	60.2	119.9	105.2
35	76.2	61.5	122.0	107.3
36	77.6	62.9	124.1	109.4
37	79.0	64.3	126.3	111.6
38	80.4	65.7	128.5	113.8
39	81.8	67.1	130.7	116.0
40	83.3	68.6	133.0	118.3
41	84.7	70.0	135.3	120.6
42	86.2	71.5	137.6	122.9
43	87.7	73.0	139.9	125.2
44	89.2	74.5	142.3	127.6
45	90.8	76.1	144.7	130.0
46	92.3	77.6	147.1	132.4
47	93.9	79.2	149.6	134.9
48	95.5	80.8	152.1	137.4
49	97.1	82.4	154.6	139.9
50	98.8	84.1	157.2	142.5
51	100.4	85.7	159.8	145.1
52	102.1	87.4	162.4	147.7
53	103.8	89.1	165.1	150.4
54	105.5	90.8	167.8	153.1
55	107.3	92.6	170.5	155.8
56	109.0	94.3	173.2	158.5
57	110.8	96.1	176.0	161.3
58	112.6	97.9	178.8	164.1
59	114.5	99.8	181.7	167.0
60	116.3	101.6	184.6	169.9
61	118.2	103.5	187.5	172.8
62	120.1	105.4	190.4	175.7
63	122.0	107.3	193.4	178.7
64	124.0	109.3	196.5	181.8
65	125.9	111.2	199.5	184.8
66	127.9	113.2	202.6	187.9
67	129.9	115.2	205.8	191.1
68	132.0	117.3	208.9	194.2
69	134.0	119.3	212.2	197.5
70	136.1	121.4	215.4	200.7
71	138.2	123.5	218.7	204.0
72	140.4	125.7	222.0	207.3
73	142.5	127.8	225.4	210.7
74	144.7	130.0	228.8	214.1
75	146.9	132.2	232.2	217.5
76	149.2	134.5	235.7	221.0
77	151.4	136.7	239.2	224.5
78	153.7	139.0	242.8	228.1
79	156.0	141.3	246.4	231.7
80	158.3	143.6	250.0	235.3
81	160.7	146.0	253.7	239.0
82	163.1	148.4	257.4	242.7
83	165.5	150.8	261.1	246.4
84	167.9	153.2	264.9	250.2
85	170.4	155.7	268.7	254.0
86	172.9	158.2	272.6	257.9
87	175.4	160.7	276.6	261.9
88	177.9	163.2	280.5	265.8
89	180.5	165.8	284.6	269.9
90	183.1	168.4	288.6	273.9
91	185.7	171.0	292.7	278.0
92	188.4	173.7	296.9	282.2
93	191.1	176.4	301.0	286.3
94	193.8	179.1	305.3	290.6
95	196.5	181.8	309.6	294.9
96	199.3	184.6	313.9	299.2
97	202.1	187.4	318.2	303.5
98	204.9	190.2	322.7	308.0
99	207.7	193.0	327.1	312.4
100	210.6	195.9	331.6	316.9
101	213.5	198.8	336.2	321.5
102	216.5	201.8	340.8	326.1
103	219.4	204.7	345.4	330.7
104	222.4	207.7	350.1	335.4
105	225.5	210.8	354.8	340.1
106	228.5	213.8	359.6	344.9
107	231.6	216.9	364.5	349.8
108	234.7	220.0	369.4	354.7
109	237.9	223.2	374.3	359.6
110	241.1	226.4	379.3	364.6
111	244.3	229.6	384.4	369.7
112	247.5	232.8	389.5	374.8
113	250.8	236.1	394.6	379.9
114	254.1	239.4	399.8	385.1
115	257.5	242.8	405.1	390.4
116	260.8	246.1	410.4	395.7
117	264.2	249.5	415.8	401.1
118	267.7	253.0	421.2	406.5
119	271.1	256.4	426.7	412.0
120	274.7	260.0	432.2	417.5
121	278.2	263.5	437.8	423.1
122	281.8	267.1	443.5	428.8
123	285.4	270.7	449.2	434.5
124	289.0	274.3	454.9	440.2
125	292.7	278.0	460.7	446.0
126	296.4	281.7	466.6	451.9
127	300.1	285.4	472.5	457.8
128	303.9	289.2	478.5	463.8
129	307.7	293.0	484.6	469.9
130	311.6	296.9	490.7	476.0
131	315.5	300.8	496.9	482.2
132	319.4	304.7	503.1	488.4
133	323.3	308.6	509.4	494.7
134	327.3	312.6	515.8	501.1
135	331.4	316.7	522.2	507.5
136	335.4	320.7	528.7	514.0
137	339.5	324.8	535.3	520.6
138	343.7	329.0	541.9	527.2
139	347.9	333.2	548.6	533.9
140	352.1	337.4	555.4	540.7
141	356.3	341.6	562.2	547.5
142	360.6	345.9	569.1	554.4
143	365.0	350.3	576.1	561.4
144	369.3	354.6	583.1	568.4
145	373.7	359.0	590.3	575.6
146	378.2	363.5	597.5	582.8
147	382.7	368.0	604.7	590.0
148	387.2	372.5	612.1	597.4
149	391.8	377.1	619.6	604.9
150	396.4	381.7	627.1	612.4
151	401.0	386.3	634.6	619.9
152	405.7	391.0	642.3	627.6
153	410.4	395.7		
154	415.2	400.5	Critical:	158.3°F
155	420.0	405.3		691.8 psia
156	424.9	410.2		
157	429.8	415.1	Refrigerant	
158	434.7	420.0	properties from	
159	439.7	425.0	Refprop v6.01	
160	444.7	430.0		
161	449.8	435.1		
162	454.9	440.2		
163	460.1	445.4		
164	465.3	450.6		
165	470.6	455.9		
166	475.9	461.2		
167	481.2	466.5		
168	486.6	471.9		
169	492.0	477.3		
170	497.5	482.8		

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