



R-470A (RS-53)

Characteristics and applications of R-470A (RS-53)

RS-53 is a blend of HFC+HFO refrigerant gases. It is non-azeotropic, **non-flammable** with a **zero ODP** and a **low global warming potential (GWP)** and was developed to comply with the requirements of the European F-Gas Regulation for reducing CO₂ emissions.

Some of its main properties are:

- It is a good alternative to R-410A for new medium and low temperature systems.
- It is a **direct drop-in** replacement for R-410A in existing systems.
- Its global warming potential (GWP) is **approximately 53% less** than that of R-410A.
- It has a refrigeration capacity and energy efficiency (COP) similar to that of R-410A.
- It is a blend that is compatible with POE synthetic oils.
- Since RS-53 is a blend, it should always be transferred in liquid phase or, if transferred in gas phase, in full loads.

Applications

RS-53 is the only direct drop-in replacement for R-410A with a GWP less than half that of R-410A. RS-52 can also be used with new equipment designed for R-410A and one of its major advantages is that it's **non-flammable**.

Working and service conditions

Since RS-53 is a blend, it should always be transferred in liquid phase or, if transferred in gas phase, in full loads.

There is no need to make any changes to an R-410A system to convert it to RS-53, whether it be a fixed expansion system (capillary) or a thermostatic expansion valve (TXV).

Lubricants

RS-53 is compatible with the same polyolester oils that are used with R-410A, so there is no need to change the oil type when converting systems from R-410A to RS-53.

Environmental data

None of the components of RS-53 contain chlorine, so the product has an ODP of zero (ozone depletion potential).

RS-53 has a **low** global warming potential (GWP), less than half that of R-410A, thus reducing CO₂ emissions if there is a direct leak.



Safety

RS-53 is not flammable under any blend fractionation situation, in accordance with the ASHRAE Standard 34.

The safety classification of RS-53 is **A1/group L1**.

Compatibility with materials

RS-53 is compatible with all materials commonly used in systems that have previously worked with R-401A. The materials used with R-410A are generally compatible with RS-53. It is recommended that you contact the equipment manufacturer to obtain precise information regarding the adaptation of said equipment in relation to the compatibility of the materials.

Pressure / temperature tables

The pressure / temperature tables and graphs for the refrigerant indicate both the bubble point of the liquid and the dew point of the vapour.

Bubble point temperature: this is the temperature at which the liquid refrigerant begins to vaporise at the given pressure. When below this temperature, the liquid refrigerant will be subcooled.

Dew point of vapour: this is the temperature at which the refrigerant vapour begins to condense at the given pressure. When above this temperature, the refrigerant vapour is considered to be in a superheated state.

Superheated vapour: to determine the evaporator superheat, measure the temperature and pressure from the suction line in the evaporator outlet pipe. Use the P/T tables to determine the vapour dew point, with the pressure measured in the suction line. Subtract the current temperature from the dew point and the difference will be the evaporator superheat.

Subcooling in refrigeration liquid: to determine subcooling, measure the temperature and pressure from the suction line in the condenser outlet pipe. Use the P/T tables to determine the bubble point, with the pressure measured in the condenser. Subtract the current temperature from the bubble point and the difference will be the condenser subcooling.

Note: with the RS range of refrigerants, the average evaporation and condensation temperatures will be the midpoint between the bubble point temperature and the dew point temperature.

Components

Chemical Name	% By weight	N° CAS	N° CE
Trans-1,3,3,3- Tetrafluoroprop-1-ene (R-1234ze)	44	29118-24-9	471-480-0
1,1,1,2,2- Pentafluoroethane (R-125)	19	354-33-6	206-557-8
Difluoromethane (R-32)	17	75-10-5	200-839-4
Carbon Dioxide (R-744)	10	124-38-9	204-696-9
1,1,1,2- Tetrafluoroethane (R-134a)	7	811-97-2	212-377-0
1,1,1,2,3,3,3-Heptafluoropropane (R-227ea)	3	431-89-0	207-079-2



Physical properties

PHYSICAL PROPERTIES	UNITS	R-470A (RS-53) ⁽²⁾	R-410A ⁽²⁾
Molecular weight	(kg/kmol)	84.43	72.60
Boiling point (at 1,013 bar) ⁽¹⁾	(°C)	-62.50	-51.40
Critical temperature	(°C)	88.70	71.30
Critical pressure	(bara)	55.91	49.00
Liquid density at 25°C ⁽¹⁾	(kg/m ³)	1088	1059
Saturated vapour density at 25°C ⁽¹⁾	(kg/m ³)	61.99	64.87
Cv (25°C y 1 bara) Specific heat at V const.	(kJ/kg.K)	0.749	0.700
Cp (25°C y 1 bara) Specific heat at P const.	(kJ/kg.K)	0.854	0.823
Cp/Cv (25°C y 1 bara)		1.141	1.1755
Vapour pressure 25°C ⁽¹⁾	(bara)	18.40	16.57
Latent heat of vaporization at the boiling point. ⁽³⁾	(kJ/kg)	267.30	273.00
Vapour viscosity (25°C y 1 bara)	cP	0.013	0.0133
Liquid viscosity (25°C) ⁽¹⁾	cP	0.135	0.118
Thermal conductivity of liquid (25°C)	W/m.K	0.0828	0.0892
Surface tension (25°C) ⁽¹⁾	N/m	0.00592	0.00521
Specific heat of liquid (25°C) ⁽¹⁾	kJ/kg.K	1.59	1.71
Flammability in air at 1 atm	%vol.	No	No
ODP		0	0
GWP*		979*	2088*
Inhalation exposure (8h/day and 40h/week)	(ppm)	1000	1000

(1) Bubble point.

(2) Properties of the RS-53 refrigerant obtained from the REFPROP v10 program from NIST.

(3) Difference between the enthalpy of the liquid bubble point and the enthalpy of the vapour dew point at 1 atm.

* According to IPPCC-AR4/CIE (Fourth Assessment Report of the Intergovernmental Panel of Experts on Climate Change)-2007.

Remember to consult the guidelines for conversion from RS-53.

R-470A (RS-53) Absolute Saturation Properties

T [°C]	Pressure Liquid [bar]	Pressure Vapour [bar]	Density Liquid [kg/m ³]	Density Vapour [kg/m ³]	Enthalpy Liquid [kJ/kg]	Enthalpy Vapour [kJ/kg]	Entropy Liquid [kJ/K·kg]	Entropy Vapour [kJ/K·kg]
-60	1.1515	0.25481	1397.7	1.229	117.24	366.36	0.66131	1.8959
-59	1.207	0.27168	1394.7	1.305	118.57	367.02	0.66749	1.8928
-58	1.2645	0.28945	1391.7	1.3848	119.89	367.67	0.67365	1.8897
-57	1.3241	0.30816	1388.7	1.4684	121.22	368.33	0.67979	1.8866
-56	1.3859	0.32785	1385.8	1.556	122.55	368.98	0.6859	1.8836
-55	1.4498	0.34855	1382.8	1.6478	123.88	369.64	0.69199	1.8807
-54	1.516	0.37031	1379.7	1.7439	125.21	370.29	0.69806	1.8778
-53	1.5845	0.39317	1376.7	1.8444	126.55	370.95	0.7041	1.875
-52	1.6553	0.41715	1373.7	1.9495	127.88	371.6	0.71013	1.8722
-51	1.7285	0.44231	1370.7	2.0594	129.21	372.25	0.71613	1.8695
-50	1.8042	0.46869	1367.6	2.1741	130.55	372.91	0.72211	1.8669
-49	1.8824	0.49634	1364.6	2.2939	131.89	373.56	0.72807	1.8642
-48	1.9631	0.52528	1361.5	2.4189	133.23	374.21	0.734	1.8617
-47	2.0464	0.55557	1358.5	2.5493	134.57	374.86	0.73992	1.8591
-46	2.1324	0.58726	1355.4	2.6852	135.91	375.51	0.74582	1.8567
-45	2.2211	0.62039	1352.3	2.8268	137.26	376.16	0.7517	1.8542
-44	2.3125	0.65501	1349.3	2.9743	138.6	376.81	0.75756	1.8519
-43	2.4068	0.69117	1346.2	3.1278	139.95	377.46	0.76339	1.8495
-42	2.5039	0.72891	1343.1	3.2875	141.3	378.1	0.76921	1.8472
-41	2.604	0.76829	1339.9	3.4537	142.65	378.75	0.77501	1.845
-40	2.707	0.80935	1336.8	3.6264	144.01	379.4	0.7808	1.8427
-39	2.8131	0.85216	1333.7	3.8059	145.36	380.04	0.78656	1.8406
-38	2.9222	0.89675	1330.6	3.9924	146.72	380.68	0.79231	1.8384
-37	3.0345	0.94319	1327.4	4.186	148.08	381.32	0.79804	1.8363
-36	3.15	0.99152	1324.2	4.387	149.44	381.96	0.80375	1.8343
-35	3.2688	1.0418	1321.1	4.5955	150.8	382.6	0.80944	1.8323
-34	3.3908	1.0941	1317.9	4.8118	152.16	383.24	0.81512	1.8303
-33	3.5162	1.1485	1314.7	5.0361	153.53	383.87	0.82078	1.8283
-32	3.6451	1.205	1311.5	5.2685	154.9	384.51	0.82643	1.8264
-31	3.7774	1.2636	1308.3	5.5093	156.27	385.14	0.83206	1.8245
-30	3.9132	1.3245	1305.1	5.7588	157.64	385.77	0.83767	1.8227
-29	4.0526	1.3878	1301.8	6.017	159.02	386.4	0.84327	1.8208
-28	4.1957	1.4533	1298.6	6.2843	160.39	387.03	0.84885	1.819
-27	4.3424	1.5213	1295.3	6.5609	161.77	387.66	0.85442	1.8173
-26	4.4929	1.5918	1292	6.847	163.15	388.28	0.85997	1.8156
-25	4.6472	1.6648	1288.8	7.1428	164.54	388.91	0.86551	1.8139
-24	4.8054	1.7405	1285.5	7.4487	165.92	389.53	0.87103	1.8122
-23	4.9675	1.8188	1282.1	7.7647	167.31	390.15	0.87655	1.8105
-22	5.1336	1.8999	1278.8	8.0913	168.7	390.77	0.88204	1.8089
-21	5.3037	1.9837	1275.5	8.4286	170.09	391.38	0.88753	1.8073
-20	5.4778	2.0705	1272.1	8.7769	171.49	391.99	0.893	1.8058
-19	5.6562	2.1602	1268.8	9.1365	172.89	392.61	0.89845	1.8042
-18	5.8387	2.2529	1265.4	9.5077	174.29	393.22	0.9039	1.8027
-17	6.0255	2.3487	1262	9.8906	175.69	393.82	0.90933	1.8012
-16	6.2166	2.4477	1258.6	10.286	177.1	394.43	0.91475	1.7998
-15	6.412	2.5499	1255.2	10.693	178.51	395.03	0.92015	1.7983
-14	6.6119	2.6554	1251.7	11.113	179.92	395.63	0.92555	1.7969
-13	6.8162	2.7642	1248.3	11.546	181.33	396.23	0.93094	1.7955
-12	7.0251	2.8765	1244.8	11.993	182.75	396.82	0.93631	1.7941
-11	7.2386	2.9923	1241.3	12.453	184.17	397.41	0.94167	1.7928
-10	7.4567	3.1118	1237.8	12.927	185.59	398	0.94702	1.7914
-9	7.6795	3.2349	1234.3	13.415	187.02	398.59	0.95236	1.7901
-8	7.9071	3.3617	1230.7	13.917	188.45	399.17	0.95769	1.7888
-7	8.1395	3.4924	1227.2	14.435	189.88	399.76	0.96301	1.7875
-6	8.3767	3.627	1223.6	14.968	191.32	400.33	0.96832	1.7862
-5	8.6189	3.7656	1220	15.516	192.76	400.91	0.97363	1.785
-4	8.866	3.9082	1216.4	16.081	194.2	401.48	0.97892	1.7838
-3	9.1182	4.055	1212.8	16.661	195.64	402.05	0.9842	1.7826
-2	9.3754	4.2061	1209.1	17.259	197.09	402.62	0.98948	1.7814
-1	9.6378	4.3614	1205.4	17.873	198.54	403.18	0.99474	1.7802

T [°C]	Pressure Liquid [bar]	Pressure Vapour [bar]	Density Liquid [kg/m ³]	Density Vapour [kg/m ³]	Enthalpy Liquid [kJ/kg]	Enthalpy Vapour [kJ/kg]	Entropy Liquid [kJ/K·kg]	Entropy Vapour [kJ/K·kg]
0	9.9053	4.5212	1201.8	18.505	200	403.74	1	1.779
1	10.178	4.6854	1198	19.155	201.46	404.3	1.0053	1.7778
2	10.456	4.8542	1194.3	19.823	202.92	404.85	1.0105	1.7767
3	10.74	5.0277	1190.5	20.51	204.39	405.4	1.0157	1.7756
4	11.029	5.206	1186.8	21.217	205.86	405.94	1.021	1.7745
5	11.323	5.389	1183	21.942	207.33	406.48	1.0262	1.7733
6	11.623	5.577	1179.1	22.688	208.81	407.02	1.0314	1.7723
7	11.928	5.7701	1175.3	23.455	210.3	407.55	1.0366	1.7712
8	12.239	5.9682	1171.4	24.242	211.78	408.08	1.0418	1.7701
9	12.556	6.1716	1167.5	25.052	213.27	408.61	1.047	1.769
10	12.878	6.3802	1163.6	25.883	214.77	409.13	1.0522	1.768
11	13.206	6.5943	1159.6	26.737	216.27	409.65	1.0574	1.7669
12	13.54	6.8138	1155.6	27.614	217.77	410.16	1.0626	1.7659
13	13.88	7.039	1151.6	28.515	219.28	410.67	1.0677	1.7649
14	14.226	7.2698	1147.6	29.44	220.79	411.17	1.0729	1.7638
15	14.577	7.5064	1143.5	30.39	222.31	411.67	1.0781	1.7628
16	14.935	7.7489	1139.4	31.366	223.83	412.16	1.0832	1.7618
17	15.299	7.9975	1135.3	32.368	225.36	412.65	1.0884	1.7608
18	15.668	8.2521	1131.1	33.396	226.89	413.13	1.0936	1.7598
19	16.044	8.513	1126.9	34.453	228.43	413.61	1.0987	1.7588
20	16.427	8.7801	1122.7	35.537	229.97	414.08	1.1039	1.7578
21	16.815	9.0537	1118.5	36.651	231.52	414.55	1.109	1.7568
22	17.21	9.3338	1114.2	37.794	233.07	415.01	1.1142	1.7558
23	17.611	9.6206	1109.8	38.968	234.63	415.47	1.1193	1.7548
24	18.018	9.9142	1105.5	40.173	236.19	415.91	1.1245	1.7538
25	18.432	10.215	1101	41.41	237.76	416.36	1.1296	1.7529
26	18.852	10.522	1096.6	42.681	239.34	416.79	1.1348	1.7519
27	19.279	10.837	1092.1	43.985	240.92	417.22	1.1399	1.7509
28	19.713	11.158	1087.6	45.324	242.51	417.65	1.1451	1.7499
29	20.153	11.487	1083	46.7	244.1	418.06	1.1502	1.7489
30	20.599	11.824	1078.4	48.112	245.7	418.47	1.1554	1.7479
31	21.053	12.168	1073.7	49.562	247.31	418.88	1.1605	1.7469
32	21.513	12.52	1069	51.051	248.92	419.27	1.1657	1.7459
33	21.979	12.88	1064.3	52.581	250.54	419.66	1.1708	1.7449
34	22.453	13.248	1059.5	54.152	252.17	420.04	1.176	1.7439
35	22.933	13.624	1054.6	55.765	253.81	420.41	1.1812	1.7429
36	23.421	14.008	1049.7	57.423	255.45	420.77	1.1863	1.7419
37	23.915	14.401	1044.7	59.127	257.1	421.12	1.1915	1.7408
38	24.416	14.802	1039.7	60.877	258.76	421.47	1.1967	1.7398
39	24.924	15.212	1034.6	62.676	260.42	421.81	1.2019	1.7387
40	25.438	15.631	1029.5	64.524	262.1	422.13	1.2071	1.7377
41	25.96	16.059	1024.3	66.425	263.78	422.45	1.2123	1.7366
42	26.489	16.496	1019	68.379	265.47	422.76	1.2175	1.7355
43	27.025	16.942	1013.7	70.388	267.18	423.05	1.2227	1.7344
44	27.568	17.398	1008.2	72.455	268.89	423.34	1.228	1.7333
45	28.118	17.864	1002.8	74.582	270.61	423.62	1.2332	1.7322
46	28.676	18.34	997.21	76.77	272.34	423.88	1.2385	1.731
47	29.24	18.825	991.58	79.022	274.08	424.13	1.2437	1.7299
48	29.811	19.321	985.86	81.34	275.83	424.37	1.249	1.7287
49	30.39	19.827	980.06	83.728	277.59	424.6	1.2543	1.7275
50	30.975	20.344	974.17	86.187	279.37	424.81	1.2596	1.7262
51	31.568	20.872	968.19	88.722	281.15	425.01	1.265	1.725
52	32.168	21.411	962.11	91.335	282.95	425.19	1.2703	1.7237
53	32.775	21.961	955.93	94.029	284.77	425.36	1.2757	1.7224
54	33.389	22.523	949.64	96.808	286.59	425.52	1.2811	1.7211
55	34.01	23.096	943.24	99.677	288.43	425.66	1.2865	1.7197
56	34.638	23.681	936.72	102.64	290.29	425.78	1.2919	1.7183
57	35.272	24.279	930.08	105.7	292.16	425.88	1.2974	1.7169
58	35.914	24.889	923.3	108.86	294.05	425.97	1.3029	1.7155
59	36.563	25.512	916.39	112.13	295.96	426.03	1.3084	1.7139
60	37.218	26.149	909.33	115.52	297.88	426.07	1.314	1.7124



Questions and answers regarding R-470A (RS-53)

1 Q: What is RS-53?

A: RS-53 is an HFC+HFO blend for the direct replacement of R-410A. It is non-flammable, has a low global warming potential (GWP) and a zero ozone depletion potential (ODP).

2 Q: OK, but what does RS-53 contain?

A: RS-53 is a blend of R-1234ze, R-125, R-32, R-744, R-134a and R-227ea.

3 Q: Is RS-53 in the process of being phased out, in accordance with regulations, as is the case with CFCs and HCFCs?

A: No, none of the components of RS-53 are subject to a phase-out calendar within the framework of the Montreal Protocol or other European regulations.

4 Q: Can RS-53 be used with the same oil when used as a replacement for R-410A?

A: Yes. RS-53 is fully compatible with synthetic polyolester oils (POE), which are commonly used with R-410A.

5 Q: Is RS-53 non-flammable and non-toxic?

A: RS-53 is non-flammable and has a low toxicity. It is non-flammable under all fractionation conditions. It is classified as group L1.

6 Q: Is RS-53 approved by compressor manufacturers?

A: The components that make up RS-53 are widely used for compressors produced by the main manufacturers.

7 Q: Should RS-53 be charged in liquid or gas phase?

A: Since RS-53 is a blend, it is recommended that it be charged in liquid phase. However, if the entire content of the cylinder is being charged into a system, it can be done in gas phase.

8 Q: Is RS-53 included in SNAP (US programme for new alternatives)?

A: An application will be made to the Environmental Protection Agency (EPA) in the USA for RS-53 to be included in SNAP.

9 Q: Does RS-53 have an ASHRAE number, and what is its classification?

A: Yes, the ASHRAE number for RS-53 is R-470A, and the safety classification is A1, meaning that it has a low toxicity and it is non-flammable under all fractionation conditions.

10 Q: What are the pressures of RS-53 compared with R-410A?

A: The discharge pressure of RS-53 is similar to that of R-410A.

11 Q: What is the capacity of RS-53 compared with R-410A?

A: The capacity of RS-53 is similar to that of R-410A.

12 Q: Is RS-53 as efficient as R410A?

A: The tests demonstrate that RS-53 has a similar COP to that of R-410A.

13 Q: What is the working temperature of RS-53 compared with R-410A?

A: The discharge temperature of RS-53 is similar to that of R-410A.

14 Q: What are the flammability properties of RS-53?

A: RS-53 is non-flammable, as established in the ASHRAE EN 681-09 test, and therefore has neither a flash point nor explosion limits. The autoignition temperature of RS-53 has not been determined but is expected to be higher than 750 °C. RS-53 is non-flammable at room temperature and atmospheric pressure, and has the same classification as R-410A, R-134a, R-404A, R-507, etc.



15 Q: What are the decomposition products resulting from the combustion of RS-53?

A: The decomposition products resulting from the exposure of RS-53 to a high temperature source are similar to those produced by R-410A when it is exposed to fire. The decomposition products in any case are irritants and toxic, and in the case of exposure, a self-contained breathing apparatus should be used.

16 Q: Should any special precautions be taken into account with RS-53?

A: There are no particular precautions that need to be taken with RS-53. Common sense and good practices are always recommended, as with all refrigerants.

17 Q: Is RS-53 compatible with systems designed for R-410A?

A: Yes, RS-53 is compatible with all the materials commonly used in systems that were designed for and loaded with R-410A. Magnesium and zinc alloys should be avoided.

18 Q: Can R-470A (RS-53) be recovered and regenerated?

A: Yes, RS-53 can be recovered and reused after a cleaning process, as with regeneration, which is carried out by an authorised waste management service provider.

19 Q: What technical advice would you give when changing from R-410A to RS-53?

A: Use the same kind of oil that is already in use, which should be POE. After recovering the R-410A and emptying the system, change the filter dehydrator and charge 10% less than the original charge of R-410A. The flow rate of the liquid is similar to that of R-410, meaning it is compatible with equipment that has either a fixed expansion system (capillary) or a thermostatic expansion valve (TXV). Finish charging the equipment with small charges of RS-53 while keeping an eye on the superheating.

20 Q: How does the price of RS-53 compare to other alternatives?

A: RS-53 is the only alternative for existing R-410A equipment, the price is competitive and the tax is approximately 53% lower than that of R-410A.

21 Q: What is the main benefit of RS-53?

A: The global warming potential (GWP) of RS-53 is 53% lower than that of R-410A.

22 Q: Is RS-53 compatible with the joints, seals, hoses and toric joints that are used with R-410A?

A: Yes, there is no need to change any seal, hose, etc. when replacing R-410A with RS-53.

23 Q: What is the specification of R-470A (RS-53)?

A: RS-53 complies with the AHRI-700 specification for fluorocarbon refrigerants.

24 Q: What are the effects of prolonged exposure to RS-53 by inhalation?

A: As is the case with all CFC, HCFC, HFC and HFC+HFO refrigerants, prolonged exposure to RS-53 can cause anaesthetic effects. Very prolonged exposure may lead to heart arrhythmia and could be fatal, as is the case with all CFC, HCFC, HFC and HFC+HFO refrigerants.

25 Q: What kinds of leak detectors should be used with RS-53?

A: The same leak detectors used for other HFC and HFC+HFO refrigerants can also be used with RS-53.

26 Q: What is the correct way to respond to a major leak of RS-53?

A: As is the case with all other refrigerants of this type, the area should be immediately evacuated. The vapours may concentrate at ground level and in poorly ventilated areas they may disperse slowly. The area should be properly ventilated before entering.

27 Q: Can RS-53 be used in new systems?

A: RS-53 has also been developed as an alternative to R-410A in new systems due to its low global warming potential (GWP) and one of its major advantages is that it's non-flammable.



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28 Q: What tests have been carried out on RS-53, and what were the results?

A: A change of refrigerant from R-410A to RS-53 was carried out on a split air conditioning system and the resulting performance and operating parameters were both satisfactory.

29 Q: Do RS-53 cylinders have probe tubes?

A: It depends on the type of cylinder. All the blue cylinders from Gas Servei have them. If there isn't one, it is recommended that you turn the cylinder upside down.

30 Q: Is RS-53 available in rechargeable and disposable cylinders?

A: Yes, although disposable cylinders may only be used outside of the European Union.