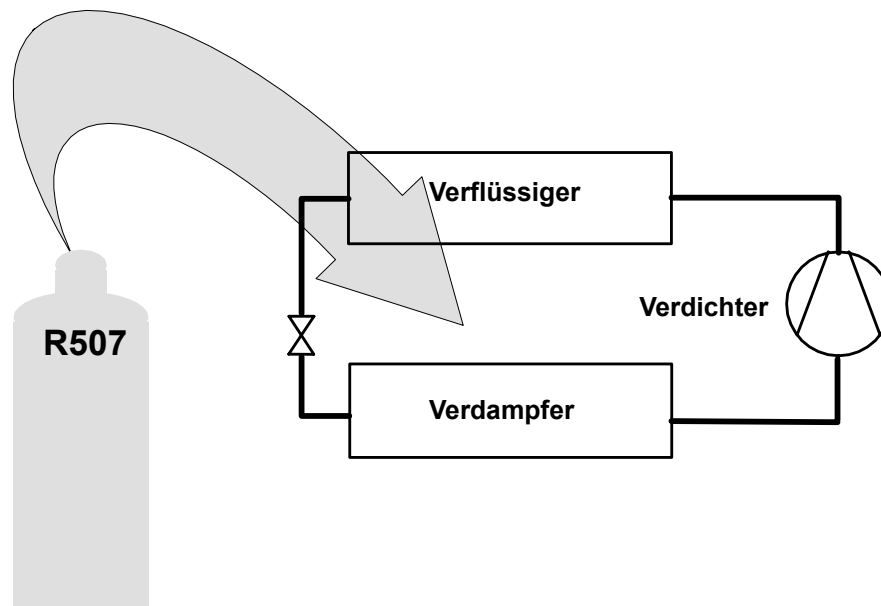


SOLKANE® - INFORMATION SERVICE

Filling refrigeration plants with Sol Kane® 507



SOLVAY FLUOR UND DERIVATE GmbH

Technical Service – Refrigerants –

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1. Introduction

SOLKANE® 507 is a replacement for the refrigerant R 502 suitable for use in new-construction and existing refrigeration plants alike. Covering the evaporating temperature range between $t_o = -60\text{ °C}$ and $t_o = +15\text{ °C}$, SOLKANE® 507 has already been shown to be an excellent substitute for R 502 [1]. It is also the only azeotropic refrigerant among all such replacements currently available.

This product bulletin discusses the issue of charging refrigeration plants with SOLKANE® 507. Due to its azeotropic characteristics, SOLKANE® 507 may be filled in either liquid or vapour form.

2. Azeotropic refrigerants

Definition:

Azeotropes are mixtures of two or more liquids in which the liquid and vapour have the same composition at equilibrium. In normal mixtures the vapour is richer in the lower-boiling or more volatile component [2]. An example is the refrigerant R 404A, a ternary blend in which R 125 and R 143a dominate in the vapour phase while R 134a dominates in the liquid phase. Azeotropes typically have a boiling point that is different from the boiling point of the individual blend components. As a result the blend's vapour pressure will also be different from the vapour pressures of the individual components. It is not possible to separate out the components of an azeotropic blend by means of distillation.

The precise composition required for an azeotropic blend depends on the pressure and temperature. For atmospheric pressure and a temperature of approximately -40 °C , a blend containing 53% R 125 and 47% R 143a by weight have been shown to possess the characteristics described.

Phase equilibrium measurements [3] have shown that blends, composed of between 40% and 60% by weight of each of the two components R 143a and R 125, have an extensive range of azeotropic behaviour at atmospheric pressure and -40 °C . The azeotropic range shows a vapour pressure minimum for these blends. The composition of the vapour and of the liquid phase was shown to be identical to the degree of accuracy that could be obtained in laboratory measurements. The SOLKANE® 507 blend, composed of equal parts of R 143a and R 125, is thus well within the range where it may be called azeotropic.

3. Filling with SOLKANE® 507 at normal ambient temperatures

Blends of R 125 and R 143a behave for all practical purposes almost like an azeotropic refrigerant blend [4] at those temperatures that are normally encountered in refrigerating applications. Basically, the azeotropic composition varies slightly with temperature. The composition of commercial products is in accord with the specifications. For a given blend with constant composition, a temperature glide can be calculated, but in practice it is negligibly small. Table 1 gives the maximum temperature glide that may theoretically be expected in the range from -40 °C to +60 °C for R 404A, R 500, R 502 and SOLKANE® 507.

Table 1: Predicted temperature glide for azeotropic and near-azeotropic refrigerants in the temperature range from -40 °C to +60 °C

Refrigerant	Composition [% by weight]	Azeotropic temperature [°C]	Max. glide [K]
R 404A (R125/R134a/R143a)	44 / 4 / 52	-	0.6
R 500 (R 12/R 152a)	73.8 / 26.2	0	0.17
R 502 (R 22/R 115)	48.8 / 51.2	19	0.04
R 507 (R 125/R 143a)	50 / 50	-40	0.04

The refrigerant R 404A has a temperature glide of approximately 0.6K, which is greater than that of R 502 and SOLKANE® 507 by a factor of fifteen! The temperature glide of the latter two azeotropic refrigerants has been listed for its theoretical interest, but it is so small as to be of no practical importance.

In addition to experiments conducted by Solvay, the company Hoechst also carried out a study on the changes in the composition of the liquid phase of SOLKANE® 507 while removing the refrigerant on the vapour side [5]. In this study, refrigerant vapour was gradually allowed to escape from a test vessel at a temperature of approximately 20 °C while monitoring the composition of the liquid phase. The results are depicted in Figure 1.

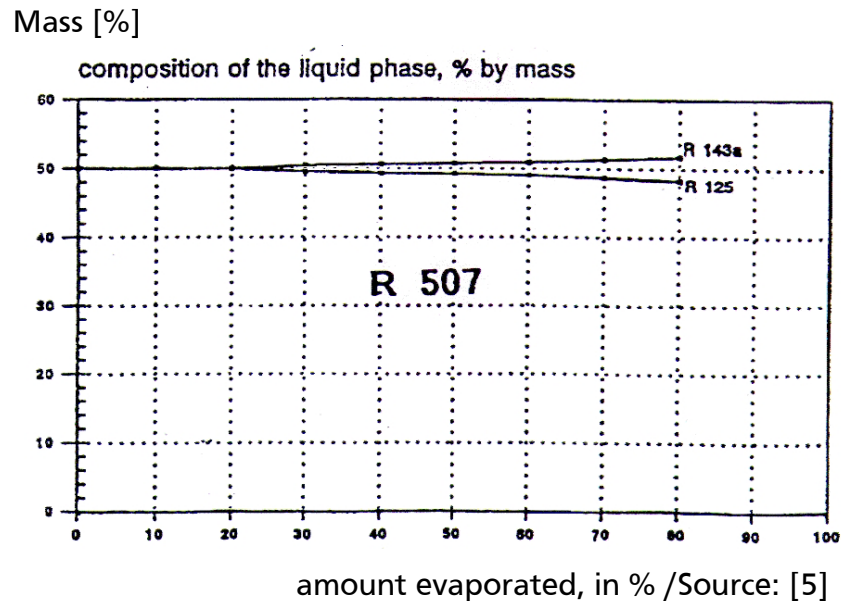


Figure 1: Leakage tests involving R 507 gas escaping at ambient temperature; composition of the remaining liquid phase

In the tests, the ratio of R 125 to R 143a changed only very slightly: after approximately 80% of the refrigerant had been evaporated, the R 143a content in the remaining liquid rose by some 2%. The measurable effects of this minute change on the performance of the refrigeration plant are negligible for all practical purposes.

These results have also been confirmed in tests of a similar nature performed by Allied Signal [3]. For example, a container was liquid filled to 15% capacity with R 507, and then gradually emptied through evaporation at 60 °C. In the worst case the blend composition changed to 55% R 143a and 45% R 125. At a temperature of $t = -40$ °C, this blend composition is still well within the azeotropic region and remains non-combustible.

Calculations of the theoretical performance of such a worst-case blend show that its properties remain virtually unchanged. The coefficient of performance and the operating pressures and temperatures changed by less than 0.5%. The effects of minimal changes in blend composition on the operating characteristics of refrigerating plants may thus be neglected for all practical purposes.

4. Conclusions for practical use

It is possible to fill systems with a charge of SOLKANE® 507 in liquid or vapour form. If several systems are charged from the same bottle of SOLKANE® 507, very slight changes in the refrigerant composition may be expected, but their effects on performance can be neglected. Neither the operating characteristics nor the performance of the plant should be

negatively affected by such changes; indeed, even detecting the differences would require measuring instruments of a very high accuracy.

Likewise, there is no danger of a possible fire hazard involving a flammable blend mixture. The tests clearly demonstrated that even under worst-case conditions, assuming a situation of gross negligence, the blend does not form any flammable mixtures either within the system, in the bottle, or in any vapour leaks arising from the system.

Thanks to its azeotropic properties, SOLKANE® 507 has many advantages which make it the ideal replacement for R 502.

References

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