

The present invention relates to new compositions on the basis of hydrogen-containing fluorochlorohydrocarbons from the group of dichloropentafluoropropanes in a mixture with acetone, to their use and also to a process for cleaning surfaces of objects using these compositions and a process for fixing toner applied to a recording material in the fixing apparatus of printers and copiers.

Very high demands are made on solvents for cleaning purposes and for fixing toner. Such solvents should have a relatively low boiling point and be non-flammable and largely non-toxic and also have beneficial solvent properties for impurities which are to be removed or for toner particles which are applied to a recording material and are to be fixed by solubilising. However, these demands cannot as a rule be met by only one single pure solvent. Therefore in practice a plurality of solvent mixtures with compositions which differ to a greater or lesser extent are used. For instance, it is generally known also to use mixtures of fluorochlorohydrocarbons (as the main solvent) with a co-solvent in addition to pure chlorinated and/or fluorinated hydrocarbons for industrial cleaning processes or for vapour de-greasing. Such mixtures may be either non-azeotropic or alternatively azeotropic or azeotrope-like. "Azeotrope-like" is understood to mean that mixtures boil substantially constantly over a relatively large concentration range (change in boiling temperature of not more than 5°C) and therefore behave similarly to azeotropes for practical use. Those solvent mixtures which when boiling in the vapour phase contain the solvent constituents of the mixture in the same relative composition as in the liquid phase are regarded as azeotropes. Solvent mixtures which are suitable for use in fixing apparatus of printers and

copiers generally consist of at least two solvent constituents, at least one of which must have toner-solubilising properties. Since solvent mixtures in modern fixing apparatus act on the toner in the vapour state, the solvent mixture should evaporate as evenly as possible, i.e. without separating into the constituents or at least without relatively large shifts in the proportions of the constituents, in order to be able to ensure constantly good fixing of the toner on the recording material even over relatively long periods of use. For this purpose, it is expedient if the solvent mixture used in the fixing apparatus has at least azeotrope-like, but especially azeotropic, boiling properties. However, it is not possible to predict the formation of azeotropic or azeotrope-like compositions, which renders the search for new azeotropic or azeotrope-like solvent systems more difficult.

Non-azeotropic compositions consisting of 75% by weight dichloropentafluoropropane and 25% by weight acetone are described in WO-A-89 12 674.

Azeotropic compositions for use in the fixing devices of printers and copiers and also a method for fixing by means of these azeotropes are known from GB-A-20 29 325. In addition to acetone, the fully-halogenated hydrocarbon trichlorotrifluoroethane is used in these compositions.

Although many attempts have already been made to obtain compositions with the desired properties for different fields of use, the known mixtures are still in need of improvement in terms of their use properties, toxicological properties and properties affecting the environment. For instance, in conjunction with the technical further developments in the field of fluxes new

demands have resulted relating to the removal of these newly-developed fluxes. These demands are not always or frequently only unsatisfactorily met by the known solvent mixtures. Furthermore, known solvent mixtures are often multi-component systems of complicated composition, or contain relatively large proportions of solvents which are risky toxicologically and from the point of view of safety aspects (low flash point). For a range of solvent constituents, furthermore replacement by other solvents which are at least equally well suited for the respective purposes is desirable owing to their properties affecting the environment. Therefore there is a need for new solvent mixtures with special new properties, which furthermore have increased safety with respect to the criteria of toxicology and in particular effect on the environment as well.

It was therefore an object of the invention to make available new azeotrope-like, especially azeotropic, solvent mixtures which overcome the drawbacks of the prior art and are firstly particularly well suited for cleaning purposes, and also in particular for the removal of modern fluxes, and also for use as solvents in the fixing apparatus of printers and copiers.

In order to achieve this object, the invention proposes new azeotrope-like compositions which are distinguished by a content of 90.0 to 80.0% by weight of at least one hydrogen-containing fluorochlorohydrocarbon from the group 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca), 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) or a mixture thereof and 10.0 to 20.0% by weight acetone, with the sum of the constituents being 100% by weight.

Dichloropentafluoropropanes in the spirit of the invention are the fluorochlorohydrocarbons of the empirical formula $C_3HCl_2F_5$ bearing one hydrogen atom. They are in particular the not fully halogenated isomeric fluorochloro-
5 hydrocarbons 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) or 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) and also a mixture thereof.

The compositions of the invention are distinguished by azeotrope-like or azeotropic behaviour. Such azeotropic
10 or azeotrope-like compositions of solvents have a number of use-related advantages. Firstly they boil at a constant or substantially constant temperature and secondly while so doing the composition of the mixtures remains constant or substantially constant. If the
15 compositions according to the invention are used, therefore fractionation of the solvent constituents of the compositions does not occur, thus avoiding undesirable changes in properties, such as reduced solvent power, reduced inertness to items to be cleaned or increased
20 flammability by accumulation of flammable co-solvents. Furthermore, the azeotropic or azeotrope-like compositions can be readily purified by conventional distillation after use and are thus readily available for re-use, without the characteristics of the original composition being lost.

25 Binary or ternary compositions according to the invention of 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) and/or 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) on one hand and acetone on the other hand have very narrow, azeotrope-like boiling ranges. The binary
30 azeotrope-like compositions which contain 90.0 to 80.0% by weight 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) or 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) in a mixture with 10.0 to 20.0% by weight acetone boil within a

range of 51 to 56°C (atmospheric pressure). A particularly favourable binary azeotropic composition with approximately 85.2% by weight 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) and 14.8% by weight acetone has a boiling point of approximately 55.5°C at atmospheric pressure. The ternary azeotrope-like compositions of the invention contain 90.0 to 80.0% by weight of a mixture of the isomers 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) and 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) on one hand in a mixture with 10.0 to 20.0% by weight acetone on the other hand and boil in a range of 55 to 56.5°C (atmospheric pressure). In very expedient forms of these above ternary compositions, they are distinguished in that the isomers 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) and 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) are present in a weight ratio of 1:3 to 1:5.5 to each other. Particularly preferred are weight ratios of approximately 1:4 for the isomer mixture of R225ca and R225cb. A particularly favourable ternary azeotropic composition with approximately 85.8% by weight of a mixture of the isomers 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) and 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) on one hand and 14.2% by weight acetone on the other hand has a boiling point of approximately 55.7°C at atmospheric pressure.

The azeotropic or azeotrope-like compositions of the invention have beneficial solvent properties. This makes them particularly suitable for many purposes, for instance as solvents for cleaning the surfaces of objects or as solvents in fixing apparatus of printers and copiers.

The compositions according to the invention are solutions which are clear at room temperature, to which known additives may be added (this means that the relative ratio

of dichloropentafluoropropane to acetone, which is determined by the above percentage weight details, is not altered).

One group of known additives are stabilisers. This group comprises those compounds which prevent an undesirable reaction of constituents of the composition with each other or with other reaction participants, such as atmospheric oxygen, metal, water etc. Known stabilisers are for instance nitroalkanes, in particular nitromethane, nitroethane, alkylene oxides, in particular butylene oxide, or branched alkinols such as 2-methyl-butin-(3)-ol-(2). These stabilisers may be used singly or in combination with each other, with quantities of 0.01 to 5% by weight, preferably of 0.05 to 1% by weight, relative to the total mixture, being highly suitable.

Another group of additives comprises known compounds from the group of corrosion inhibitors, non-ionic or ionic emulsifiers, dyes etc.

The compositions according to the invention have numerous possible uses in the sector of cleaning and/or vapour degreasing. In these known processes, the object to be cleaned is dipped into liquid and/or vaporous cleaning mixture or is sprayed with liquid cleaning mixture in one or more stages. The cleaning action may be increased in known processes by using at boiling temperature and/or with ultrasound and/or with stirring. Likewise it is known to improve the cleaning action by mechanical action, for instance brushing.

For instance, the electronics industry uses predominantly organic resin fluxes for soldering processes, the surpluses of which fluxes have to be removed from printed

circuit boards after the soldering operation. This is done using organic solvents which are compatible with the circuit boards and the electronic components, i.e. the solvent must not react therewith. The resin fluxes to be removed are mixtures of polar and non-polar compounds, and often additionally contain special activators. Dichloro-pentafluoropropanes alone, which are non-polar, are not effective for removing the polar constituents of the resins. Nor are they capable of completely removing in particular special high-activator-containing fluxes. Surprisingly, however, the compositions of dichloro-pentafluoropropanes and acetone according to the invention are able to remove both the polar and the non-polar constituents, and are therefore effective on a broad basis as removal agents for resin fluxes, in particular for those having a high activator content. The compositions with 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca), in the azeotropic, optionally stabiliser-containing compositions, are particularly well suited for this application.

Thus circuit boards with or without inserted components (in particular also those with SMD-components inserted) can be cleaned without problems using the compositions according to the invention, even when using fluxes having high activator contents, without the "white coatings" which are feared when using the conventional cleaning agents being produced.

The low surface tension, the high wetting power and the density of the compositions according to the invention make them particularly suitable for cleaning capillary systems.

The compositions according to the invention may for instance also be used as follows:

- for cleaning small parts or bulk material (preferably in closed installations),
- for stripping paint,
- as special solvents, extraction agents and/or recrystallisation agents in the chemical and pharmaceutical industry.

The new azeotrope-like and azeotropic compositions according to the invention are also desired systems for fixing toner onto recording materials in printers and copiers. The invention therefore also relates to the use of these azeotrope-like or azeotropic compositions in the fixing apparatus of printers and copiers. The compositions according to the invention used for this may also contain stabilisers.

The azeotrope-like or azeotropic compositions according to the invention solubilise very well in particular dry toners on the basis of polystyrene. In the printing and copying process, first of all a charged image (negative image) is produced on a photoconductor drum by duplicating the printer or copier document, which image is developed in a subsequent developing station, i.e. the charged image is provided with toner. The developed charged images on the photoconductor drum then pass into a transfer printing station. The toner image is transferred onto a record carrier, for instance a web of paper or alternatively a single sheet, supplied to the transfer printing station, using an electrostatic field in the transfer printing station. The toner image then adheres to the surface of the record carrier, although it can be smeared. The record carrier provided with the toner image (positive

image) is then passed through a fixing apparatus. In this fixing apparatus, the vapour necessary for fixing is produced. For this purpose, the solvent is located on the base of the housing of the fixing apparatus. The base of the fixing apparatus is heated by means of a heating apparatus so that the solvent evaporates from the base. The solvent vapour produced thereby acts on the record carrier, in particular on the toner applied thereto. This solubilises the toner, so that it can penetrate into the record carrier. After this fixing operation, the record carriers are freed, by drying, of any residues of the solvent vapour which may still be adhering, and a dry, well-adhering and non-smearing toner image is obtained on the record carrier.

The compositions according to the invention ensure to a high extent the high degree of purity which is necessary in special fields of use, for instance for cleaning components and circuit boards in the electronics industry. In terms of their properties, they are not inferior to the compositions with fully halogenated fluorochloro-hydrocarbons known hitherto in the prior art. It is all the more surprising that the new compositions according to the invention, unlike many mixtures of the prior art, also possess outstanding cleaning properties without additional polar additives to increase the solvent power and are very well suited for the afore-mentioned uses. Furthermore, the azeotrope-like and azeotropic compositions according to the invention have very good toner-solubilising properties, especially for dry toners on the basis of polystyrene. These compositions are on one hand able to solubilise the toner particles very well, without on the other hand leading to an unwanted deliquescence of the toner on the record carrier. This makes it possible to produce well-adhering, non-smearing images with high

resolution or sharpness on the record carrier. Another advantage of the compositions according to the invention consists in that they have elevated flash points and in the case of the azeotropes even no flash points (closed crucible method). The compositions according to the invention therefore permit new solutions to problems in many fields of use. Furthermore, it proves advantageous that the not fully halogenated fluorochlorohydrocarbon solvents used have easier degradability and thus considerably higher environment-compatibility compared with fully halogenated fluorochlorohydrocarbons.

The following examples are intended to explain the invention in greater detail, but without limiting its scope. Unless stated otherwise, % always means % by weight.

Example 1: Cleaning of printed circuit boards, glass lenses and aluminium plates

Cleaning tests with printed circuit boards which were contaminated both with conventional halogen-containing soldering fluxes and with high-activator-containing soldering fluxes were carried out in a commercially available 2-chamber cleaning unit. It was possible to remove from the circuit boards both the impurities due to conventional halogen-containing soldering fluxes and those due to high-activator-containing fluxes with outstanding cleaning results. Furthermore, glass lenses and aluminium plates contaminated with oil and/or grease were cleaned. The cleaning compositions, cleaning conditions and cleaning results are reproduced in Table 1.

Table 1:

No.	Compositions for bath 1 and 2	Cleaning conditions	Material	Result
1	R225ca/acetone: 90.0% / 10.0%	2-bath: 1) 3 min. ultra- sound 2) 1 min. vapour degreasing	a) Circuit boards b) Glass lenses c) alumi- nium plates	++ ++ ++
2	R225ca/acetone: 85.2% / 14.8%	2-bath: 1) 3 min. ultra- sound 2) 1 min. vapour degreasing	a) Circuit boards b) Glass lenses c) alumi- nium plates	++ ++ ++
3	R225/acetone: 90.0% / 10.0% Weight ratio R225ca:R225cb = 1:4	2-bath: 1) 3 min. ultra- sound 2) 1 min. vapour degreasing	a) Circuit boards b) Glass lenses c) alumi- nium plates	++ ++ ++
4	R225/acetone: 85.8% / 14.2% Weight ratio R225ca:R225cb = 1:4	2-bath: 1) 3 min. ultra- sound 2) 1 min. vapour degreasing	a) Circuit boards b) Glass lenses c) alumi- nium plates	++ ++ ++

In the cases marked "++" in the "Result" column, a very good cleaning effect was achieved, and there was no

formation of "white coatings". In the case of cleaning glass lenses and aluminium plates, these were completely free of oil or grease after cleaning. It is clearly apparent that the compositions according to the invention show outstanding cleaning powers.

Example 2: Cleaning of bulk material

a) Bulk material (transistor caps) was cleaned in a 2-chamber unit (3 minutes ultrasound, 1 minute vapour degreasing) with an azeotropic composition of 85.2% R225ca and 14.8% acetone in order to remove drawing oils. The bulk material was satisfactorily clean after treatment.

b) Bulk material (transistor caps) was cleaned in a 2-chamber unit (3 minutes ultrasound, 1 minute vapour degreasing) with an azeotropic composition of 85.8% R225 (R225ca:R225cb in a weight ratio of 1:4) and 14.2% acetone in order to remove drawing oils. The bulk material was satisfactorily clean after treatment.

Claims

1. Azeotrope-like compositions, characterised by a content of 90.0 to 80.0% by weight 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca), 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) or a mixture thereof and 10.0 to 20.0% by weight acetone, the sum of the constituents being 100% by weight.
2. A composition according to Claim 1, characterised by an azeotropic composition of approximately 85.2% by weight 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) and 14.8% by weight acetone with a boiling point of approximately 55.5°C at atmospheric pressure.
3. A composition according to Claim 1, characterised by a ternary azeotropic composition of approximately 85.8% by weight of a mixture of the isomers 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) and 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) on one hand and 14.2% by weight acetone on the other hand with a boiling point of approximately 55.7°C at atmospheric pressure.
4. A composition according to Claim 1 or 3, characterised in that the isomers 1,1-dichloro-2,2,3,3,3-pentafluoropropane (R225ca) and 1,3-dichloro-1,1,2,2,3-pentafluoropropane (R225cb) are present in a weight ratio of 1:3 to 1:5.5, preferably approximately in a weight ratio of 1:4 relative to each other.
5. Compositions according to one of the preceding Claims, characterised by an additional content of stabiliser of 0.01 to 5% by weight, preferably 0.05 to 1%



by weight, relative to the total mixture, preferably from the group nitroalkane, alkylene oxide and/or alkinol.

5 6. The use of the compositions according to one of the preceding Claims in immersion cleaning and/or spray cleaning processes or in vapour de-greasing, or as a solvent in the fixing apparatus of printers and copiers.

7. A process for cleaning surfaces, characterised in that the surfaces are treated with compositions according to one of Claims 1 to 5.

10 8. A process according to Claim 7, characterised in that the surfaces to be cleaned are printed circuit boards contaminated with soldering flux or soldering flux residues.

15 9. A process for fixing toner applied to a record carrier and constituted on the basis of polystyrene, wherein a solvent contained in the fixing apparatus of printers or copiers and optionally containing stabiliser, and consisting of an azeotrope-like or azeotropic mixture of pure liquids, at least one of which has a toner-
20 solubilising property, is evaporated and acts in this state on the toner and solubilises it, characterised in that a composition according to one of Claims 1 to 5 is used as the solvent in the fixing apparatus.

