Use of liquid cooling is becoming increasingly popular for such devices. In many power electronic devices, the desired power density makes air cooling of the components within it impractical. In large data and telecommunications centres, liquid cooling is replacing air in many of the heat transfer processes in order to increase energy efficiency.

Cooling may take place directly (the heat-dissipating component is immersed directly in a heat transfer fluid) or indirectly (heat is transferred through a thermal interface material).

Usually organic, especially fluorinated organic liquids, see e.g. WO 2020/250104 A1 or WO 2018/224908 A1, are used as heat transfer fluids, since, water or water-based systems usually exhibit a certain electrical conductivity which may cause an electrical short circuit on direct contact with electrical components or, in the case of indirect cooling, in case of a leakage of the coolant loop.

On the other hand, organic heat transfer fluids often exhibit a low flashpoint and are flammable which leads to an inacceptable fire hazard. Fluorinated organic liquids are often non-flammable but are environmentally questionable due to their ozone-depleting potential or their atmospheric lifetime.

WO 02/101848 and unpublished European Patent Application No. 20192954.4 filed on 26. August 2020 both disclose an aqueous coolant with low electrical conductivity for use in cooling systems of vehicles with electric engines, fuel cells or hybrid engines. Application of such coolants is limited to cooling fuel cells and electric vehicles but no further application is disclosed or render obvious.

It was an object of the present disclosure to provide an aqueous heat transfer fluid which may be used for electronic components even on direct contact.

In an aspect, there is provided a use of a coolant, comprising

(A) at least one glycol
(B) water
(C) at least one azole derivative
(D) at least one ester of orthosilicic acid or alkoxy alkylsilane
(E) at least one tertiary amine bearing at least one 2-hydroxyethyl- or 2-hydroxypropyl-group
(F) optionally at least one monocarboxylic acid
(G) optionally at least one silicophosphonate

(H) optionally at least one further coolant additive

wherein

- components (C) to (H) are present in amounts so that the coolant exhibits an electrical conductivity of less than 50, preferably less than 45 µS/cm; and
- the coolant does not contain any carboxylic acids with a functionality higher than 1

for thermally managing heat-generating electronic devices, preferably electronic devices comprising a datacentre, more preferably electronic devices comprising a datacentre comprising an electronic component.

In another aspect, there is provided a method of thermally managing heat-generating electronic devices, preferably electronic devices comprising a datacentre, more preferably electronic devices comprising a data-centre comprising an electronic component by directly or indirectly bringing the heat-generating electronic devices in contact with a coolant as defined above, conveying the coolant to a heat exchanger and recirculating the coolant.

In another aspect, there is provided a system, comprising at least one heat-generating electronic device in direct or indirect con-tact with a coolant as described in any of the preceding claims, in which the coolant is re-circulated in a thermal management system to at least one condenser or heat exchanger, preferably a heat exchanger in contact with a heat sink, and recirculated to the at least one heat-generating electronic device.

The object was achieved by coolants, comprising

(A) at least one glycol
(B) water
(C) at least one azole derivative
(D) at least one ester of orthosilicic acid or alkoxy alkylsilane
(E) optionally at least one tertiary amine bearing at least one 2-hydroxyethyl- or 2-hydroxypropyl-group
(F) optionally at least one monocarboxylic acid
(G) optionally at least one silicophosphonate, and

Claims

1. Use of a coolant, comprising

(A) at least one glycol
(B) water
(C) at least one azole derivative
(D) at least one ester of orthosilicic acid or alkoxy alkylsilane
(E) at least one tertiary amine bearing at least one 2-hydroxyethyl- or 2-hydroxypropyl-group
(F) optionally at least one monocarboxylic acid
(G) optionally at least one silicophosphonate
(H) optionally at least one further coolant additive

wherein

- components (C) to (H) are present in amounts so that the coolant exhibits an electrical conductivity of less than 50, preferably less than 45 µS/cm; and
- the coolant does not contain any carboxylic acids with a functionality higher than 1

for thermally managing heat-generating electronic devices, preferably electronic devices comprising a datacentre, more preferably electronic devices comprising a datacentre comprising an electronic component.

2. Method of thermally managing heat-generating electronic devices, preferably electronic devices comprising a datacentre, more preferably electronic devices comprising a datacentre comprising an electronic component by directly or indirectly bringing the heat-generating electronic devices in contact with a coolant as described in claim 1, conveying the coolant to a heat exchanger and recirculating the coolant.

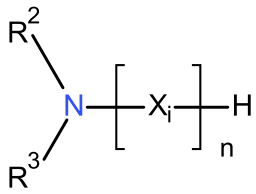
3. Use and method according to Claim 1 or 2, wherein the glycol (A) is selected from the group consisting of monoethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, monopropylene glycol, dipropylene glycol, 1,3-propanediol, higher poly alkylene glycols, alkylene glycol ethers, and glycerol.

4. Use and method according to any of the preceding claims, wherein the azole derivative (C) is selected from the group consisting of benzimidazole, benzotriazole, tolutriazole, hy-

drogenated tolutriazole, (2-benzothiazylthio)acetic acid, and (2-benzothiazylthio) propionic acid.

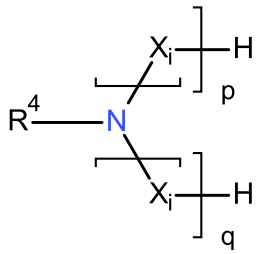
5. Use and method according to any of the preceding claims, wherein the ester of orthosilicic acid (D) is orthosilicic acid tetra ethyl ester or orthosilicic acid tetra methyl ester.

6. Use and method according to any of the preceding claims, wherein the tertiary amine (E) is selected from compounds
- of the general formula (I)



where
R^2 and R^3 independently of another each are a substituent as described above, preferably a linear or branched, preferred a linear alkyl substituent comprising 1 to 18 carbon atoms, preferably 2 to 16, more preferably 4 to 14, and especially 6 to 12 carbon atoms, or together may form a five- or six-membered ring including the nitrogen atom,
X_i is $-CH_2-CH_2-O-$, $-CH_2-CH(CH_3)-O-$ or $-CH(CH_3)-CH_2-O-$, preferably $-CH_2-CH_2-O-$, and
n is a positive integer from 1 to 5, preferably from 1 to 4, more preferably from 1 to 3, even more preferably 1 or 2, and especially 1,

- of the general formula (II)



where
R^4 is a substituent as described above, preferably a linear or branched, preferred a linear alkyl substituent comprising 1 to 18 carbon atoms, preferably 2 to 16, more preferably 4 to 14, and especially 6 to 12 carbon atoms,
each Xi for i = 1 to p and 1 to q is independently selected from the group consisting of $-CH_2-CH_2-O-$, $-CH_2-CH(CH_3)-O-$ or $-CH(CH_3)-CH_2-O-$, preferably $-CH_2-CH_2-O-$, and

p and q independently of another are a positive integer from 1 to 5, preferably from 1 to 4, more preferably from 1 to 3, even more preferably 1 or 2, and especially 1, and
- tertiary amines bearing three 2-hydroxyethyl- or 2-hydroxypropyl-groups.

7. Use and method according to Claim 6, wherein the tertiary amine of general formula (I) is selected from the group consisting of dimethyl ethanolamine, dimethyl propanolamine, diethyl ethanolamine, diethyl propanolamine, di-n-butyl ethanolamine, di-n-butyl propanolamine, N-hydroxyethyl pyrrolidine, N-hydroxyethyl piperidine, and N-hydroxyethyl morpholine.

8. Use and method according to Claim 6, wherein the tertiary amine of general formula (I) are bis(2-hydroxyethyl) amines or bis(2-hydroxypropyl) amines bearing as substituent R^4 n-hexylamine, 2-methylpentylamine, n-heptylamine, 2-heptylamine, isoheptylamine, 1-methylhexylamine, n-octylamine, 2-ethylhexylamine, 2-aminooctane, 6-methyl-2-heptylamine, n-nonylamine, isononylamine, n-decylamine and 2-propylheptylamine or mixtures thereof.

9. Use and method according to Claim 6, wherein the tertiary amine bearing three 2-hydroxyethyl- or 2-hydroxypropyl-groups is selected from the group consisting of triethanolamine and tripropanolamine.

10. Use and method according to any of the preceding claims, wherein the monocarboxylic acid (F) is aliphatic, aromatic or cycloaliphatic, preferably aliphatic with 5 to 14 carbon atoms, preferably from 6 to 12 carbon atoms.

11. Use and method according to any of the preceding claims, wherein the monocarboxylic acid (F) is linear or branched, preferably branched aliphatic.

12. Use and method according to any of the preceding claims, wherein the monocarboxylic acid (F) is selected from the group consisting of 2-ethylhexanoic acid and isononanoic acid.

13. Use and method according to any of the preceding claims, wherein both tertiary amine (E) and monocarboxylic acid (F) are present and the molar ratio between tertiary amine (E) and monocarboxylic acid (F) is from 1 : 0.1 to 1 : 0.6.

14. System, comprising at least one heat-generating electronic device in direct or indirect contact with a coolant as described in any of the preceding claims, in which the coolant is re-

circulated in a thermal management system to at least one condenser or heat exchanger, preferably a heat exchanger in contact with a heat sink, and recirculated to the at least one heat-generating electronic device.

15. System according to claim 14, wherein the at least one heat-generating electronic device is selected from the group consisting of microprocessors, wafers used to manufacture semiconductor devices, power control semiconductors, circuit boards, multi-chip modules, packaged or unpackaged semiconductor devices, semiconductor integrated circuits, personal computers, microprocessors, servers, cell phones, personal digital assistants, and datacentres.

16. System according to claim 14 or 15, wherein the applied voltage does not exceed 60 V.