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WO 02/101848 and unpublished European Patent Application No. 20192954.4 filed on 26.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) 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

(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

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

(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 100, preferably less than 50, and more preferably less than 45 µS/cm.

In one preferred example both components (E) and (F) are absent.

In another preferred example both components (E) and (F) are present with the proviso that

- the molar ratio between tertiary amine (E) and monocarboxylic acid (F) is from 1 : 0.1 to 1 : 0.6, and
- components (C) to (H) are present in amounts so that the coolant exhibits an electrical conductivity of less than 100, preferably less than 50, and more preferably less than 45 µS/cm.

Such coolants exhibit both, a low electrical conductivity which makes them usable as coolants for heat-generating electronic devices, preferably electronic devices comprising a datacentre, more preferably electronic devices comprising a datacentre comprising an electronic component.

It is an advantage of the aqueous coolants according to the present disclosure that they are non-flammable and exhibit a higher heat capacity than the organic or fluorinated organic liquids known in the prior art which increases their effectiveness for cooling. Furthermore, the aqueous coolants according to the present discosure exhibit a higher boiling point resp. enthalpy of evaporation than the organic or fluorinated organic liquids which lessens their vapour pressure at the operating temperature of the heat-dissipating component. Therefore, the coolant in the loop remains fluid without forming a second (gaseous) phase. Furthermore, the fluid is inert so that it is compatible with the materials of construction and the electrical components.

Another object of the present disclosure is the use of such aqueous coolants for thermally managing heat-generating electronic devices, preferably electronic devices comprising a datacentre, more preferably electronic devices comprising a datacentre comprising an electronic component.

Another object of the present disclosure is a 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 the coolant, conveying the coolant to a heat exchanger and recirculating such aqueous coolants.

The methods may include at least partially immersing a heat generating component (e.g., a computer server) in the aqueous coolant. The method may further include transferring heat from the heat generating component using the aqueous coolant.

Another object of the present disclosure is a system comprising:
a heat-generating electronic device;
a thermal management system comprising at least one recirculating thermal management fluid, the thermal management system designed so as to transfer heat from the heat-generating electronic device.

The system may be designed as an immersion cooling system which includes a housing having an interior space; a heat-generating component disposed within the interior space; and a working fluid liquid disposed within the interior space such that the heat-generating component is in contact with the working fluid liquid.

In some examples, a heat generating component may be disposed within the interior space such that it is at least partially immersed (and up to fully immersed) in the liquid phase of the working fluid.

In some examples, the heat generating components may include one or more electronic devices, such as computing servers.

In some examples, the present disclosure may be directed to an immersion cooling system which operates by single phase immersion cooling. Generally, the single phase immersion cooling system is similar to that of a two phase system in that it may include a heat generating component disposed within the interior space of a housing such that it is at least partially immersed (and up to fully immersed) in the liquid phase of the working fluid. The single phase system may further include a pump and a heat exchanger, the pump operating to move the working fluid to and from the heat generating components and the heat exchanger, and the heat exchanger operating to cool the working fluid. The heat exchanger may be disposed within or external to the housing.