Inorganic Aqueous Solution (IAS) for Phase-Change Heat Transfer Medium

Tech ID: 23455 / UC Case 2012-426-0

SUMMARY

UCLA researchers in the Department of Mechanical and Aerospace Engineering have invented a novel inorganic aqueous solution (IAS) that can be used with aluminum (Al) heat pipes for lightweight and space electronic cooling applications.

BACKGROUND

Heat pipes, which transfer heat between a heat source and a heat sink, are an effective way to manage heat generated by electronics, regenerators in electrical power plants, aircraft carrier decks, and satellites. Copper (Cu) is commonly used due to its high thermal conductivity, water compatibility, and wide availability. For space applications, which require lightweight materials, Al is used instead since it is three times less dense than Cu. However, Al is water incompatible and this combination causes heat pipe failure due to the formation of non-condensable gas (NCG), or hydrogen gas. Although ammonia has been used in Al heat pipes, it is unideal as it can only operate from -60 ˚C to 100 ˚C and does not have the operation range of water (-25 ˚C – 200 ˚C). Other attempts reduce NCG formation with Al pipes by using IAS to passivate the Al surface, but these methods lack continuous protection and long-term stability.

INNOVATION

Researchers led by Professor Ivan Catton have invented a novel IAS media that can be used with Al heat transfer pipes. This invention is lightweight and is a more efficient heat transfer method that operates at desirable temperatures (-25 ˚C – 200 ˚C) using non-toxic components with long-term stability and lower failure risk due to NCG formation. This innovative device was shown to have a lifetime compatibility and to effectively resist NCG formation after more than nine weeks of continuous testing. Potentially, this technology can be expanded to work with other water-incompatible materials.

APPLICATIONS

- Electronic device cooling systems
- Regenerators in electrical power plants
- Aircraft carrier decks
- Cooling systems for satellites

ADVANTAGES

- Can be used with Al without generating NCG (after 9 weeks of continuous testing)
- Lighter heat transfer pipes (compared to Cu)
- Desirable operating temperatures (-25 ˚C to 200 ˚C)
- Long-term stability
- Can be extended to other water-incompatible materials

STATE OF DEVELOPMENT

IAS media that is compatible with Al devices has been developed. Lifetime testing results with different Al materials has been studied and been shown to effectively resist NCG formation after more than nine weeks of continuous testing.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	8,967,236	03/03/2015	2012-426

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OTHER INFORMATION

KEYWORDS

Heat transfer fluid, solar energy collectors, regenerators, computers, aluminum, aluminum heat pipes, inorganic aqueous solution, IAS, non-condensable gas, NCG, hydrogen gas, electronic devices, regenerators, electrical power plants, aircraft carrier deck

CATEGORIZED AS

- **Energy**
  - Other
  - Solar
  - Storage/Battery
- **Engineering**
  - Engineering
  - Other
- **Materials & Chemicals**
  - Chemicals
  - Other
- **Transportation**
  - Aerospace

RELATED CASES

2012-426-0

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