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Metal Matrix-Hydrophobic Nanoparticle Composites for Promoting Dropwise Condensation

Water vapor condensation is an essential aspect of many technologies in energy generation, desalination, and air conditioning. An increased heat transfer rate during water vapor condensation could lead to considerable economic savings as well as environmental benefits. Hydrophobization improves heat transfer by switching the condensation mode from filmwise to dropwise. Unfortunately, most hydrophobic surface modifiers have low thermal conductivity and limited durability. For example, a power plant condenser must have a 20-30 μm thick Polytetrafluoroethylene (PTFE) film to last its projected lifetime. However, the thermal resistance added by this thickness of the PTFE film negates any heat transfer benefits. Therefore, there is a need for a thermally conductive and durable hydrophobic material.

Researchers at Arizona State University have developed a surface modifier with nanoscale hydrophobic particles dispersed in a metal matrix. This hydrophobic material is durable and thermally conductive. It stimulates more efficient dropwise condensation, resulting in overall heat transfer enhancement. Additionally, durability has been improved due to the similarity of thermomechanical properties between the metal condensers and the surface material.

Potential Applications

- Desalination
- Power Plants
- Heat Exchange

Benefits and Advantages

- Increased Durability and Longevity – Minimal degradation to material and condenser, yielding a longer lifetime.
- Increased Efficiency –
  - Increased thermal conductivity and the resulting heat transfer allow for high levels of dropwise condensation.
  - Increased contact angle creates a smaller shedding diameter, thereby increasing heat transfer.
- Versatility - Can be applied as a coating to retrofit existing metal condenser surfaces, or could be used as bulk material for condenser itself.

For more information about the inventor(s) and their research, please see

Dr. Konrad Rykaczewski's directory webpage