POPULAR SCIENCE PROJECT SUMMARY

Aim of the project

One of the most important factors determining the development of society, science and technology is the efficiency of transmission and storage of energy. Based on current state of knowledge, it is justified to say that currently used methods of transport and accumulation of thermal energy reached such an advanced level that any improvement in efficiency is possible only through a return to basic research, including studying on new working fluids. Nanofluids, which are simply suspensions of nanoparticles (sizes smaller than 200 nm) in selected base fluid (e.g. water or glycol) have potential to become such a breakthrough solution because their apparent thermal properties are noticeably better than those of the conventional liquids.
The thermosyphon is one of the most efficient systems to transport heat known today. The lower part of the tube (evaporation section) filled with small amount of fluid is heated by external heat source, what causes the boiling of the liquid and the vapour moves upward to the cold end of the tube. Contact with the cold surface of the upper part of tube causes condensation and the condensate returns to the evaporator by gravity. Research on thermosyphon allows to implement various complex physical phenomena and fundamental laws in the thermal-fluids area into relatively simple device.
Technological development is possible only with the knowledge about basic mechanisms connected with occurring processes. Unfortunately, mechanisms responsible for enhanced thermal properties of nanofluids are still inconclusive. Therefore, the main research objective of presented proposal is study of **influence of nanoparticle interaction with evaporator surface on heat transfer effectiveness during boiling of two types of nanofluids** used as a working fluid in thermosyphon. Additionally, we intend to determine **if geometrical dimensions affect this process and performance of nanofluids during boiling** (with additional support of ILK Dresden).

Research carried out in the project

We have developed a project plan which covers the scope of work for 12 months and consists of four research tasks. First, we will build experimental set up designed for the purpose of the presented project. After conduction of measurements, the result will be analysed in cooperation with Dr Matthias Buschmann from ILK Dresden, Germany. Obtained data will be compared with results available in the literature and additionally with the experimental results from analogous measurements that principal investigator of this project will conduct in Germany in the beginning of the year 2017. The study is planned with similar working conditions and with two equal nanofluids but devices will have different geometrical dimensions. Additionally, this joined research effort will lead to comparative parameter study and will help to draw the conclusions about the mechanisms that occur during boiling of nanofluids. It is currently not clear which mechanisms are responsible for lowering the thermal resistance of device employing nanofluids.
In this research proposal, we decided to study two especially selected kinds of nanoparticles: silicon dioxide (SiO_2) and graphene oxide (GO). Both are promising materials that enhance heat transfer capabilities of traditional fluids due to their unique properties (strong hydrophilicity of SiO_2 and high thermal conductivity of GO).

Reasons for choosing the research topic

Further improvement of technology based on nanofluids is possible only with essential knowledge the fundamental laws that are behind their behaviour. Despite the big interest in this area, the fundamental mechanisms responsible for enhanced thermal properties are still not verified for more types of nanofluids. This creates a big need for bigger number of comparable results and draw more general conclusions. We have consulted recognized experts in the field of nanofluids (many of whom are part of COST Action NanoUptake network of researchers, as we do), who confirmed that study of surface effect due to use of nanofluid is currently one of the most interesting and important research area in this field. The presented project tries to follow this suggestion. Moreover, none of the research took under consideration different geometrical dimensions of the thermosyphons and few equal nanofluids**.** The intended outcome is to obtain more complex information about behaviour and mechanisms that occur during nanofluid boiling in the device.
We think that such knowledge will have substantial impact on development of nanofluids, and thermosyphons using working fluids enhanced with nanoparticles. The consequence will be reduction of investment and operating costs, as well as reduced usage and better allocation of non-renewable resources such as fossil fuels. All these improvements would be possible only if consequences of using nanofluids in thermal systems (especially interaction with equipment surface) are studied and understood. Results of our work will significantly contribute to the development of balanced, more environmentally aware society powered by highly efficient green energy systems.