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Nanofluids and Their Advances Towards Renewable Energy Applications

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Summary:

The increasing global energy demand, coupled with the environmental damage caused by fossil fuels, underscores the urgent need to harness renewable energy through various technologies. Despite its numerous benefits, solar energy remains largely underutilized, even though it is a clean and efficient source for both electricity and heat production. It has been demonstrated that the mechanisms for heat extraction and the choice of fluids used in solar thermal systems are critical factors in improving their performance. Thus, there is a necessity to improve the heat transfer characteristics of working fluids to increase their efficiency. It is also widely recognized that the efficiency of photovoltaic (PV) solar cells declines as temperature increases. Therefore, cooling of PV modules is essential under high illumination conditions, such as in extreme environments like cosmic or tropical climates. In this regard, nanofluids have the potential to make a significant contribution to the advancement of solar energy systems. Nanofluids are mixtures of common liquids and solid nanoparticles with at least one dimension smaller than 100 nm, they have seen significant advances since their discovery two decades ago. While colloidal suspensions of particles have been studied for many years, the term 'nanofluids' specifically refers to fluid systems that exhibit enhanced thermal and optical properties. In this work, both experimental and numerical analyses will showcase the transport properties of nanofluids, revealing promising results that position them as advanced heat transfer mediums in various renewable energy systems.