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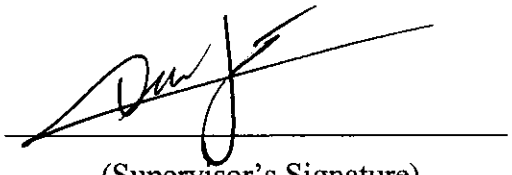

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ELUCIDATION OF NANOCELLULOSE AS A NEW COOLANT FOR RADIATOR

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ABSTRAK

Nanoselulosa dengan air dan etilena Glikol tambahan untuk penyejuk untuk aplikasi radiator kereta mempunyai manfaat untuk meningkatkan kecekapan radiator. Kecekapan yang lebih baik dari penyejuk membawa kepada reka bentuk radiator yang lebih padat kerana kawasan kurang diperlukan. Penyelidikan ini dijalankan untuk membuktikan bahawa penambahan nanocellulose yang berasal dari asas tumbuhan dengan kepekatan yang berbeza memberikan kecekapan pemindahan haba yang lebih baik berbanding dengan penggunaan air sebagai penyejuk radiator. Objektif penyelidikan adalah untuk memperbaiki dan mencipta penyejuk radiator baru berdasarkan kolaborasi nanocellulose dengan penyejuk yang sedia ada iaitu Ethylene Glycol. Bidang utama penyelidikan ialah nanocellulose antara rentang saiz 35-39 nm. Kepekatan nanofluid selulosa diuji adalah 0.1%, 0.5%, 0.9% dan 1.3%. Penyediaan nanofluid selulosa dilakukan di Laboratorium Cecair Automotif Advance (A2LL) Universiti Malaysia Pahang. Analisis alat statistik menunjukkan bahawa kepekatan isipadu 0.5% mempunyai sifat termophysical yang dioptimumkan dan ia boleh berfungsi sebagai nanofluid (cecair pengangkutan haba) dalam radiator. Kemudian, eksperimen untuk perbandingan prestasi pemindahan haba untuk nanofluid dan aliran haba aliran konvensional konvensional dalam rig ujian radiator automotif. Eksperimen untuk analisis pemindahan haba aliran haba berbeza dengan kadar aliran. Hasil eksperimen menunjukkan bahawa pekali pemindahan haba, pemindahan haba konveks, nombor Reynolds, nombor Nusselt mempunyai hubungan berkadar dengan kadar aliran volumetrik. Sementara itu, faktor geseran mempunyai hubungan songsang dengan kadar aliran volumetrik. Hasilnya, selepas menjalankan rig ujian radiator dengan kadar kepekatan volum 0.5% air suling dan etilena Glycol nanofluid menunjukkan terdapat perubahan ketara dalam perbezaan antara suhu masuk dan keluar cecair yang mengalir melalui rig ujian radiator. Selain itu, dari data konduktiviti terma, ia menunjukkan peningkatan kekonduksian terma dari 0.487 W / m. ° C pada 30 ° C hingga 0.532 W / m. ° C pada suhu 70 ° C manakala kelikatan berkurangan dari 15.01 m.Pa.s pada suhu 30 ° C hingga 1.77 m.Pa.s pada suhu 70 ° C. Oleh itu, nanofluid mampu mengeluarkan haba dengan cekap dalam sistem penyejukan automotif. Oleh itu, nanofluid berasaskan nanocellulose sesuai untuk aplikasi penyejukan automotif kerana ia mempunyai prestasi pemindahan haba yang lebih baik daripada cecair pengangkutan terma konvensional.

ABSTRACT

Nanocellulose with water and Ethylene Glycol addition to coolant for car radiator application has benefits of improving the efficiency of the radiator. Improved efficiency of the coolant leads to the more compact design of the radiator due to less area required. The research is conducted to prove that addition of nanocellulose originating from plant base with varying concentration provides a better heat transfer efficiency compared to the usage of water as radiator coolant. The objective of the research is to improve and create a new radiator coolant based on the collaboration of nanocellulose with readily available coolants which is Ethylene Glycol. The main scopes of the research are the nanocellulose between ranges of size 35-39 nm. The tested concentration of the cellulose nanofluids are in of 0.1%, 0.5%, 0.9% and 1.3%. The preparation of cellulose nanofluids is carried out at Advance Automotive Liquid Lab (A^2LL) of Universiti Malaysia Pahang. Analysis of statistical tool shows that volume concentration 0.5% has an optimized thermophysical property and it can function as nanofluid (thermal transport fluid) in the radiator. Then, the experiment for heat transfer performance comparison for nanofluid and conventional thermal transport fluid flows in the automotive radiator test rig. Experiment for heat transfer analysis of thermal flow varies with the flow rate. The experimental result shows that heat transfer coefficient, convective heat transfer, Reynolds number, the Nusselt number has proportional relation with volumetric flow rate. Meanwhile, friction factor has an inverse relation with the volumetric flow rate. The result, after running the radiator test rig with 0.5% volume concentration of distilled water and Ethylene Glycol nanofluid shows there is a significant change in the difference between inlet and outlet temperature of the fluid flowing through radiator test rig. Besides, from the thermal conductivity data, it shows thermal conductivity increases from 0.487 W/m. °C at 30°C to 0.532 W/m. °C at 70°C while the viscosity decreases from 15.01 m.Pa.s at 30°C to 1.77 m.Pa.s at 70°C. Thus, nanofluid able to remove heat efficiently in the automotive cooling system. Thus, nanocellulose based nanofluid is suitable for automotive cooling application since it has a better heat transfer performance than conventional thermal transport fluid.

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LIST OF SYMBOLS

TiO_2	Titanium Dioxide
ZnO	Zinc Oxide
SiO_2	Silicon Dioxide
CNT	Carbon Nanotube
MWCNT	Multi Walled Carbon Nanotube
CuO	Copper Oxide
GO	Graphene Oxide

LIST OF ABBREVIATIONS

CNC	Cellulose Nanocrystals
EGW	Ethylene glycol-distilled water mixture
TEM	Transition Electron Microscope
SEM UV-	Scanning Electron Microscope
VIS	Ultra Violet Visible Spectrometry
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
DSC	Differential Scanning Calorimetry
STA	Simultaneous Thermal Analyzer
IEP	Isoelectric Point
LPM	Litre per Minute
RPM	Rotation per Minute
RSM	Response Surface Methodology

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