NANOFLUID APPLICATION IN

ELECTRIC MOTOR COOLING

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Abstract

Electronics devices such as electric motors generate enormous amount of heat, which disturbs the normal performance of the devices and reduces their reliability. This temperature rise has to be limited for two reasons: mechanical stress and the deterioration of the insulating materials. Heat generation is also caused the life span of the motors to decrease and its cause a new replacement which normally cost high. To overcome the heat transfer problems, many cooling methods were applied to the electric motors but still it cannot be solve effectively due to some limitations in these methods. To improve the heat transfer rate, the water or the other liquids such as ethylene glycol were dispersed and suspended with nanoparticles. This new class of heat transfer fluids is called nanofluids where the high thermal conductivity solid particles were mixed into the heat transfer liquids to gain a higher heat transfer rates. Therefore, a study was conducted and encompasses in cooling of the electric motors by nanofluids. The study has shown that by replacing nanofluids to the base fluids, the heat transfer rate can be improved. Also, this study has opened the opportunity for the researchers to do researches under nanofluids for cooling purposes.

Abstrak

Peranti elektronik terkini seperti motor elektrik menghasilkan sejumlah besar haba panas yang boleh mengganggu prestasi peranti dan mengurangkan kebolehpercayaan peranti tersebut. Kenaikan suhu ini harus terhad untuk dua alasan iaitu: tekanan mekanik dan kerosakan bahan isolasi. Peningkatan haba juga menyebabkan jangka hayat motor tersebut menurun dan ini akan menjurus kepada penggantian motor yang baru yang biasanya akan melibatkan kos yang tinggi. Untuk mengatasi masalah permindahan haba panas, banyak kaedah pendinginan diterapkan pada motor elektrik tetapi ini tidak dapat menyelesaikan masalah tersebut secara berkesan kerana terdapat beberapa keterbatasan pada kaedah ini. Untuk meningkatkan kelajuan permindahan haba, air atau cecair lain seperti glikol etilena dibubarkan dan dihentikan dengan nanopartikel. Cecair perpindahan panas yang digunakan ini disebut nanofluids dimana partikel yang mempunyai konduktiviti panas yang tinggi dan padat dicampur ke dalam cecair permindahan haba untuk mendapatkan tahap permindahan panas yang lebih tinggi. Oleh kerana itu, kajian ini dilakukan dan merangkumi pendinginan motor elektrik oleh nanofluids. Penyelidikan telah menunjukkan bahawa dengan menggantikan nanofluids ke cecair asas, tahap permindahan haba dapat ditingkatkan. Selain itu, kajian ini telah membuka peluang kepada para penyelidik untuk melakukan kajian di bawah nanofluids untuk tujuan pendinginan.

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Sree Rama Dasson VELAYUDLAN

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Nomenclatures

η	Efficiency
k	Thermal conductivity of the elements [W/ K·m]
c_P	Specific heat [J/kg. m^3]
K_t	Torque constant [mm/N/amp]
K_v	Voltage constant [rpm/V]
Q_c	Copper losses
Q_i	Iron losses
α	Thermal coefficient [1 / °C]
d	Thickness [nm]
ρ	Fluid density [kg/m^3]
r_p	Nanoparticle radius [nm]
μ	Viscosity [Ns/m^2]
C	Heat capacity
h	Heat transfer coefficient
Pr	Prantl Number
Nu	Nusselt Number
Re	Reynolds Number
φ	Volume fraction in percentage

G_a Mass velocity

D Hydraulic diameter [cm]

m Mass [kg]

W Transfer per unit time [Nm/s]

A Area [m^2]

σ Free flow area/ frontal area

υ Volumetric flow

U Heat Transfer Coefficient

ε Heat transfer effectiveness for cross flow unmixed fluid

α Heat transfer area/ total volume [m^2/m^3]

β Fin area/total area