EFFICIENT TiO_2-SiO_2 HYBRID NANOCOOLANT

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PRODUCT BACKGROUND

Modern and compact design → heat generation / dissipation ↑

Conventional coolant → heat transfer rate ↓

Limitation with existing single nanofluids:

- less in stability
- more pumping power
- high production cost

Hybrid nanofluids → improve the stability, enhance the heat transfer performance

Optimum concentration and the best composition ratio of hybrid nanofluids are required for the heat transfer application

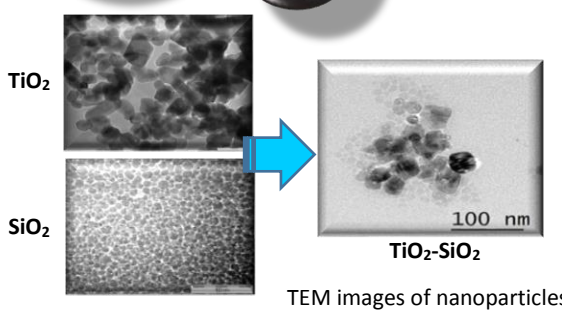
Potential application in heat exchangers and cooling systems

STATE OF ARTS / METHODS

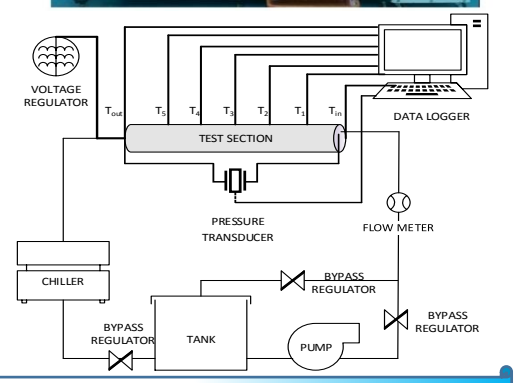
MATERIALS & BASE FLUIDS:
TiO_2 / SiO_2 / EG / DISTILLED WATER

MIXING & SONICATION:
MECHANICAL STIRRER
ULTRASONIC BATH / HOMOGENIZER

SAMPLES:
VOLUME CONCENTRATION
$0.5 \leq \phi \leq 3.0$ %



TEM images of nanoparticles



BENEFITS / USEFULLNESS

1. Improve the stability of nanocoolant (**avoid system clogging**)
2. More efficient heat transferred (**faster cooling process**)
3. Possibility to minimize the size of pump (**small pump size with same performance**)
4. Optimize the overall system size
5. Reduce the investment, operating and production cost
6. Efficient with low cost and size

PUBLICATIONS

1. K. Abdul Hamid, W.H. Azmi, M.F. Nabil & Rizalman Mamat. 2018. *Experimental investigation of nanoparticle mixture ratios on TiO_2–SiO_2 nanofluids heat transfer performance under turbulent flow*. International Journal of Heat and Mass Transfer. **Q1 (IF = 3.458) (Rank: 11/130)**

2. K. Abdul Hamid, W.H. Azmi, M.F. Nabil, Rizalman Mamat & K.V. Sharma. 2018. *Experimental investigation of thermal conductivity and dynamic viscosity on nanoparticle mixture ratios of TiO_2-SiO_2 nanofluids*. International Journal of Heat and Mass Transfer. **Q1 (IF = 3.458) (Rank: 11/130)**

3. M.F. Nabil, W.H. Azmi, K. Abdul Hamid, Rizalman Mamat & Ftwi Y. Hagos. 2017. *An experimental study on the thermal conductivity and dynamic viscosity of TiO_2-SiO_2 nanofluids in water: Ethylene glycol mixture*. International Communications in Heat and Mass Transfer. **Q1 (IF = 3.718) (Rank: 4/58)**

4. M.F. Nabil, W.H. Azmi, K. A. Hamid, N.N.M. Zawawi, G. Priyandoko, Rizalman Mamat. 2017. Thermo-physical properties of hybrid nanofluids and hybrid nanolubricants: A comprehensive review on performance. International Communications in Heat and Mass Transfer. **Q1 (IF = 3.718) (Rank: 4/58)**

COLLABORATORS

UMP HOLDING SDN. BHD.

AUTOMOTIVE ENGINEERING CENTRE

PATENT

PATENT FILLING: In Progress

PRODUCT NOVELTY

1. Enhanced the thermo-physical properties of nanocoolant (**Figure A**)
2. The best composition ratio of TiO_2-SiO_2 is 20:80 (**Figure B**) – best configuration
3. Improved the heat transfer performance up to **282%** higher than conventional coolant (**Figure C**) – heat transfer rate
4. No significant increment in friction factor (**Figure D**) – related to pumping power
5. Hydraulic performance of hybrid nanocoolant with insert improved up to **2.06** (**Figures E and F**) – product reliability
6. Best combination: ϕ = 2.5%, wire coil pitch/diameter ratio = 1.5

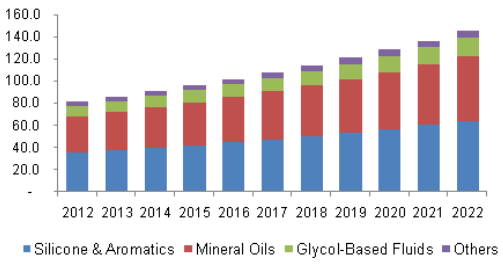
PRODUCT FEATURES

Consists of **TiO_2-SiO_2 dual nanoparticles** dispersed in **water:ethylene glycol (W:EG) (60:40) mixture**.

Specifically designed for optimum features with **TiO_2-SiO_2 composition ratio of 20:80**, **2.5% volume concentration** and 1.5 wire coil ratio.

MARKETABILITY

1. Coolant for application in cooling systems
2. Automotive coolant (radiator coolant)



3. Glycol-based thermal fluids are expected to gain market share for over 13% of global revenue by 2022.

ACHIEVEMENTS / AWARDS

GOLD MEDAL, CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION, FEB 2018, UMP

PRODUCT PERFORMANCE

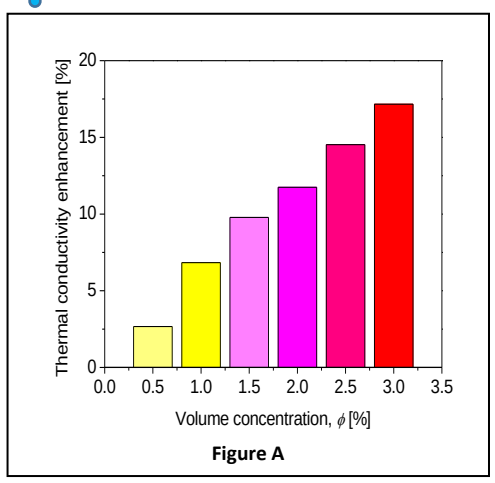


Figure A

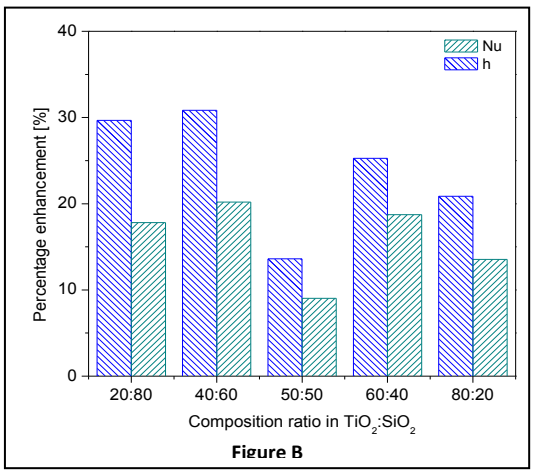


Figure B

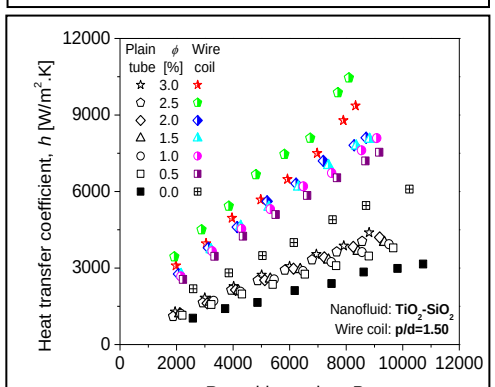


Figure C

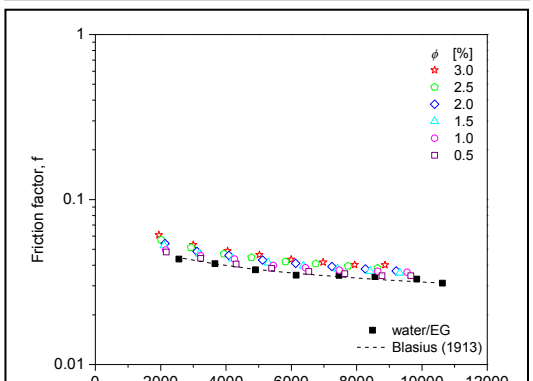


Figure D

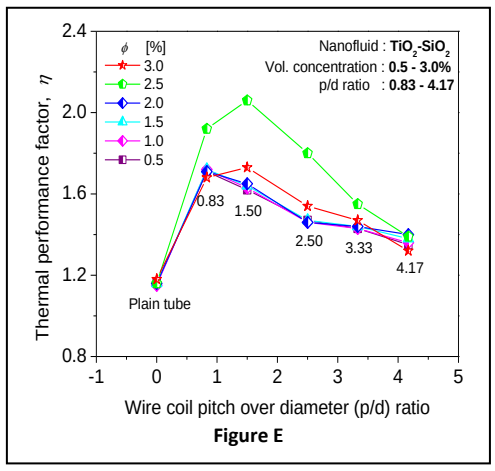


Figure E

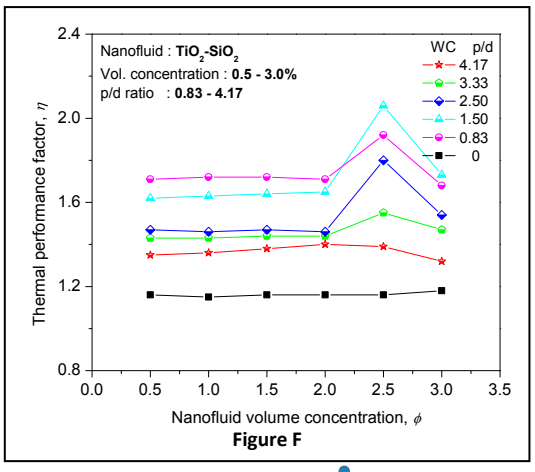


Figure F

COSTING VS. PERFORMANCE

TYPES OF COOLANT	TiO_2	TiO_2-SiO_2	TiO_2-SiO_2	TiO_2-SiO_2
COMPOSITION RATIO	-	50:50	20:80	20:80
WITH INSERT	NO	NO	NO	WIRE COIL
HEAT TRANSFER PERFORMANCE	↑ 15%	↑ 23%	↑ 37%	↑ 180%
COST / 1 LITRE	RM41.44	RM37.41	RM34.96	RM34.96
COST SAVING / 1 LITRE	-	↓ 9.7%	↓ 15.6%	↓ 15.6%