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Comparative Analysis of Nanofluids and Basefluids in Heat Exchangers: A Conceptual Review

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ABSTRACT

Today, the world has experienced a great need of efficient heat exchangers, and the research in this field is increasing day by day. Considering this fact, the resent research work is based on the acknowledgement of contributions of researchers in the field applications of nano fluids and base fluids in heat exchangers, and concludes with the gaps in the research and objectives of proposed research.

Keywords: Heat exchanger, nano fluids, base fluids, heat transfer.

1. INTRODUCTION

Researchers have reportedly been attempting to make heat exchangers smaller and lighter in recent years, according to Akyürek et al. (2018). Conventional heat transfer fluids, such as ethylene glycol, water, and oil, are used in numerous sectors. Due to their weak thermal characteristics, heat transfer fluids have poorer thermal conductivity than solids, which places restrictions on how well and how compactly they may be used in engineering equipment. To increase the effectiveness of heat transfer, some techniques are used. One of them is the addition of tiny solid particles, such as polymeric, metallic, and non-metallic ones, to common heat transfer fluids. Although they improve thermal performance, millimeter- or even micrometer-sized particles cannot be employed in many applications. Because they have poor stability, cause flow channels to fill up quickly, produce rapid particle settling, and increase fluid pressure loss. Nanometer-sized particle dispersions can be used to solve these issues. Instead of these particles, base fluids are employed with nanoparticles with a size range of 1-100 nm for this exact purpose. One of the more recent innovations, these suspensions known as nanofluids are utilised in many different industries. These properties of nanofluids make them useful in a variety of fields, including energy production, the chemical and automotive industries, heating and cooling systems, microelectronics, and others. Considering these aspects, the present research work focuses on the research on heat exchangers and nanofluids along with the base fluids. During the research paper, contributions of researchers in the fields of heat exchangers, nano fluids and based fluids shall be acknowledge, along with the investigated gaps in the research and objectives of proposed research.

2. LITERATURE REVIEW

Present section is devoted to some of the unique aspects and contributions of researchers in the field of heat exchangers, nano fluids and based fluids.

2.1 Evolution of Heat Exchangers

Table 2.1 shows the timeline of the evolution of the heat exchangers (www.kinam.in).

Table 2.1: Timeline of Heat Exchangers

1880s	Plate heat exchangers for pasteurization of Milk in Germany
1900-1920	Development of tubular heat exchangers
Early 1920s	Development of Shell and Tube Heat Exchangers
1923	Invention of first commercially viable plate heat exchanger for applications in breweries and vegetable oil industries

Early 1930s	Sweden produced the first Spiral plate heat exchanger
1939	Otto Happel and German engineer Dr. Kurt Lang commissioned the first pilot project using an air-cooled condenser for stationary steam turbines
1955	Babcock and Wilcox Co. with inventor Johannes H Ammon filed the Patent for Shell and Tube Heat Exchanger
1960s	Heat Exchanger manufacturing improved and covered a variety of applications and size requirements
1970-2000	User of computational software in Heat Exchanger design
2000 till Date	Use of recent technologies in heat exchangers

2.2 Scenario of Research on Heat Exchangers, Nanofluids and Base Fluids

Figure 2.1 shows the radar graph for the research publications containing the terms heat exchanges in last five years.

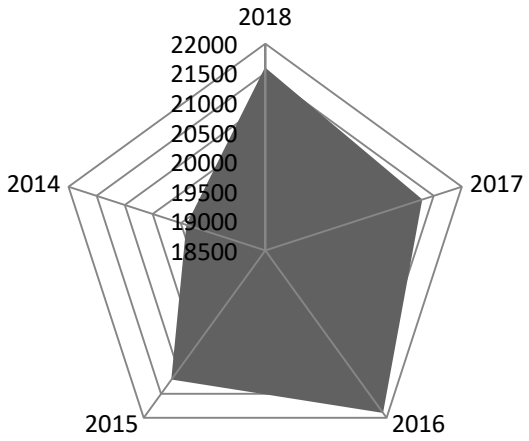

Figure 2.1: Radar Graph on Publications containing the terms Heat Exchangers in last five years

Figure 2.2 shows the radar graph for the research publications containing the terms heat exchanges and nano fluids in last five years.

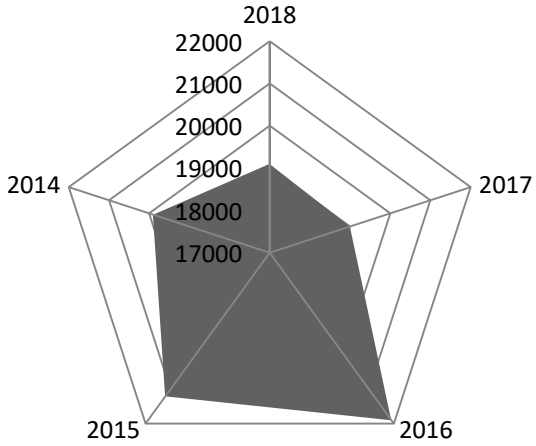

Figure 2.2: Radar Graph on Publications containing the terms Heat Exchangers and Nano Fluids in last five years

2.3 Contributions of Researchers in the field of Heat Exchangers, Nano-fluids and Base fluids

Present section tells about the contributions of researchers in the field of heat exchangers, nano-fluids and based fluids, as follows:

Somasekhar et al. (2018)

A multi pass shell and tube heat exchanger with 3 tubes modelling is done using CATIA and meshing has done using ICEM CFD software, simulations has done by using CFD-FLUENT software. Using Fluent, computational fluid dynamics software the pressure drop, heat transfer characteristics of Al_2O_3-water nanofluid, and Distilled water are analyzed under turbulent flow condition. Nanofluid such as Al_2O_3-H_2O is used as cooling medium instead of Distilled water. Finally the CFD simulated results are compared with experimental results.

Bhanvase et al. (2018)

The effect of polyaniline nanofibers concentration in nanofluid and Reynolds number on heat transfer coefficient have been investigated in helical coiled heat exchanger. It was found that the average heat transfer coefficient increases with an increase in the volume% of polyaniline nanofibers in nanofluid and Reynolds number.

Gugulothu et al. (2017)

The main objective of this research paper is to study the heat transfer enhancement using passive techniques as these are economical and no external additions are required.

Yiamsawas et al. (2013)

Measurement and Correlation of the Viscosity of Water-Based Al_2O_3 and TiO_2 Nanofluids in High Temperatures and Comparisons with Literature Reports was reported by Yiamsawas et al. measured the viscosity of TiO_2 nanofluids prepared using an ultrasonicator at higher temperature and nanoparticle concentration and compared the viscosity variation trend that they observed by varying the particle concentration to the experimental results of several different researchers.

Palabiyik et al. (2011)

Dispersion stability and thermal conductivity of propylene glycol-based nanofluids was reported by Palabiyik et al. observed several important characteristics of the TiO_2 nanofluid that was prepared during their experiment. They found that the nanoparticle size decreased by increasing the sonication time and this decrease in size becomes stationary after reaching a specific signification time.

Yu et al. (2009)

Heat transfer to a silicon carbide/water nanofluid was reported by Yu et al. conducted heat transfer experiments of nanofluids containing 170-nm silicon carbide particles at 3.7% volume concentration. The results showed that heat transfer coefficients of nanofluids are 50-60% greater than those of base fluids at a constant Reynolds number.

Table 2.2 shows some of the selected research contributions of Indian researchers in last five years.

Table 2.2: Research Contributions of Indian Researchers in last five years

S. No	Reference	Research Contribution
1.	Bhanvase et al. (2018)	Heat transfer enhancement with the use of water based polyaniline nanofluid was investigated in vertical helically coiled tube heat exchanger
2.	Naik and Vinod (2018)	Intensification of heat transfer due to use of non-Newtonian nanofluids in shell and helical coil has been investigated
3.	Amanuel and Mishra (2018)	numerical investigation of CuO/water nanofluids in a triple concentric-tube heat exchanger has been carried out using a commercial CFD software
4.	Somasekhar et al. (2018)	A CFD Investigation of Heat Transfer Enhancement of Shell and Tube Heat Exchanger Using Al2o3-Water Nanofluid
5.	Thakur et al. (2018)	An Experimental Study of Nanofluids Operated Shell and Tube Heat Exchanger with Air Bubble Injection
6.	Manikandan and Baskar (2018)	Heat transfer studies in compact heat exchanger using ZnO and TiO2 nanofluids in ethylene glycol/water

7.	Sharma et al. (2017)	Study of hydrodynamics of CNT nanofluids in helical coils
8.	Palanisamy & Kumar (2017)	The heat transfer and pressure drop analysis of a cone helically coiled tube heat exchanger handling Multi Walled Carbon/water nanofluid carried out experimentally
9.	Gugulothu et al. (2017)	Study of heat transfer enhancement using passive techniques
10.	Thakur & Singh (2017)	Experimentation on heat transfer characteristics of shell and tube heat exchanger was done with the injection of air bubbles at the tube inlet and throughout the tube with water based $Al2O_3$ nanofluids
11.	Barzegarian et al. (2017)	The effect of using $Al2O_3$-water nanofluid on thermal performance of a commercial shell and tube heat exchanger with segmental baffles assessed experimentally

GAPS IN THE RESEARCH AND OBJECTIVES OF THE PROPOSED RESEARCH

Following section presents the gaps in the research and objectives of the proposed research, the details of which are presented in upcoming sections.

Gaps in the Research

Following are the gaps investigated from the survey of available research:

a) There are very limited number of research papers which focus on the investigations on different combinations of nano fluids and base fluids used in heat exchangers; and
b) There are very less number of research papers which focus on ranking of different combinations.

Objectives of Research

Following points research objectives of proposed research work:

a) Comparison of different combinations of nanofluids and base fluids with conventional fluids;
b) Ranking of different alternatives.

CONCLUSION

Present research work was focussed on the contributions of researchers in the field of heat exchangers, nano fluids and based fluids. Considering the dire need of present society, the research work should be helpful for new researchers as well as industries dealing in the field of enhancement in heat transfer processes.

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