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KARMAVEER ADV. BABURAO GANPATRAO THAKARE COLLEGE OF ENGINEERING

मराठा विद्या प्रसारक समाज, नाशिक

बहुजन हिताय बहुजन सुखाय

KBTCOE

DEPARTMENT OF MECHANICAL ENGINEERING

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Institute Vision

To be internationally accredited, Multidisciplinary, and Multi-collaborative institute working on technology enabled platform fostering innovations and patents through state-of-art academic system designed by highly qualified faculty for the development of common masses at large

Institute Mission

To educate and train common masses through undergraduate, post graduate, research programs by inculcating the values for discipline, quality, transparency and foster career and professional development for employment thereby contributing to the development of society

Department Vision

To be the centre for excellence and centre of learning for innovation, incubation and research in the domain of product design, thermal engineering and manufacturing technology thereby path finder for professionalism, entrepreneurship and new knowledge contributing to the common masses.

Department Mission

To educate and train undergraduate and post graduate students in Mechanical Engineering by inculcating the values for discipline, quality and transparency and profession development in the job and self-employment emphasis industry-based practices.

Program Education Objectives (PEO's)

PEO1: To prepare technocrats that can satisfy the need of mechanical and allied industries.

PEO2: To develop critical thinking, problem solving skills, research aptitude and career and professionalism among the students.

PEO3: To improve and expand technical and professional skills of students through effective teaching-learning and industry interaction.

Program Specific Outcomes (PSOs)

PSO1: Ability to design, analysis and problem-solving skills using basic principle of mechanical engineering.

PSO2: Ability to impart technical and professional skills through industry institute interaction

PSO3: Develop practical skills for the benefits of society.

Objectives of Magazine

1. Primary objective of the magazine is to provide a wide platform to the aspiring engineers to showcase their technical knowledge and to explore innovative ideas.
2. This magazine is intended to bring out the hidden literary talents in the students and teachers to inculcate strong technical skills among them.

Parameter optimization of coriolis mass flow meter in laminar flow regime using Doe-Taguchi method

The paper outlines the progression of a mathematical model using the Taguchi approach to analyze the performance of a Coriolis mass flow meter (CMFM). the sensor position, excitation frequency, and flow rate parameters were optimized using the taguchi method for the meter's maximum time-lag output. an orthogonal array of experiments was designed, and the time lag results were obtained for two tube configurations (viz. omega and diamond) and parameter levels. the obtained data was analyzed using analysis of variance (anova) to understand the relationship between the variables and the time lag. the results showed that the omega tube configuration exhibited a lower percentage error compared to the diamond tube configuration. additionally, an increase in flow rate led to a decrease in the error. the regression models fitted the experimental data well, with high r2 values indicating a good fit. the anova showed the factors' importance in affecting the time lag and the levels of interaction between the best individual parameters for maximizing the outcome. the most important factors affecting the omega and diamond tube configurations' maximum performance have been identified as the flow rate and sensor position, respectively. this study offers a systematic method for optimizing sensor parameters and provides light on how cmfms behave in laminar flow. the experimental setup and mathematical model also serve as a basis for future research and advancements in CMFM design and functionality.

Methodology

defining the range and the levels of that the experiment will take into account. after that designing the experimental setup using taguchi approach. next step is carrying out the experiments in accordance with the planes procedure and recording the findings. the analysis of the data and determination of each factors signal to noise ratio. after that is to find the ideal mix of factor levels that result in the optimum meter performances. next step is to verify the optimized parameter values by confirmation tests or simulation and last step is the application of coriolis mass flow meter optimized parameter settings.

Experimental setup parameters and their levels

A systematic experimental setup was designed and developed to investigate the performance of Coriolis mass low meters (CMFM) with various tube configurations in the laminar flow regime. The experiments were carried out using water as the working fluid, and the setup was designed to be flexible enough to accommodate different tube configurations and predict the effect of various working parameters on the performance of the sensor tube. The flow was controlled by two ball valves, while an exciter was used to vibrate the tube at a specific frequency and amplitude. The flow rate was measured using the conventional method of collecting the fluid in a container for a specific time, and the time lag was measured using an indigenously developed time lag measurement unit comprising an Arduino board.

Fig:- Experimental setup

Model Development for CMFM and Implementation of Taguchi Approach

This objective can be accomplished in a number of ways, including the Taguchi approach to experimental design and trial-and-error techniques. The Taguchi approach has been used in this study to create a mathematical model for comprehending the of design variables on the functionality of CMFM. The Taguchi approach is a systematic procedure that includes several steps, such as identifying the characteristic to be optimised, choosing variables and their corresponding levels, choosing test conditions and noise factors, designing the experiment and layout, analysing the obtained data, determining the optimal levels of variables, and projecting the system's performance at the optimal levels. The designed setup was used to carry out the experimental tests and results from experimentation for several tube configurations and the accompanying parameter values.

Results And Discussions

Analysis of Variance

Using the mathematical software programme MINITAB17, the experiment's outcomes were examined. The time lag data was analysed using an ANOVA, and various plots for regression and graphical analysis were made. It was found

that the three variables—sensor position (A), vibration frequency (B), and mass flow rate—together make up the linear response function for the time lag (C). In order to determine how these parameters affected the outcome, an analysis of variance was used.

A. Omega shape tube configuration

The time lag experimental results and anticipated values for the Omega tube configuration from the regression model are compared. When vibrated at the tube's natural configuration has been found to function best among the two configurations being studied, with the sensor position set along the tube's centre line. The flow rate, however, has been the factor that has had the most impact on the meter output, as seen by the interaction and main effect plots. As a result, the flow rate that is anticipated has a major impact on the meter output of an Omega tube arrangement. The constant curvature of the Omega tube configuration reduces secondary flow while providing the least amount of resistance to flow disruption. This will cause the Coriolis effect to be as strong as possible, increasing tube twist and creating the longest time lag in the laminar area.

B. Diamond shape tube configuration

The relationship between the design variables and their impact on the time lag is revealed by these graphical depictions. The examination of these plots enables the determination of the design variables' optimum values for obtaining the intended system performance. It has been established that the regression model created for the diamond tube arrangement is adequate since it produces good agreement between the anticipated and experimental time lag values. This indicates that the selected design variables and their corresponding levels have a significant impact on the performance of the system.

frequency, the Omega-shaped tube

Conclusion

The Design of Experiments (DOE) by Taguchi method is a powerful statistical tool used to analyze experimental data and predict the impact of design parameters on time lag results. In this study, mathematical MINITAB 17, which are either quadratic or linear, representing the time lag, and expressed as a function of design parameters. This enables researchers to gain valuable insights into the relationships between the design parameters and the time lag, allowing for more efficient and effective optimization of the system.

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Experimental Investigation of Coefficient of Performance Enhancement (COP) in Ice Plant Using Brine-Based Metal Oxide Nanofluids

The research investigates brine-based metal oxide nanofluids to improve heat transfer and ice plant COP. The novelty of the study is in the use of stable nanofluids of ZnO, CuO, and Al_2O_3 prepared using surfactants and ultra-sonication to improve the performance of an ice plant working on the vapor compression refrigeration cycle. The study found that the COP of the ice plant was significantly enhanced using these nanofluids, with the greatest improvement of 27% observed for Al_2O_3 nanofluids at a particle volume concentration of 0.3%. The experiment also showed a reduction in compressor power consumption by 22% at the same concentration and temperature, indicating the potential use of these nanofluids in ice plant applications. The study further demonstrated that the COP improvement was more significant at a controlled temperature of 20 °C than at 25 °C.

Introduction

Nanofluids refer to the distribution of nanoparticles which possess high thermal conductivity in a base fluid. Thermal systems often utilize a variety of fluids to facilitate heat transfer, including water, ethylene glycol, refrigerants, and lubricating oils. These fluids are commonly used due to their heat transfer properties and availability. Operating expenditure of the thermal systems of the ice plant, gearbox, compressor, and power pack mainly depends on the power consumption of the prime mover used in these thermal systems. The heat carrying capacity of the traditional thermal fluids (water, ethylene glycol, refrigerant, and lubricating oil) worked in the ice plant, gearbox, compressor, and power pack decides the power consumption of the prime mover.

Experimental set-up

The experiments were conducted by adding stable nanofluids of ZnO, CuO, and Al2 O 3 prepared using surfactants and ultra-sonication, to the brine solution. The COP was then determined for each nanofluid at different particle volume concentrations and temperatures. The experiment was conducted under controlled laboratory conditions to ensure accuracy and reliability of the results

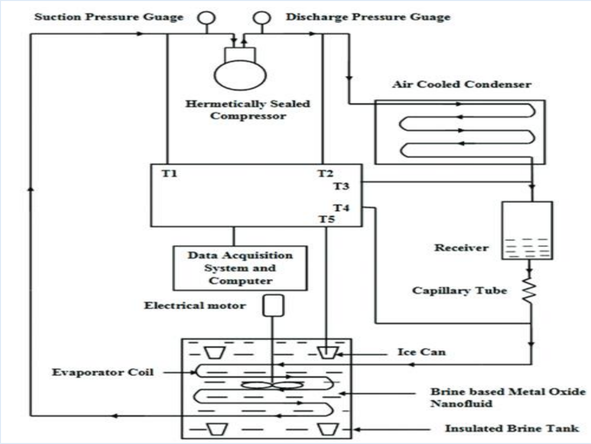

Fig shows Illustrative diagram of the experimental set-up used for measurement of COP using brine-based metal oxide nanofluid

Low pressure and low-temperature refrigerant from the capillary tube (shown in above Fig.) vaporized by the heatfrom the brine (stored in the insulated brine/nanofluids tank). Hence brine gets cooled. This cooled brine further absorbs the heat from water (filled in the ice cans), and the phase transforms from water to ice. These icecans have been soaked in a brine solution. Hence the heat transfer occurs from water (available in the ice can) brine across the walls of the ice cans. Temperatures of the primary (R22) and secondary refrigerant (brine) at various locations are measured using thermocouples. The initial temperature of the water was kept at 25 _C, and ice formed at −2 _C for all the experimental trials. Initially, the practice tests were conducted using brine as a secondary refrigerant. Then brine is removed from the brine tank and replaced with brine-based metal oxide nanofluids. Primary refrigerant (R22) is kept the same in both cases. Compressor power consumption is measured by an energy meter. Experimental readings of temperature, pressure and the energy meter were transmitted to the computer through Labview software. Refrigerating effect and electrical power required to drive the refrigerating compressor for the production of ice are determined using the experimental data stored in the computer.

Experimental results and discussions

It has been seen that the COP of brine based metal oxide nanofluids improved with rise in the particle volume concentration. It has been clearly analysed that compressor power consumption of nanofluids is lower compared with the simple brine. Also, compressor power consumption decreases with an particle volume concentration increment. In particular, maximum saving of compressor power of approximately 21% is obtained using brine–Al2O3 nanofluids at 0.3% volume concentration of particle in comparison with the simple brine. It indicates that brine–Al2O3 nanofluids is the most suitable nanofluids for ice plant application.

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An Experimental Study on the Performance Enhancement of a Heat Pump System using Nanofluids

Heat pumps are frequently used for heating, cooling, and air conditioning. It is well known that nanoparticles can improve the coefficients of conduction and convection, increasing heat transfer along with other properties. The considered heat pump was loaded with R-134a. Titanium dioxide (TiO2) and aluminium oxide (Al2O3) were blended with clean water to create a nanoscale solution used to cool the heat pump condensers. A total of three TiO2 and Al2O3 proportions (0.1%, 0.2%, and 0.3%) were used. The study's findings showed that utilizing 0.3% Al2O3 instead of conventional clean water to cool the heat pump condenser boosted the coefficient of performance by 18% while reducing energy consumption by 26%.

Introduction

The introduction discusses the emergence of nanofluids, a new category of heat transfer fluids due to advancements in nanotechnology. Researchers have explored the effects of nanoparticles added to various refrigerants and lubricants on the performance of vapor compression refrigeration (VCR) systems. Studies have demonstrated enhancements in thermal conductivity and heat transfer efficiency when nanoparticles like TiO2, CuO, and Al2O3 are incorporated into fluids. These improvements have been observed in applications ranging from home refrigerators to automotive cooling systems, showing reductions in energy consumption and improvements in system performance metrics like coefficient of performance (COP) and heat transfer rates.

Materials and methods

This setup is typical for experimental studies in refrigeration systems, where precise control and measurement of temperatures, pressures, and power consumption are crucial for analyzing the performance and efficiency of the system under varying conditions.

Components

Hermetically Sealed Compressor: Responsible for compressing the low-pressure, low-temperature vapor refrigerant.

Drier-Filter: Ensures that the refrigerant entering the compressor is free from moisture and contaminants.

Expansion Device: Typically a capillary tube, which controls the flow of refrigerant into the evaporator.

Heat Absorption Chamber (Evaporator): Where the refrigerant absorbs heat from its surroundings, providing the cooling effect.

Performance analysis

Detailed analysis of the refrigeration cycle, while understanding COP, heat-rejection ratio, and compressor work helps in evaluating and improving the efficiency of heat pump systems. These factors collectively contribute to achieving desired

cooling or heating outputs with minimal energy consumption.

Results and discussions

Optimal Nanofluid Concentration: The study concludes that using Al_2O_3 nanoparticles in water at a concentration of 0.3% yielded the best overall performance improvements:

COP: Improved by 18%

Compressor Power Usage: Reduced by around 26%

Heat Rejection: Decreased by about 1%

Temperature Effects: Additionally, the study noted significant reductions in the outlet temperatures of the evaporator and condenser when using the optimal nanofluid mixture, indicating enhanced heat transfer efficiency throughout the system.

In summary, the use of Al_2O_3 nanoparticles in the heat pump system demonstrated substantial improvements in COP, reduced compressor power consumption, and enhanced heat transfer efficiency. These findings highlight the potential benefits of nanofluids in enhancing the performance and efficiency of thermal systems.

Experimental Investigation of Heat Transfer and Pressure Drop Performance of a circular Tube with Coiled wired Inserts

This paper evaluates the thermo-hydraulic performance of a coiled wire passive insert for internal turbulent flow through a circular copper tube test section in an in-tube exchanger. Experiments were carried out using water as the working fluid with Reynolds number ranging from 8000 to 32000. The experimental setup was validated for Nusselt number and friction factor with well-established equations for plain tubes.

Introduction

The primary goal is to improve the efficiency of heat exchangers across various applications (refrigeration, automotive, solar heaters, etc.) by increasing the heat transfer coefficient. Three main categories are discussed: active methods (using external power), passive methods (inserting tabulator elements like coiled wires), and compound methods (combining active and passive techniques). Coiled wires are highlighted as effective passive tabulators. Their helical shape induces swirls in the fluid flow, which enhances heat transfer rates. This configuration is noted for being relatively simple to manufacture and install. The research involves experimental setups where parameters such as wire thickness, length, pitch, and flow regime are systematically varied to optimize heat transfer and minimize pressure drop. Techniques like Taguchi experimental design are used for parametric optimization. The findings suggest that coiled wire inserts can significantly improve heat transfer efficiency, particularly at lower Reynolds numbers. They are also noted for their ease of installation and removal without causing significant pressure drops.

Experimental set up and methodology

the experimental setup and procedure for validating and conducting trials with a plain tube before moving on to trials with an inserted tube. it consists of hot water system having storage: 100l hot water tank. it has heating equipped with five 2 kw heaters, heating water to 75°c. hot water circulated through the system using a hot water circulation pump in a closed circuit. cavitation prevention consist of hot water tank placed 0.5 m above the pump. gate valve in the hot water circulation pipe, flow rate calculated via differential manometer and venturi meter. cold water system supply fed counter currently from a large underground tank. water is circulated through the inner tube (test section) using a cold water through pump in a closed circuit. Flow Rate Control is managed by one bypass valve and two shut-off valves.

Fig: Experimental Setup

Differential pressure head measured with a manometer through a calibrated Venturi meter located upstream of the test section. Pressure drop is measured by a U-tube manometer filled with carbon tetrachloride (CCl4). Temperature is Measured using pre-calibrated copper/constantan t-type thermocouples connected to a data logger. Inlet and outlet points of the test section, with two thermocouples at each location for accuracy. Six thermocouples placed equidistantly around the tube test section.

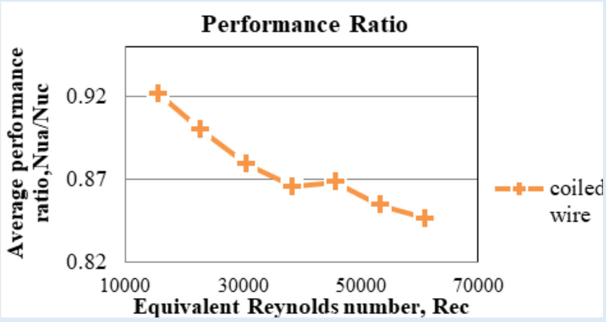
Procedure

1. Steady State: The system allowed to reach a steady state.
2. Data Collection: Temperature and pressure drop measured for the plain tube at cold water Reynolds number of 8000-32000.

Results and discussion

- The effect of coiled wire inserts on heat transfer enhancement increases with higher Reynolds numbers due to the creation of vortices by the twisted wires, leading to better heat transfer rates. Performance ratio is less than 1 for the selected range of Reynolds numbers and decreases at higher Reynolds numbers. Despite the enhancement in Nusselt number, significant friction factor increments lead to increased pumping power requirements, making the thermo hydraulic performance of the insert not competitive in the selected Reynolds number range. More significant at higher Reynolds numbers due to vortices created by twisted wires.
- **Friction Factor**: Higher in the presence of coiled wire inserts, leading to increased pressure drop and pumping power requirements.
- **Performance Ratio**: Decreases with increasing Reynolds numbers,

indicating that the overall thermo hydraulic performance of the insert is not competitive within the studied Reynolds number range.



Conclusions

Coiled wire inserts are suitable for heat transfer augmentation in applications where the increased pumping power requirements are not a major concern. The performance ratio R3 is less than unity for the selected Reynolds number range. Indicates that while coiled wire inserts enhance heat transfer, they also increase friction significantly.

Editorial Team

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