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Energy saving gas stove using PCM Heat Exchanger

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ABSTRACT

The main aim of work is experimentally investigating the feasibility of an expanded paraffin wax phase change material (PCM) heat exchanger operating as a condenser in an instant air source. The temperature distribution and volume expansion of an expanded paraffin wax were investigated and tested under different inlet water flow rates. However, in the PCM heat charging/discharging process, non-uniform temperature distributions played an important role in the heat exchanger efficiency. During the heat discharging process, the energy efficiency and the heat transfer rate were also analyzed using experimental data. [1]

The main aim of work is to design and develop PCM heat exchanger. The 3D model is drawn. All the parts are manufactured and then assembled together and then the experimental testing of model is carried out. [1]

INTRODUCTION

Due to the increase of energy costs, buildings energy consumption has tended to decrease in the past decades. This gives an opportunity for developing innovative renewable technologies that are more adapted to recent buildings with low energy demand. So, the main challenge is to manage non-simultaneous availability of heat source or sink and the energy demand of buildings. Hence, different technologies dedicated to energy storage have been developed recently; one of them is the use of Phase Change Materials (PCM). These materials are considered because they exhibit a higher heat storage capacity than sensible storages and a tune able phase change temperature according to their composition. [2]

PCM are used in many applications, for instance, Campos-Caldor et al. (2014) designed a finned plate PCM energy storage for domestic application using RT60 and water. They developed and validated a mathematical model to cover the simulations of the system. They finally compared their prototype with a conventional 500 l hot water tank and concluded that the PCM storage can allow a volume reduction of more than 50% which leads to lower heat losses at the same time. The work focuses only on PCM heat exchanger. In the last decades, many researchers studied this type of heat exchanger. Ten years ago, Zelda et al. (2004) studied of system is technically feasible and economically advantageous. [5]

Due to the increasing gap between the global energy supply and demand, reaching to a thermally efficient and cost optimized thermal energy storage system has received a considerable attention among researchers. There are three methods for storing thermal energy: sensible, latent and thermal– chemical. Among these methods, latent heat thermal

storage (LHTS) using phase change materials (PCMs) is known as the most favorable for its high energy storage density with small temperature variation (Melling and Cabeza, 2007). In other words, PCMs are attractive as they are capable of absorbing and releasing a considerable amount of energy at a nearly constant temperature during melting and solidification processes. Latent heat energy storage systems can be used to store a considerable amount of available thermal energy to be utilized during energy demand period, hereafter providing a promising solution for smoothing the discrepancy between energy supply and demand. Thus, many authors have reported their results of researches on PCM thermal storage during melting and solidification processes in energy storage systems. [3]

Fins, or more generally extended surfaces, are used to provide additional heat transfer surface in thermal systems. In LHTS systems, various researchers extensively studied the role of different configurations of fins on the performance improvement characteristics of LHTS systems. Subsequently, different numerical studies looking at the impact of fins on overall PCM melting and solidification. [5]

LITERATURE SURVEY

"Numerical analysis on the advantage of using PCM heat exchanger in liquid-flow window" This paper proposes a ventilated window with a Phase Change Material (PCM) heat exchanger as a new window application. In summer, night ventilation mode is operated to discharge energy stored in PCM by the ambient cold air, which can be reloaded again, when ventilation pre-cooled air is provided. Numerical models are built and verified by full-scale experiment to evaluate the PCM ventilation system. [4]

The nonlinear properties and hysteresis of PCM are set in the model. The conclusion is that the configuration optimization should be based on different climates. In the case study in Copenhagen, the heat exchanger with 10 mm plate thickness is optimized. It can cool down the ventilated air 6.5 ºC on average in 3.9 h pre-cooling effective time with 3.19 MJ/day energy saving. The material cost saving is 16.87% compared to 20 mm plate thickness which has similar discharged heat amount. Nevertheless, the heat exchanger with 5 mm plate thickness has a faster thermal response and a higher cost saving ability, which is good for the climate when the period of outdoor air temperature suitable for night ventilation in a day is short. This paper presents a new window application for pre-cooling of ventilation air using a PCM heat exchanger. [5]

In summer, the PCM heat exchanger is discharged by night ventilation, and recharged by high temperature ambient air in pre-cooling mode. The nonlinear properties and hysteresis of PCM are set in the model. The hysteresis of PCM used in the model is slightly overvalued by DSC measurement, but the deviation from the experiment lies within a reasonable range. The numerical works are conducted based on a severe summer day in Copenhagen. Results show that in night ventilation mode, the increase in PCM plate thickness does not have a big influence on the outlet air temperature and discharged heat in the first hours this literature shows Phase change materials (PCM) are capable of storing thermal energy within a small temperature range due to their high latent heat. When designing a thermal energy storage (TES) system with PCMs, besides the phase change enthalpy, thermal conductivity and density, viscosity based on temperature must be characterized to take into account natural convection. Taking advantage of the facilities of the different research groups working within an international network, a set of interoperative tests were executed to determine the viscosity based on the temperature of two PCMs: octadecane and the commercial paraffin RT70 HC. Three laboratories have participated, which have used three different rheology equipment's: two controlled stress rheometers, AR-G2 from TA Instruments and MCR 502 from Anton Par and a translational rheometer, IMETER. The Intercomparative tests were executed based on a starting methodology approach defined previously by some of the authors. The highest deviations were observed

when temperature-controlled geometries or temperature hoods were not used at elevated test temperatures due to the temperature gradients within the sample, as consequence of the heat losses due to the room temperature. [2]

SYSTEM DESIGN

Mechanical design phase is very important from the view of designer as whole success of the work depends on the correct deign analysis of the problem. Many preliminary alternatives are eliminated during this phase. Physical properties of material, loads stresses, deformation, and failure all this information has been understood by us. Theories and wear analysis, to identified the external and internal forces acting on the area concerns with the various physical constraints and ergonomics, space requirements, arrangement of various components on the mainframe of machine no of controls position of these controls ease of maintenance scope of further improvement; height of m/c from groundetc. [1]

METHODOLOGIES

- We have started the work of our work with literature review. After referring several papers, we got many ideas. From these ideas we select best design of our work. [2]
- By referring the design, we will buy the standard component required for the works. After this we will start manufacturing work in workshop. By taking proper dimensions we will manufacture components one by one. [4]
- After this, assembly of different components will be done. Later testing will be started for getting various results. After completing testing work fair report will be done and submitted. [5]

ADVANTAGES

- It is chemical stable
- Non-Corrosive
- Available in low cost
- High heat capacity

DISADVANTAGES

- Low phase change enthalpy
- High changes in volume during phase transition

DESIGN AND MODELLING

Computer-aided design (CAD) is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations.

Its use in designing electronic systems is known as electronic design automation (EDA). In mechanical design it is known as mechanical design automation (MDA) or computer-aided drafting (CAD), which includes the process of creating a technical drawing with the use of computer software.

CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space.

CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, prosthetics, and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals,

often called DCC digital content creation. The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in computational geometry, computer graphics (both hardware and software), and discrete differential geometry.

The design of geometric models for object shapes, in particular, is occasionally called computer-aided geometric design (CAGD)

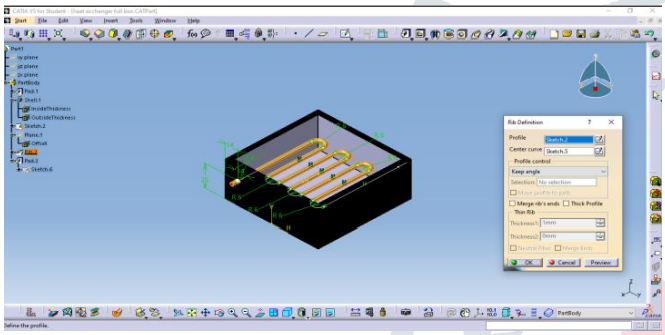

Fig. 1 Catia Modeling

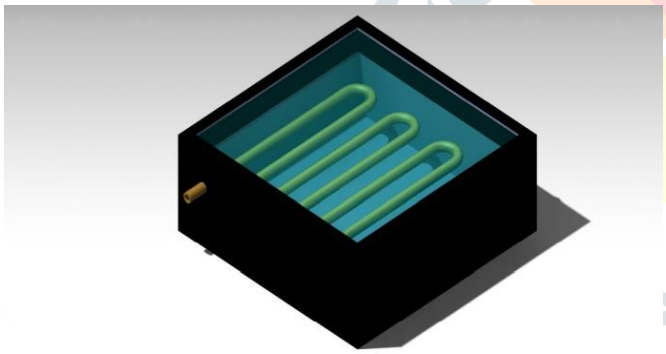

Fig. 2 PCM Heat Exchanger

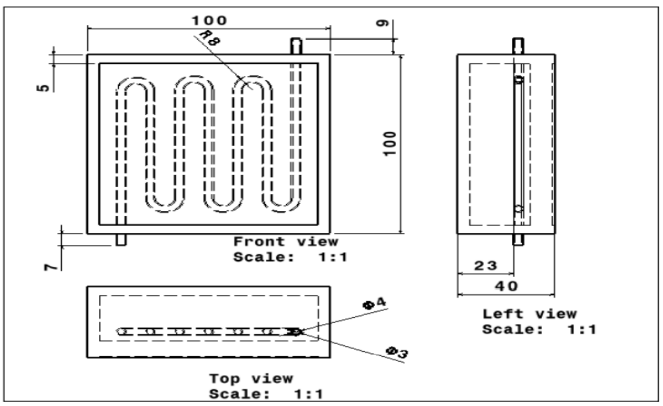

Fig. 3 Drafting

CONCLUSION

FUTURE SCOPE

- It will focus on lowering energy consumption and cost for energy. It also focuses developing next generation water-based heat exchanger. This type of heat exchanger can be used for compact spaces due to its high energy density.
- The scope of the work is multi-fold; the study encompasses material study, component study, and finally system study. Energy is backbone to human activity; while the global population increasing the demand for energy also increases. As demand for energy is increasing worldwide and the increasing levels of greenhouse gases, this will be greener approach for energy storage and supply.
- In future demand for energy will increase at every moment, for maintain proper balance between demand and supply of energy use of paraffin wax-based heat exchanger will be good choice. This paper presents a new application of PCM heat exchanger. It is generally used for reusing the heat which is getting wasted from burners. The design and optimization process of heat exchanger are connected by means of numerical modelling, which is verified by full scale experiment. The non-linear properties and hysteresis of PCM are set in the model. The numerical works are conducted based on a different heating range. The result shows that the heat energy getting wasted from burner is being utilized for heating of water, through convection via copper tubes. Thus, the heating of copper tube and hot water leads to melting of paraffin wax. So even if the burner is off we get the hot water which is being getting dissipated via conduction from hot molten paraffin wax New methods to get more accurate PCM heat capacity is essential for future works. In the next stage, the feasibility of applying the PCM exchanger for other general uses.

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