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Numerical simulation of heat transfer enhancement from tubes surface to airflow using concave delta winglet vortex generators

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Abstract

Improvement of the convection heat transfer coefficient of the airflow has become a concern nowadays to increase the rate of heat transfer . Therefore, the present study is focused on evaluating the improvement of heat transfer numerically from several heated tubes to the airflow in the channel using vortex generators . Airflow into the channel is varied in the range of Reynolds number of 2100–11,200. The vortex generators used in this study are delta winglet pairs and concave delta winglet pairs with in-line or staggered configurations for one to three pairs of vortex generators . The results of the study showed that the installation of three pairs of concave delta winglet vortex generators with a staggered arrangement resulted in the best convection heat transfer improvements with the highest increase in convection heat transfer coefficients up to

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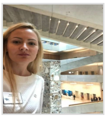

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Numerical simulation of heat transfer enhancement from tubes surface to airflow using concave delta winglet vortex generators

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ARTICLE INFO

Keywords:
Convection heat transfer coefficient
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ABSTRACT

Improvement of the convection heat transfer coefficient of the airflow has become a concern nowadays to increase the rate of heat transfer. Therefore, the present study is focused on evaluating the improvement of heat transfer numerically from several heated tubes to the airflow in the channel using vortex generators. Airflow into the channel is varied in the range of Reynolds number of 2100–11,200. The vortex generators used in this study are delta winglet pairs and concave delta winglet pairs with in-line or staggered configurations for one to three pairs of vortex generators. The results of the study showed that the installation of three pairs of concave delta winglet vortex generators with a staggered arrangement resulted in the best convection heat transfer improvements with the highest increase in convection heat transfer coefficients up to 53.58% than those from the baseline (without vortex generators). However, the increase in the convection heat transfer coefficient is accompanied by an increase in pressure drop of up to 69.69% against the baseline.

1. Introduction

Fin-and-tube heat exchangers (FTHE) are widely used in industry, refrigeration and air conditioning (AC) systems, and heating ventilation [1]. Therefore, energy efficiency in FTHE has become a very important thing to pay attention to in this decade. This energy efficiency can be performed by increasing the rate of heat transfer in the FTHE. This heat transfer improvement is carried out by lowering the gas side thermal resistance of the FTHE due to the low thermal conductivity of the gas. The decrease in the thermal resistance of the gas causes an increase in the convection heat transfer coefficient (h). One way to increase h is to add vortex generators (VGs) to the fin side of the FTHE [2,3]. The shape of the vortex generator (VG) is divided into delta wing, rectangular wing, delta winglet, and rectangular winglet [4,5]. Installation of VGs can be done by embossing, mounting, or punching [6,7].

The numerical analysis of the increase in heat transfer is also a concern for researchers. Ranjan numerically estimates the conduction-convection parameters of rectangular fins in relation to the improvement of heat transfer [8]. Furthermore, Ranjan and Ooi predict a combination of several parameters to enhance heat transfer in fins [9]. They considered the porous fins, thermal conductivity of the fins, permeability, length and thickness of the fins as estimation parameters. Kundu et al. in his work tried to improve heat transfer in wet fins [10]. They tried to improve the heat transfer improvement in longitudinal fins and pin fins under transient operating conditions. Even further, Ranjan and Kundu studied heat generation and magnetic field strength in radial porous fins using the surface temperature response [11]. The study they carried out was due to the increasing efficiency demands of cooling and heating systems.

Li et al. [12] conducted experiments and numerical simulations using delta winglet vortex generators (DWVGs) to determine the thermal characteristics of the fluid on the pin-fin heat sink by varying the Reynolds number (Re), configuration and position of the VGs. They found that low thermal resistance was observed in the common-flow-up (CFU) configuration with the highest Re. Meanwhile, the best results obtained by considering thermal resistance and pressure drop were shown in the use of DWVGs with an angle of attack of 30°. Song et al. [13] conducted an experimental study to determine the effect of the geometry size of curved delta winglet vortex generators (CDWVGs) on heat transfer and pressure loss. The results of their study showed that the small size of the CDWVGs located close to the tube provided an advantage in increasing heat transfer at low Re. Meanwhile, large CDWVGs are good for use at high Re. Wu et al. [14] studied experimentally the effect of pitch and tube diameter on the heat transfer performance of an FTHE mounted on

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Heating energy implications of utilizing gas-phase air cleaners in buildings' centralized air handling units

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ARTICLE INFO

Keywords:
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ABSTRACT

Ventilation systems are a vital component of buildings in order to ensure a healthy and comfortable environment for the occupants. In cold climate regions, ventilation systems are responsible for approximately 30% of building heat losses. In addition to outdoor pollutants (particulate matters, NO_X, etc.), indoor emissions from materials in the form of gas pollutants and emissions from occupants are the principal indoor air quality metrics for securing an acceptable indoor concentration level. Therefore, it is of great interest to study the use of gas-phase air cleaning technologies in low-energy centralized air handling units. This study focused on reducing buildings' heating requirements by recirculating indoor air while maintaining an acceptable indoor air quality level. The heating performance of a typical residential and office building in the central Swedish climate was studied by dynamic building simulations. Indoor air recirculation rates and air changes per hour were the key parameters considered during the simulation of the building's heating demand and indoor gaseous air pollution concentration. We found that introducing indoor air recirculation reduces buildings' heating demand depending on the air change rates per hour. The results show that it is possible to reduce the energy use for heating by less than approximaytely 10% and 20% for residential and office buildings, respectively and maintain acceptable indoor air quality by using gas-phase air cleaning.

1. Introduction

Meeting occupants' indoor air quality requirements and reducing the pollutants emitted by indoor sources is important [1]. Heating, ventilation, and air-conditioning (HVAC) systems are used to ensure a healthy and comfortable indoor climate for occupants. HVAC systems can be configured in various ways, depending on the type and use of buildings, specific requirements of the residents, and climate conditions [2]. Maintaining an acceptable indoor environment and reducing the energy needed for this task in buildings are in line with several of the United Nations' Sustainable Development Goals (SDG) [3]. Thus, a transformation in the building sector towards zero-energy buildings is required without compromising occupants' health, comfort, and productivity.

In a set of countries participating in the IEA Energy Conservation in Buildings Program, all buildings' primary ventilation energy demand is approximately 9% of their total primary energy use. It is estimated that ventilating US residential buildings consumes 30% of the total energy used in these buildings, in addition to heating, cooling, and domestic hot water (DHW) needs. By increasing the air tightness of buildings, ventilation plays a more important role in maintaining acceptable indoor air quality and its share of total energy use incease [4]. In addition to ventilation energy use, carbon dioxide (CO_2) emissions have become a concern. The US annual CO_2 emissions of residential and service sector ventilation are approximately 1000 and 800 million tons, respectively [5]. Ventilation energy is utilized to heat up, cool down, filter, and dehumidify/humidify the ventilated air and to run the circulation fans. However, ventilation energy use may vary significantly based on the local climate. In Europe, most of this energy is used to heat the outdoor air for ventilation [4], while in warmer climates, the energy is used for both heating and cooling purposes. In Sweden in 2017, approximately

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Numerical modelling of the poto-poto by coupling of finite elements and boundary elements for acoustic characterization

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ABSTRACT

Sustainable development encourages the construction of buildings based from local raw materials because they are ecological, renewable, available, low energy consumption, less costly, low pollution, and therefore without risk to human health. The poto-poto is a widespread material, made of soil material and bamboo, two natural materials widely used in construction throughout the world and particularly in Central African countries, due to their affordable cost or the low technical requirements for their implementation. This material (poto-poto) although widely used, remains very insufficiently explored as well from the point of view of its mechanical characteristics as from the normative point of view necessary for its modernization. This is why, given the extent and large scale of its use, we considered it important to explore it by establishing its physical characteristics. In this paper, we have chosen to continue the characterization of poto-poto already started in the previous paper by also addressing its acoustic characteristics.

Indeed, the effects of climate change are manifested by abnormal variations in temperature against seasons. Hence the urgency to master the physical properties in order to make the most of it both in terms of acoustic implementation and/or thermal insulation as regards its use as a green and modern construction material. In this work, we have, on the basis of the Biot model, carried out a 2D numerical modelling of a poto-poto wall by coupling finite elements method (FEM) and boundary elements method (BEM). The MATLAB software was used to obtain the sound absorption curves of our model. We then made several specimens of our eco-material (3 cm, 4 cm and 5 cm) dosed with 2%, 4% and 6% of bamboo fibers, on which Kundt tube measurements were performed to determine the experimental sound absorption curves. The comparison of these curves with those of the model showed acceptable standard deviations and above all allowed us to conclude that the poto-poto presents an acoustic absorption in the range of frequencies 500–1250 Hz and can thus be effectively used for the acoustic implementation of the walls and certain rooms of the buildings.

1. Introduction

The observation made so far shows that in Cameroon and in some countries of the sub-region bordering Cameroon, most of the local materials are only used under the angle of their low cost and generally oriented for a habitat identified as poor and in particular in rural areas. By choosing to explore their physical characteristics, we open the way to the use of these properties for sustainable building (eco-construction). And for good reason, sustainable construction encourages the more abundant use of materials used throughout history in cultural models of housing. Modernization and construction on a larger scale require the exploration of physical characteristics in order to standardize them and ensure their controlled and mastered use. This is not new, as it is now encouraged [1–3]. It should also be noted that in Central Africa, we are still behind in taking into account the environmental and energy impact in the construction policy. Most largest cities (e.g. Douala, Yaoundé) use mainly non-biodegradable building materials, including cement-based breeze blocks, which have major disadvantages. Indeed, as the balance of gas emissions from the cement manufacturing process is estimated at 0.8 tonnes of CO_2 equivalent per tonne of clinker, our approach

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Assessment and determination of 2030 onshore wind and solar PV energy targets of Türkiye considering several investment and cost scenarios

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Keywords:
Solar PV
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Installed capacity estimation

ABSTRACT

The importance of renewable energy (RE) shift increases as the instabilities around the world enhanced by the pandemic raise issues about energy security while the energy demand of countries continue to increase. This is especially the case for Türkiye, which is a member of OECD and among developing countries. In the next decade, onshore wind, and solar photovoltaics (PV) will be the focus of Türkiye's RE sector due to the rapid decrease in their costs. Hence, reasonable estimation of investments to the RE sector and cost projections of onshore wind and solar PV is crucial to plan, decide and set effective energy policies. In this study, three different investment scenarios are generated for RE of Türkiye. In addition, global and local cost projections are conducted for onshore wind and solar PV, again in three different scenarios. These scenarios are then utilized to estimate the annual installed capacity changes of Türkiye. Then, annual installed capacity amounts of Türkiye for onshore wind and solar PV are projected until 2030 in five novel scenarios: Economic, Average, Ambitious, Best-Case, and Worst-Case. According to the results, achievable and the most suitable 2030 targets for onshore wind and solar PV are determined as 25,000 MW and 60,000 MW for Türkiye, respectively. These results will assist the policymakers by elucidating the onshore wind and solar PV future of Türkiye, and the methodology may be useful for determination of RE targets for other countries.

1. Introduction

Energy generation has always been a crucial priority for nations worldwide for both economic and security concerns [1,2]. This is especially the case in 2022, where instabilities around the world enhanced by the COVID-19 pandemic threaten the supply of energy [3] while the energy demand continues to increase [4]. In addition, the world faces a climate emergency which necessities the utilization of the renewable and clean sources rather than the fossil fuels in energy generation [5,6]. The International Energy Agency (IEA) repeatedly reports that the temperature rise cannot be kept bellow 2 °C if additional fossil fuel projects are realized [7,8]. It was emphasized that the "net-zero" hinges on an unprecedented clean technology push to 2030 [7]. In addition, in terms of both sustainable development goals (SDG) 7 (affordable and clean energy) and 13 (climate action), the transition from fossil based energy to the renewable energy is crucial. Indeed, renewable energy transition has been counted as one of the most promising approaches for meeting the world's increasing energy demand [9]. Hence, reasonable assessment and determination of annual and overall renewable energy targets up to 2030 has gained immense importance.

To begin the discussion on the costs of renewable energy technologies, two main indicators should be introduced: the total installed cost (TIC) and the levelized cost of electricity (LCOE). The TIC is used to indicate the cost of energy capacity (usually in USD/kW), while the LCOE is used to indicate the cost of electricity production (usually in USD/kWh) [10–12]. These two indicators are related in solar and wind energy technologies since the operating costs (opex) is much lower than initial investments (capex) [13]. LCOE is a useful tool to evaluate the performance of individual projects over time, while TIC is generally used for macro-economic analysis since it directly relates the energy capacity and the capex.

Among renewable energy technologies, onshore wind and solar PV have recently reached grid parity and have become economically competitive with the other energy sources [14]. Global projections of Sens et al. shows that the capex of onshore wind and solar PV

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