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Energy and Thermal Performance of Social Housing: Analysis of Heat Flow Through the Envelope and Comparison With International Schemes

Some of the greatest potentials for improving building energy efficiency are found in the residential sector. Social housing, in particular, has drawn heavy research interest because it affects the welfare of large populations, is the source of significant energy consumption, and has outsize importance in the construction and regulatory sectors. Energy regulation in Mexico focuses on reducing the energy needed to cool buildings down, neglecting the importance of heating buildings built in the colder regions of the country. To address this gap, the present work focuses on the thermal behavior of social housing in the regions of Mexico with cold semi-arid climate. We found that thermal discomfort inside houses is primarily driven by low temperatures. We calculated annual heat flows in houses, visualizing heat gains and losses through each part of the building envelopes, and found that the highest heat flows occur through the floor. We also found that windows have the greatest heat transfer per unit area of all construction elements. We estimated the energy that each building would require if heating and air conditioning were used throughout the year to bring indoor temperatures within the range of thermal comfort. Finally, we used evaluation schemas from several countries to evaluate the energy demand per unit area (kWh/m^2*) of several local houses in a typical year. The houses analyzed here presented low scores under these schemas.* [DOI: 10.1115/1.4045171]

Keywords: building, conservation, cooling, energy, heat transfer, heating, simulation

1 Introduction

Energy is a central driver of human development. Improvements in energy availability have increased the rate of population growth throughout the world, and the rate of socioeconomic growth within all countries. Diminishing reserves of fossil fuels, concern about global climate change, and the cost of energy itself have motivated architects, scientists, and society at large to decrease energy consumption wherever possible. It is in this context that energy efficiency in buildings takes particular importance.

Many of the most effective strategies for solving energy and environmental problems are specific to particular sectors of the economy. In the USA and Europe, the residential sector accounts for about 40% of energy consumption and, therefore, presents one of the greatest opportunities for energy savings.[2,3] Nearly half of this energy is used for domestic heating, ventilation, and air conditioning (HVAC) [1]. The International Energy Agency (IEA) reports that residential buildings account for 20% of worldwide energy use [2]. According to a 2018 IEA report, cooling indoor spaces accounts for ~20% of electricity use in buildings, and heating accounts for ~6% [3]. Increased adoption will increase the fraction of residential energy used for cooling to 30%, and that of heating to 7.5%, according to projections for the year 2050 [3].

1.1 Housing in México: Current State and Regulation.

According to the 2011 census of the Mexican National Institute of Statistics and Geography (INEGI), Mexico contains 112×10^6 people in 28×10^6 homes, averaging 3.9 people per household, and will contain 122×10^6 inhabitants by 2050.[4] INEGI's National Energy Balance 2016 reports that the Mexican residential sector accounts for 17.5% of the total energy consumption and increased 1.8% between 2015 and 2016 [4]. The main fuel sources in Mexican households are natural gas (33%), firewood (33%), electricity (28%), and solar energy (0.77%) [5]. Air conditioning systems account for the greatest proportion of domestic energy use, up to 44% of the total, while lighting and appliances can account for up to 33% [5].

The Mexican Department of Energy, through project SENER-118665 [6], asked a consortium of researchers to study passive energy systems that could be applied to households in different climate zones throughout Mexico. The researchers found that these systems are rarely used in practice and that the relevant regulations tend to attend other issues rather than thermal comfort [7–12]. Lucero-Alvarez, Rodríguez-Muñoz, and Martín-Dominguez report electrical consumption in 20 Mexican cities and calculate the cooling and heating needs for each one [13]. This study

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[2] https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

[3] https://www.eia.gov/totalenergy/data/monthly/pdf/flow/total_energy.pdf

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[4] http://www.beta.inegi.org.mx/proyectos/ccpv/2010/

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Tamoxifen-Loaded Nanodiamonds as a Potential Nanosystem for Drug Delivery to Breast Cancer Cells

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Nanodiamonds (NDs) are considered excellent carriers for drugs due to their high capacity for absorbance and marked biocompatibility. We assembled tamoxifen-loaded NDs and evaluated their effect on MCF-7 breast cancer cells. For this purpose, carboxylated NDs were covalent bound with lactic acid to promote the electrostatic coupling of tamoxifen. The nanodiamond-lactic acid-tamoxifen (ND$_{LA}$-TMX) nanosystem was also characterized to define its composition and size. We managed to load 78.2 ± 0.13 μg tamoxifen/mg ND$_{LA}$, with a hydrodynamic size of 1136 ± 18.7 nm and ζ potential of -19.8 ± 0.8 mV. According to Fourier transform infrared spectra, prominent C=O and C=C bands in ND$_{LA}$ were associated with the esterification of COOH and –OH groups from NDs and lactic acid. The flattening of these bands and the distinctive bands between 1500 and 600 cm^{-1} in the nanosystem, indicated that tamoxifen was bound as a result of electrostatic interactions with ND$_{LA}$. Detection of Raman peak profiles for nanodiamonds (1330 cm^{-1}), lactic acid (1440 cm^{-1}) and tamoxifen (1590–1640 cm^{-1}) corroborated the assembly of the ND$_{LA}$-TMX nanosystem. The ND$_{LA}$-TMX nanosystem reduced the viability of MCF-7 cells to around 15% at 9.3 μg/mL TMX, whereas the equivalent concentration of free tamoxifen reduced viability to 50%. The enhanced efficiency of the nanosystem to combat MCF-7 cells, suggests its potential for the treatment of breast cancer cells.

Keywords: Tamoxifen, Nanodiamonds, Cell Viability, Breast Cancer Cells, Nanocarrier.

1. INTRODUCTION

Breast cancer is portrayed as the most common cancer and is the principal malignant neoplasm among women worldwide [1]. To date, chemotherapy involving anticancer drugs is the principal cancer treatment employed. Tamoxifen (TMX) is a strong, hydrophobic endocrine drug that has been widely used for more than 30 years, for the prevention and treatment of estrogen-dependent breast cancer [2]. This drug competes with estrogen for estrogen receptor coupling, which is upregulated in a majority of breast cancers. Thus, treatment with TMX prevents the stimulatory effects of estrogen in tumor growth; causing apoptosis [2, 3]. Despite, the benefits of TMX in breast cancer treatment, dose-related side effects, such as increased risk of endometrial and liver cancer, ocular damage, liquid retention, among others, still represent a therapeutic challenge [2, 4, 5]. These adverse effects are associated with the low specificity, solubility and bioavailability of TMX [6]. In the light of these limitations, the effective delivery of TMX to tumor tissues is imperative to improve treatment specificity, efficacy, and reduce adverse effects [7].

Nano-based drug delivery systems have been shown to enhance cancer chemotherapy treatments, because of improved drug solubility, delivery efficiency and target releasing [8–10]. Recently, the loading of TMX into solid lipid nanoparticles and polymeric nanomicelles was demonstrated as equal to, or more efficient than free-TMX for inhibiting the growth of cancer cells, and sustained drug release was also achieved [7, 11, 12].

Likewise, nanodiamonds (NDs) are considered excellent carriers for drugs and proteins due to their high adsorbance capacity and their biocompatibility [13–15]. The binding of drugs to NDs may be achieved by means of direct electrostatic interactions, or by indirect attachment through chemical linkage or electrostatic interaction with

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TESIS
QUE PARA OBTENER EL GRADO DE

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CHIHUAHUA, CHIH. **JUNIO, 2020**

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DESIGN OF A CONTROL SYSTEM FOR AN ORGANIC RANKINE CYCLE FED WITH SOLAR COLLECTOR FOR DOMESTIC CO-GENERATION

THESIS
TO OBTAIN THE DEGREE OF
Ph.D. in Environmental Science and Technology

By:
M.Sc. Emmanuel Dami Kajewole

Thesis Director:
Dr. Ricardo Beltrán Chacón

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Numerical Simulation of Direct Solar Vapor Generation of Acetone for an Organic Rankine Cycle Using an Evacuated Tube Collector

This paper analyzes the direct solar vapor generation of acetone by solar radiation falling on the heat pipes of an evacuated tube collector (ETC) that can activate a domestic scale organic Rankine cycle (ORC). The irradiance from the sun determines the mass flow of acetone along the horizontal manifold of the ETC to produce vapor at the collector outlet. A SCILAB *code is developed to simulate the flow of acetone inside the manifold where subcooled acetone undergoes heating and evaporation process. Simulation is run from 60 °C to a saturation temperature of 120 °C at a pressure of 604 kPa, vapor qualities from 1% to 100%, and solar radiation from 300 to 1100 W/m^2. The Kattan–Thome–Favrat flow boiling model is used to obtain the two-phase local heat transfer coefficients along the horizontal manifold, and it is validated with the numerical and experimental values of ammonia. The ORC system can generate 218 kWh/year of electrical energy, a thermal power capacity of 1616 kWh/year and achieve an ORC efficiency of 84.4%. The solar-ORC has a thermal efficiency of 3.25% and an exergy efficiency of 21.3% with a solar collector of 2.84 m^2.* [DOI: 10.1115/1.4048302]

Keywords: direct steam generation, organic Rankine cycle, acetone, evacuated tube solar collector, controlled mass flow, absorber, collector, heat transfer, simulation, solar, thermal power, thermodynamics

1 Introduction

Renewable energy is the most promising solution in the world of an ever-increasing global demand for energy [1]. Solar energy is the most abundant renewable energy resource when compared with others, and it is permanent to date. The development of diverse economies around the world has led to the irregular rise and fall of the price of oil in recent times. This event also leads to the administering of more severe environmental rules that patents to the emission of greenhouse gas [2]. As a result, there has been more research on the organic Rankine cycle (ORC) that converts low-grade heat to electric power as a high-efficiency energy technology in recent decades [3]. The ORC is seen as a promising technology [4] where electrical power output is produced from low-grade thermal sources [5], as it has an ability to improve the efficiency of energy whereby greenhouse gas emission is diminished [6]. A typical Rankine cycle and an ORC are structurally alike, but an ORC uses organic fluids as a working fluid instead of water. One advantage that organic fluids have over water is that their specific vaporization heat is much lower than that of water.

Solar-ORC systems can be implemented using the direct steam generation (DSG) technology [7,8]. The DSG designs usually have an indirect heat exchanger between the solar heating system and the absorber tube where a fluid is pre-heated by the solar system and thereafter the fluid evaporates with the help of a conventional heat source in a controlled condition. The heat transfer is carried out directly from the absorber tube, and vapor is generated in the process. This system has an advantage because it increases the efficiency by the elimination of two pumping devices thereby not requiring the use of an intermediate heat exchanger.

Once-through, injection, and recirculation mode are the operating modes in which DSG can operate [9]. In Once-through mode; the working fluid is pre-heated, turned into vapor and evaporated, and changed into superheated vapor, as it flows from the inlet to the outlet of the solar collector. To control the outlet vapor temperature, a working fluid injector is positioned in front of the last collector. In Injection mode, the working fluid is injected at various points through the solar collector row. In Recirculation mode, the working fluid liquid–vapor separator is placed at the end of the evaporation section of the solar collector row. Excess working fluid is recirculated to the field inlet and mixed with the pre-heated working fluid in the separator. In the separator, the remaining vapor is used to feed the superheating section [10].

Studies on DSGs have been conducted with different types of solar collectors by varying the mass flow of fluids to produce vapor. Aurousseau et al. [11] regulated the mass flowrate by determining the outlet specific enthalpy from an energy balance in the control of steam quality and outlet temperature for DSG in linear concentrating solar power plants. Zapata [12] manipulated the feedwater mass flow at the receiver inlet to maintain a pre-determined specific enthalpy at the receiver outlet of a paraboloidal dish, making up for changes in solar radiation and other ambient conditions. Eck and Hirsch [13] proposed a model that varied the mass flowrate and used the heat transfer coefficient in the energy balance for the closure equation to obtain the desired outlet temperature in a parabolic trough collector (PTC). Although these

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