CFD ANALYSIS AND ASSESSMENT OF PERFORMANCE PARAMETERS OF A CO-AXIAL PIPE EVACUATED TUBE SOLAR AIR HEATER

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE DEGREE OF

MASTER OF TECHNOLOGY

(Machine Design)

Submitted by

SUBHRANT LAHREY

(Roll Number- 21040109)

Under the supervision of

PROF. T.V. ARJUNAN

and

MR. PRASHANT KUMAR JANGDE

DEPARTMENT OF MECHANICAL ENGINEERING

School of Studies of Engineering and Technology

Guru Ghasidas Vishwavidyalaya (A Central University) Bilaspur,

Chhattisgarh, India

OCTOBER 2023

CERTIFICATE

As per University Grant Commission (promotion of academic integrity and prevention of plagiarism in higher education institute) regulation 2018 dated 13th july 2018 progress report **"CFD ANALYSIS AND ASSESSMENT OF PERFORMANCE PARAMETERS OF A CO-AXIAL PIPE EVACUATED TUBE SOLAR AIR HEATER"** of **Subhrant Lahrey**, a student of M.Tech (Machine Design) 4th semester has been checked by URKUND software available at Central Library, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, India. The amount of similarity in the progress report ___. The signed URKUND similarity report is attached to the certificate.

Signature of the student

Subhrant Lahrey

Signature of supervisors

Prof. T. V. Arjunan

Mr. Prashant Kumar Jangde

Signature

Head

Department of Mechanical Engineering

Guru Ghasidas Vishwavidyalaya, Bilaspur

CERTIFICATE BY EXAMINERS

This is to certify that the "Dissertation-Interim Evaluation" entitled **"CFD ANALYSIS AND ASSESSMENT OF PERFORMANCE PARAMETERS OF A CO-AXIAL PIPE EVACUATED TUBE SOLAR AIR HEATER"**

Submitted by

Name - Subhrant Lahrey Roll no. - 21040109 Enrollment No. - GGV/21/01609

Has been examined by undersigned as a part of an examination of Master of Technology (Machine Design) at Department of Mechanical Engineering, School of Studies of Engineering and Technology, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, INDIA. The dissertation is found to be satisfactory.

Examiner 1	Examiner 2	Examiner 3
Date: 10/1/2024	Date: 10/01/2024	Date: 10/1/24

ABSTRACT

The increasing exponential demand for energy today is straining our resources, particularly traditional energy sources that are depleting rapidly. In response, there's a growing emphasis on utilizing non-conventional energy sources across various applications. Solar energy stands out as a vast and environmentally friendly energy source, and India benefits from abundant sunshine year-round. Over time, various solar collectors have been developed to capture the Sun's thermal energy. One such innovation is the Evacuated Tube Solar Collector (ETSC), designed to harness solar energy for heating water or air. The energy collected by ETSC can serve a wide range of purposes, both in domestic and industrial settings.

This research involves a computational fluid dynamics (CFD) analysis of a co-axial Evacuated Tube Solar Collector (ETSC) used for air heating applications. The primary goal is to evaluate how the ETSC performs thermally under various mass flow rates and heat flux conditions. The validity of our computational model is established by comparing it to an existing experimental study. Our findings indicate that the highest air outlet temperature 356.708 K and 37.3 ℃ whereas the inlet temperature 319.4 K from the solar collector manifold are achieved when using a configuration with a mass flow rate of 9.36 kg/h and a constant heat flux of 888 W/m^2 and the maximum thermal efficiency 63.45% achieved at a mass flow rate of 18.36 kg/h and a constant heat flux of 822 W/m^2. This particular configuration outperforms all other configurations considered. Furthermore, we explore potential design enhancements that could further boost the overall thermal efficiency of the system.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

NOMENCLATURES

CFD	Computational fluid dynamics
ETSC	Evacuated tube solar collector
ETC	Evacuated tube collector
C	Specific heat (J/kg-k)
T	Temperature (℃)
I	Constant heat flux (W/m^2)
η	Thermal efficiency
ρ	Density (g/mm^3)
m_a	Mass flow rate of fluid
SC	Solar collector
K	Thermal conductivity (W/m-k)
V	Velocity of the fluid
υ	Poisson's ratio
E	Elastic modulus
ρ_0	Density of fluid
A	Area of tube
p	Pressure of the fluid
g	Acceleration due to gravity
G	Shear modulus