

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

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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE

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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,

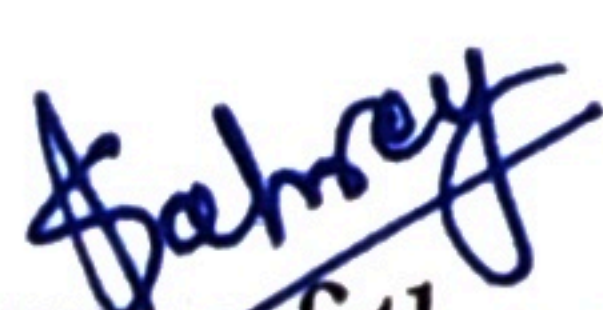
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Signature of the student

Subhrant Lahrey

Signature of supervisors

  
Prof. T. V. Arjunan

  
Mr. Prashant Kumar Jangde

  
Signature

Head

Department of Mechanical Engineering

Guru Ghasidas Vishwavidyalaya, Bilaspur

विभागाध्यक्ष / Head  
विभाग / Mechanical Engg. Dept  
प्रौद्योगिकी संस्थान / Institute of Technology  
गुरु घासीदास वि.वि. / Guru Ghasidas V.V.  
कोनी, बिलासपुर (छ.) / Koni, Bilaspur (C.G.)



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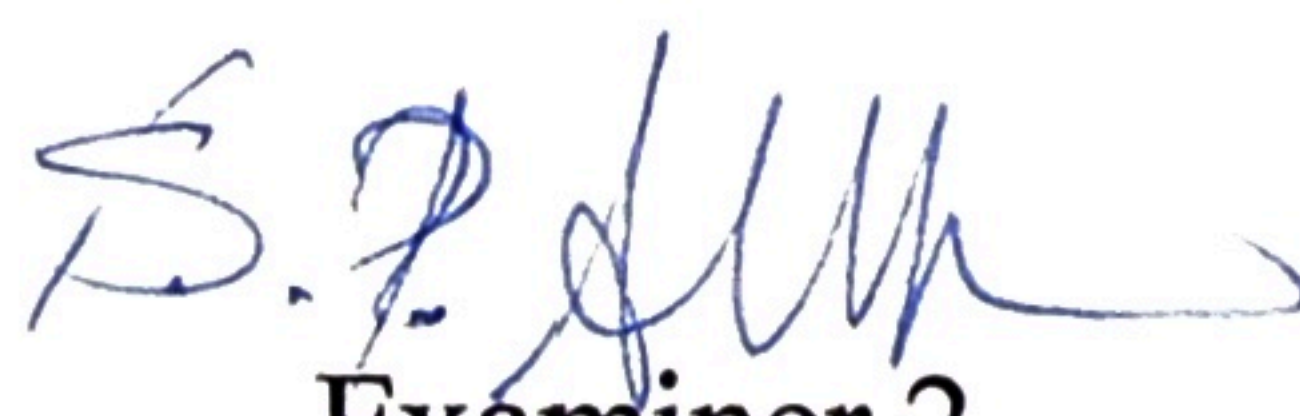
Submitted by

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

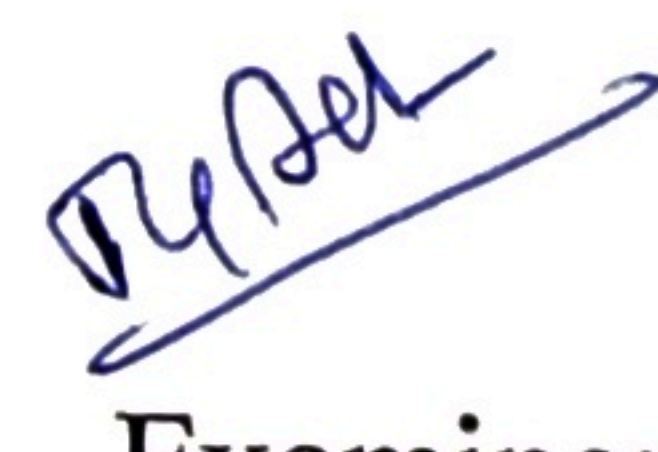
Has been examined by undersigned as a part of an examination of Master of Technology (Machine Design) at Department of Mechanical Engineering, School of Studies of Engineering and Technology, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh, INDIA. The dissertation is found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

  
Examiner 1

Date: 10/1/2024

  
Examiner 2

Date: 10/01/2024

  
Examiner 3

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## 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 °C 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<sup>2</sup> 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<sup>2</sup>. 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

<b>TITLE PAGE</b>	
<b>CANDIDATE'S DECLARATION</b>	I
<b>CERTIFICATE</b>	II
<b>CERTIFICATE BY EXAMINERS</b>	III
<b>ACKNOWLEDGEMENT</b>	IV
<b>ABSTRACT</b>	V
<b>TABLE OF CONTENTS</b>	VI
<b>LIST OF FIGURES</b>	VIII
<b>LIST OF TABLES</b>	IX
<b>NOMENCLATURES</b>	IX
<b>CHAPTER-1</b>	<b>INTRODUCTION</b>
	1
1.1	Solar Energy
	1
1.2	Solar Collectors
	1
1.2.1	Types of Solar Collectors
	2
1.2.2	Evacuated Tube Solar Collector
	3
1.2.3	Coaxial Pipe Configuration
	5
1.2.4	Evacuated Tube Solar Collector Operation
	6
1.2.5	The Proficiency of Solar Collectors
	7
1.3	Background and Motivation
	8
<b>CHAPTER-2</b>	<b>LITERATURE REVIEW</b>
	9
2.1	Literature Review
	9
2.2	Observations from the Literature review
	17
2.3	Objectives of the Research
	17
<b>CHAPTER-3</b>	<b>METHODOLOGY</b>
	18
3.1	Steps involved in the research work
	18
3.2	Outline for the computational analysis
	19
<b>CHAPTER-4</b>	<b>COMPUTATIONAL FLUD DYNAMICS</b>
	20
4.1	Introduction of Computational Fluid Dynamics (CFD)
	20
4.2	Description of model
	21
4.3	Mathematical Equation
	27
4.3.1	Thermal efficiency
	27
4.3.2	Bernoulli's equation
	27
4.3.3	Continuity, Momentum and Energy equation
	28



## LIST OF FIGURES

Figure: 1.2.1 – Types of solar collectors	3
Figure: 1.2.2 – Evacuated tube solar collectors	3
Figure: 1.2.3 – Heat pipe ETC	4
Figure: 1.2.4 – Direct flow ETC	4
Figure: 1.2.5 – Thermosyphon type	5
Figure: 1.2.6 – Schematic diagram of coaxial ETSC	5
Figure: 1.2.7 – Working process of ETSC	6
Figure: 3.2.1 – Outline of process planning for computational analysis	19
Figure: 4.2.1 (a) – CFD model of co-axial solar air heater	21
Figure: 4.2.1 (b) – CFD model of co-axial solar air heater	22
Figure: 4.2.2 – Meshed fluid model	24
Figure: 4.2.3 – Meshed solid model	25
Figure: 4.2.4 – Named selections applied for analysis	26
Figure: 4.2.5 – Fluent diagram of solar air heater	26
Figure: 4.5.1 – Referred experimental setup	30
Figure: 5.2.1 – Variation of temperature at various locations of the air heater for 699 W/m <sup>2</sup>	33
Figure: 5.2.2 – Variation of temperature at various locations of the air heater for 864 W/m <sup>2</sup>	35
Figure: 5.2.3 – Variation of temperature at various locations of the air heater for 822 W/m <sup>2</sup>	37
Figure: 5.2.4 – Variation of temperature at various locations of the air heater for 888 W/m <sup>2</sup>	39
Figure: 5.3.1 – Difference in temperature from Table 4.2.1	42
Figure: 5.3.2 – Difference in temperature from Table 4.2.2	42
Figure: 5.3.3 – Difference in temperature from Table 4.2.3	43
Figure: 5.3.4 – Difference in temperature from Table 4.2.4	43
Figure: 5.4.1 – Difference in thermal efficiency from Table 4.4.1	46
Figure: 5.4.2 – Difference in thermal efficiency from Table 4.4.2	46
Figure: 5.4.3 – Difference in thermal efficiency from Table 4.4.3	47
Figure: 5.4.4 – Difference in thermal efficiency from Table 4.4.4	47



## LIST OF TABLES

Table: 4.2.1 – Material properties used for computational model	23
Table: 5.3.1 – Comparison of outlet air temperature for Case-I	39
Table: 5.3.2 – Comparison of outlet air temperature for Case-II	40
Table: 5.3.3 – Comparison of outlet air temperature for Case-III	40
Table: 5.3.4 – Comparison of outlet air temperature for Case-IV	41
Table: 5.4.1 – Comparison of efficiency for heat flux 699 W/m <sup>2</sup>	44
Table: 5.4.2 – Comparison of efficiency for heat flux 864 W/m <sup>2</sup>	44
Table: 5.4.3 – Comparison of efficiency for heat flux 822 W/m <sup>2</sup>	45
Table: 5.4.4 – Comparison of efficiency for heat flux 888 W/m <sup>2</sup>	45

## NOMENCLATURES

CFD	Computational fluid dynamics
ETSC	Evacuated tube solar collector
ETC	Evacuated tube collector
C	Specific heat (J/kg-k)
T	Temperature (°C)
I	Constant heat flux (W/m <sup>2</sup> )
$\eta$	Thermal efficiency
$\rho$	Density (g/mm <sup>3</sup> )
$m_a$	Mass flow rate of fluid
SC	Solar collector
K	Thermal conductivity (W/m-k)
V	Velocity of the fluid
$\nu$	Poisson's ratio
E	Elastic modulus
$\rho_0$	Density of fluid
A	Area of tube
p	Pressure of the fluid
g	Acceleration due to gravity
G	Shear modulus