# Harnessing of solar energy by Helio- aero gravity action

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# Harnessing of solar energy by Helio- aero gravity action

Submitted to University of Management and Technology Lahore in partial fulfillment of the requirements for the award of degree of

**MASTER OF PHILOSOPHY**

**IN**

**PHYSICS**

**By**

**Tayyaba Shaheen**

**I.D**

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SESSION: 2013-2015

DEPARTMENT OF PHYSICS

SCHOOL OF SCIENCE

UNIVERSITY OF MANAGEMENT AND TECHNOLOGY

C-II, JOHAR TOWN LAHORE – 54770, PAKISTAN

# RESEARCH COMPLETION CERTIFICATE

Certified that the research work contained in this thesis titled, **"Harnessing of solar energy byHelio- aero gravity action"** has been carried out and completed by **Tayyaba Shaheen, ID: 13002139002**. The quantum and the quality of the work contained in this thesis is adequate for the award of Degree of MS/M.Phil.

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## CANDIDATES DECLARATION

I hereby declare that this project titled "Harnessing of Solar Energy by Helio-aero-gravity action" submitted in partial fulfillment of award of MS Physics to the Department of Physics, School of Science and Technology at the University of Management and Technology, Lahore is an authentic record of my work carried out under the supervision of M. A. K. Lodhi, University of Management and Technology, Lahore, Pakistan.

Signature: ..............................................................

TayyabaShaheen

Place: UMT, Lahore, Pakistan.

Date: 02.06.2016

## BONAFIDE CERTIFICATE

This is to certify that the above declaration made by Ms. TayyabaShaheen is true to the best of my knowledge and belief.

Date:

Place: University of Management and Technology, Lahore, Pakistan.

M. A. K. Lodhi<br>University of Management and Technology, Lahore<br>Pakistan.

## ACKNOWLEDGEMENT

First and foremost, my unconditional thanks to God Almighty (the highest of all) for providing me with the strength to follow this project from genesis to a meaningful revelation.

Moreover, I am heartily thankful to my supervisor M. A. K. Lodhi, whose consistent encouragement, guidance and support from initial to the final level enabled me to develop a thorough understanding of the project.

Lastly, I offer my humble regards and blessings to all of those who supported me in any respect during the completion of the project.

TayyabaShaheen.

## ABSTRACT

The energy by Helio-aero-gravity action can be produced by choosing a plane area of land in a desert where solar radiation is bountiful. The land is covered with some diaphanous material. A solar chimney enclosing an air turbine is to be placed at the center of canopied land. At the boundary of the patch, the canopy should be kept above the ground allowing ample space for the entrance of air. The flat patch of land is heated by direct solar radiations entering through diaphanous cover. When air moves over the heated land surface it gets heated. As a result of pressure difference, the heated air will rise in the chimney and drive the turbine. The Helio-aero plant, in which the height and diameter of the chimney are 200 m and 10 m, respectively, and the diameter of the solar collector cover is 500 m, can produce 110 to 190 kW electric powers all year. Some parameters, like ambient temperature, height of chimney, diameter of collector, solar irradiance and the efficiency of turbine, etc. which affect the performance of power generation, are analyzed.

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## SYMBOLS, NOMENCLATURE AND ABBREVIATIONS

| | |
|---|---|
| $A_c$ …………..... | Solar collector cross sectional area $[m^2]$ |
| $A_o$ ……….….. | Tower cross sectional area $[m^2]$ |
| $B$ …………... | Exponential constant of proportionality |
| $C_p$ …………... | Specific heat capacity of air at constant temperature $[kJkg^{-1}]$ |
| $C_v$ …………... | Direct solar irradiance $[kJkg^{-1}]$ |
| $d$ …………….. | Diameter of the tower $[m]$ |
| $D$ …………….. | Diameter of the solar collector $[m]$ |
| $E$ …..……... | Solar irradiation of the Sun (Without hindrance) $[Wm^{-2}]$ |
| $\dot{G}$ ………... | Global radiation $[Wm^{-2}]$ |
| $g$ …………….. | Acceleration of the free-fall due to gravity $[ms^{-2}]$ |
| $h_e$ …..……….. | Greenhouse entrance height $[m]$ |
| $h_f$ ……….….. | Head loss due to friction $[J]$ |
| $h_o$ ……..…….. | Enthalpy at dead state $[J]$ |
| $h_u$ …..……….. | Enthalpy at elevated temperature state $[J]$ |
| $\dot{I}_d$ ……..…... | Direct solar irradiance $[Wm^{-2}]$ |
| $\dot{I}_h$ ……..…... | Horizontal insolation (Horizontal solar intensity) $[Wm^{-2}]$ |
| $K$ …………... | Relationship constant |
| $\dot{m}$ ……….….. | Air mass flow $[Kgs^{-1}]$ |
| $\dot{m}_{opt}$ ……….. | Optimum mass flow $[Kgs^{-1}]$ |
| $N_s$ ………..... | Geometric orientation $[degrees]$ |
| $\dot{P}$ ……………. | Turbine power output $[Js^{-1}]$ |

| | |
|---|---|
| $\Delta P$………..... | Pressure drop $[Pa]$ |
| $\dot{P}_{max}$ ………….. | Maximum power of turbine $[Js^{-1}]$ |
| $P_o$…………..... | Pressure outside the tower $[Pa]$ |
| $P_u$……….….. | Atmospheric pressure inside the heat exchanger $[Pa]$ |
| $R$………….. | Radius of the Sun $[6.96 \times 10^5\ km]$ |
| $ROI$…………. | Return on Investment |
| $r$…………... | Average Sun-collector distance $[1.5 \times 10^8\ km]$ |
| $S_r$…………... | Sunrise time $[hours]$ |
| $S_s$……..…... | Sunset time $[hours]$ |
| $SFEE$……….. | Steady Flow Energy Equation |
| $T_n$…..………... | Time of the year $[hours]$ |
| $T_o$…..……….. | Outside temperature (dead state) $[K]$ |
| $T_r$……….…. | Opacity of the atmosphere |
| $T_u$..………….. | Temperature inside the greenhouse heat exchanger $[K]$ |
| $t$…………... | Time of the day $[hours]$ |
| $u$…………….. | Peripheral velocity of the turbine blades $[ms^{-1}]$ |
| $\dot{V}$…..……….. | Pressure outside the tower $[Kgs^{-1}]$ |
| $w$…………….. | Velocity of air $[ms^{-1}]$ |
| $\alpha$…………... | Absorptivity of the collector |
| $\beta$…………..... | Latitude |
| $\gamma$…………..... | Adiabatic constant |
| $\phi$…………... | Time angle $[degrees]$ |
| $\epsilon$…………... | Emissivity of the Sun |
| $\tau$…………... | Transmittivity of the collector |

| | |
|---|---|
| $\lambda_{max}$ ……..... | Peak wavelength of sunlight [$m$] |
| $\varphi$ …………... | Solar declination angle [$degrees$] |
| $\psi$…………... | Zenith angle |
| $\delta$…………... | Differential change |
| $\xi$…………... | Roughness co-efficient [$dimensionless$] |
| $\omega$…………... | Angular velocity [$rads^{-1}$] |
| $x$…………... | Turbine tip speed ratio [$dimensionless$] |
| $\mu_t$……….…. | Time reduction factor |
| $\varepsilon$…………... | Turbine power coefficient [%] |
| $\sigma$…………... | Steffan-Boltzmann constant [$Wm^{-2}$] |
| $\eta_c$…………... | Carnot efficiency [%] |
| $\eta_{conc}$ ………. | Solar concentrator efficiency [%] |
| $\eta_{th}$………….. | First-law thermal efficiency [%] |
| $\eta_{II}$…………... | Second-law efficiency [%] |
| $\overline{\omega}$……………. | Absolute/specific humidity [%] |

# **CHAPTER ONE**

## **1.1 INTRODUCTION**

The concept of using environment friendly methods to generate energy has been envisioned for a long time, and any inexhaustible energy such as solar, wave, tidal, wind and hydroelectric energy occurring naturally, other than nuclear or fossil fuels is delegate to as renewable energy. The pertinence of rising field like these becomes more pronounced due to the requirement to have safe, efficient and reliable sources of generating electricity while keeping the environment safe.