CERTIFICATE

This is to certify that the work contained in the thesis entitled "STUDY OF COOLING CHARACTERISTICS OF INFRARED DETECTOR CRYOCHAMBER" by Mr. Mayank Singhal in partial fulfillment of the requirements for the award of the degree of Master of Engineering in Thermal Engineering has been carried out under my supervision and this work has not been submitted elsewhere for a degree.

Date: 27-06-2011
Place: New Delhi

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STUDENT DECLARATION

I hereby certify that the work which is being presented in the minor project entitled **“**STUDY OF STEADY STATE COOLING CHARACTERISTICS OF INFRARED DETECTOR CRYOCHAMBER**”**, in partial fulfillment of the requirements for the award of the degree of Master of Engineering in Thermal Engineering, is an authentic record of my own work carried under the supervision of **Dr A. Arora, Astt. Prof** of Mechanical Engineering Department, University of Delhi, Delhi

I have not submitted the matter embodied in this minor project for the award of any other degree.

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ACKNOWLEDGEMENT

"If brain is the nucleus of thoughts, teacher is the source of energy to run the operation of solving cross puzzles of doubts that often poise the mind of students."

It is my privilege to express my deep sense of gratitude and sincere thanks to my able and versatile guide **Dr. A. Arora** for his invaluable guidance. I am highly indebted for his critical discussion and continuous encouragement. his critics and suggestions on my experiments have always guided me towards perfection. Moreover, his ways of analyzing the results have given a new dimension to my scientific aptitude. This work is simply the reflection of his thoughts, ideas, concepts and above all his efforts. Working under his guidance has been a privilege and an excellent learning experience that I will cherish for a long time.

I would also like to express my deep gratitude to Dr. Samsher, Professor, Mechanical Engineering Department, Delhi College of Engineering, Delhi, for his moral support and help whenever needed.

My special thanks to all the faculty members and friends for their continuous support, motivation and enthusiastic help in every difficult situation of this work.

Finally, the blessing of God, the love, care, expectations and encouragement from my parents and family have invaluable contribution in successful completion of my degree.

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ABSTRACT

The present work, along with the study of design considerations of an Infrared detector cryochamber investigates the steady and transient cooling characteristics of an Infrared detector cryochamber for various operating conditions.

The design aspects of a cryochamber housing the device for achieving its have also been studied. The major considerations as far as design of cryochamber is concerned are; choice of material of the cryochamber, manner of electrical feedthrough, vacuum sealing and type of cryocooler. These few prime areas concerns which influence the performance of the devices sealed in these cryochambers.

The thermal model developed considers the conduction heat transfer through a cold well, the gaseous conduction due to outgassing, and the radiation heat transfer. The thermal modeling of the cryochamber has been carried out for both steady state as well as transient conditions using a finite volume method. The basic algorithms for solution of steady state and transient state cryochamber heat transfer problem were developed and the numerical codes for both the cases were written in MATLAB. In case of steady state analysis it is found that the length profile of temperature is linear owing to conduction at negligible gas conduction. However, as the influence of gas conduction increases it greatly affects the length temperature profile. In case of transient flow, the cooling down time is mostly affected by the bore conductivity and gas conduction coefficient seems to have little influence. The efficacy of the numerical models has been established by performing detailed experimental studies and also by comparing with existing data.

The code enables prediction of transient cooling performance of the cryochamber under various conditions viz., “no bias” and “with bias” condition, variation in ambient temperature, variation in cryochamber vacuum and its influence on gas conduction coefficient

The computer program developed allows the determination of cooling characteristics specially the cool down time of cryochambers of varying materials and dimensional configurations with differing material and transport properties.

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Nomenclature

Notations

COP	Coefficient of Performance
COP_{carnot}	Ideal Coefficient of Performance
T	Temperature (in °C and K)
T_R	Minimum Cycle Temperature
T_C	Maximum Cycle Temperature
Q_w	Heat being conducted into the finite volume
Q_e	Heat being conducted away from the finite volume
Q_c	Heat Transfer due to gaseous conduction
Q_R	Radiative Heat Transfer
T_b	Temperature of the metal base
T_∞	Ambient Temperature
T_d	Detector Temperature
K_n	Knudsen number
K_B	Boltzmann constant
d	Molecular diameter of air (= 0.37)
h	Gas conduction coefficient
µm	micron
ppm	Parts per million
P	Pressure in bar or psi
mW	milli Watt

Subscript

c	Conduction
r	Radiation
b	base
∞	Ambient
d	Detector
B	Boltzmann

Greek symbol

α	Coefficient of Linear Expansion & Thermal diffusivity
η	Efficiency
μ_{JT}	Joule Thomson Coefficient
σ	Stefan Boltzmann Constant
ε	Emissivity
λ	Mean free path