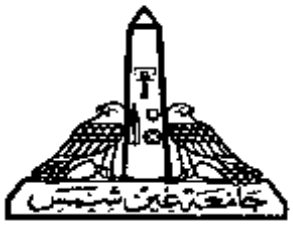

AIN SHAMS UNIVERSITY
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EFFECT OF SOME DESIGN PARAMETERS ON THE PERFORMANCE OF HIGHLY COOLED AIR CONDITIONING OUTLETS

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Statement

This dissertation is submitted in partial fulfillment for the degree of Masters of Science in Mechanical Power Engineering – Ain Shams University. The work included in this thesis is carried out by the author at the laboratories of the Mechanical Power Engineering Department – Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any other University, or a place of learning.

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PREFACE

This thesis is submitted in partial fulfillment for the degree of masters in Mechanical Power Engineering Department, Ain Shams University.

The work included in this thesis is carried out by the author at the laboratory of Mechanical Power Engineering Department, Faculty of Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or qualification at any other university.

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ABSTRACT

Highly cooled air conditioning systems supply air to the conditioned space at temperatures ranging from 5°C to 11°C resulting in air volume flow rates lower than that required for the conventional air conditioning systems, which supply air to the conditioned space at temperatures ranging from 13°C to 18°C, by about 30%. The reduced supply air volume flow rates required with a lower supply air temperature result in smaller air ducts, smaller air handling units (AHUs), reduced fan energy consumption, potential for thermal storage and reduced pump energy consumption. In addition, improvements in indoor air quality have been noted.

One concern for these systems is that the supply cold air volume flow rate is lower than for the conventional systems that result in the occupant experiencing cold drafts and hence, thermal discomfort. To overcome this problem, some mechanical engineers have used fan-powered mixing boxes to increase the supply air temperature. Unfortunately, fan-powered mixing boxes introduce maintenance problems and can negate the energy and first cost saving of the highly cooled air conditioning systems.

The most straight forward, lowest first cost and energy efficient approach to overcome cold drafts problems is to supply the highly cooled air directly to the space using supply air diffusers designed for the required characteristics.

Successful supply of the highly cooled air directly to the space requires a diffuser that introduces the air along the ceiling at a high velocity. Therefore, high air velocity increases entrainment

of the room air, length of attachment to the ceiling and results in higher air temperatures at the point where the air stream leaves the ceiling.

The current research focuses on the air distribution to overcome the cold draft problem. Different swirl diffuser configurations are designed and manufactured to meet the desired characteristics.

An experimental investigation is conducted to study the effect of the design parameters on the performance of the highly cooled air conditioning outlets. Also, comparison is made between the conventional diffuser and designed diffusers performances, based on the air temperatures distribution in different test locations in the conditioned space.

For this purpose, a test rig was designed, constructed and installed in the refrigeration laboratory. Many experiments were conducted by the different diffuser configurations, under the supply air temperature and test heat loads.

The experimental results obtained are plotted to show the performance of the conventional diffuser with the highly cooled air conditioning system. Also, the results show the effect of the design parameters on the performance of the swirl diffuser.

The expected results are to show that the conventional diffuser, with the highly cooled air conditioning system, produces cold drafts and cold spots in the occupied and unoccupied zones of the test space but the swirl diffuser of different configurations, do not produce cold drafts or cold spots in the occupied zone of the test space. Even though, few cold spots are noticed near the ceiling for some configurations.

Also, it is expected that the swirl diffuser configurations affects the range of the air temperatures inside the test space.

NOMENCLATURE

SYMBOLS

T	:	Air temperature	[°C]
q	:	Sensible heat load	[W]
Q	:	Air volume flow rate	[L/S]
U	:	Overall heat transfer coefficient	[W/m^2. °C]
A	:	Surface area	[m^2]
S	:	switch	[-]

SUBSCRIPTS

Sup.	:	Supply
room	:	Room
out.	:	Outside
in.	:	Internal
ext.	:	External
tot.	:	Total

ABBREVIATIONS

AHU	:	Air Handling Unit
HVAC	:	Heating, Ventilation and Air Conditioning
CFD	:	Computational Fluid Dynamics
ASHRAE	:	American Society of Heating, Refrigeration and Air conditioning Engineers

TABLE OF CONTENTS

PREFACE		**i**
ACKNOWLEDGEMENT		**ii**
SUMMARY		**iii**
NOMENCLATURE		**vi**
CHAPTER 1	**INTRODUCTION**	**1**
	1.1 Difference between conventional and highly cooled air systems	2
	1.2 The benefits of highly cooled air distribution systems	3
	1.3 The potential problems associated with the highly cooled air distribution systems	7
	1.4 Economical comparison between conventional and highly cooled air system	10
	1.5 Current research	11
CHAPTER 2	**REVIEW OF PREVIOUS WORK**	**12**
CHAPTER 3	**EXPERIMENTAL APPARATUS AND TESTPROCEDURE**	**29**
	3.1. EXPERIMENTAL APPARATUS DESCRIPTION	**30**
	3.1.1. THE CONDITIONED SPACE (TEST ROOM)	**32**
	3.1.2. THE REFRIGERATION SYSTEM	**34**
	a. The hermetic compressor	35
	b. Air cooled condenser	36
	c. Liquid refrigerant receiver	37
	d. Capillary tubes	37
	e. Submerged evaporators	38
	f. Piping and accessories	38

3.1.3. THE CHILLED WATER SYSTEM 39
a. Chilled water tank 40
b. Supply line pump 40
c. Circulation pump 42
d. Piping and fittings 42
3.1.4. THE AIR CYCLE 42
a. The air blower 43
b. The air cooling coils 43
c. Ducts and connections 44
3.1.5. THE INTERNAL HEAT LOAD 46
3.2. SUPPLY AIR DIFFUSERS 47
a) Conventional circular diffuser 47
b) Swirl diffusers 48
3.3. INSTRUMENTATIONS 49
3.3.1. Air volume flow rate 49
3.3.2. Chilled water flow rate 51
3.3.3. Temperature measurements 52
I. Supply and return air temperature 52
II. Chilled water supply temperature 53
III. Chilled water return temperature 54
IV. Outside air temperature 54
V. Room space air temperatures and scanning mechanism 55
VI. Room walls temperatures 59
3.4. TEST PROCEDURE 61

CHAPTER 4 Results and discussion 66

4.1. The performance of the different diffusers at 1040 W internal heat load and 10°C supply air temperature 66

1. The conventional diffuser 71
2. Four straight passages swirl diffuser 74
3. Four curved passages swirl diffuser 83
4. Six straight passages swirl diffuser 91
5. Eight straight passages swirl diffuser 99

4.2. The performance of the different diffusers at 480 W internal heat load and 10°C supply air temperature 108

1. The conventional diffuser 109
2. Four straight passages swirl diffuser 117
3. Four curved passages swirl diffuser 125
4. Six straight passages swirl diffuser 133
5. Eight straight passages swirl diffuser 142

CHAPTER 5 CONCLUSION 152

REFERENCES 156

APPENDIX 157

LIST OF FIGURES

		Page
Figure (2.1)	Comfort graph generated by Houghten et al. (1938)	15
Figure (2.2)	Relationship betwwen the local air velocity and temperature drop required for feeling of equal warmth	17
Figure (2.3)	Modified comfort graph of Houghten	18
Figure (2.4)	Range of discharge temperature difference and CFM/ft^2 for experiments conducted for ADPI tests	20
Figure (2.5)	Room mean velocity vs total momentum for all diffusers	21
Figure (2.6)	ADPI vs momentum number for circular diffusers	22
Figure (2.7)	Series fan-powered mixing box	23
Figure (2.8)	Parallel fan-powered mixing box	23
Figure (2.9)	Non-powered induction units	24
Figure (2.10)	Measurement of air flow and temperature distribution	25
Figure (2.11)	Specifications of test outlets	26
Figure (3.1)	Schematic diagram of the experimental test rig	31
Figure (3.2)	Conditioned space (Test room)	33
Figure (3.3)	Refrigeration system components	34
Figure (3.4)	The hermetic compressor	35
Figure (3.5)	Air cooled condenser	36
Figure (3.6)	Liquid refrigerant receiver	37

			Page
Figure	(3.7)	Schematic diagram of the chilled water system	41
Figure	(3.8)	Schematic diagram of the air system	45
Figure	(3.9)	The internal heat load distribution	46
Figure	(3.10)	The circular conventional diffuser	48
Figure	(3.11)	different designs of the swirl diffuser	49
Figure	(3.12)	The Pitot tube	50
Figure	(3.13)	The four piezometers for measuring air static pressure	50
Figure	(3.14)	The orifice flow meter	52
Figure	(3.15)	Location of supply air temperature sensor	53
Figure	(3.16)	Temperature thermometer module	54
Figure	(3.17)	Chilled water temperature measurement in the return pipe	54
Figure	(3.18)	Room space air temperatures scanning mechanism	56
Figure	(3.19)	Test levels and angles	58
Figure	(3.20)	The LED indication board	59
Figure	(3.21)	The levels of the room wall at which the temperature modules are fixed	60
Figure	(4.1)	Air temperatures distribution of the vertical section at an angle 0 degree, when using conventional diffuser, at 1040 W	66

		Page
Figure (4.2)	Air temperatures distribution of the vertical section at an angle 22.5 degree, when using conventional diffuser, at 1040 W	67
Figure (4.3)	Air temperatures distribution of the vertical section at an angle 45 degree, when using conventional diffuser, at 1040 W	67
Figure (4.4)	Air temperatures distribution of the vertical section at an angle 67.5 degree, when using conventional diffuser, at 1040 W	67
Figure (4.5)	Air temperatures distribution of the vertical section at an angle 90 degree, when using conventional diffuser, at 1040 W	68
Figure (4.6)	Air temperatures distribution of the vertical section at an angle 112.5 degree, when using conventional diffuser, at 1040 W	68
Figure (4.7)	Air temperatures distribution of the vertical section at an angle 135 degree, when using conventional diffuser, at 1040 W	68
Figure (4.8)	Air temperatures distribution of the vertical section at an angle 157.5 degree, when using conventional diffuser, at 1040 W	69

		Page
Figure (4.9)	Air temperatures distribution of the horizontal section at level 249 cm from the floor, when using conventional diffuser, at 1040 W	70
Figure (4.10)	Air temperatures distribution of the horizontal section at level 226 cm from the floor, when using conventional diffuser, at 1040 W	70
Figure (4.11)	Air temperatures distribution of the horizontal section at level 203 cm from the floor, when using conventional diffuser, at 1040 W	70
Figure (4.12)	Air temperatures distribution of the horizontal section at level 180 cm from the floor, when using conventional diffuser, at 1040 W	71
Figure (4.13)	Air temperatures distribution of the horizontal section at level 157 cm from the floor, when using conventional diffuser, at 1040 W	71
Figure (4.14)	Air temperatures distribution of the horizontal section at level 134 cm from the floor, when using conventional diffuser, at 1040 W	71
Figure (4.15)	Air temperatures distribution of the horizontal section at level 111 cm from the floor, when using conventional diffuser, at 1040 W	72
Figure (4.16)	Air temperatures distribution of the horizontal section at level 88 cm from the floor, when using conventional diffuser, at 1040 W	72