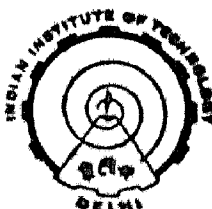


STUDIES
IN
FINE PARTICLE COLLECTION IN UNIFLOW CYCLONE

by
ASHWANI MALHOTRA

*Thesis submitted
in fulfilment of the requirements
for the degree of*
DOCTOR OF PHILOSOPHY

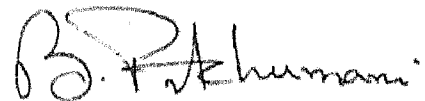


Department of Chemical Engineering
INDIAN INSTITUTE OF TECHNOLOGY, DELHI
INDIA

CERTIFICATE

This is to certify that the thesis entitled, " **STUDIES IN FINE PARTICLE COLLECTION IN UNIFLOW CYCLONE** " being submitted by Mr. Ashwani Malhotra to the Indian Institute of Technology, Delhi for the award of the degree of '**Doctor of Philosophy**' is a record of the bonafide research work carried out by him. He worked under my guidance for the submission of this Thesis which to my knowledge has reached the requisite standard.

The Thesis or any part thereof has not been submitted to any University or Institute for the award of any degree or diploma.



Dr. B. Pitchumani

Professor,

Department of Chem. Engg.

I.I.T New Delhi - 110 016, India

ACKNOWLEDGEMENT

I take this opportunity to acknowledge with deep sense of gratitude the invaluable guidance and help given to me by Prof. B. Pitchumani throughout the work of this thesis.

I also take this opportunity to thank the faculty members of the chemical engineering department for the encouragement and help given during the course of this work.

I am also thankful to Mr. S.K Sethi and the supporting staff members of the chemical engineering department for the help and assistance rendered by them during my experimental work.

I wish to express my gratitude to the GM and my group Manager (EIL.-HMTD) for their kind permission to allow me to undertake this work. I am also thankful to my colleagues especially Mr. K.K Gupta for their moral support.

Finally, with all my sentiments, I wish to express my heart felt gratitude to my parents, my wife and other members of my family for their patience and understanding shown during this work.

Ashwani Malhotra
(ASHWANI MALHOTRA)

ABSTRACT

One of the methods of fine particle collection is by centrifugal separation. Cyclone separator are most widely used as dust collecting devices. In conventional reverse flow cyclone the collection efficiency is low for particles of size less than 20 microns. The use of multi-cyclone is also not able to effectively solve the problem of re-entrainment of collected particles because of wide size distribution of feed. The uniflow cyclone have been reported to be advantageous for use in application with wide size distribution of feed.

Studies are made in 'Fine Particle Collection in an Uniflow Cyclone'. Performance characteristics namely Efficiency, Cut Particle Size and Pressure drop of the uniflow cyclone have been studied. A theoretical model is developed to predict the effect of various operating parameters and cyclone dimensions on the performance characteristics of the uniflow cyclone. An experimental Set-up is made to test the fabricated cyclone to study the effect of inlet velocity, purge rate and vortex finder position on the performance characteristics of the uniflow cyclone. It is seen that both the efficiency and pressure drop increases with the increase in velocity. This indicates that there is a trade-off between these parameters for the optimum design of the cyclone. The cut particle size decrease with the increase in the velocity. The above results are in agreement with the predictions of the developed model equation.

CONTENTS

	Page No.	
CHAPTER 1	INTRODUCTION	1
2	LITERATURE SURVEY	12
	NOMENCLATURE	17
	REFERENCES	18
3	EXPERIMENTAL	21
3.1	Introduction	22
3.2	Experimental Setup	22
3.3	Material	25
3.4	Experimental Procedure	25
3.5	Instruments Used	35
3.5.1	Sampler	35
3.5.2	Micron Photo Sizer	35
3.5.3	Hot Wire Anemometer	35
3.6	Definitions	36
3.6.1	Bulk Density	36
3.6.2	Purge Rate	36
3.6.3	Vortex Finder Position	36
3.7	Nomenclature	37
4	CUT PARTICLE	38
4.1	Introduction	39
4.2	Theory	39
4.3	Verification of Equation for Cut Particle Size	45
4.4	Effects of Variables on Cut Particle Size	63
4.4.1	Effects of Velocity on Cut Particle Size	63
4.4.2	Effects of Purge Rate on Cut Particle Size	67

4.4.3	Effects of Vortex Finder Position on Cut Particle Size	71
4.5	Cylindrical Cyclone of 31.4 mm Diameter	75
4.6	Effect of Diameter on Cut Particle Size	80
4.7	Conclusion	81
4.8	Nomenclature	82
	Reference	83
5	GRADE EFFICIENCY	85
5.1	Introduction	86
5.2	Theory	86
5.3	Verification of Grade Efficiency Equation	87
5.4	Effects of Variables on Grade Efficiency	106
5.4.1	Effects of Velocity on Grade Efficiency	106
5.4.2	Effects of Vortex Finder Position on Grade Efficiency	110
5.4.3	Effects of Purge Rate on Grade Efficiency	114
5.5	Conclusion	118
5.6	Nomenclature	119
	Reference	121
6	TOTAL EFFICIENCY	122
6.1	Introduction	123
6.2	Theory	123
6.3	Verification of Equation for Total Efficiency	125
6.4	Effects of Variables on Total Efficiency	136
6.4.1	Effects of Velocity on Total Efficiency	136
6.4.2	Effects of Purge Rate on Total Efficiency	140
6.4.3	Effects of Vortex Finder Position on Total Efficiency	144
6.5	Conclusion	148
6.6	Nomenclature	149
	Reference	150

7	PRESSURE DROP	152
7.1	Introduction	153
7.2	Theory	153
7.3	Verification of Pressure Drop Equation	156
7.4	Effects of Variables on Pressure Drop	167
7.4.1	Effects of Velocity on Pressure Drop	167
7.4.2	Effects of Purge Rate on Pressure Drop	172
7.4.3	Effects of Vortex Finder Position on Pressure Drop	176
7.5	Conclusion	180
7.6	Nomenclature	181
	Reference	182
8	CONCLUSION	183
9	SCOPE FOR FURTHER WORK	185

APPENDIX