MEASUREMENT OF WALL FRICTION DURING SOLID LOADING IN REVERSE FLOW CYCLONE

AND

EXPERIMENTAL STUDIES ON EFFECT OF SOLID LOADING ON PERFORMANCE OF UNIFLOW CYCLONE

by

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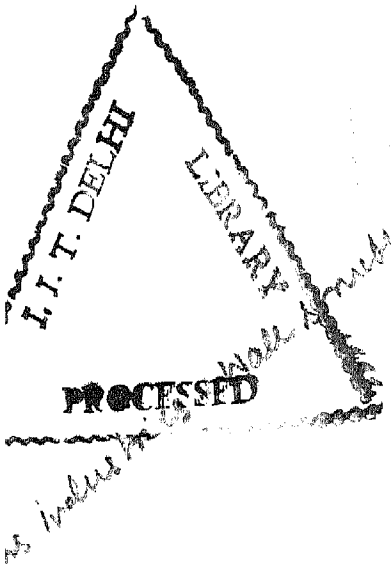
Submitted

In fulfilment of the requirements of the degree of Doctor of Philosophy

to the

Indian Institute of Technology, Delhi

May, 2000



CERTIFICATE

This is to certify that the thesis entitled "**MEASUREMENT OF WALL FRICTION DURING SOLID LOADING IN REVERSE FLOW CYCLONE AND EXPERIMENTAL STUDIES ON EFFECT OF SOLID LOADING ON PERFORMANCE OF UNIFLOW CYCLONE**" being submitted by **J. SARAT CHANDRA BABU** for the award of the degree of **DOCTOR OF PHILOSOPHY** is a record of the original bonafide research carried by him. He has worked under my guidance and supervision and has fulfilled the requirements for the submission of thesis. The results presented in this thesis have not been submitted in part or full to any other University or Institute for award of any degree/ diploma.

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ACKNOWLEDGEMENTS

"GURU BRAHMA GURU VISHNU GURU DEVO MAHESWRA GURU SAKSHAT PARABRAHMA TASMAISRI GURUVENAMAHA"...

Words cannot explain the affectionate and serious guidance bestowed on me by Prof. B. Pitchumani. I sincerely thank him for introducing me the subject Particle Technology and guiding me through learning the Cyclone Separators. I am extremely thankful to him for his moral and emotional support throughout the tenure of this work.

I greatly acknowledge the Principal, Regional Engineering college, Tiruchirappalli for providing necessary leave and sanctioning the permission to visit Germany.

I sincerely acknowledge All India Council for Technical Education for providing the necessary facilities for carrying out my research work. I am thankful to all faculty members of Chemical Engineering Department for the encouragement by them throughout this period.

I am thankful to Mr. S. K. Sethi, lab-in-charge, Mr. Bindu Madhavan and Mr. Rajan and Mr. Mohan Medhe for their timely help made the thesis work to progress uninterruptedly.

I am grateful to Prof. Peter Meissner, Fachhochschule, konstanz, Germany for his affectionate, valuable guidance, helpful ideas and moral support and affectionate care rendered me throughout my stay for six months at Konstanz, Germany.

I thank Mr. P. Ramanan for his keen insight on the subject that worked as an inspiration all the time. I also thank him for flamboyant decisions that helped me in completing the thesis work uninterruptedly.

I am personally indebted to Prof. S. Sundaram, Head, Dr. T. K. Radhakrishnan, Dr. N. Anantharaman and Prof. V. Venkata Ramani, Regional Engineering College, Tiruchirappalli for their constant support and help throughout my work.

I am grateful to my wife, Aruna for taking full responsibility on domestic matters and leaving me free to concentrate on research work. My loving cheers to the kids Shravni and Lakshmi Priyanka.

At his happy moment, it is great pleasure to remember my friends, seniors, colleagues and many other who have helped me directly or indirectly during this course of time.

I thank almighty for giving me courage to fulfill the required efforts for completing the work.

J.SARAT CHANDRA BABU

ABSTRACT

Cyclone separators are used for removal of fine particulate material in process industries. The thesis presents the results of experimental investigations on measurements of wall friction during solid loading in reverse flow cyclone and the effect of solid loading and particle size distribution on performance characteristics of an uniflow cyclone. Uniflow cyclones belong to a class of cyclone separators, where the discharge of dust and clean gas are in parallel to the inlet. In conventional reverse flow cyclones the clean gas and solids exit in opposite direction.

The wall friction is estimated by measuring deflection of the test section, which is related to the torque on the wall due to rotating fluid. The experiments are carried out at Machinenbau und Verfahrenstechnik, Fachhochschule, konstanz, Germany.

Experimental results show that the wall friction increases during solid loading compared with clean air. An empirical equation of the form $\lambda_f = a\ Nre^n$ is proposed to predict the wall friction for clean air as well as during solid loading. The constants a and n are 10.5, 0.195 and 62.5, 0.365 respectively for clean air and solid loading.

Experiments on uniflow cyclone are carried out at IIT Delhi, Inidia. The rotating plate feeder is developed and interfaced to the computer for accurate control of solid feeding. The measurement for pressure drop is made online using Rosemont pressure transducers and A/D card. The online analysis of solid particles in gas stream is made from sampling using cascade Retsch™ impactor. Two uniflow cyclones with different diameters and vane angles are used in the study.

A parametric equation is developed to predict grade efficiency for uniflow cyclone by assuming viz., a) inertial forces dominate particle motion, and b) the separation chamber can be considered as swirling tank for separation of particles in similarity to a mixing tank so that the concentration in the outlet duct is same as that in separation chamber.

The radial flux of particles is obtained by solving steady state force balance on particle motion. The mass balance resulted in parametric equation consisting all geometric and operating parameters to predict grade efficiency of cyclone. The equation is observed to predict the results of experimental values closely. The calculated correlation coefficient is 0.895. The particle cut-size and total separation efficiency are predicted close to the experimental values.

The experimental results show that the inlet velocity and purge rate are significant parameters to influence the performance. The particle cut size decreases with increasing inlet velocity and purge rate. The total separation efficiency increases as length of separation chamber decreases.

The inlet dust concentration significantly influences the particle cut size and total separation efficiency. The particle cut size is inversely proportional to inlet concentration. The separation efficiency increases with concentration proportionally.

The particle size distribution has shown to influence total separation efficiency. The separation efficiency increases with increase in width of distribution. The particle cut-size is observed to decrease as the width of distribution decreases.

Experiments are carried out to measure pressure drop with clean air and during solid loading for various operating conditions. The pressured drop is observed

to increase with inlet velocity. The pressure drop decreases proportionally with purge rate. The pressure drop for uniflow cyclone is estimated using equation deduced for conventional reverse flow cyclone after introducing suitable entrance factor for wall tangential velocity. The predicted pressure drop values are compared with measurements with clean air and during solid loading. The prediction is in good agreement with experimental measurement. The correlation factor is calculated to 0.92.

CONTENTS

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