2D COMPUTER MODELLING OF FLOW IN AIR FILTER

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UNIVERSITI MALAYSIA SARAWAK
2002

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2D COMPUTER MODELLING OF FLOW IN AIR FILTER

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This report is submitted in partial fulfilment of the requirement for the
Degree of Bachelor of Engineering (Hons.)
Mechanical Engineering and Manufacturing System from the
Faculty of Engineering
Universiti Malaysia Sarawak
2002

To my beloved father and mother

ACKNOWLEDGEMENTS

The author is very grateful to her supervisor, Ir. Dr. Wan Ali bin Wan Mat, who has provided complete guidance, critical comments and suggestions throughout this project.

The author would also like to extend her thanks to her family and best friends, especially Lee Wan Inn, Lee Pey Ling, How Siou Ying and Meow Wee Sing, who have kindly given their encouragement and support to her.

Finally, the author would like to thank to everyone who have helping her in any ways. The author is grateful to them all.

ABSTRAK

Penuras ialah sejenis peralatan yang digunakan untuk mengasingkan zarah-zarah pepejal dari bendalir yang mengandunginya dengan mengalirkan bendalir tersebut melalui medium penuras. Projeck tahun akhir ini mempersembahkan pemodelan penuras udara dan gabungan sistem prapenuras udara/ penuras akhir udara dengan menggunakan program FLUENT. Pemodelan ini dilakukan dalam kartesian dua dimensi dengan pelbagai kelajuan udara dan ketelapan penuras. Empat jenis kelajuan udara yang digunakan dalam kajian ini ialah 5 m/s, 10 m/s, 50 m/s dan 100 m/s. Tiga jenis ketelapan penuras yang digunakan dalam kajian ini ialah 2.5×10^{-8} m^2, 2.5×10^{-10} m^2 dan 2.5×10^{-11} m^2. Analisis-analisis yang dilakukan ke atas kedua-dua jenis model penuras udara ini ialah analisis vector kelajuan, analisis tekanan, analisis kelajuan-u (kelajuan udara dalam paksi x) dan analisis kelajuan-v (kelajuan udara dalam paksi y) Daripada keputusan analisis-analisis yang dilakukan, keadaan input yang paling baik dalam process penurasan untuk kedua-dua penuras udara tersebut disimpulkan.

ABSTRACT

Filter is equipment that use in the separation of solid particles from a fluid-solid suspension by passage of the fluid through a filter medium. This project presents the computer modelling of flow in air filter and air prefilter/ final filter combination by using the FLUENT software. The modelling are conducted in two dimensions Cartesian by varying the input of air velocity and filter permeability. Four different applied air velocities that use in the analysis are 5 m/s, 10 m/s, 50 m/s and 100 m/s and the three different applied filter permeability are 2.5×10^{-8} m^2, 2.5×10^{-10} m^2 and 2.5×10^{-11} m^2. The several analyses that have been done on these two filter models are velocity-vector analysis, pressure analysis, u-velocity analysis (the analysis of airflow through filter models in x-axis) and v-velocity analysis (the analysis of airflow through filter models in y-axis). From the results obtain, the best condition of the airflow through the air filter and air prefilter/ final filter combination is concluded.

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LIST OF SYMBOLS

Symbol	Description	Unit
ρ	Density	kg/ m^3
μ	Viscosity	N.s/m^2
v	Velocity	m/s
α	Permeability	m^2
Re	Reynolds number	-
P	Pressure	Pascal
d	diameter	m

CHAPTER 1

INTRODUCTION

1.1 Overview Of filtration

Filtration is a fundamental unit operation aimed at the separation of solid particles from a fluid-solids suspension of which they are a part by passage of most of the fluid through a septum or membrane that retains most of the solids on or within itself. The septum is called a filter medium, and the equipment assembly that holds the medium and provides space for the accumulated solids is called filter. The fluid may be a gas or a liquid. The solid particles may be coarse or very fine, and their concentration in the suspension may be extremely low (a few parts per million) or quite high (> 50%). [McGraw-Hill Encyclopedia Of Science & Technology, 1992]

A simplified representation of filtration is shown in figure 1.1.

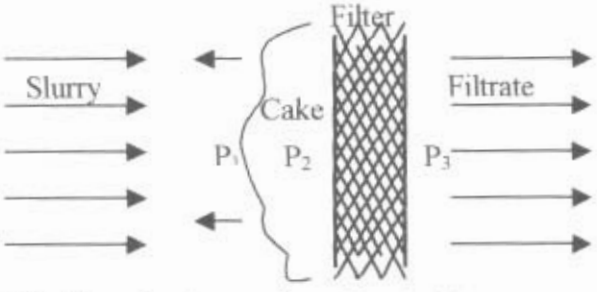

Figure 1.1: Filtration of a slurry of particles held by the filter in the form of accumulating cake, letting the cleaned liquid (filtrate) through. [Tasos C. Papanas Tasiou, 1994]

For any prefilter/ final filter combination systems, the larger pores present in the prefilter constructions as a result of broader pore-size distributions invite penetration by

particles. Particle arrest occurs largely within the pores of the prefilter, using its vast inner surfaces. Hence, the prefilter is able to accommodate large loadings of particles. Less than complete particle retention is a concomitant of prefilter pore penetration. Some particles pass completely through the prefilter because of its broader pore-size distribution. These particles emerge to confront the final filter. The load on the final filter is, however, reduced by the prefilter, and the useful life of the final filter is thereby in increased. The final filters through which the fluid is to receive its eventual filtrative cleansing; the filters are selected on the basis of their pore-size ratings, composition, and so on to give the treated fluid the ultimate degree of purification sought for it in the filtrative step. [Nicholas P. Cheremisinoff and Paul N Cheremisinoff, 1993]

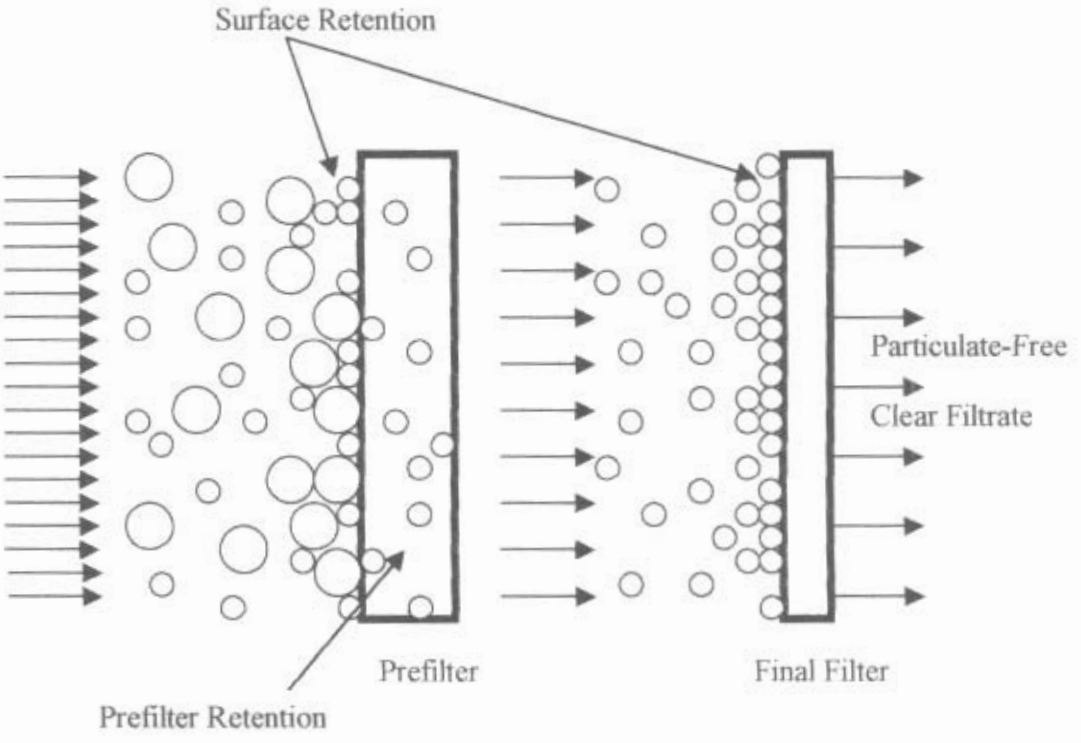

Figure 1.2: Prefilter/ final combination [Nicholas P. Cheremisinoff and Paul N Cheremisinoff, 1993]

1.2 Filter Media

A filter medium is a porous media that inhomogeneous with no uniform pores size, irregular in geometry and distributed randomly over the surface. [Nicholas P. Cheremisinoff and Paul N Cheremisinoff, 1993]

In general, there are two types of filter media, surface media and depth media. Surface type media is plane surface with nearly uniform orifices. The available pores in surface media determines the time between cleanings for a given pressure drop. This cleaning is important because the dirt particles are small and compressible. Pressures drop increase disproportionate because of the relatively small build-up of cake. Some examples of surface media are wire mesh, membrane, and simple edge-type.

The tortuous path in depth media will cause the particles interrupts between fibres when flow through it. The large concentrations of solids will cause the formation of cake quite rapidly and the depth type of filter will becomes surface type. Examples of depth media are paper, felt, glass fibre, sintered powder, matter wool and wound spools.

1.3 Gas Filtration

Gas filtration is one of the methods to separate solids from gas-solid mixture. Some important reasons to perform gas filtration are; the dust particle is a contaminant that cause the gas unsafe to its future use; the dust particles will separate themselves from the suspension and create an irritation; or the solid are valuable product but in the coarse of its manufacture has been mixed with the gas.