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Approaches for Predicting Collection Efficiency of Fibrous Filters

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ABSTRACT

This paper describes different approaches for predicting collection efficiency of nonwoven fibrous filters. Traditionally, the flow field has been obtained by analytically solving the Navier-Stokes equations inside over-simplified geometries with the fibers placed in regular arrays perpendicular to the flow direction. Our approach, on the other hand, is to exploit a numerical method based on the finite-volume technique to solve the flow inside 3-D virtual webs generated based on the properties of real filters. Our results showed a good qualitative agreement with previous works.

Keywords: Permeability; Cell model; CFD; Filtration; Nonwoven.

INTRODUCTION

During the past several years, there have been many pioneering studies (Davies, 1973; Brown, 1998; Hinds, 1999), which have helped developing the filtration science and technology to its current level. This is because the rising awareness of environmental agencies and the general public for a clean environment together with demands of many advanced industries have urged the filtration industry to investigate on ways to prove the indoor-air-quality.

Fibrous filters, such as nonwoven media, are widely used to remove submicron particles owning to its low cost and easy implement. It is quite important to evaluate the filters' performance of based on various particle and filter properties, which is generally characterized by collection efficiency and other parameters. In next section, we first introduce the traditional analytical method to predict the collection efficiency. Section 3 introduces our algorithm for generating nonwovens and then investigates on their nano-particle collection efficiency. In section 4, we compare our study with the well-known available 2-D model mentioned in section 2.

Analytical Models: Cell Model

It is difficult to analytically analysis the flow field around a fiber in the real fibrous filter. In order to predict collection efficiency of fibrous filter, influence of a single fiber has been extensively investigated.

Several results from calculation of efficiency of this smallest element in the fibrous filter have been obtained based on different flow models. Potential flow and

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