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STOCHASTIC SIMULATION OF CONVECTIVE
DIFFUSIONAL DEPOSITION OF POLYDISPERSE
AEROSOLS ON A DUST LOADED FIBER

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| หัวข้อวิทยานิพนธ์ | การจำลองแบบ เชิงสโตแคสติกของการสะสมอนุภาคแอโรซอลขนาดต่าง ๆ กันโดยคอนเวกทีฟฟิซันบนเส้นใยที่มีอนุภาคเกาะอยู่ |
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บทคัดย่อ



การสะสมอนุภาคแอโรซอลขนาดต่าง ๆ กันโดยคอนเวกทีฟฟิซัน (convective diffusion) บนเส้นใยที่มีอนุภาคเกาะอยู่ได้ถูกจำลอง (simulate) ขึ้นที่เงื่อนไขสำหรับการกรองต่าง ๆ กันโดยใช้คอมพิวเตอร์ IBM 370/138 งานที่ทำการดัดแปลง และขยายแบบจำลอง (model) ที่มีอยู่เดิมของการสะสมอนุภาคแอโรซอลที่มีขนาดเท่ากันในลักษณะเดียวกัน (Kanoaka et al. 1981, 1982) ให้ใช้ได้สำหรับกรณีอนุภาคแอโรซอลมีขนาดไม่เท่ากัน โดยถือว่า การกระจายของขนาดอนุภาคแอโรซอลเป็นแบบล็อก-นอร์มัล (log-normal)

รูปร่างลักษณะของเดนไดรต์ (dendrite) บนเส้นใยได้ถูกเฉลี่ยเพื่อหาโปรไฟล์ (profile) ของการเกาะอนุภาคบนผิวเส้นใย นอกจากนี้มีการเสนอการกระจายเชิงจำนวนของเดนไดรต์ขนาดต่าง ๆ จำนวนรวมของเดนไดรต์ และจำนวนรวมของอนุภาคที่เกาะอยู่เป็นต้นในรูปฟังก์ชันของมวลของอนุภาคที่เข้ามา อีึ่งส่วนประกอบของประชากรเดนไดรต์ และอัตราการเจริญเติบโตของเดนไดรต์ก็มีแสดงไว้ในรูปฟังก์ชันของอายุเดนไดรต์ด้วย

การศึกษานี้พบการเกาะของอนุภาคที่ด้านหลังของเส้นใยซึ่งไม่ปรากฏในกรณีการขวางกั้น (interception) และการชนโดยความเฉื่อย (inertia) และยังพบว่าตัวเลขเพคเลย์ Pe (Peclet number) และพารามิเตอร์ของการขวางกั้น R (interception parameter) มีผลมากส่วนความเบี่ยงเบนมาตรฐานเชิงเรขาคณิต σ_g มีผลเล็กน้อยต่อโปรไฟล์เฉลี่ยของอนุภาคที่เกาะปรากฏการณ์ข้างต้นเหล่านี้สอดคล้องอย่างคึกกับผลงานในอดีตของกรณีอนุภาคแอโรซอลมีขนาดเท่ากันหมด

ในงานนี้ได้หาความสัมพันธ์ระหว่างอัตราส่วนของประสิทธิภาพการกรอง η_{DIM}/η_{DI} กับ ปริมาณของมวลอนุภาคที่สะสมอยู่ในหนึ่งหน่วยปริมาตรไส้กรอง m โดยใช้ R , σ_g และ Pe เป็น พารามิเตอร์ ผลที่พบคือ η_{DIM}/η_{DI} จะแปรผกผันเกือบเป็นเส้นตรงกับ m และอัตราการเพิ่ม λ จะมีค่าสูงขึ้นถ้า Pe หรือ R ของระบบมีค่าเพิ่มขึ้น ส่วน σ_g มีผลเพียงเล็กน้อยต่อ η_{DIM}/η_{DI} และ ยังหาแนวโน้มที่แน่นอนไม่ได้ อนึ่งได้พบว่าค่าแรกเริ่มของประสิทธิภาพการกรองจะใกล้เคียงกับค่า ทางทฤษฎีของเส้นใยสะอาด แต่มักทำนายค่าที่น้อยกว่า

ส่วนใหญ่การกระจายของขนาดอนุภาคที่จับได้ จะเป็นแบบล็อก-นอร์มัล ซึ่งได้ทดสอบ โดยใช้ วิธีไค-สแควร์ (Chisquare goodness of fit test) นอกจากนี้ได้เสนอฮิสโตแกรม ที่แสดงการกระจายของขนาดอนุภาคที่จับได้ในงานนี้

Thesis Title Stochastic Simulation of Convective Diffusional
Deposition of Polydisperse Aerosols on a Dust
Loaded Fiber

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ABSTRACT

Convective diffusional deposition of polydisperse aerosols on a dust loaded fiber was simulated stochastically (using Monte Carlo technique) under various filtration conditions. A recently proposed three dimensional stochastic model for the convective diffusional deposition of monodisperse aerosols on a single fiber (Kanoaka et al., 1981, 1982) was extended here to the case of polydisperse aerosols, while the size distribution of aerosol particles was assumed to be log-normal.

Configurations of individual dendrites were averaged to give the profile of deposition on the fiber surface. Also shown as a function of the mass of incoming particles are the number distribution of dendrites of size N , total number of dendrites and total number of deposited particles. Population composition and dendritic growth rate are also given as a function of dendritic age. The model predicted the deposition of particles on the rear surface of a fiber, which is totally absent from deposition by inertia and/or interception. The average profile of deposited particles on the fiber surface was shown to be affected by Pe and R , and to a lesser extent by σ_g . The above effects of Pe and R were found to agree well with previous work

on monodisperse aerosols.

The normalized collection efficiency $\eta_{\text{DIM}}/\eta_{\text{DI}}$ of a dust loaded fiber was correlated to the accumulated mass m of deposited particles in a unit filter volume, using R , σ_g and Pe as parameters. $\eta_{\text{DIM}}/\eta_{\text{DI}}$ was found to increase almost linearly with m and the rate of increase, namely λ , was more rapid as either Pe or R increased. The effect of size dispersion, namely σ_g , on λ was small and its trend was inconclusive. It was found that the predicted initial collection efficiencies were close to the theoretical values for a clean fiber but tended to underestimate.

The null hypothesis that the size distribution of deposited particles was log-normal was tested using the Chi-square goodness of fit test, and histograms of sample size distribution are given.

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MONTREE WONGSRI

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