Textile Research Journal Article

A Note on an Optical Method to Evaluate Fiber Dispersion in Wet-laid Nonwoven Process

M. Latifi[1]
Textile Engineering Department, Textile Research & Excellence Center, Amirkabir University of Technology, Tehran, Iran

H. Vahedi Tafreshi
Department of Mechanical Engineering, Virginia Commonwealth University, Virginia, 23284-3015, USA

B. Pourdeyhimi
Nonwovens Cooperative Research Center, North Carolina State University, Raleigh, NC, USA

Abstract A laboratory set-up using an online vision system was designed to observe the dispersion behavior of glass and polyester fibers. The effect of different blend ratios, agitation speed, and dispersion time in dispersing "logs" and formation of "ropes", was studied. Our results indicate that there is a specific dispersion time period in which optimum fiber dispersion can be achieved. This time was found to be shorter for glass fibers. It was observed that the dispersion behavior of each fiber type has a profound influence on the dispersion of fiber blends. It was also noted that there is an optimum agitation energy which allows the logs to be dispersed while minimizing the rope formation.

Introduction

The manufacturing process for producing wet-laid nonwovens can be divided into a number of steps. These are:

- dispersing and blending the fibers;
- lay-down or web formation;
- drying; and
- bonding the fibers in the web.

Fiber dispersion is the most challenging step in this process. The process usually involves the suspension of fibers in water, and forming the nonwoven by draining this solution through a forming (monofilament woven) screen. Most fibers are in the form of separable clumps and need to be separated into individual fibers in a mixing tank through the shear exerted on them by the flow field. To form a uniform nonwoven, fibers must be well-dispersed prior to lay-down otherwise they may stay as fiber bundles and appear as defects (the so-called log defects) in the final product. In most cases, the cut ends of the fibers in logs remain aligned. Logs usually appear in the fabric because of under-agitation during the initial dispersion.

Synthetic fibers, because of the manufacturing process, come in separable clumps or logs. The separation is accomplished by agitation brought about in the dispersion (mixing) tank through the shear exerted on them by the flow field. This shear force is resisted by surface tension, friction, and fiber fusion forces. For dispersion to occur, the following inequality must be satisfied [14, 15]:

$$F_s > F_\sigma + F_\mu + F_f$$

where

F_s = shear force exerted on the bundles
F_σ = surface tension force
F_μ = friction force
F_f = forces from polymer fusion

Separation only occurs if the shear field force F_s is high enough to overcome other resistance forces. When the shear force exceeds the resistance forces, the fiber bundles (logs) will separate and disperse if agitated long enough. Logs usually appear in the fabric because of under-agitation during the initial dispersion. An analytical study

[1] Corresponding author: Textile Engineering Department, Amirkabir University of Technology, Tehran, Iran. email: latifi@aut.ac.ir.