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Influence of Packing Density of Layers Placed in Specific Order in Composite Nonwoven Structure for Improved Filtration Performance

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Abstract : Objectives: An approach is being suggested to design the filter media to maximize the filtration efficiency with minimum possible pressure drop of composite nonwoven by incorporating the layers of different packing densities induced by fibre of different deniers and punching parameters by using the concept of sequential punching technique in specific order in layered composite nonwoven structure. X-ray computed tomography technique is used to measure the packing density along the thickness of layered nonwoven structure composed by placing the layer of differently oriented fibres influenced by fibres of different deniers and punching parameters in various combinations to minimize the pressure drop at maximum possible filtration efficiency. Methodology Used: This work involves preparation of needle punched layered structure with batts 100g/m2 basis weight having fibre denier, punch density and needle penetration depth as variables to produce 300 g/m2 basis weight nonwoven composite. X-ray computed tomography technique is used to measure the packing density along the thickness of layered nonwoven structure composed by placing the layers of differently oriented fibres influenced by considered variables in various combinations. to minimize the pressure drop at maximum possible filtration efficiencyFor developing layered nonwoven fabrics, batts made of fibre of different deniers having 100g/m2 each basis weight were placed in various combinations. For second set of experiment, the composite nonwoven fabrics were prepared by using 3 denier circular cross section polyester fibre having 64 mm length on needle punched nonwoven machine by using the sequential punching technique to prepare the composite nonwoven fabrics. In this technique, three semi punched fabrics of 100 g/m2 each having either different punch densities or needle penetration depths were prepared for first phase of fabric preparation. These fabrics were later punched altogether to obtain the overall basis weight of 300 g/m2. The total punch density of the composite nonwoven fabric was kept at 200 punches/ cm2 with a needle penetration depth of 10 mm. The layered structures so formed were subcategorised into two groups- homogeneous layered structure in which all the three batts comprising the nonwoven fabric were made from same denier of fibre, punch density and needle penetration depth and were placed in different positions in respective fabric and heterogeneous layered structure in which batts were made from fibres of different deniers, punch densities and needle penetration depths and were placed in different positions. Contributions: The results concluded that reduction in pressure drop is not derived by the overall packing density of the layered nonwoven fabric rather sequencing of layers of specific packing density in layered structure decides the pressure drop. Accordingly, creation of inverse gradient of packing density in layered structure provided maximum filtration efficiency with least pressure drop. This study paves the way for the possibility of customising the composite nonwoven fabrics by the incorporation of differently oriented fibres in constituent layers induced by considered variablres for desired filtration properties.

Keywords : filtration efficiency, layered nonwoven structure, packing density, pressure drop
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