Chapter 6

Conclusions

This thesis presents the study of acoustic properties of unconventional natural fibre nonwoven needle punched fabrics developed using Kapok and Estabragh (Milkweed) fibre. Experiments are carried out using RSM-CCD methodology with the help of Minitab 18 software, which is more commonly used software for planning the design of experiments and statistical analysis. Sound absorbing material composed of a blend of natural hollow fibres kapok and modal, milkweed and modal fibres are used to produce needle-punched nonwoven samples. Sixty-two different samples were produced by varying blend ratio, carded web mass per unit area, needle stroke frequency, and needle depth. Sound Absorption Coefficient (α) of the samples evaluated using the impedance test method for different frequencies (250 Hz to 6300 Hz) of the incident sound. To measure the sound absorption coefficient of developed nonwoven fabric, a customized Impedance tube with 100 mm and 30 mm diameters are used. Different physical properties of fabrics like mass per unit area, thickness, air permeability, and porosity of developed nonwoven samples are measured and their effect on the sound absorption coefficient is also investigated. Response surface analysis is used to investigate the effect of different factors, physical properties, and their interaction effect on the sound absorption coefficient value with the help of Minitab 18 software. Multiple regression analysis are used to find out the relation between sound absorption coefficient and various parameters, their interaction at different frequency levels. The sound absorption coefficient is defined as the dependent variable, and fabric thickness, mass per unit area, air permeability and fabric porosity is defined as the independent variable. Another relation using multiple regression analysis is established by considering the sound absorption coefficient as dependent variable and fibre

proportion in the blend%, carded web mass, stroke frequency, and needle depth as the independent variable at different frequency level. Multiple linear regression analysis has been applied to find out the relation and investigate the effect of various parameters and their interaction on the sound absorption coefficient using Minitab 18 software. Analysis of variance (ANOVA) technique is also used. P-value was used to decide the statistical significance of the parameters and their interaction on the sound absorption coefficient.

Following inferences have been drawn after considering out comes of experiments and investigation reports:

- The sound absorption coefficient value of kapok and milkweed fibre nonwoven fabric increase with the increase in the kapok and milkweed fibre proportion in the blend ratio respectively. All sample gives the highest sound absorption coefficient at 6300 Hz frequency, and the best value of sound absorption coefficient observed at 6300 Hz frequency with 70% proportion of kapok fibre and milkweed fibre in the blend.

- The sound absorption coefficient of kapok and milkweed fibre nonwoven fabric increase linearly with increased carded web mass. The sound absorption coefficient value above 0.5 indicates that the samples with different carded web mass show excellent sound absorption properties in the frequency range 2500 Hz to 6300 Hz for kapok fibre and 3150 Hz to 6300 Hz for milkweed fibre. Sample with carded web mass 600 g/m^2 gives the highest sound absorption values at all frequency levels with a peak at 6300 Hz frequency.

- An increase in the stoke frequency from 150 to 350 /min leads to an increase in the sound absorption coefficient value. Sample with stroke frequency value 150 to 350 /min gives the highest sound absorption coefficient value at 6300 Hz frequency. The sample produced with stroke frequency 350 /min gives the highest sound absorption coefficient value at all frequency with a peak value at 6300 Hz.

- The sound absorption coefficient value increased with an increase in the needle depth. Sample with 15mm needle penetration depth gives maximum sound absorption value at each frequency and best sound absorption property at 6300 Hz frequency.

- P-value below 0.05 indicates a significant influence of individual parameters like

kapok/milkweed fibre proportion in the blend%, carded web mass, needle penetration depth, and their interaction on the sound absorption properties of the fabric. In case of stroke frequency, it significantly influence the sound absorption coefficient of kapok fibre fabric, but it does not show any significant effect on sound absorption coefficient of milkweed fibre.

- F- Value analysis indicates the kapok and milkweed fibre proportion in the blend is the most influencing parameter for the sound absorption properties of the fabric.

- The sound absorption value increased with increasing the thickness of the fabric and GSM of the fabric for the frequency range 250 Hz to 6300 Hz. Fabric air permeability and porosity inversely affect the sound absorption properties of both kapok and milkweed fibre nonwoven fabric.

- All samples show excellent sound absorption properties in the frequency range 2500 Hz to 6300 Hz for kapok fibre and 3150 Hz to 6300 Hz for milkweed fibre nonwoven fabric. In the frequency range 250 Hz to 2000 Hz for kapok fibre and 250 Hz to 2500 Hz for milkweed fibre, all samples show increasing trends in sound absorption coefficient value with frequency, but their values are below 0.5, which indicates poor performance in this frequency range.

- For both the kapok and milkweed fibre nonwoven fabric, the lower p-value (< 0.05) indicates the significant influence of fabric thickness, air permeability and porosity on the sound absorption properties of the fabric. In case of fabric GSM, it significantly influence the sound absorption coefficient of milkweed fibre fabric, but does not show any significant effect on sound absorption coefficient of kapok fibre nonwoven fabric.

- F - value indicates the fabric porosity is the most influencing factor followed by fabric thickness for sound absorption properties of kapok and milkweed fibre nonwoven fabric.

- Sound frequency plays a vital role in achieving the sound absorption coefficient value. Higher the frequency better is the sound absorption properties of the fabric.

- The sound absorption value peaks at a frequency of 6300 Hz

- The value of the sound absorption coefficient of kapok and milkweed fibre nonwoven fabric indicates that there is a huge potential for unconventional natural fibre like kapok and milkweed fibre to be used for acoustic application as a sustainable material.

Future scope of work

1. Development of kapok and milkweed fibre nonwoven fabric for excellent sound absorption properties at low frequency levels.
2. Evaluation of sound absorption property of nonwoven fabric produces with 100% kapok and milkweed fiber.
3. Development of kapok and milkweed fibre composite material to improve the sound absorption properties of the material.
4. Development of woven and knitted fabric using kapok and milkweed fibre and evaluate its sound absorption properties.
5. Development in the carding process to process 100% kapok and milkweed fibre.
6. Study the effect of the web orientation angle during the carding on the sound absorption property of kapok and milkweed fibre.
7. Exploring the various techniques of milkweed fibre collection.