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PROPERTIES OF NONWOVEN MATERIALS PRODUCED FROM MECHANICALLY RECYCLED TEXTILE FIBRES

ÜMBERTÖÖDELDUD TEKSTIILKIUDUDEST VALMISTATUD LAUSMATERJALIDE OMADUSED

MASTER THESIS

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SUMMARY

Textile production and consumption are increasing sharply; therefore, the amount of textile waste is also rising worldwide. This waste has a detrimental impact on the environment and economy. Due to growing awareness of the circular economy in textile manufacturing, many studies have been revealed since the last century to recycle textile waste. However, most of them are in the development phase owing to some challenges, and, globally, the recycling rate is low. Moreover, the application of recycled fibres is also limited because of inferior quality compared to virgin fibres and availability and low cost of virgin fibres.

An approach for producing nonwoven materials (NWMs) from mechanically recycled textile fibres was introduced in this thesis. In the theoretical part, the general overview of the current situation of textile waste, recycling technologies, application of recycled fibres, and background information about raw materials, manufacturing methods, and properties was given. In the experimental part, a variety of nonwoven materials were prepared with different fibre content and thermal treatment temperature. Hand-carded nonwovens were prepared at TalTech Laboratory of Polymers and Textile Technology, Semi-industrially carded nonwovens were made at the University of Tartu Viljandi Culture Academy. For the preparation of nonwovens cotton (CO), polyester (PES), two types of recycled cotton (RCO and R'CO) and recycled mixed waste (RMF) fibres were used. Two different types bonding fibres were used – low-melt polyester (LMP) and polylactic acid (PLA) fibres. First, the impact of fibre types, fibre ratio, and thermal treatment temperature (TTT) on air permeability and tensile properties of nonwovens was explored. Later the comparison between the properties of hand-carded (HC) nonwovens and semi-industrially carded (IC) nonwovens was also discussed.

Bonding fibre types and ratio influenced greatly the properties of NWMs. LMP bonded NWMs showed comparatively higher specific stress values than PLA bonded NWMs. For example, hand-carded CO:LMP nonwovens showed up to 53% higher stress value than CO:PLA NWMs, and specific stress of RCO:LMP was up to 58% higher than RCO:PLA. Nonwovens made from the higher amount of boding fibres showed higher strength than those nonwovens made from lower amount of bonding fibres. When the nonwovens were bonded with high temperature, the nonwovens showed higher specific stress. Specific

stress was increased by 10-50% by increasing the thermal treatment temperature from 135 °C to 150 °C.

Nonwovens became less air permeable if the thermal treatment and the ratio of bonding fibre were high. However, the impacts were not very significant. Moreover, nonwovens made from recycled cotton showed less air permeability compared to nonwovens made from virgin cotton. NWMs with higher stress and lower air permeability could be used as automotive interior noise control. However, for thermal insulation least air permeable NWMs are suitable. On the other hand, high air permeability is preferred for ventilation or comfort, such as clothes. Therefore, NWMs made from recycled fibres could be used for automotive interior and thermal insulation. Moreover, by applying lower thermal treatment temperature it could be possible to produce high air permeable NWMs for filtration or ventilation application.

In conclusion the main aims of the thesis were achieved, nonwoven materials from recycled post-consumer textile waste were produced and characterised. Also, the optimum process parameters and possible applications were proposed.