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Utility of conditioner for reduced interfibre friction as predictor of gentler shredding

The materials in textiles have a high burden on earth; 2/3 has origin in petrochemicals while cotton is infamous for its high water use. The high production and consumption of textiles and garments, although a sign of economic growth, also results in an increasing flow of textile waste. By using the textile waste as an asset and use as raw material in textile production, the environmental burden of the textile industry can be reduced.

Fibre-to-fibre recycling is one route to direct the textile waste flow which can not be re-used as is. Fibre recycling is often divided into two categories; chemical and mechanical recycling. One way to mechanically recycle textile is to separate the fibres in a shredding machine, which at a later stage enables reassembling of the fibres into textiles and garments. Traditionally, shredded fibres have been used in products of lower value, such as rags or stuffing for insulation. Difficulties of preserving the fibre length during shredding has previously been reported, with the solution to blend recovered fibres with virgin to be able to spin yarn[1]. To recover a higher value from the textile and facilitate a wider usage of the recycled fibres, the fibre length loss needs to be reduced.

Friction is a phenomenon between two sliding surfaces that can cause vibrations, noice, and wear. In textiles, friction between fibres and between yarns is what holds a fabric together. Fibre friction in textile production has to be managed to control each step; friction between fibres and fibre to other surfaces impacts on fibre position in e.g. carding and spinning processes. During staple fibre processing, low fibre-to-fibre coefficient of friction facilitates fibre separation of the fibre bundle, while too low friction coefficient can cause fibre slippage and uncontrolled process. Fibre to fibre friction is also the main cause for fibre length loss during the shredding process of waste textiles. The friction leads to heat build-up, and results in fibre damage and breakage as well as melting of polymeric fibres. One common way to modify the fibre friction coefficient is with the help of lubricants. Polyethylene glycol (PEG) is a lubricant with antistatic function[2].

In this work it was investigated how treatment with PEG 4000 affected inter-fibre friction and the shredding process of textile. Friction force during traction was measured by a novel method developed from the fibre beard method. The friction force was measured with a tensile tester on carded fibre webs of cotton and polyester treated with varied concentrations of PEG 4000. Further, it was investigated how the treatment affected the fibre length loss during shredding and the possibility to rotor spin the recovered fibres into yarn.

Results showed in both cotton and polyester fibre webs that treatment with PEG 4000 lowered the fibre-to-fibre friction. Treatment of fabric showed that the optimal concentration of PEG 4000 lowered friction between yarns in the polyester fabric and gave a better result in the shredding process. The fibre length reduction during shredding decreased with treatment of PEG 4000 in both polyester and cotton and also gave stronger yarns. Further, melting of polyester fibres during shredding was eliminated on the treated fabrics.

It was seen that PEG 4000 had an impact on cotton and gave bigger effect on polyester. The treatment made the shredding process more efficient and decreased the fibre length loss, especially for polyester. The treatment also gave better quality and stronger rotor spun yarns, due to the longer fibre length. Further, it was seen that it is possible to predict fibre length reduction in the shredding process by measuring friction between fibres. The result showed that treating fabric with a lubricant suitable for the material can improve the shredding process with decreased fibre length reduction, making the recovered fibres suitable for a wider range of uses.

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