Tribology of Textile Materials

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Recently, there has been an upsurge in research interests on the frictional properties of materials. This has been partly due to the availability of tools to understand the structure and properties of materials at micro and nano levels. However, in the case of textile materials, currently there is a renewed interest at the macro level due to its research potential and lack of understanding at this level. The main objective of this brief communication is to clearly understand the method and the unit to characterize the frictional properties of textiles.

It has been unequivocally established that the textile materials fail to obey Amontons' laws of friction. Friction of textiles depends on many factors such as the normal load, area of contact, sliding speed, finishes, etc. The relationship between the friction force and normal load is not linear and therefore it is not logical to use the coefficient of friction $\mu$ as a measure to quantify the frictional properties of textile materials. There is a plethora of literature available to support this argument. Wilson proposed a power relationship to explain the relation between the friction force and normal load that is of the form $F = C(N)^n$. It is by far the best form to represent the relationship between the friction force and normal load. Based on the above relationship, frictional properties can be characterized using two parameters $C$ and $n$, where $C$ is the friction parameter and $n$ is the material or friction index. These two parameters are negatively and dimensionally related with each other.

It is possible to obtain the friction forces at several normal loads using a sliding friction testing apparatus. The friction and normal forces can be used to obtain the two parameters $C$ and $n$. Since friction is dependent on the area of contact, the apparent area of contact normalizes the force values so that the friction and normal force values can be represented in Pascal. The unit of the parameter $C$ is $P \alpha(n)$ and the index $n$ has no unit. The unit $P \alpha(n)$ for the parameter $C$ stress the dependency of $C$ on $n$. This makes the frictional comparisons among different textile materials difficult. In addition, this also suggests that it is only logical to use $C$ for comparing and characterizing the surface mechanical properties of similar materials. We have recently suggested a solution to this complexity in the form of a new parameter that can be conveniently expressed in Pascal.

It is very clear from the above discussion that both $\mu$ and $C$ are not correct forms to characterize the frictional properties of textiles. Furthermore, to get a true understanding of the surface properties, it is necessary that the surface forces are measured over a range of normal loads and this invariably leads us to use the power relationship to arrive at the friction parameters that can be conveniently expressed in Pascal.

References