Filter media

Viscose speciality fibres – bio-based fibres for filtration

Viscose fibres consist of cellulose and have the same advantageous health, security and environmental properties as natural cellulose fibres. However, viscose fibres are manufactured from natural wood pulp in a chemical process, in which natural variations of the raw material are levelled out. This article demonstrates that viscose speciality fibres are tailor-made cellulosic fibres for filter media manufacture and looks at potential future applications.

Fibres are a commonly used material in filtration. They are used either as filter auxiliaries or as raw material to manufacture filter media. The most common natural fibres are cellulose fibres, used to manufacture for example paper and nonwoven filter media. They are non-allergenic and physiologically neutral. Processing of these fibres into filter media is safe as they do not release harmful substances and do not irritate the skin. Cellulosic fibres have a high moisture and humidity absorbency and are fully biodegradable.

Due to their natural origin, they can be incinerated CO_2 neutral. Even composting of filters from viscose fibres is possible as long as the residues in the filter are also compostable. The disadvantage of natural cellulose fibres, however, is a certain variation of their properties, which is common for most natural substances. Especially in cases where filter media manufacturing requires a very narrow property profile these variations may be too big and hence may have a negative impact on the final product as processing of the fibres cannot equilibrate all variations.

Just like natural cellulosic fibres, viscose fibres consist of cellulose and do have the same advantageous health, security and environmental properties. Unless the natural fibres, however, viscose fibres are manufactured from natural wood pulp in a chemical process, in which natural variations of the raw material are levelled out.

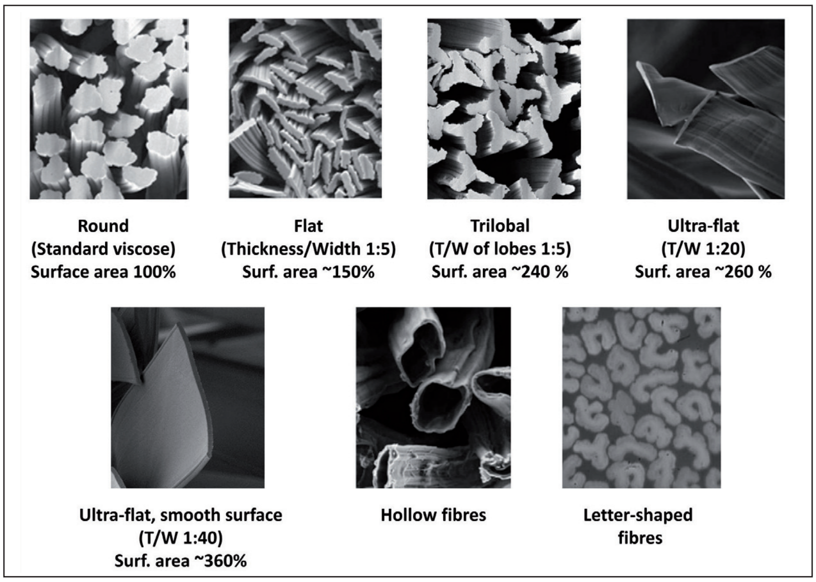

Figure 1. Viscose fibres of different cross-sections, relative surface areas of the fibres. (Images: Kelheim Fibres GmbH, Kelheim, Germany)

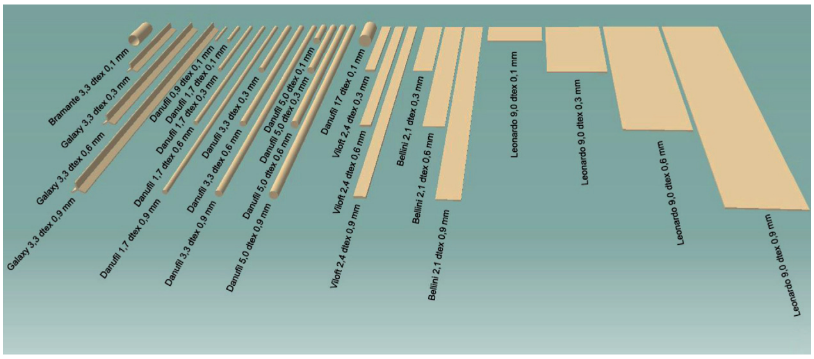

Figure 2. Selection of viscose fibres in different geometries and cut-lengths for sedimentation experiments.

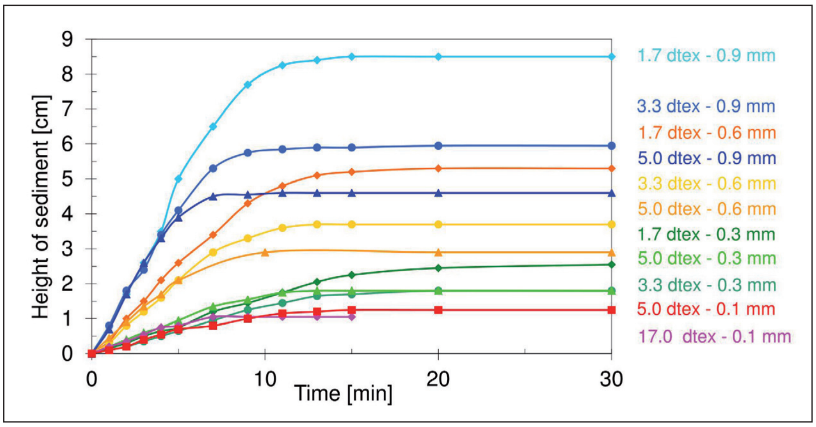

Figure 3. Sedimentation of round viscose fibres of different titers and cut-lengths.

Manufacturing process

During the viscose fibre manufacturing process the cellulose is derivatised and dissolved in lye. The cellulosic solution is then extruded into fibres of definite cross-section and length. This allows designing the fibres to the specific needs of the user independent from the origin of the cellulosic raw material used for fibre manufacture. The modification of the physical and chemical fibre properties is as well possible as the modification of the fibre geometry (Figure 1).

The fibre geometry is important for processing the fibres into filter media as many processing technologies have size restrictions. A common application for viscose fibres in filter media are filter papers. Paper manufacturing requires short fibres of cut-lengths of 10 mm or less to avoid braid formation in the process, which lead to inhomogeneous paper formation and may cause process interruptions. Hence, the viscose fibres are manufactured as short cut in the desired cut-length with a very narrow length distribution. Viscose fibres consist of cellulose like pulp from wood or fibrous plants and hence are highly compatible with pulp for processing.

Fibre geometry

During paper manufacture, natural wood pulp is blended with viscose fibres to adjust paper properties and to compensate variations from the natural pulp. Round fibres with rather big diameters will strongly increase paper bulk and porosity and hence are suitable for pressure drop reduction in filter papers. Fibres with a smaller diameter have less impact on the pressure drop, but they have a positive influence on paper strength. Trilobal fibres have a similar influence on paper porosity than round fibres.

Flat fibres, however, in most cases will lower the porosity of the papers, especially when their thickness-to-width ratio is low, as the flat fibres tend to orientate parallel to the paper surface and reduce the flow through the paper. Using flat fibres will strongly increase paper strength as the paper bulk decreases, which increases the number of binding points between the different fibres.

The fibre geometry is not only important for filter paper manufacture or for the manufacture of filter media using carding techniques. If viscose fibres are used as a filter auxiliary, for example as a substituent for other auxiliaries like diatomite, the adaptation of the fibre geometry is a basic requirement to be able to use the existing process equipment and to obtain comparable filtering results.

Intrinsic functionalisation

The viscose fibre manufacturing process allows the intrinsic functionalisation of the fibres. The functionalisation of natural cellulosic fibres is only possible by post-treatment, whereas the chemical and physical functionalisation of viscose fibres is also possible during the manufacturing process. The fibre modification during fibre manufacture can be performed similar to a post-treatment on never-dried fibres, which are particularly accessible for chemical reactions, or it can even be done before fibre extrusion by incorporation of functional additives into the spinning dope.

Particulate additives, which are incorporated during the spinning process, are locked up inside the fibre matrix and therefore cannot be separated from it anymore. Other additives, for example water soluble polymers, bind to the viscose fibre matrix by forming strong hydrogen bonds or build up a polymeric network inside the fibres after extrusion and therefore also cannot be separated from the viscose fibre matrix anymore. In all cases, the functionalisation of the viscose fibres is intrinsic as the function becomes part of the fibres themselves and is not just attached to them. Trying to separate function and fibres in most cases will destroy the fibres.

An example of such intrinsic functionalisation are ion exchange fibres. They can either be obtained by using the ion exchange functionality of cationic or anionic polyelectrolytes, which are bound to the polymer network of the viscose fibres by hydrogen bonds or by incorporation of ion exchange resin particles, which are locked up inside the fibre matrix. Other examples for functionalisation are flame retardant fibres composed of a silicate network entangled with the cellulose network, electrically conductive fibres containing carbon black or PCM fibres loaded with micro-encapsulated wax particles as heat accumulators.

The use of viscose fibres is not limited to one single application and to one single material construction. Even though