THEORY OF YARN STRUCTURE
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Compression of fibrous assemblies

Q1) What was the idea of fibre-to-fibre contact according to van Wyk?

A1) According to van Wyk, If 2 non-material cylinders were penetrated mutually, then the material fibers would create the contact.

Q2) State the relationship between the density of contacts and the packing density of a fibrous assembly?

A2) The density of fibre-to-fibre contacts in a fibrous assembly is directly proportional to the square of the packing density of the assembly.

Q3) State the relationship between the mean distance between adjacent contacts and the packing density of a fibrous assembly?

A3) The mean distance between adjacent contacts in a fibrous assembly is inversely proportional to the packing density of the assembly.

Q4) State the relationship between the compressive pressure and the packing density of a fibrous assembly?

A4) The compressive pressure is directly proportional to the cube of the packing density of the fibrous assembly.

Q5) What are the major problems of van Wyk's theory of compression of fibrous assembly?

A5) The two major problems of van Wyk's theory of compression of fibrous assembly are 1) The packing density cam be greater than one when the compressive pressure is greater than the coefficient k_p, which is logically non-sense and 2) The theory does not hold good for relatively high values of packing density.

Q6) State the basic idea behind generalization of C. M. van Wyk's theory.

A6) C. M. van Wyk's theory assumes purely point contact between fibres in a fibrous assembly, therefore, its result could be accepted, but only for compressible

(deformable) part of volume. This compressible volume is the difference between the total volume of the fibrous assembly and summation of volumes of all non-compressible ("stones") volumes.

Pores among fibres

Q1) State what are the parameters of pores in a fibrous assembly that are independent of the choice of fictive borders?
A1) The three parameters are total pore volume, total pore surface area, and surface area per unit volume of pore

Q2) Define conventional pore.
A2) Conventional pore has circular cross-section.

Q3) Why conventional pores are frequently used?
A3) All parameters of conventional pores are independent of the choice of fictive borders.

Q4) What is the basic assumption behind deriving the expressions for pore parameters in terms of fibre parameters?
A4) The basic assumption is total pore surface area is equal to total fibre surface area in a fibrous assembly.

Q5) What are the fibre parameters that decide the height of wicking?
A5) The fibre parameters are diameter of fibre and shape of fibre cross-section.

Orientation of fibres

Q1) What is the value of probability density function of isotropic fibre orientation in plane?
A1) $1/\pi$

Q2) What probability distribution does the tangent of fibre inclination angle follow?
A2) Cauchy's distribution.

Q3) Define coefficient k_n?
A3) The coefficient k_n is defined by the ratio of mean sectional area of fibre to the cross-sectional area of fibre.

Q4) What is the value of mechanical utilization of fibre in a perfectly parallel fibre bundle?
A4) 1

Mechanics of parallel fibre bundles

Q1) Which theory can explain the fact that after addition of fibers having higher tenacity, the tenacity of the resulting bundle can decrease?
A1) Hamburger's theory of mechanics of blended fibre bundle can explain this.

Q2) Define fibre strength utilization coefficient.
A2) The fibre strength utilization coefficient is defined by the ratio of the bundle strength related to one fibre to the mean fibre strength.

Q3) Define fibre breaking strain utilization coefficient.
A3) The fibre breaking strain utilization coefficient is defined by the ratio of the breaking strain of the bundle to the mean breaking strain of fibre.

Q4) What is the fibre parameter that determines both the fibre strength utilization coefficient and fibre breaking strain utilization coefficient?
A4) The fibre parameter is the coefficient of variation of fibre breaking strain.

Modelling of internal yarn geometry

Q1) Classify yarn models as shown below.

Functions	$m_i\ \zeta = 0$	$m_i\ \zeta \neq 0$
$z_i\ \zeta = 0$	?	?
$z_i\ \zeta = \text{const.}$	?	?
$z_i\ \zeta \neq \text{const.}$	?	?

A1) The yarn models are classified as follows.

Functions	$m_i\ \zeta = 0$	$m_i\ \zeta \neq 0$
$z_i\ \zeta = 0$	Parallel fibre bundle	Entangled fibre bundle
$z_i\ \zeta = \text{const.}$	Helical model	Radial migration
$z_i\ \zeta \neq \text{const.}$	Twisted migration	General migration

Q2) State the assumptions of ideal helical model of fibres in yarn.

A2) The assumptions are: 1) The fibres follow helical path in yarn, 2) All helixes have the same sense of rotation, 3) All helixes have the common axis, that is, yarn axis, 4) All fibres have the same coil height, and 5) The packing density is constant at all places inside the yarn.

Q3) State whether it is true that the coefficient k_n increases with the increase in twist angle of surface fibres.

A3) False, the coefficient k_n decreases with the increase in twist angle of surface fibres.

Q4) What is the limit value of yarn retraction according to ideal helical model under the assumption that the fibre volume does not change with twist?

A4) 0.5

Q5) What is the limit value of angle of twist of surface fibres according to ideal helical model under the assumption that the fibre volume does not change with twist?

A5) 70.5 degree

Q6) What are the parameters that determine the tensile force utilization coefficient in twisted yarn?

A6) Angle of twist of surface fibres and yarn contraction ratio.

Q7) Why Treloar's model of radial fibre migration in not considered to be enough precise?

A7) Treloar's idea of regular path of fibres in yarn is not precise. The fibre path is in fact random. Hence the number of fibre elements intersecting the yarn cylinder at any radius on one fiber per unit length of yarn is not constant.

Relation between yarn count, twist, packing density and diameter

Q1) State the assumption of Koechlin's model?

A1) Koechlin studied the yarns produced from same fibrous material using same technology for analogical end-uses. He assumed that 1) the packing density is a function of twist intensity only and 2) the twist intensity of yarns of different finenesses (counts) shall be same.

Q2) Which of the assumptions is considered not to be enough precise?

A2) Koechlin's first assumption is not enough precise. The twist intensity is not a function of packing density only, it depends on yarn count too.

A stochastic model of yarn hairiness

Q1) Why the single exponential model of yarn hairiness does not correspond well with the results of experiments?

A1) In reality, there are two types of hairs in yarn. One type of hairs is composed of shorter fibers and is concentrated mainly round the yarn surface (body); this can be imagined as "moos" on the yarn. Second type of hairs is composed of longer "flying" fibers. This intuitively suggested idea would make the double exponential model of yarn hairiness closer to the reality.

Bundle theory of yarn unevenness

Q1) State the general assmptions of Martindale's model of sliver unevenness.

A1) The general assumptions are: 1) The fibres are straight and parallel to the sliver axis , 2) They have the same length, and 3) They are positioned along the sliver individually and randomly.

Q2) Which is higher: coefficient of variation of fibre fineness or coefficient of variation of fibre diameter?
A2) The coefficient of variation of fibre fineness is two times higher than the coefficient of variation of fibre diameter.

Q3) Why the model of Martindale is considererd not to be enough correct?
A3) The index of irregularity in actual sliver is much higher than that calculated from Martindale's model. The reason is that the assumption of individual positioning of fibres in sliver is not correct.

Yarn strength as a stochastic process

Q1) What is the principle of the weakest link theory?
A1) Let us assume that a longer section of yarn is divided into n number of smaller sections. The principle of the weakest link theory states that the longer section must not break until any of n shorter sections breaks.

Q2) State the assumptions of Peirce's model of strength versus length of yarn.
A2) Peirce's model is based on the consideration that a longer yarn section is composed of many shorter sections of equal length. The three assumptions are: 1) The probability of breakage of one section of length is independent of the probability of breakage of any other section, 2) The longer section must not break until any of the shorter sections breaks, and 3) The strength of shorter section follows normal distribution.

Q3) Why Peirce's model is not considered to be enough precise?
A3) The strength versus length relation in actual yarn does not correspond well to that of Perice's model. This is because the assumption of strength independency is not true in reality.