

Introduction

- Variety of materials ranging from natural fibres, wood and metal to synthetics.
- Fishing gears such as trawls, purse seines and gillnets make extensive use of netting in the process of capture and for retaining the catch.
- Superior strength properties, service life and rot resistance, man-made synthetic fibres are almost exclusively used for construction of fishing twine, ropes and netting in recent times.

Basic Fiber Forms

- Synthetic fibres may be produced in one or more of the basic fibre forms. There are four basic fibre types

Continuous filament:

- Fibres of indefinite length and they are silk like in appearance and are produced with different degrees of fineness.
- Generally much thinner than 0.05 mm diameter.
- Fishing gear is usually made of filament of 1000 m of which weigh 0.6-0.2g.
- eg.PA., PES, PP

Staple fibres:

- These are made by cutting filaments
- Fineness is similar to that of continuous filament
- Short length varies for 40-120 mm.
- These short fibres are held under pressure to form continuous strand which is called as single yarn.
- Netting yarn made out of staple fibre have a rough surface owing to the numerous loose ends of fibre sticking out from the twine.
- This hairy nature decreases the slippage of knots.
- Lesser breaking strength than continuous filament.
- PA,PES

■ **Monofilaments :**

- The diameter varies from 0.1 to 1 mm or more.
- This is a single filament which is strong enough to function as a yarn; without any further processing.
- Transparent P.A monofilament are used in gillnets.
- These are stiff, larger in diameter, transparent and less visible.
- PE, PES,PP,PA

- **Split fibres:**

- Developed recently.

- These are originated from plastic tapes, which are stretched during manufacture to the extent that tape split longitudinally when under pressure.

- Yarn made of these filaments contains fibres of irregular fineness.

- PP, lesser extend PE

- Not all basic fibre types are available in each of the synthetic fibre group.
- Continuous filaments are mainly made in PA, PES and PP.
- Staple fibres are available in PA and PES. They are not made in PE and PP.
- Monofilaments are most popular as PE. They are also available in PES, PP and PA.
- Split fibres are mainly available in PP and to a lesser extent in PE. They are not made either in PA or PES.

Physical properties:

- **Density:** It is the mass per unit when and is expressed (g/cm³). Fibres with low density like PE(0.96), PP (0.91) float in water and hence hold more weight. Low density material gives more length/weight and vice versa. This property of the material is significant in construction of certain gear like purse seine. The sinking speed of the gear increase with the increase in the density of the material.
- **Breaking strength:** This is the maximum force applied to a specimen causing it to rupture or break. It is expressed in kg and special equipment known as Breaking strength testers/Dynanometer are used for determining is expressed in terms of tenacity and tensile strength.

- **Tenacity:** It is the Breaking strength per unit denier and $\text{Tenacity} = \text{Breaking loading} / \text{Total denier}$
- **Tensile strength:** It is the Breaking strength per unit area and expressed as kg/mm^2 . In wet condition PA & PVAA lose breaking strength and PES, PE and PP remain unaffected.
- **Elastic property:** Elasticity is a property of a material by virtue of which it tends to recover its original length and shape after removal of the stress.
- **Extensibility:** This is the property of a material to undergo extension/elongation under the influence of a force.

- **Water absorption:** This is the property of netting material to absorb water when it is immersed in water and expressed as % of dry weight. Natural fibres absorb more water where as synthetic materials do not absorb water.
- **Shrinkage:** This is the reduction in length of a material due to wetting. Shrinkage is not a major problem in synthetic fibres.
- **Abrasion resistance:** This is the resistance of a material to wear off any part when rubbed against any surface. The abrasion resistance of vegetable fibre is comparatively less. Staple fibre show lower resistance to abrasion than continuous fibres.

- **Sinking speed:** This is the speed at which material sinks through the water. It is important in purse seine.
- **Visibility:** It is the property of the netting material to be seen in water during operation. This property is relevant for gears like gill net. Veg. fibre is more visible than synthetic fibres. Mono filament is almost invisible as it is transparent.
- Breaking length(km)- calculated length of a specimen, the mass of which is equal to its breaking strength.
- Breaking length (km)= breaking load in kg/wt. in g /m
- Breaking length (km)= $9 * \text{Tenacity}(\text{g/den})$

- **Melting point:** This is the property of heat resistance of the material. The melting point and shrinking are important factors while dyeing the fibres. PA & PES are more heat resistant than PE & PP.
- **Weather resistance:** This is the property of the materials to with stand the effect of sun light, rain, wind, smoke and gases and other atmospheric element. Natural materials are more resistant than synthetic. The rate of deterioration is measured in terms of breaking strength.

Synthetic fibres: physical properties

- | | |
|----------------------------------|--|
| ■ Nylon, polyamide (PA) | Sinks (density = 1.14)
Good breaking strength and resistance to Abrasion
Very good elongation and elasticity |
| ■ Polyester (PES) | Sinks (density = 1.38)
Very good breaking strength
Good elasticity
Poor elongation (does not stretch) |
| ■ Polyethylene (PE) | Floats (density = 0.94-0.96)
Good resistance to abrasion
Good elasticity |
| ■ Polypropylene (PP) | Floats (density = 0.91-0.92)
Good breaking strength
Good resistance to abrasion |
| ■ Polyvinyl alcohol (PVA) | Sinks (density = 1.30-1.32)
Good resistance to abrasion
Good elongation |

Chemical properties

- Property of netting materials to withstand the effect of chemical lies acids, alkalis, oils and preservatives.
- Natural fibres poor resistance to acids, PES high resistance and others have fairly good resistance
- Both are good resistance to alkali
- PVAA is resistant and PA fairly good and others good.

Biological properties

- Quality to withstand damage caused by organism like fungi and foulers
- Vegetable fibres are prone to rotting quicker whereas synthetic fibres have good resistance.

Identification of synthetic netting yarns

The background of the slide features several thick, parallel diagonal stripes in a medium blue color, running from the top-left towards the bottom-right. The stripes are spaced evenly and create a sense of depth and movement against the darker blue gradient background.

- The synthetic fibre yarns have well defined **distinguishing characteristics**
- There are **less visual differences** between the various kinds of synthetic fibre yarns, as such they are rarely determined by appearance alone
- If the **trade name is known** one can find out the chemical group from trade name list.

■ The following tests are commonly employed to identify the synthetic fibres

(i) **Water test**

(ii) **Visual inspection**

(iii) **Burning test**

(iv) **Solubility test**

(v) **Melting point test**

■ The specimen used for testing should be made free from finishing agents like

- **pigments,**
- **colours,**
- **stabilizing agents,**
- **adhesive substances,**
- **oil,**
- **starch,**
- **resin etc.**

– This can be done by **boiling in distilled water.**

■ Water test :

- This is the simplest test which helps to identify **polyethylene and polypropylene** from other groups as they **floating in water** due to low density.
- The test is actually carried out by keeping the piece in a vessel filled with water after making a simple **overhand knot**.
- **Air bubbles** in the material must be squeezed out by hand under water.
- Excepting PE and PP, all other synthetic fibres sink in water.

■ Visual inspection:

- » All chemical groups are not used in all fibre types.
- » A careful look of **basic fibre types of netting** yarn often helps to identify the materials, as all the four fibre types are not common in all the chemical groups.
- » The type of single yarn used for the construction, whether it is shiny or soft, smooth or hard will give an idea about the material used.
- » For example **PE is not produced as continuous filament** and **staple fibres**.
- » **Split fibres** in fishing nets are produced only in **PP**.
- » PE monofilaments are distinguished from PP monofilaments, **oily feel to the surface of PE while PP is not slippery**.

■ Burning test —

- » This needs a **clean flame** and **two forceps**.
- » The best source of flame is a **Bunsen burner**, alternatively an **alcohol lamp** or even a **cigarette lighter** can be used.
- » The reaction of netting materials **in flame**, after **leaving flame, residue and smell** of the smoke will help to distinguish different chemical groups
- » In the early days of the introduction of synthetic fibres into fishing the burning test was very often used by fishermen as it is the simplest test for distinguishing synthetic fibres from cotton.

- Vegetable fibres and most of the man-made fibres made of regenerated cellulose burn rapidly in the flame and continue burning after removed from the flame.
- They have an afterglow, the smell of smoke is similar to that of burning paper and the residue consists of a small amount of fine ash.
- The synthetic fibres being thermoplastic shrink and melt in the flame; the melting substance drips from the flame, mostly forming a bead or a hard irregular residue.

	PA 6.6 and PA 6	PES	PE	PP	PVC	Saran	PVA(A)
In flame	Melts and then burns with light flame. White smoke, Drops of yellowish melting drip down	Melts and burns with light flame. Sooty, blackish smoke, drops of melting drip down.	Shrinks, curls, melts and burns with light flame. Drops of melting drop down	Shrinks, melts and burns with light flame, drops of melting drip down	Shrinks rapidly and melts does not burn, sooty, melts into a crumbling, black substance	Melts and burns with light flame.	Shrinks, curls and burns very rapidly with light flame.
After leaving flame	Stops burning if melting drops fall down. Small bead on the end of the sample. Hot melting bead may be stretched into fine thread	Stops burning if melting drops fall down. Small black bead on the end of the sample. Hot melting bead may be stretched into fine thread	Continues to burn rapidly. Hot melting substance cannot be stretched	Continues to burn rapidly. Hot melting substance may be stretched into fine thread	Hot melting substance cannot be stretched.	Stops burning immediately. Hot melting substance may be stretched into fine thread	Continues to burn rapidly. Melting substance cannot be stretched

	PA 6.6 and PA 6	PES	PE	PP	PVC	Saran	PVA(A)
Residue	Hard, round, yellowish bead; not crushable	Hard blackish bead; not crushable	No melting bead; like paraffin; crushable	Hard, round brown to blackish; not crushable	Hard, blackish, crumbly irregular; no bead	Porous, blackish irregular substance; crushable; no bead	Hard, brown to black, irregular; not crushable
Smell of the smoke	Celery-like; fishy odour; faintly like pyridine.	Oily, soot odour; faintly sweet; similar to scaling-wax; aromatic	Similar to burning asphalt; like wax or paraffin	Similar to burning asphalt; like wax or paraffin.	Sharp, sweet; sweetish-sourish	Sharp, acrid	Sharp, sweet like chlorine.

Properties	PA	PES	PE	PP
Floats	No	No	Yes	Yes
- Appearance	X	X	-	X
- Continuous fibres	(X)	(X)	-	(X)
- Short (staple) fibres	(X)	(X)	X	(X)
- Monofilament	(X)	(X)	(X)	X
- Sheets				
Combustion	Melts following short duration of heating - forms molten droplets	Melts and burns slowly with bright yellow flame	Melts and burns slowly with pale blue flame	Melts and burns slowly with pale blue flame
Smoke	White	Black with soot	White	White
Smell	Celery-like fishy odour	Hot oil faintly sweet	Snuffed out candle	Hot wax/ burning asphalt
Residue	Solid yellowish round droplets	Solid blackish droplets	Solid droplets	Solid brown droplets

X = Commonly available

(X) = Material exists but is less common

- = Not available

■ Solubility test –

- » The fibres of netting yarns for testing should be **as loose as possible**.
- » The netting yarn must be **untwisted** and the fibres **cut into pieces of 1 cm. in length**.
- » Materials like **split fibres, monofilaments** should be **reduced to very small pieces**.
- » The reaction of material to different reagents is to be observed : **soluble, not soluble, soluble only if boiled**.
- » The reagents quoted have been selected so that only one reaction needs to be observed i.e soluble or not soluble

Table-identification of synthetic fibres by solubility tests

Reagent\kind of fibre	PA 6.6	PA 6	PES	PE	PP	PVC	Saran	PVA (A)
(a) Hydrochloric acid/HCL (37%) 30 minutes at room temperature	+	+	○	○	○	○	○	+
(b) Sulphuric acid/H ₂ SO ₄ (97-98%) 30 minutes at room temperature	+	+	+	○	○	○	(+)	+
(c) Dimethylformamide/HCON(CH ₃) ₂ 5 minutes boiling	○	+	○	○(2)	○(2)	+(3)	+	○
(d) Formic acid/HCOOH(96-100%) 30 minutes at room temperature	+	+	○	○	○	○	○	+
(e) Glacial acetic acid/CH ₃ -COOH 5 minutes boiling	+	+	○	○	○	○	○	○
(f) Xylene/C ₆ H ₄ (CH ₃) ₂ 5 minutes boiling(inflammable!)	○	○	+	+	+	○(2)	+	○
(g) Pyridine 30 minutes at room temperature	○	○	○	○	○	+	(+)	○

- Polyamide (PA) fibres are soluble in the reagents (a) and (e). If it is desirable to separate the two types from one another, (c) can be used, in which PA 6 is soluble but not PA 6.6
- Polyester (PES) fibres are not soluble in (a), (f) and (g).
- Polyvinyl chloride (PVC) (not after-chlorinated; see note(3) in table 2 is the only synthetic fibre here mentioned which is soluble in reagent (g) at room temperature.

- Saran (PVD) may be identified by its solubility in (f) and (c).
- Polyvinyl alcohol (PVAA) (after – treated with formaldehyde; see note (4) in Table 2) is soluble in (a) but not in (e).
- PE and PP cannot be distinguished from one another by a solubility test. The burning test (Table) shows some differences in the reactions of these two synthetics but it is not always sufficient for identification. The most reliable method to distinguish PE from PP is to determine the melting point.

TABLE - I

IDENTIFICATION OF SYNTHETIC NETTING YARNS

Test	Nylon (PA) 6.6 & 6	Polyester (PES)	Polyethylene (PE)	Polypropylene (PP)	Polyvinyl chloride (PVC)	Polyvinylidene chloride (PVD)	Polyvinyl alcohol (PVA)
Burning Test (Inflame)	Melts and burns with light flame. White smoke. Drops of yellowish melting drip down, stretch into fine thread, non crushable yellowish bead like residue.	Sooty, blackish smoke. Drops of melting drip down, can be stretched into fine threads, non crushable blackish bead like residue.	Shrinks, curls, melts and burns with light flame. Drops of melting drip down, cannot be stretched into fine thread. Paraffin like crushable residue.	Shrinks, melts & burns with light flame. Drops of melting drip down can be stretched into fine thread. Non crushable, hard, round, brown to blackish residue.	Shrinks rapidly & melts. Does not burn, sooty, melts into a crumbling black substance cannot be stretched. hard, & blackish residue.	Melts and burns with light flame, can be stretched into fine thread. Residue of porous, blackish, irregular & crushable substance.	Shrinks, curls & burns very rapidly with light flame. Drip cannot be stretched into fine thread. Hard, brown to black, irregular & non crushable residue.
Solubility test	Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Soluble.
1) Formic acid & [96-100%] 30 min. at room temp.							
2) Dimethyl Formamide 5 minutes boiling	6.6 Non Soluble. 6 - soluble.	Soluble.	Non Soluble. but gets destroyed.	Non Soluble. but gets destroyed.	Soluble even at room temp.	Soluble.	Non Soluble.
3) Glacial acetic acid 5 minutes boiling	Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Non Soluble.
4) Hydrochloric acid (37%) 30 min. at room temp.	Non - Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Soluble.
5) Pyridine 30 min. at room temp.	Non - Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Soluble.	Non Soluble. But soluble if boiled.	Non Soluble.
6) Sulphuric acid (97-98%) 30 min. at room temp.	Soluble.	Soluble.	Non Soluble.	Non Soluble.	Non Soluble.	Non Soluble. But soluble if boiled.	Soluble.
7) Xylene 5 minutes boiling (Inflammable)	Non - Soluble.	Non Soluble.	Soluble.	Soluble.	Non Soluble. But gets destroyed.	Soluble.	Non Soluble.

■ Melting point test –

- This is the **most reliable test** for identification of synthetic netting materials as the melting points are significantly different