NYLON

- Nylon was the first synthetic fiber and the first fiber developed in the United States.
- Nylon fibers are one of the fibers having the longest history among synthetic fibers. They are used for a variety of uses from clothing to home furnishings and industrial uses.
- Under the most recent FTC definition, nylon is a "manufactured fiber in which fiber-forming substance is a long-chain synthetic polyamide in which less than 85 percent of the amide linkages (-C=NH-)

are attached directly to two aromatic rings.

Nylon 66

Manufacture

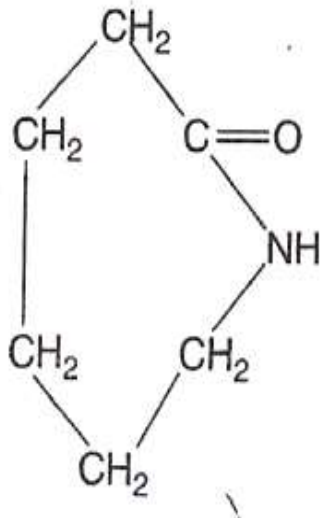
The chemicals from which nylon 66 is synthesized are adipic acid and hexamethylene diamine:

Adipic acid	Hexamethylene diamine
$COOH(CH_2)_4COOH$	$NH_2(CH_2)_6NH_2$
$1 + 4 + 1 = 6$	(6)

Note that there are six carbon atoms in each molecule of adipic acid and six carbon atoms in each molecule of hexamethylene diamine. For this reason, this nylon was designated as nylon 6.6 (six carbons in each molecule of reacting chemical). In time it came to be known as nylon 66. These materials are synthesized from benzene.

Nylon 6

Nylon 6 is made from *caprolactam,* which has the following chemical structure:



Since there are six carbons in caprolactam, the fiber is known as nylon 6.

Polymerisation of Nylon 66

The first step in the manufacturing process is to cause the reacting materials to form polymers. Nylon is formed by condensation polymerization. The reaction of adipic acid and hexa-methylene di-amine takes place in an air free atmosphere. Water, which is split off during polymerisation, is allowed to escape from the reacting tank. If the manufacturer wishes to produce a de-lustered nylon, titanium dioxide can be added to the material during this step.

The molten polymer that forms is extruded from the tank as a ribbon, several inches in width. The material is quenched in cold water, which reduces the size of the crystals formed. The ribbon is broken into smaller nylon “chips.”

Polymerisation of Nylon 6

Caprolactam is polymerized by one of two methods. In one, caprolactam is melted, heated and filtered under high pressure, during which process condensation polymerization takes place. In the second method, water in the amount of 10 per cent of the weight of the caprolactam is added, after which the water and caprolactam are heated to a high temperature, steam escapes and polymerization takes place.

In both of these methods, a certain amount of monomer material remains. The polymerized material is given a water bath in an extractor to remove the monomer, which, if it remained, would weaken the final fiber. The polymer is dried and made into nylon chips.

Spinning

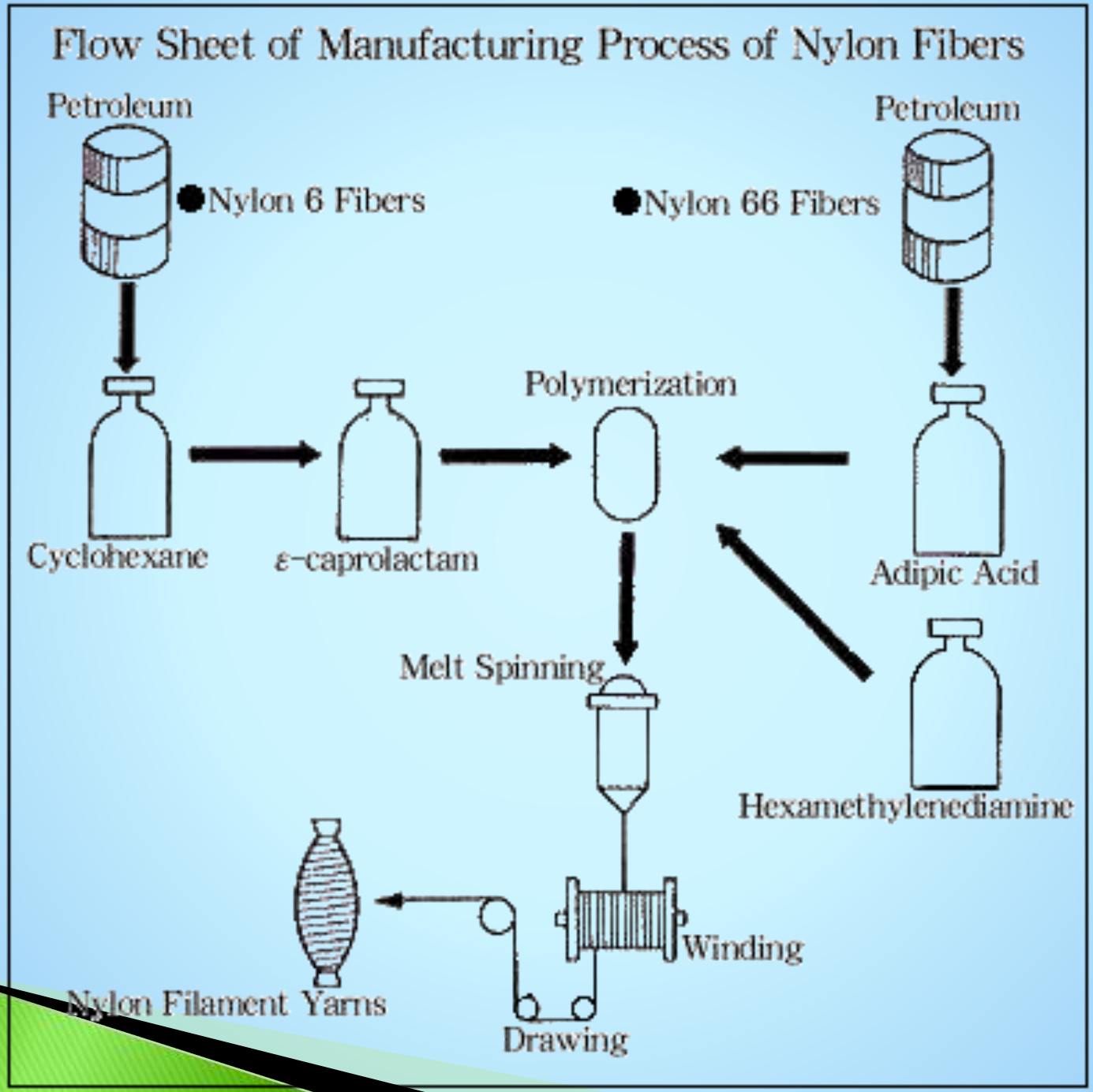
Both nylon 66 and nylon 6 are melt spun, although nylon 66 has a higher melting point (482 degree F) than nylon 6 (415 deg F). The chips fall onto an electrically heated grid that is too small to allow the chips to pass through until they have been melted. The melted polymer is delivered from an extruder, and then passes through a filter that removes any impurities and finally through a small filter and spinneret.

As they exit from the spinneret, the molten filaments enter a chimney where they are air cooled and simultaneously stretched. Spin finish (a mixture of materials such as wetting agents, antistatic agents and adhesives) is coated onto the fiber. The finish lubricates fibers for subsequent processing and disperses static electrical charges that would interfere with yarn formation. The finish is eventually washed off from the fabric.

Drawing

After addition of the finish, the fiber is wound onto a bobbin. In this state, nylon is not especially strong or lustrous, so fibers are heated and stretched to 400 to 600 per cent of their original length. The stretching orients the molecules, making the fiber more crystalline, increasing luster, and improving tensile strength.

Nylon is available in multifilament, monofilament, staple, and tow in a wide range of deniers and shapes and as partially drawn or completely finished filaments. Many staple lengths are also available. Fibers are produced in bright, semi dull, and dull lusters, with varying degrees of polymerization and strengths.


Flow Sheet of Manufacturing Process of Nylon Fibers
Petroleum
Nylon 6 Fibers
Petroleum
Nylon 66 Fibers
Polymerization
Cyclohexane
ε-caprolactam
Adipic Acid
Melt Spinning
Hexamethylenediamine
Winding
Nylon Filament Yarns
Drawing

Nylon Characteristics:

- Exceptionally strong
- Elastic
- Abrasion resistant
- Lustrous
- Easy to wash
- Resistant to damage from oil and many chemicals
- Can be precolored or dyed in wide range of colors
- Resilient
- Low in moisture absorbency
- Filament yarns provide smooth, soft, long-lasting fabrics
- Spun yarns lend fabrics light weight and warmth

PROPERTIES OF NYLON

1. Physical Appearance

In microscopic appearance nylon looks like a long, smooth cylinder or like fine glass rod. Its cross section is circular, and it is naturally lustrous and transparent, unless it is delustered or solution dyed.

2. **Specific Gravity:** A relatively low-density fiber, nylon has a specific gravity of 1.14 which is lower than most other fibers. (Rayon, for example, has a specific gravity of about 1.5, polyester 1.22 or 1.38) Nylon can be made into very light, sheer fabrics of good strength.

3. Strength: The strength of nylon is excellent. It is produced in a variety of tenacities. The exceptional strength of nylon has led to its use not only for tire cords but also for a variety of industrial items. Its abrasion resistance is superior being four to five times that of wool. The strength and abrasion resistance plus the elasticity of nylon have led to its predominance in the field of women's hosiery. Since the fibers are so strong they can be made in very fine deniers require for sheer hosiery and lingerie.

4. Elasticity and Resilience: The elasticity of nylon is very high. Its resilience and wrinkle resistance are good. Its exceptional compression resilience has led to its prominence in carpets and rugs.

5. Absorbency and Moisture Retain: Nylon is moderately hydrophilic, having better moisture regain than many manufactured fibers. Nylon fabrics dry quickly after laundering.

6. Dimensional Stability: Nylon has good dimensional stability at low to moderate temperature, neither shrinking nor stretching out of shape. At high temperatures nylon fabrics may shrink so washing and drying temperatures should be kept low.

7. Heat and Electrical Conductivity : Nylon is a poor conductor of electricity and it builds up static electricity, especially when humidity is low. Nylon serves as a good insulator in electrical materials because of its non-conducting qualities. Heat conductivity is also low.

8. Effect of Heat, Combustibility: The melting point of nylon 66 is about 500 deg F. It will soften and may start to stick at 445 deg F. Nylon 6 is even more heat sensitive. If a hot iron is used on nylons, the fibers may glaze, soften or stick. The fiber burns in a flame but usually self extinguishes when the flame is removed. However nylon fibers do melt and as with any fiber that melts, if the molten fiber drips onto the skin, it may cause serious burns. The thermo-plasticity of nylon allows it to be heat-set.

9. Chemical Reactivity : Like most synthetics, nylon is chemically stable. Dry cleaning solvents will not harm the fiber. It is not seriously affected by dilute acids but is soluble in strong acids. Treatment with concentrated hydrochloric acid at high temperatures will break nylon 66 down into adipic acid and hexa-methylene diamine, the substances from which it is made. This reaction could be used to reclaim these basic materials and permit this fiber to be recycled after use. Prolonged exposure to acidic fumes from pollution will decrease the dye ability of nylon.

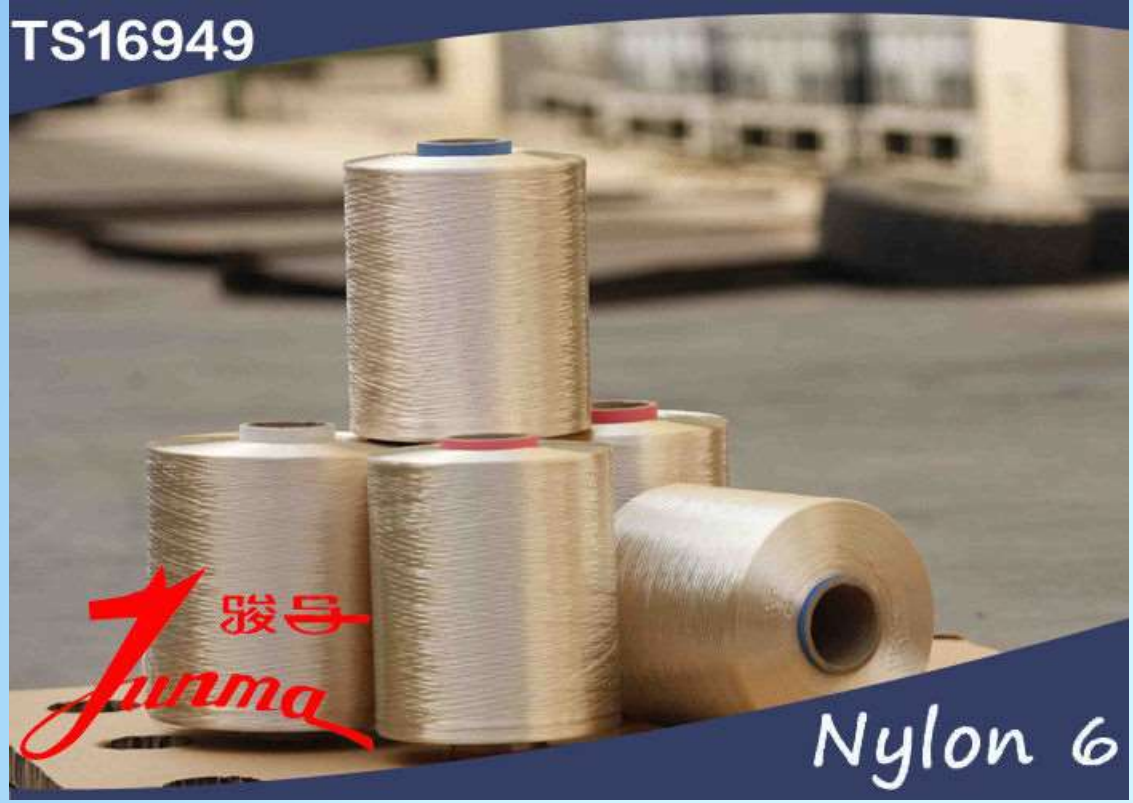
10. Resistance to Microorganisms, Insects, Sunlight and Aging: Moths, mildew and bacteria will not attack nylon. The fiber is degraded by long exposure to sunlight but age has no appreciable effect if fabrics are stored away from sunlight. Sheer nylon fabrics are unsuitable for use in curtains.

End Uses In Clothing

Pantyhose, Socks, Ski Wear, Swimsuits, Sports Wear, Casual Wear, Lingerie, Women's Underwear, Rain Wear, Linings, etc.

Uses in home

Cloth for Bags, Cover Cloth for Futon (Japanese Bedding), Cloth for Umbrella, Sewing Threads, Tooth Brush, Interlinings, etc.


TS16949
骏马
Junma
Nylon 6

Home furnishings:

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TREAD
BREAKER
CARCASS PLIES
BEAD WIRE
CARCASS
INNER LINER

Uses: The availability of a wide variety of types of nylon (from fine to coarse, from soft to crisp, from sheet to opaque) has resulted in the use of nylon in an enormous range of products for apparel, home and industry.

Nylon has long been of major importance in the manufacture of women's' hosiery because it can be heat set and is strong and elastic. Sheer fabrics of nylon have been popular because of their inherent strength and abrasion resistance. Special purpose nylons have been manufactured for upholstery and carpets. Nylon is often used in blends for abrasion resistance.

Nylon is one of several fibers being made in microfiber size. To date, nylon microfibers are mostly being used in active sports apparel, ski wear, camping apparel and sleeping bags. The applications take advantage of the high strength of nylon.

Thank you…