Polymeric fiber technology lecture (5) Fiber synthetic techniques

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:Methods for fiber spinning

嫋 1- Melt spinning:

The simplified explanation of melt spinning is that polymer granules are melted and then extruded through the spin head. The metering pump controls the flow of molten liquid to the spin head, where it is filtered before extrusion to ensure any un-melted are removed so that they do not form part of the fiber, which would cause weak points. The quench air cools the fibers as they emerge. In order to then spin the cooled Filament fibers a Lubricant must be applied as the synthetic fibers are not conductive and therefore static can be

- The melt spun method has a variety of benefits;

1- It is very cost effective, the least expensive of the spinning methods- In larger providers the polymer solution is sent direct to the extruder taking out the steps of granule production and melting

2- As no solvent is used no washing is required

3-It is high speed, making around 8000m/minute

- It is the preferred method of production of polymers that will not suffer thermal degradation at temperatures required to form a melt solution of the desired viscosity.
- Fibers produced in this manner include nylon, PE, PP and polyester.
- Monofilament yarns can also be produced in this method, however due to their larger Cross section they require cooling in water instead of air.

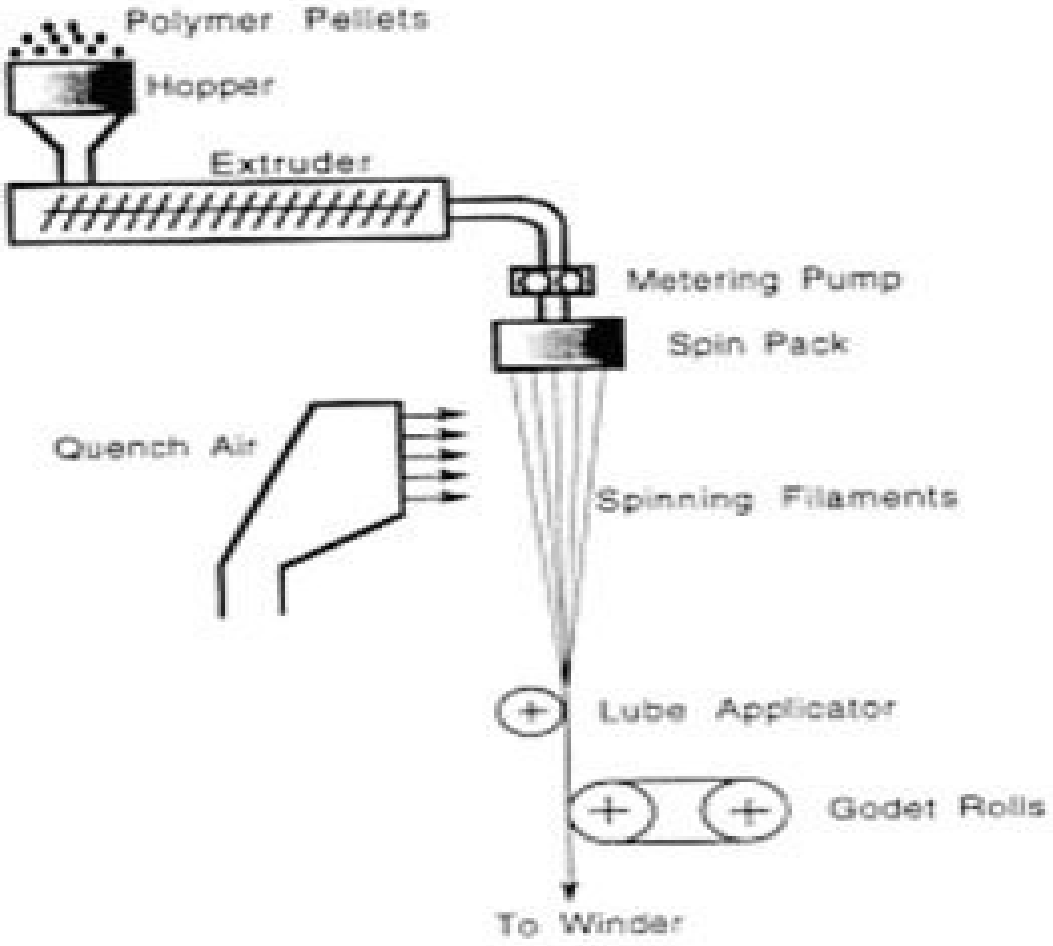

Fig. (1) Melt Spinning

2- Wet spinning:

Wet spinning is required for polymers that require dissolving in a solvent to be spun. It is named wet spinning because the fibers are extruded directly into a liquid bath. Being extruded into a liquid provides a greater drag force on the Filament than those extruded directly into air, therefore the speeds at which this occurs is reduced from that of melt and dry spinning. Once evaporated these fibers then have to be drawn or stretched in order to orient the polymers to give the fiber its strength.

- The fiber solution is extruded into a liquid that will draw out the solvent, leaving behind only the polymer. The rate at which this occurs is crucial, as if it occurs too quickly the bath liquid can create micro-voids in the fiber which will be a weak point.
- Wet spinning is based on precipitation, where a polymer is drawn through a spinneret into a non-solvent. The prepared spinning dope is extruded into the non-solvent and precipitation or coagulation occurs.
- Fibers spun using this process include Acrylic, Rayon, Aramid, and Spandex.

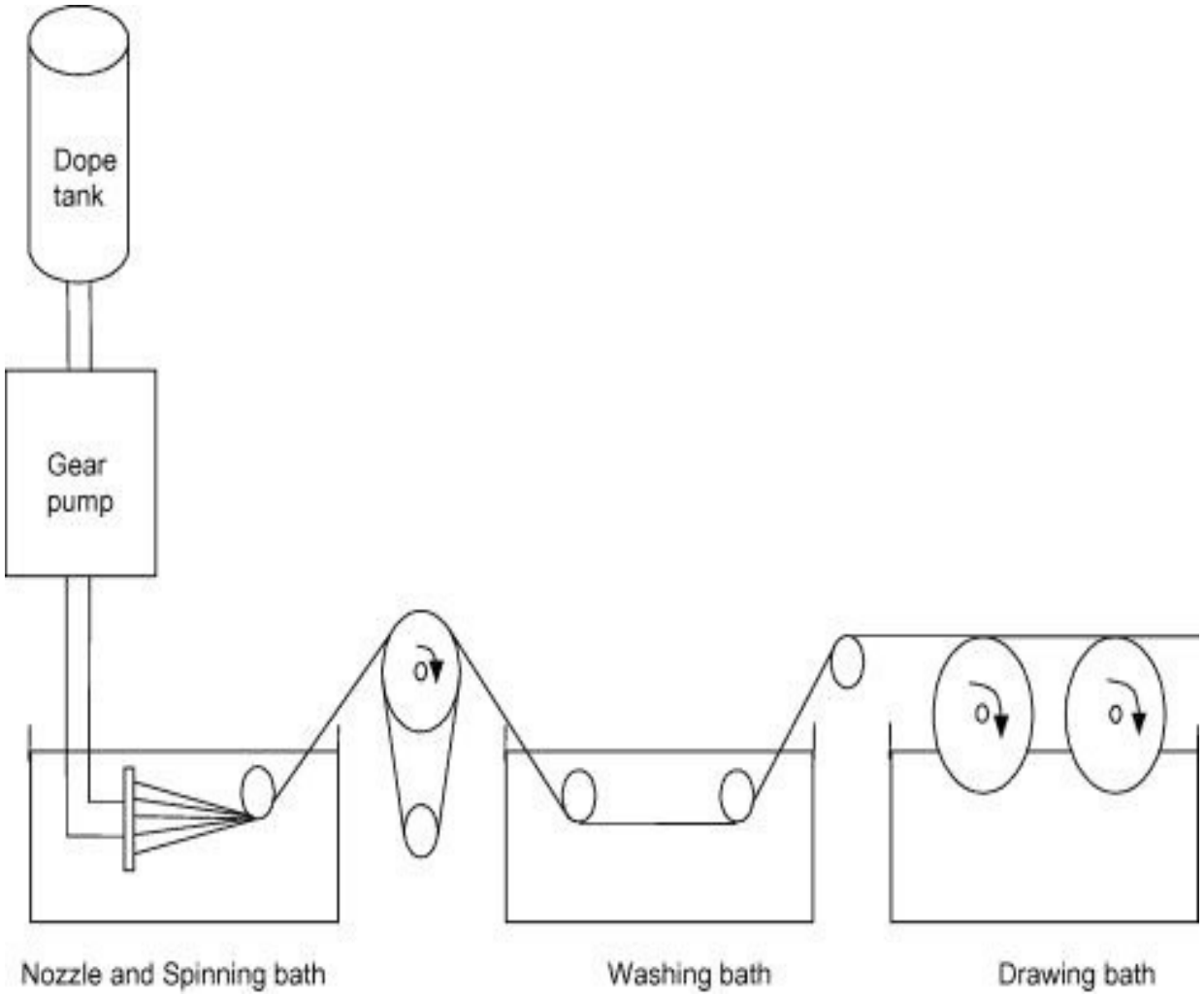

Fig. (2) Wet Spinning

3- Dry spinning:

In dry spinning the polymer is dissolved in its solvent and then extruded, as the fibers emerge through the spinneret the solvent is evaporated off with hot air, in most cases this is then collected and re-used. Figure 3 illustrates the process. Dry spinning is required for polymers with a melt temperature equal to or close to their thermal degradation temperature, therefore they require dissolving in a solvent in order to be processed into fibers.

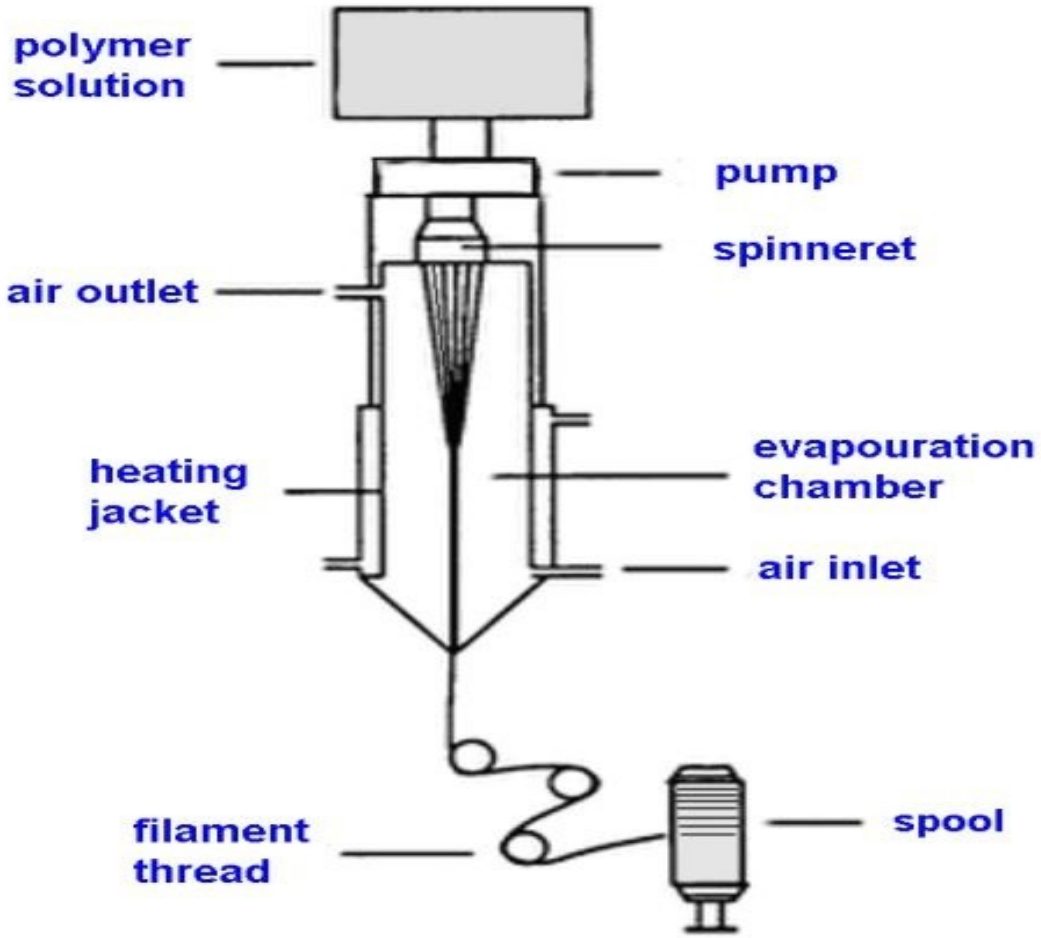

Fig. (3) Dry spinning

4- Dry- Jet wet spinning:

- In this method, the polymer is dissolved in an appropriate solvent to make the fiber solution. This solution is then extruded under heat and pressure into an air gap before it enters a coagulation bath. The produced fiber is then washed and dried before it is heat treated and drawn. This is an alternative method to wet spinning and is required as spinning directing into the bath, for some fibers, creates micro voids that negatively affect the fiber properties, this is due to the solvent being drawn out of the liquid too quickly. An inert atmosphere may be required to prevent oxidization in some

- This method is often required for high performance fibers with a liquid crystal structure. Due to their structural properties, their melt temperature is either the same as, or dangerously close to their decomposition temperature, therefore they must be dissolved in an appropriate solvent and extruded in this manner.

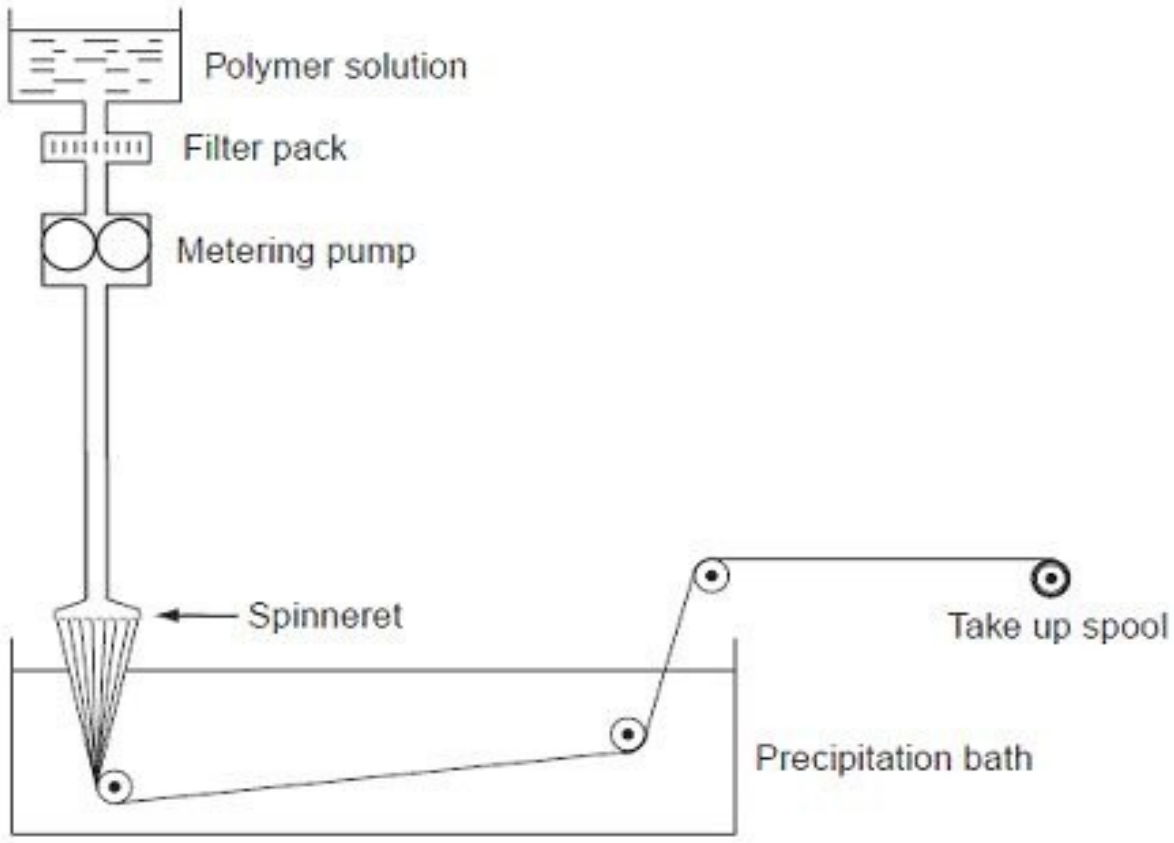

Fig. (4) Dry-jet Wet Spinning