Extrusion

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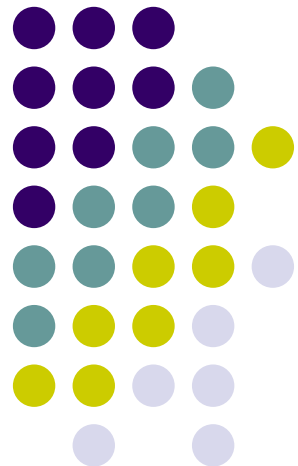
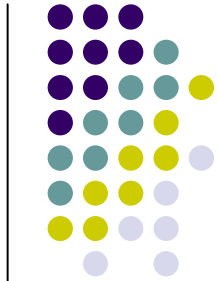
Introduction to Polymers

CE 435

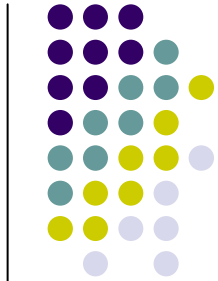


OVERVIEW



- Introduction
- Extruction in general
  1. Vented and twin-screw extruders
- Finishing the process
  1. Films and sheets
  2. Tubing
  3. Insulation
- Fibers
- Question and comments

INTRODUCTION



1. Product design enhances:
- Profitability
- Customer satisfaction
2. Some important parts of product design are:
- Design parameters
- Material selection
- Fabrication process selection
3. The most popular fabrication processes are:
- Molding
- Extrusion

INTRODUCTION

4. The Melt Flow Index is a quantity used to determine the suitability of a particular process for a polymeric material
5. Generally, extrusion is used to process high melt viscosity materials and some elasticity
6. Rubber extrusion for wire coating was the first mainstream application of a extruder
7. The first extruder in the United States was build in 1880

EXTRUSION IN GENERAL

- In extrusion, polymers in the form of pellets or flakes are melted and forced through a die

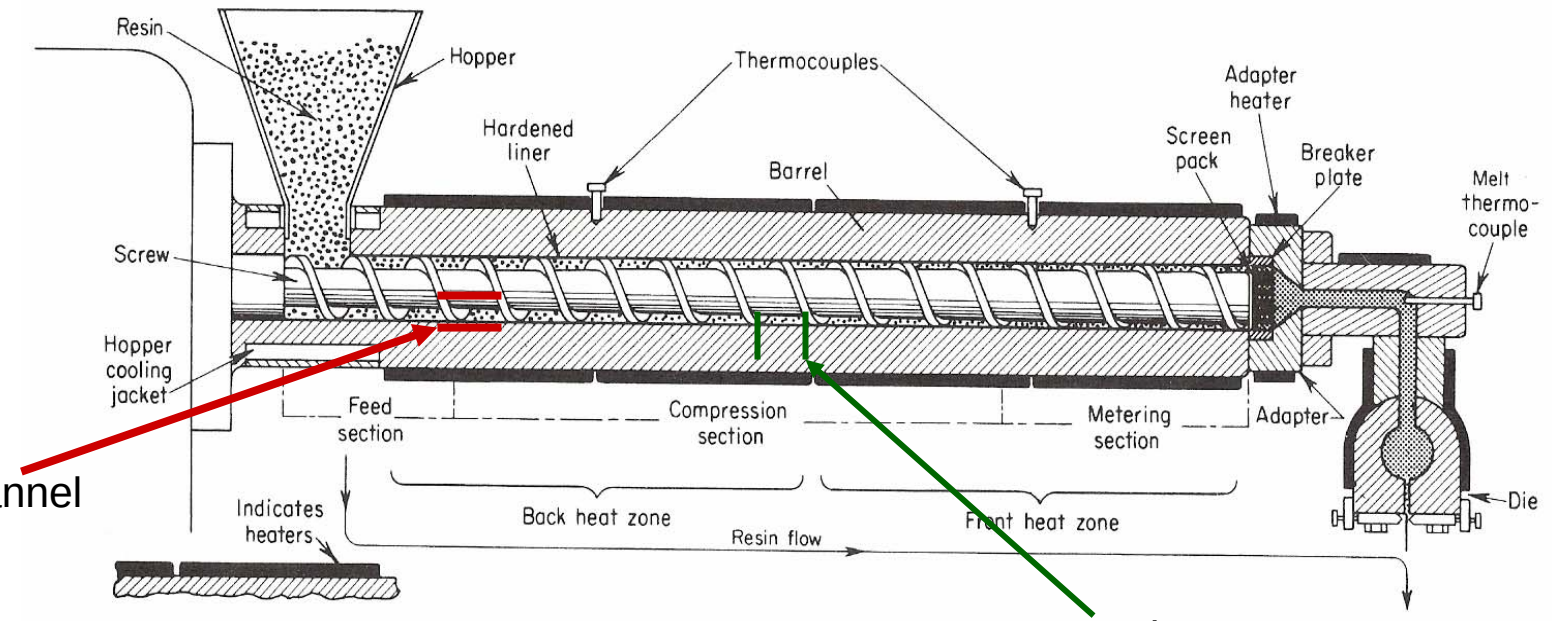
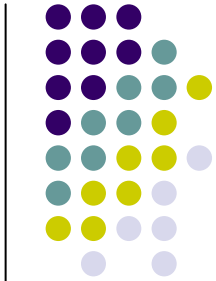


Figure 13.1 Cross-section of a typical extruder [1].

EXTRUSION IN GENERAL



- Standard sizes of screw extruders are 1 1/2, 2, 2 1/2, 3, 4 1/2, 6, and 8 (Barrel diameter)
- The length to diameter ratio of an extruder is most often specified
- As a rough guide, extruder capacity Q_e varies with the barrel inside diameter as follows:

$$Q_e = 16D_b\text{^}2.2$$

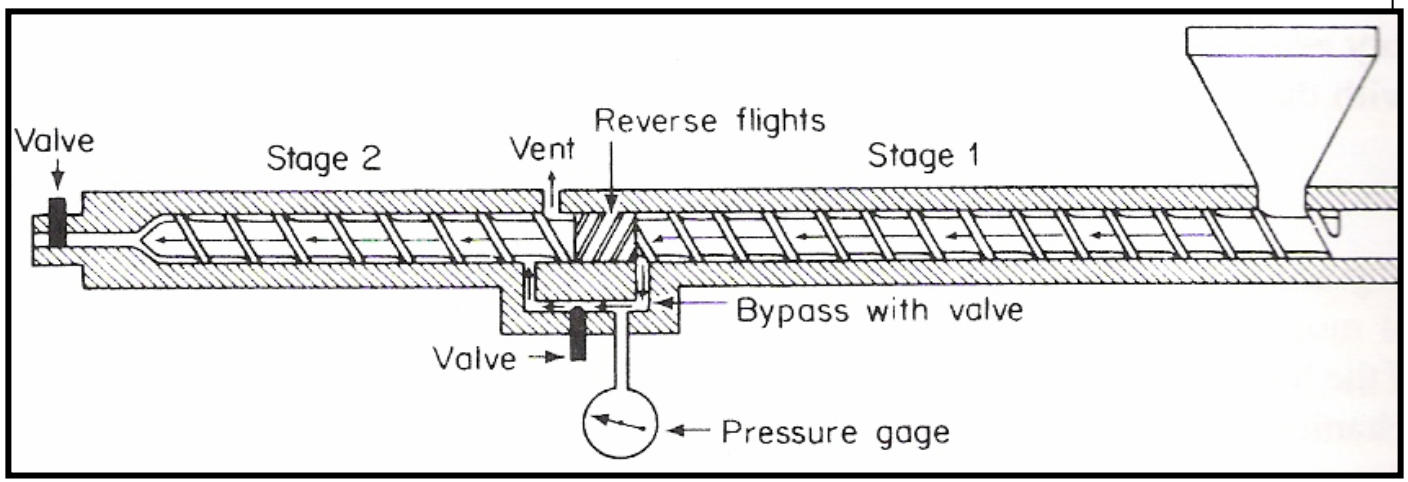
EXTRUSION IN GENERAL

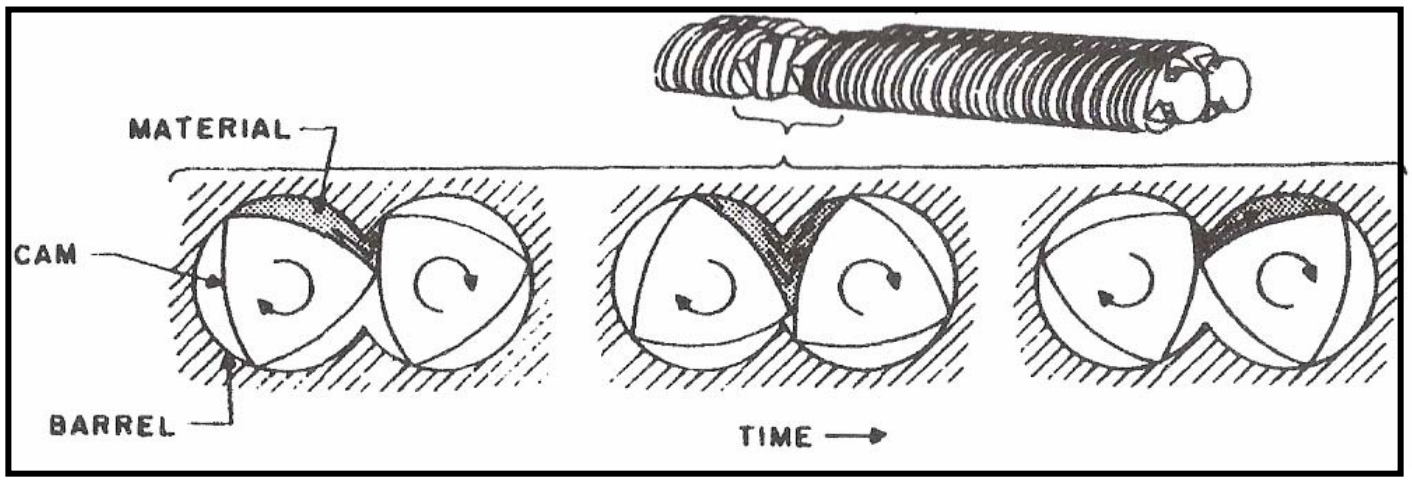
- Standardized tables for the extrusion of some materials are available

Processing Guide:	ABS - Acrylonitrile-butadiene-styrene
Extruder:	Single screw, no vacuum, grooved feeding section
Screw Design:	Barrier screw 25 - 30 L/D
Compression Ratio:	2,75 : 1
Cylinder Temperatures:	190-240 C 374-464 F
Melt Temperature:	200-245 C 392-473 F
Miscellaneous:	approx. 30 % higher torque (than PVC)

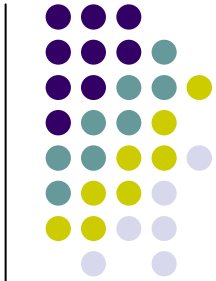
Extrictly-extrusion.com

VENTED AND TWIN-SCREW EXTRUDERS





FINISHING THE PROCESS



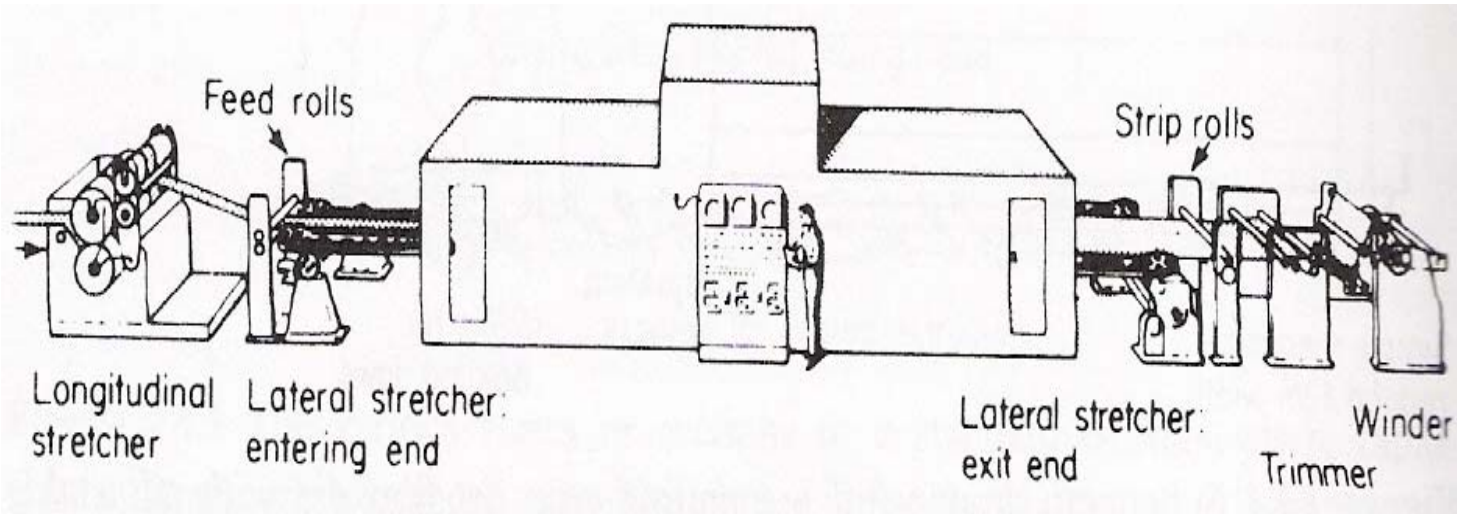
- Films, sheets, and tubing are all manufactured by extrusion.
  1. The term film is used for materials that are less than 0.01 in. thick. Thicker materials are called sheets
  2. T-shaped dies are used for the fabrication of flat materials, ring-shaped dies are used for pipes or tubing
  3. On leaving the extruder, a thermoplastic material must be cooled below T_m or T_g to achieve its final geometry
  4. Rubbers must be heated subsequent to extrusion to accomplish cross-linking

FILMS AND SHEETS

- Films and sheets reach geometrical stability by chilling the material below its T_m or T_g:
  1. Water bath cooling
  2. Water-cooled roll operation
- Thermoplastics are drawn (stretched) at low temperatures at the end of the process for molecular orientation
  1. Molecular orientation makes a material stronger in the drawing direction
  2. Greater dimensions can be attained

FILMS AND SHEETS

- A biaxically oriented film (tentered) features an increased modulus and a decreased elongation at break in both directions



FILMS AND SHEETS

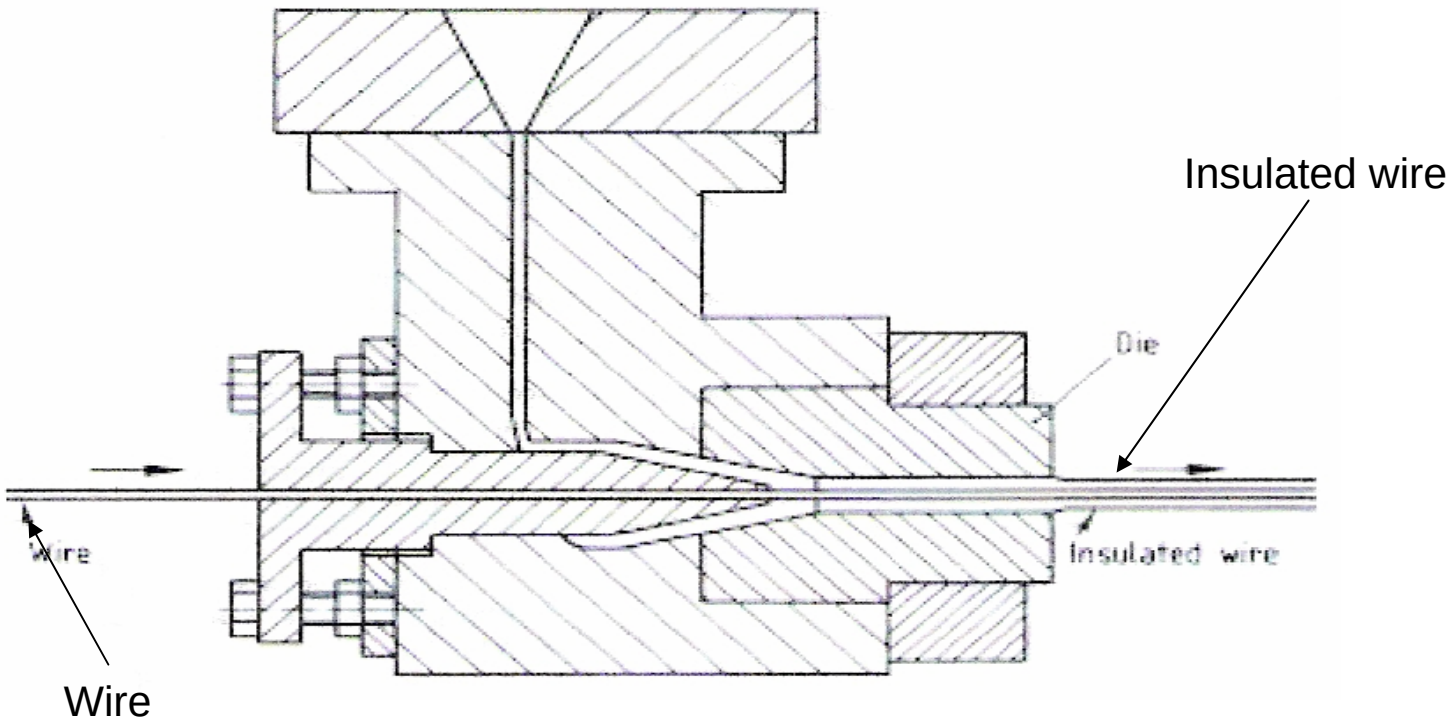
- Laminates or multilayered sheets can be produced during extrusion by combining the flows from different extruders into a flowblock and then forced through the same die
- Better adhesion between layers is achieved during coextrusion rather than by coating a cold material with a molten film

TUBING

- Pipes or tubes are also extruded through a ring-shaped die and around a mandrel
  1. Thick walls are required; therefore cool water circulates inside the mandrel
- Rubber tubing must be vulcanized for cross-linking
  1. If the melt is not viscous enough to remain stable during the cross-linking process at high temperatures, a filler might be added to induce viscosity

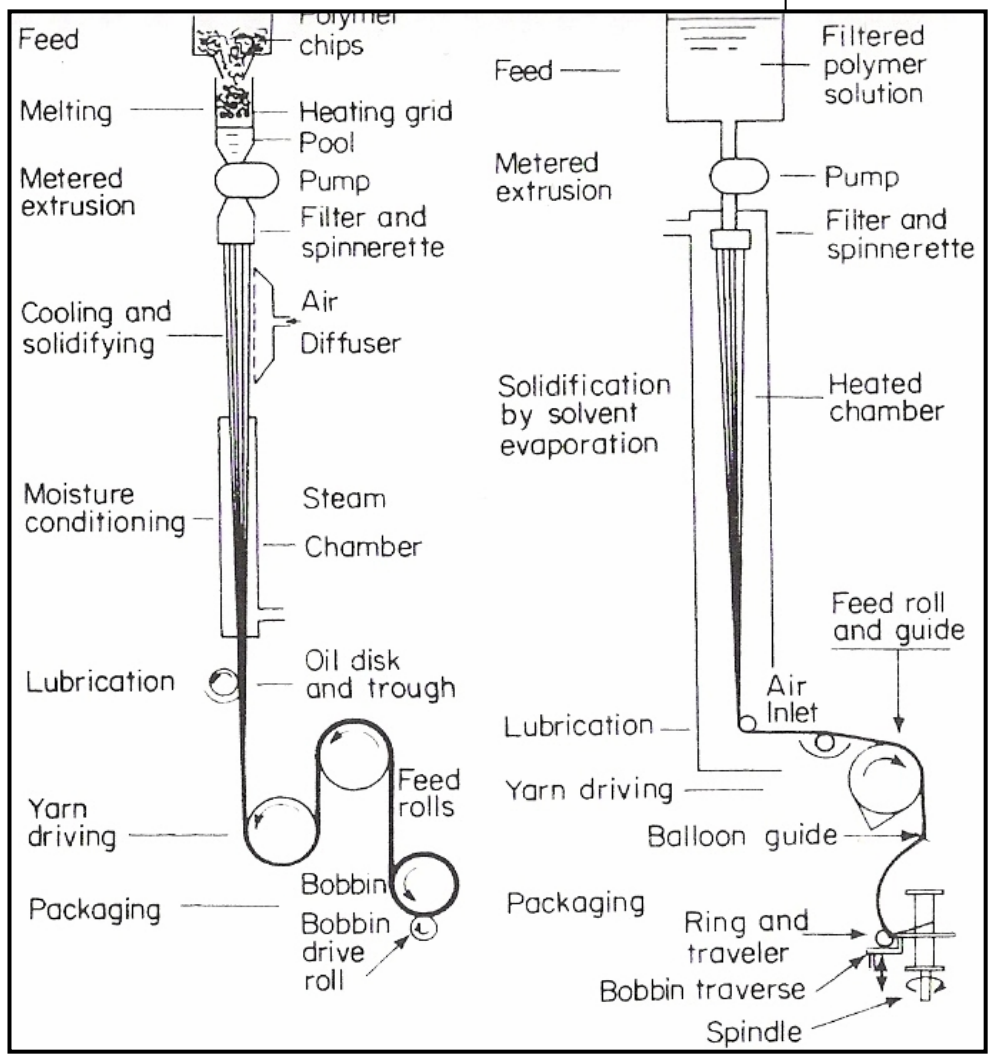
INSULATION

- Ressembles the tubbing process, but the material is extruded around a wire



FIBERS

- The term spinning is used in the modern synthetic fiber industry to denote the production of continuous lengths of a fiber
- The die is replaced by a spinnerette with up to 10,000 holes



QUESTIONS AND COMMENTS

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