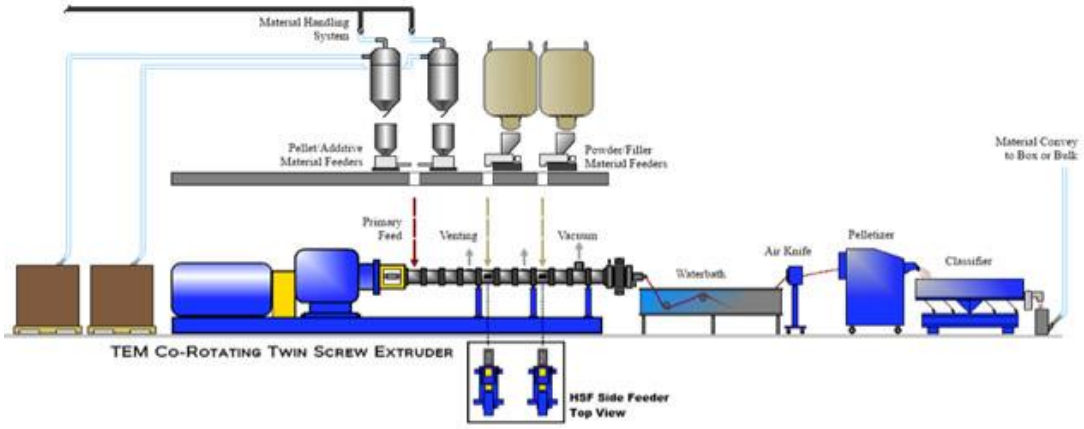
Foster Corporation

Compounding 101



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Continuous Process Melt Extrusion

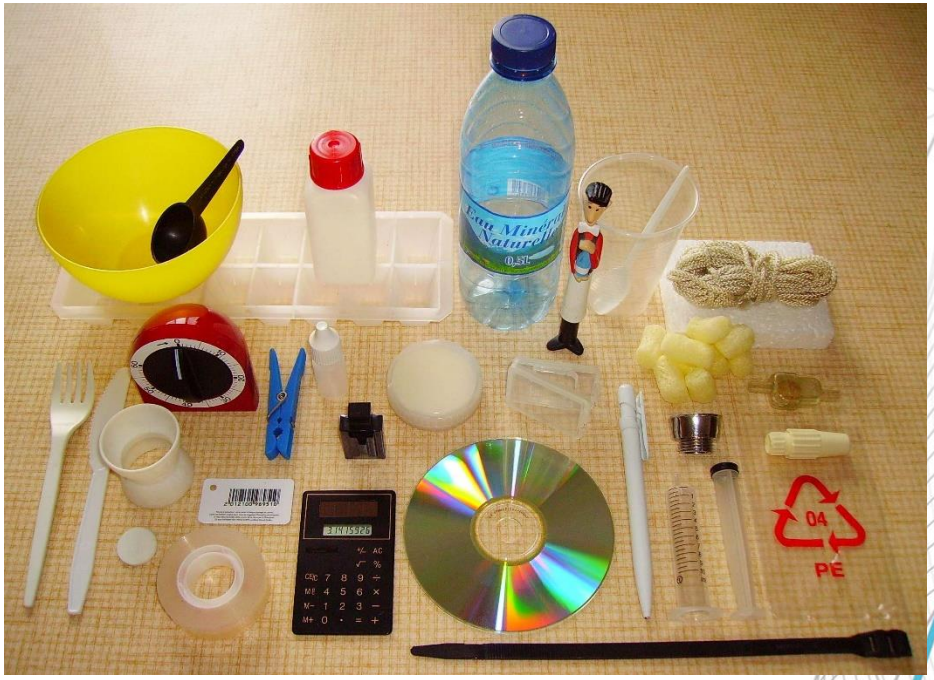
Polymer Compounding

- Definition
  - Upgrading or adding value of polymers or polymer systems through melt blending & mixing of additives into a polymer matrix or melt mixing two or more polymers together to make an alloy

Why Compound ?

Every plastic product has unique requirements – e.g. flexibility, strength, clarity, flammability, UV resistance, processability, color, etc…

Most of these requirements cannot be met by using only the raw polymers, so someone has to blend the additives together with the polymers…



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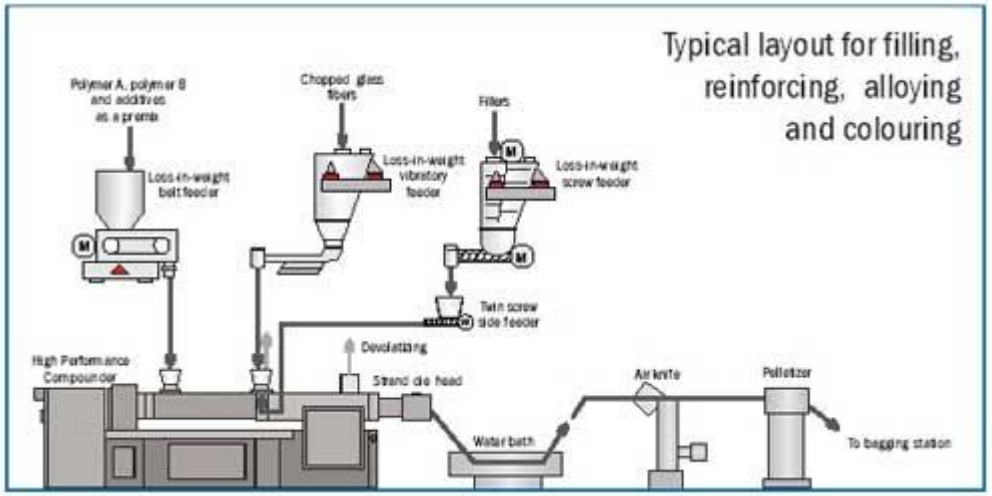
Compound Line

Consists of:

- Drying
- Feeding system(s)
- Extruder
  - Screw (s)
  - Barrel
  - Motor
  - Die
- Cooling
- Size reduction and segregation

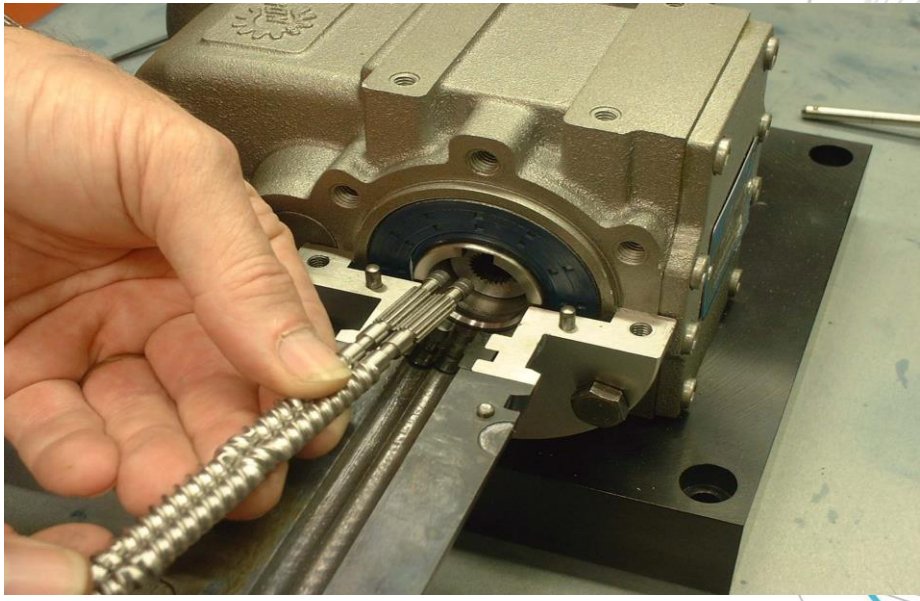


Twin Screw Extruder (TSE)

Comes In All Sizes

World's smallest twin-screw extruder

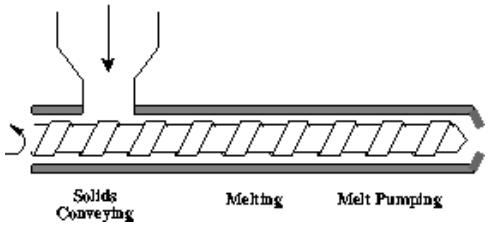
Diameter = 7.5mm

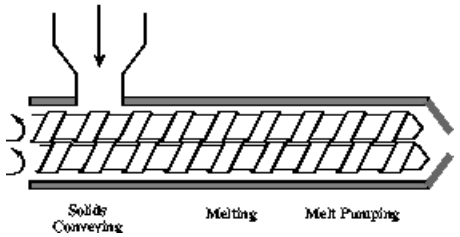


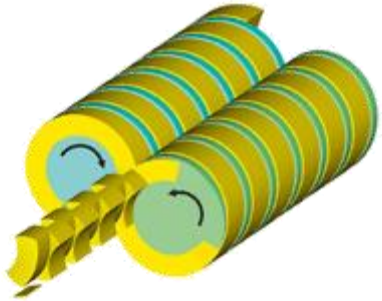
They make big ones too!!!

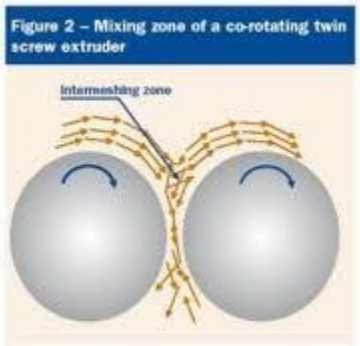
Compounder Types

- Single screw extruders
  - Used more for production of components
- Twin Screw Extruders
  - Co-rotating
    - Higher speed
    - Higher shear
    - More mixing capability
    - Used for dispersive compounding
  - Counter-rotating
    - Low speed
    - Low shear
    - Hi productivity
    - Used a lot for PVC products
- Hi intensity mixers
  - Intense mixing
  - Short time in barrel
  - High production









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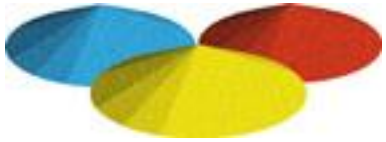
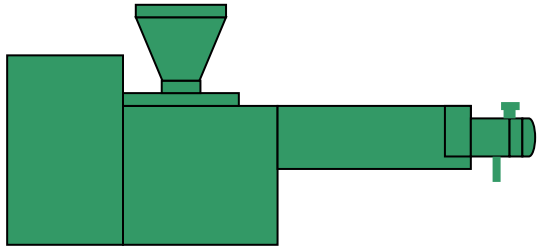
Pellets

Powders/Fillers



Fibers

Liquids



TSE

Pellets

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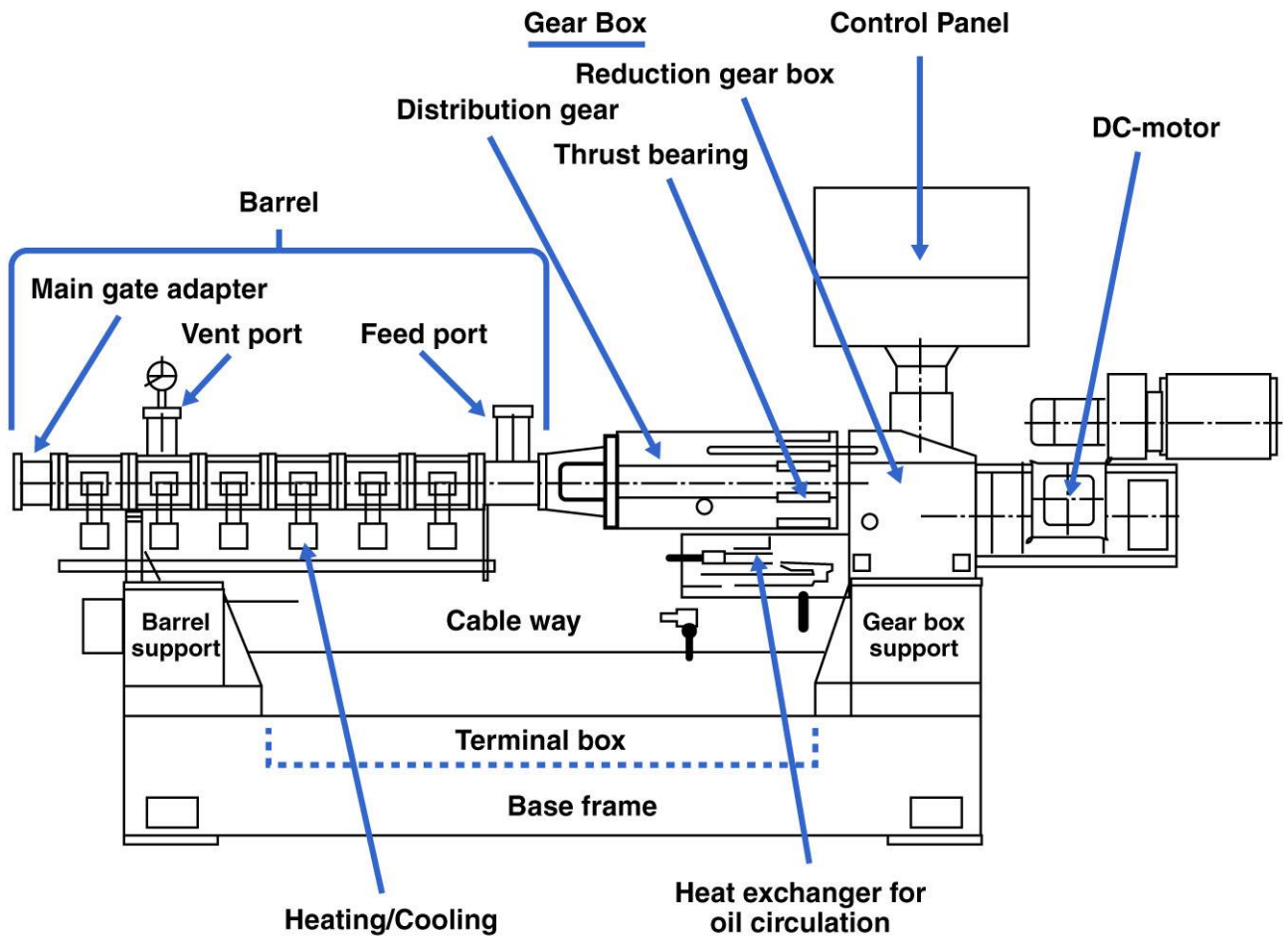
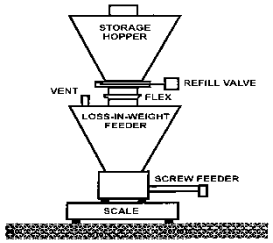
Twin Screw Extruder Schematic

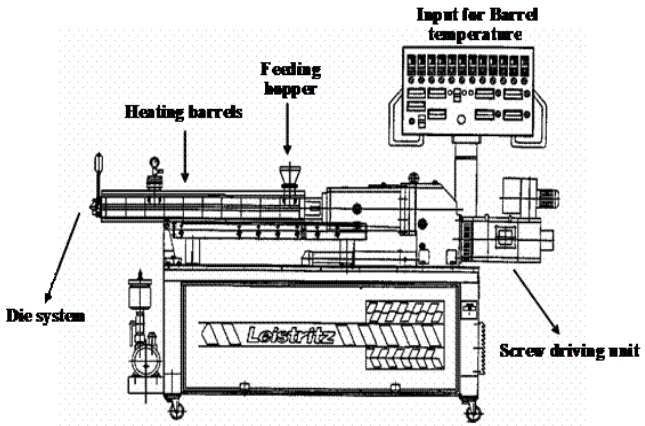


What Happens?
In a Compounding Operation

- Preparation of inputs
- Feeding of inputs
- Compounding
  - Conveying
  - Plasticizing/melting
  - Mixing
  - Homogenizing/Distributing
  - Dispersing
  - Devolatilizing
  - Reacting
  - Heating/cooling
  - Viscosity breakdown
  - Cooking pressurizing
- Cooling
- Size reduction and packaging



Inside Extruder



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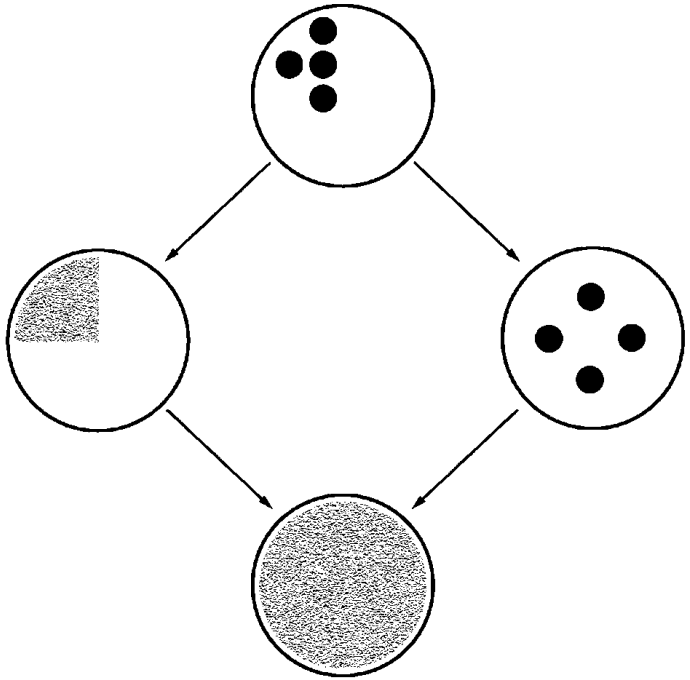
Example of Compounding

Conceptual representation of components prior to compounding



Example dispersive mixing

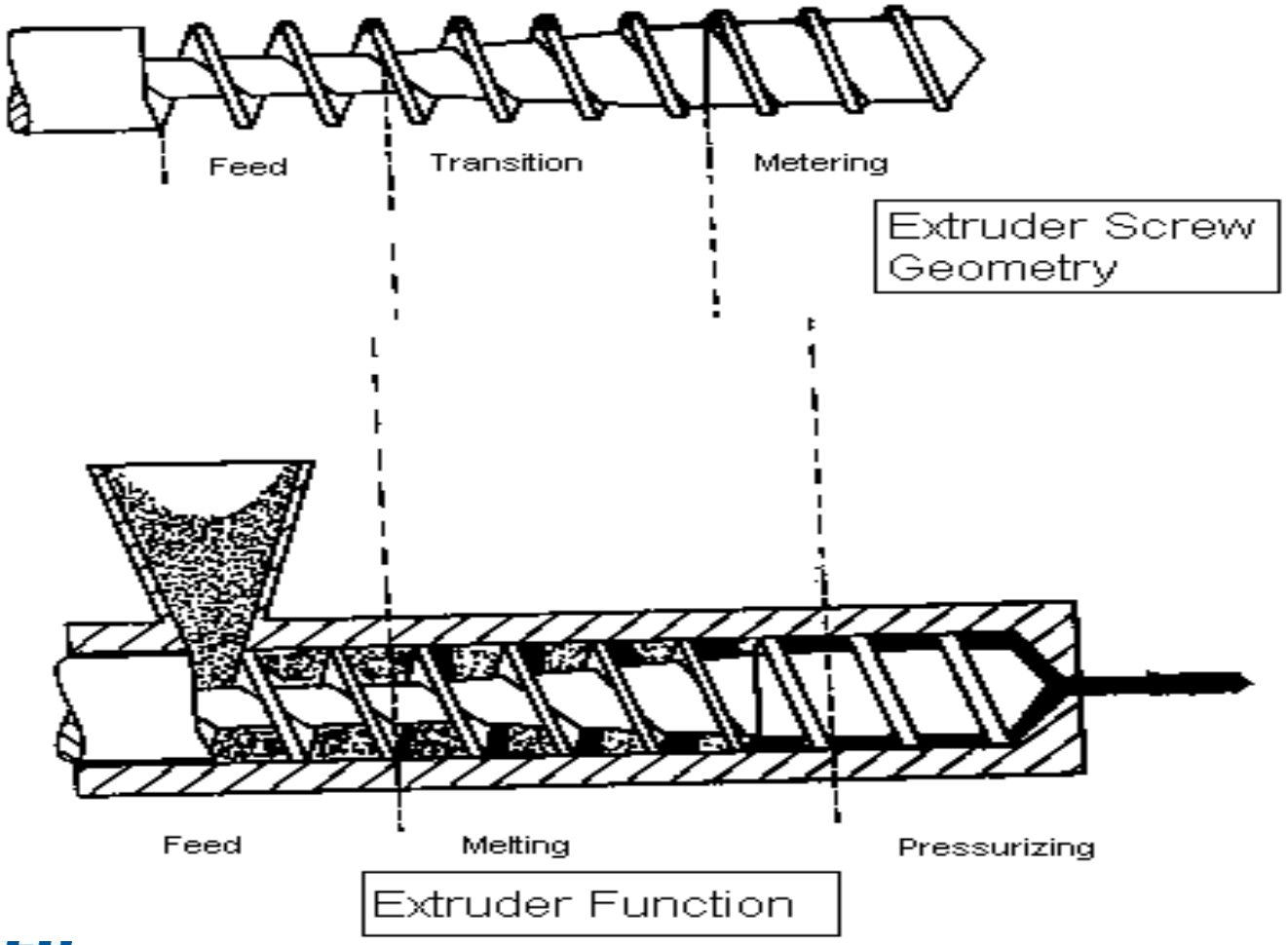
Example distributive mixing

Homogenous compound

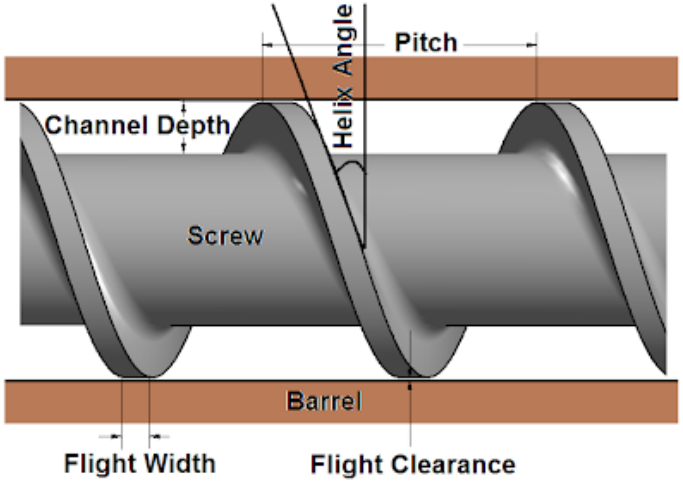
Mixing

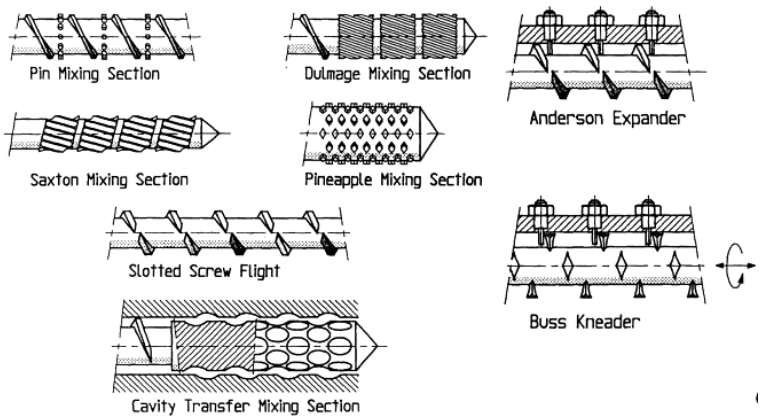
- Distributive
  - Uniformly distributes ingredients without using high shear stresses
- Dispersive
  - Intense process that employs high stress techniques to break up cohesive agglomerated solids
- Foster uses both methods

Screw: Geometry Vs Function

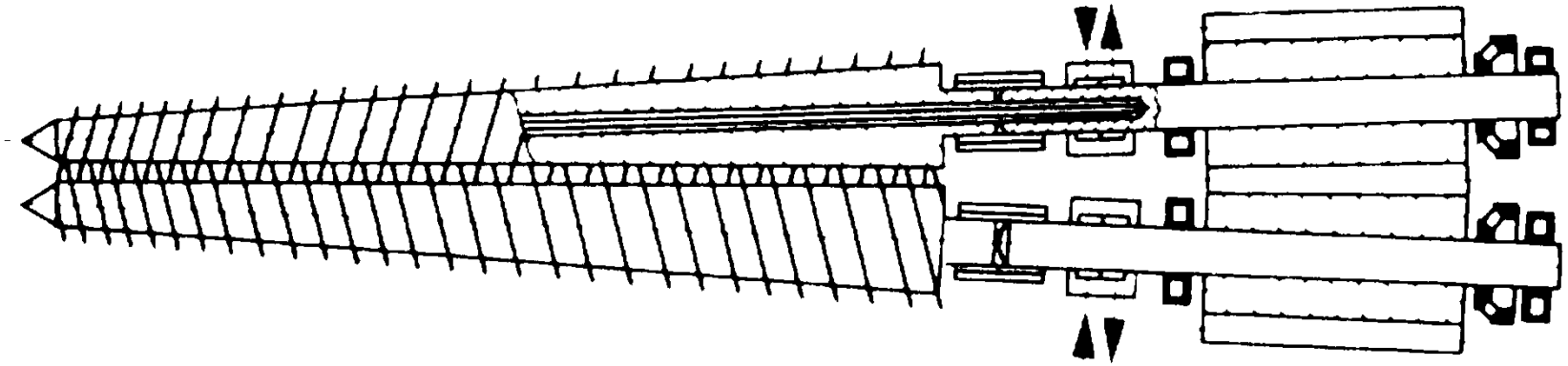


Screw Design



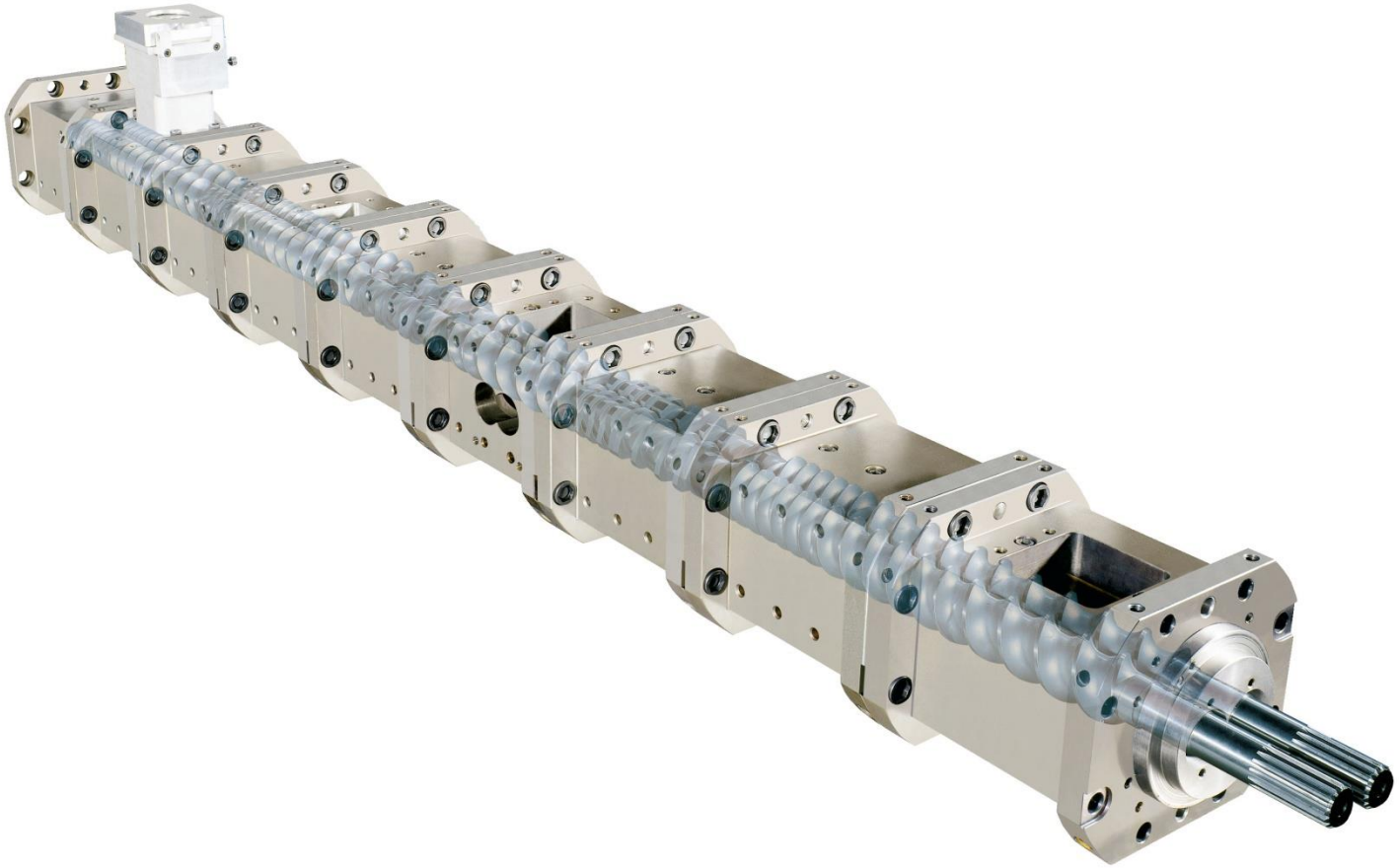


Conical Twin Screw Extruder



- Small bench-top HAAKE conical twin screw extruder
  - minimum 1 pound runs
  - good for small R & D blending
  - does not scale up to production well

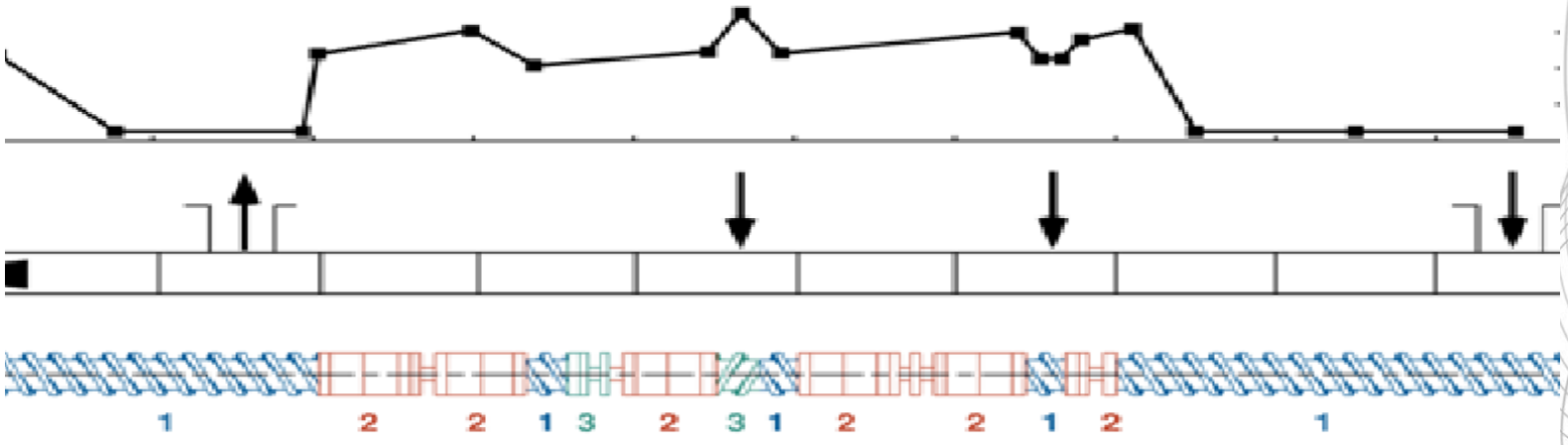
Typical Process Section



3 Categories of Screw Elements

Design Flexibility

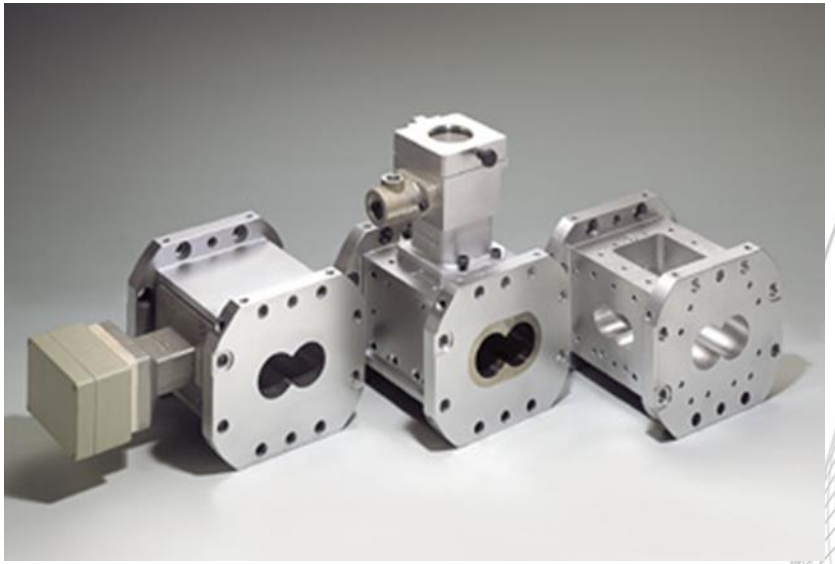
- **Flighted/Feed Elements**
- **Mixing Elements (dispersive & distributive)**
- **Zoning Elements**



Screws & Barrels Are Modular

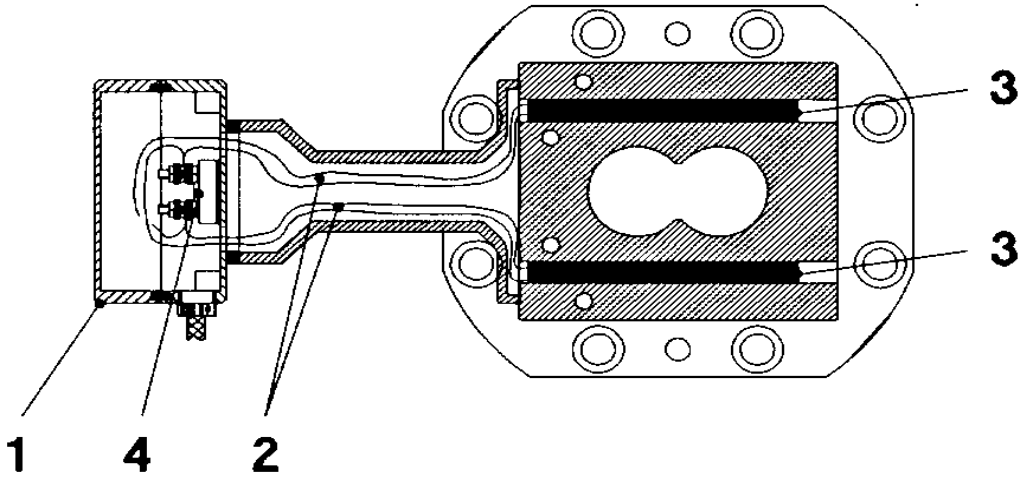
Design Flexibility

Screws are assembled on high torque splined shafts

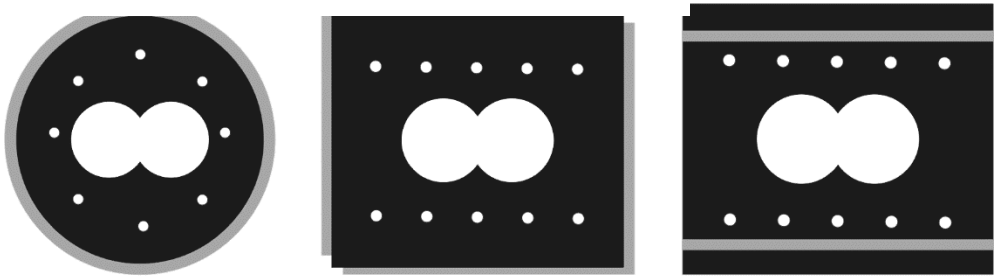


Flanged barrels, electrically heated and liquid cooled

Barrel Cooling



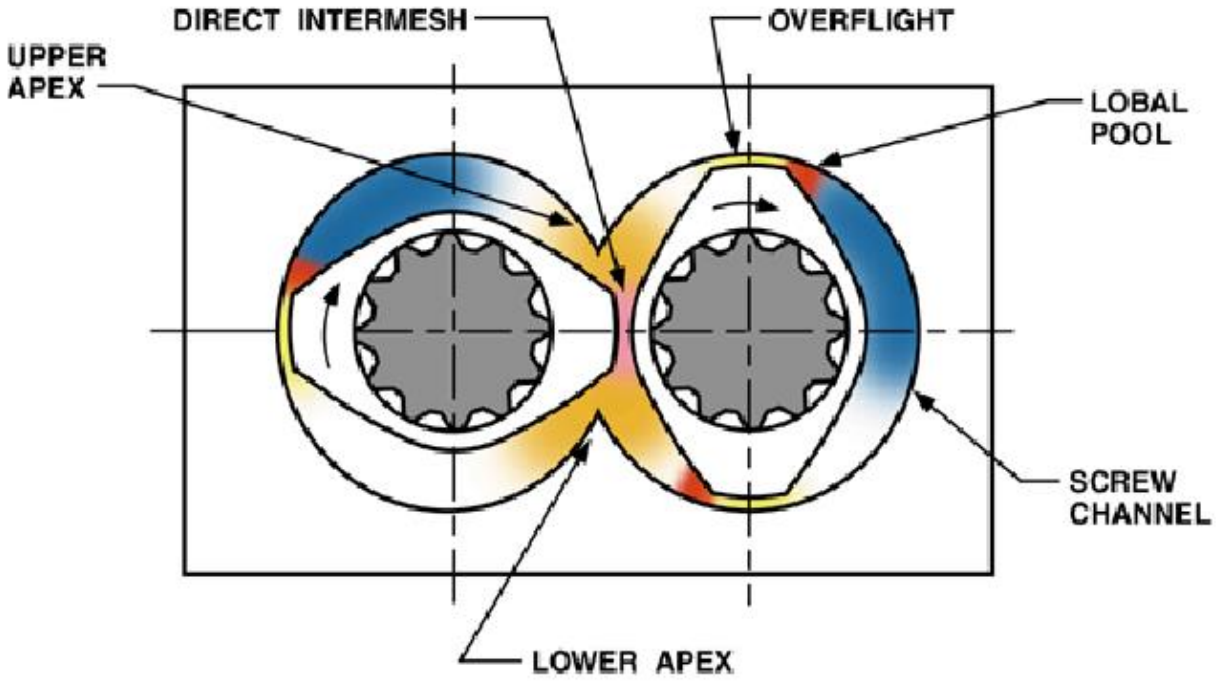
The processing unit is cooled with air, water or oil by means of axial bores in the barrel.



The temperature of the processing unit can be controlled exactly

Twin Screw Theory

5 Mass Transfer Regions

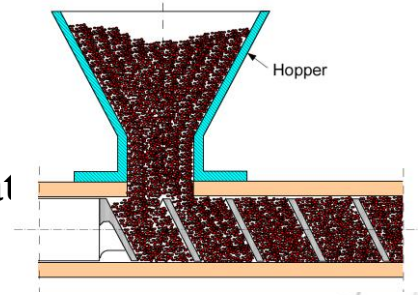


Feeding/Dosing

Twin screw extruders are starve-fed, NOT flood fed

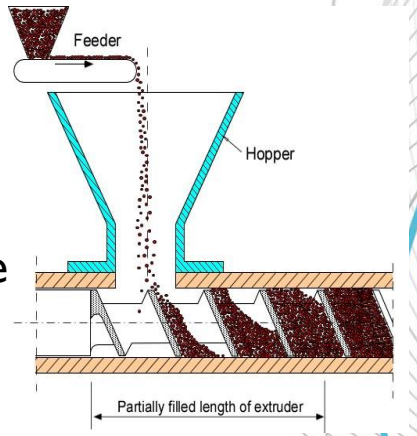
Single screw extruders:

- SSE are "flood" fed, hopper sits over screw, screw rpm determines rat
- SSE are high pressure machines used mainly for pumping



Twin screw extruders:

- TSE are "starve" fed
- Feeders set rate for twin screw extruder, screw rpm independent
- TSE screw rpm up to 1200, used to optimize compounding efficiencie
- Pressure gradient is controlled in TSE, and 0 for much of the process
- 0 Pressure in TSE facilitates sequential process operations



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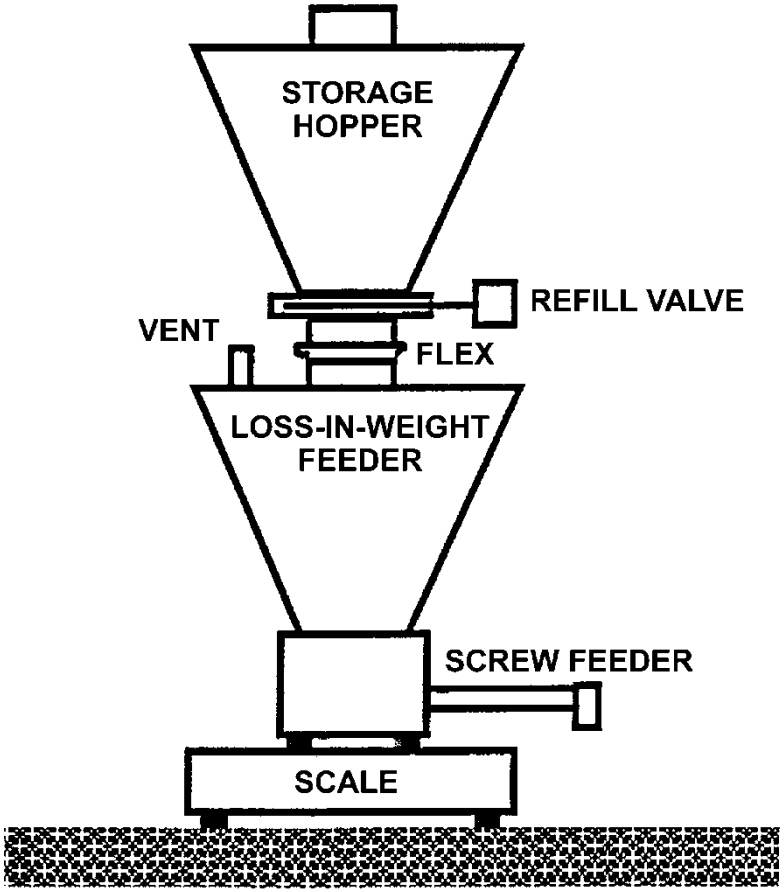
Feeding/Dosing

Example of a Loss-in-Weight Feeder



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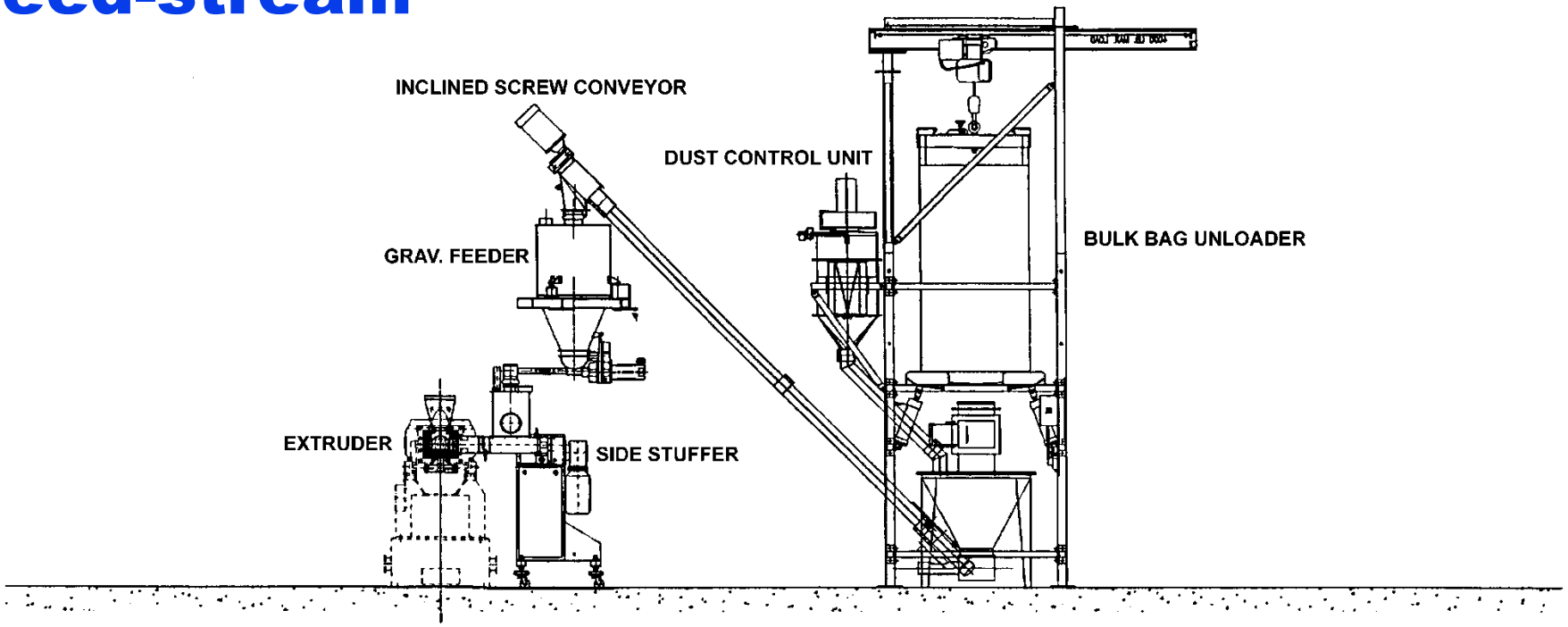
Feeding/Dosing

Typical Filler/Powder Feed-stream



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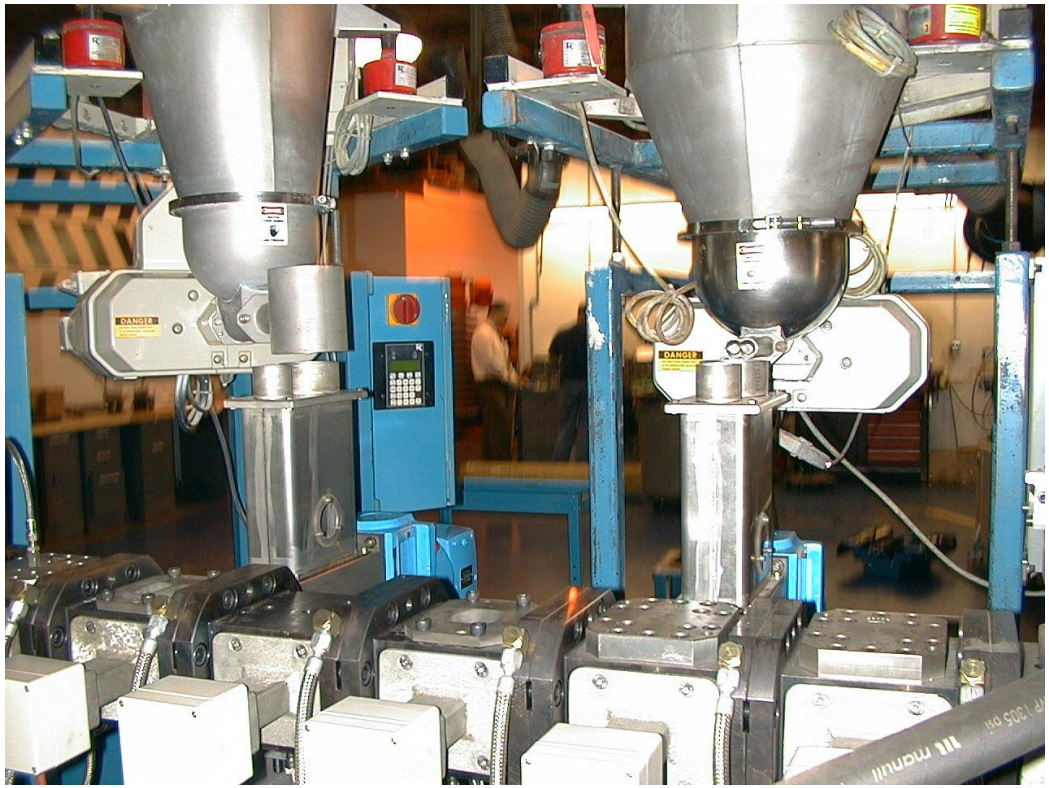
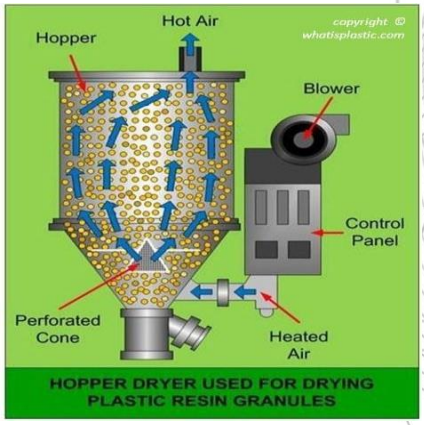
Feeding/Dosing
Multiple Downstream Feeders



Drying

- Very important pre-compounding operation
  - Many polymers are hydroscopic (attract water)
  - Polymers with water present will lose properties
  - Drying drives moisture out of the polymer for optimal processing and properties
    - Desiccant/dehumidifying - most common type
      - Can be hopper based or stand alone
    - Hot air (stand alone) - Tray dryers
    - Vacuum dryers (stokes tumbler was originally a vacuum dryer)



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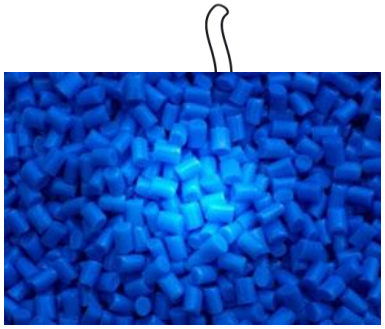
Types of Pelletization

- Underwater
  - Foster

- Strand cut
  - Foster



- Die face cut

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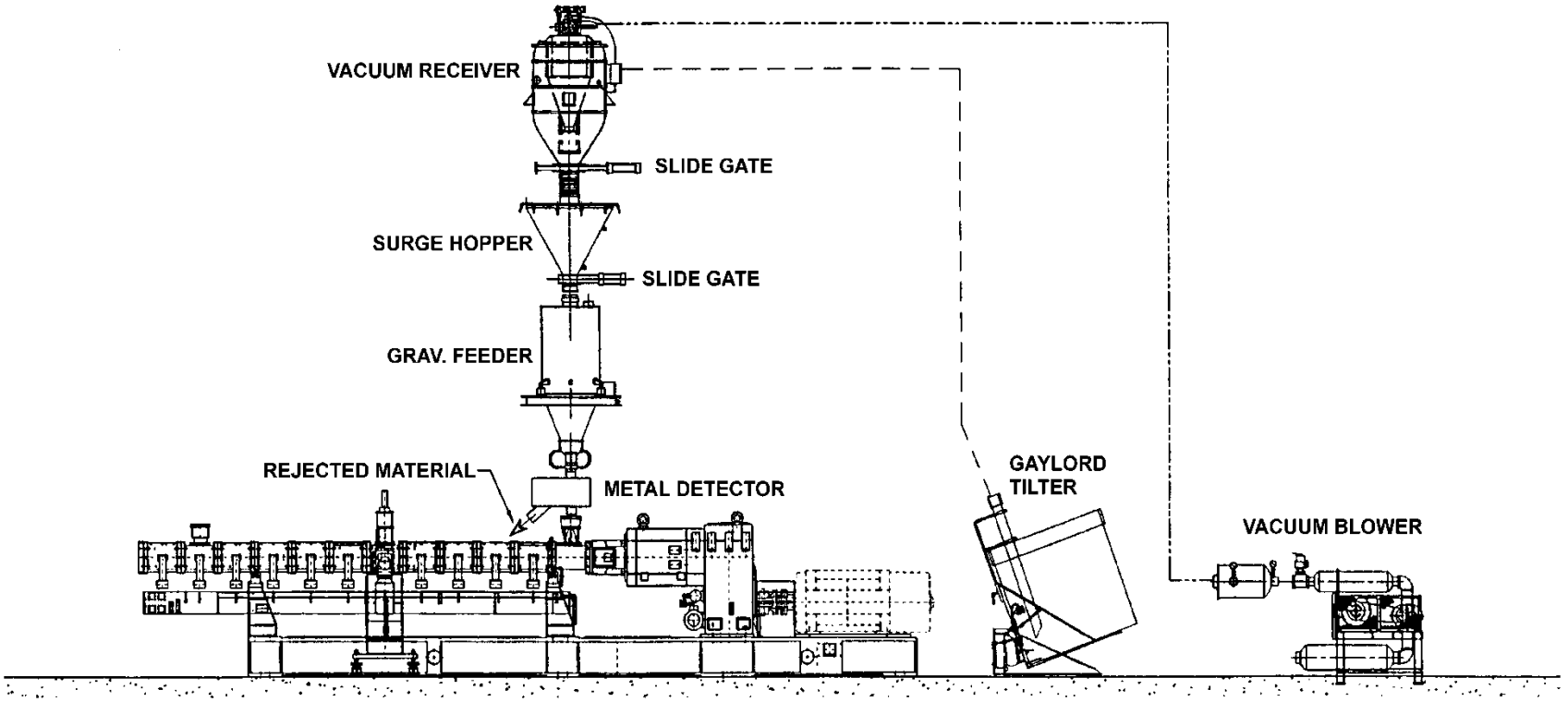
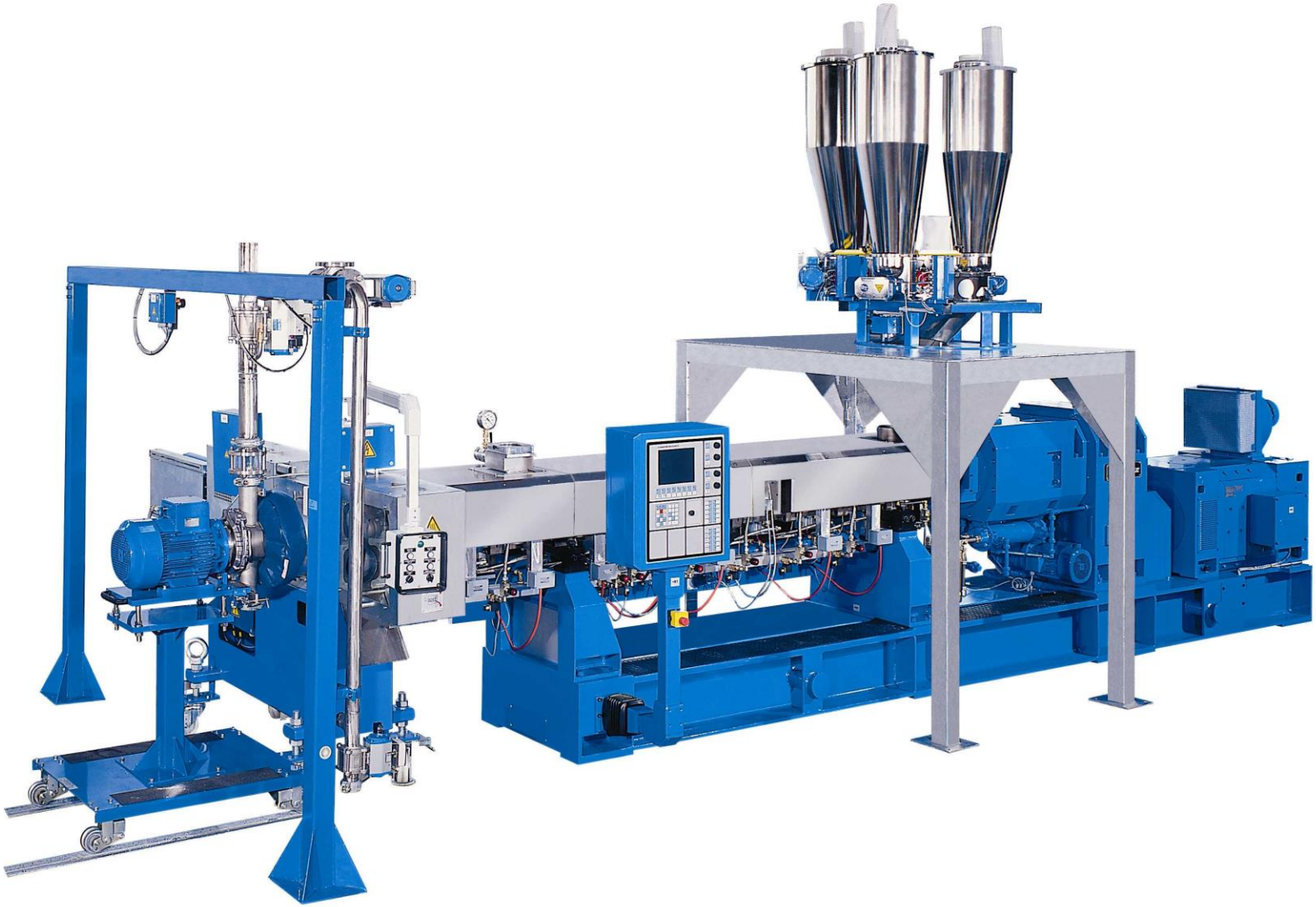
Typical Pellet/Regrind Feed-stream






Leistritz

Thank You!