

Innovations Available for Pet Food Extrusion Processes

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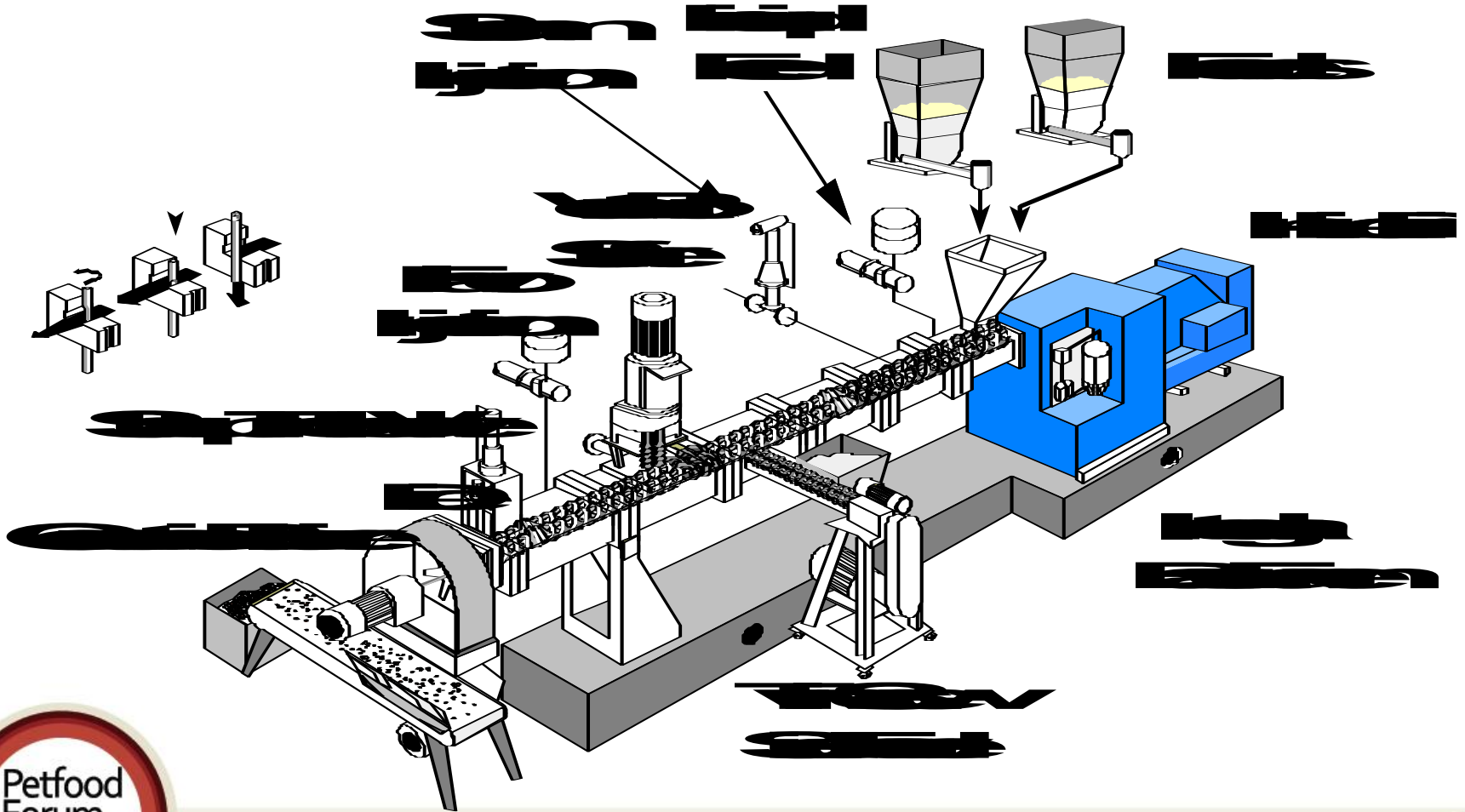


Topics

- Solids Gravimetric Feeder Technology
 - Why are Solids Feeders Necessary for for Continuous Extrusion?
 - What key features affect gravimetric feeder accuracy?
 - What options can optimize feeder accuracy and performance?
 - How is a gravimetric feeder refilled and how does this affect accuracy?
- Extrusion Technology
 - Steam Injection
 - Screw Geometry
 - Feed Enhancement



Twin-Screw Extruder System



Solids Feeder Technology

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Why are Gravimetric Feeders Necessary in a continuous extrusion process?

- To set the **precise & consistent** throughput and flow rates to a downstream process, ie an extruder
- Introduce ingredients in proper order for **selective control of residence times** in the process
- **Eliminate pre-mixing/segregation** of solids
- Consistent feed maintains **consistent output**



What are key issues to consider for feeder accuracy improvement on short term basis in a continuous process?

- Feeder **type and configuration chosen** in accordance with material characteristics

- Vibratory, weigh belt or screw feeder
- Single screw versus Twin screw
- Screw configuration
- Hopper configurations
- Agitation versus vibration

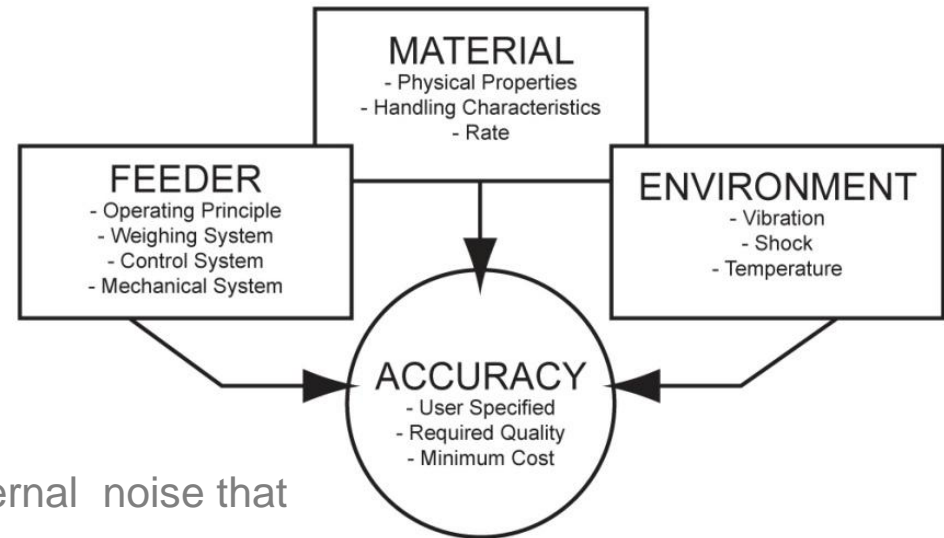
- **Controls and Weight Measurement**

- Load Cell Resolution
- Reaction Time of Controller
- Signal Clarity
 - Goal of filtering is to eliminate external noise that affects the **true weight signal**

- Method of **refill**

- **Environmental influences** and upstream/downstream connections

- Flexible Connections
- Proper Venting
- Drafts/Air currents
- Excessive Plant Vibration

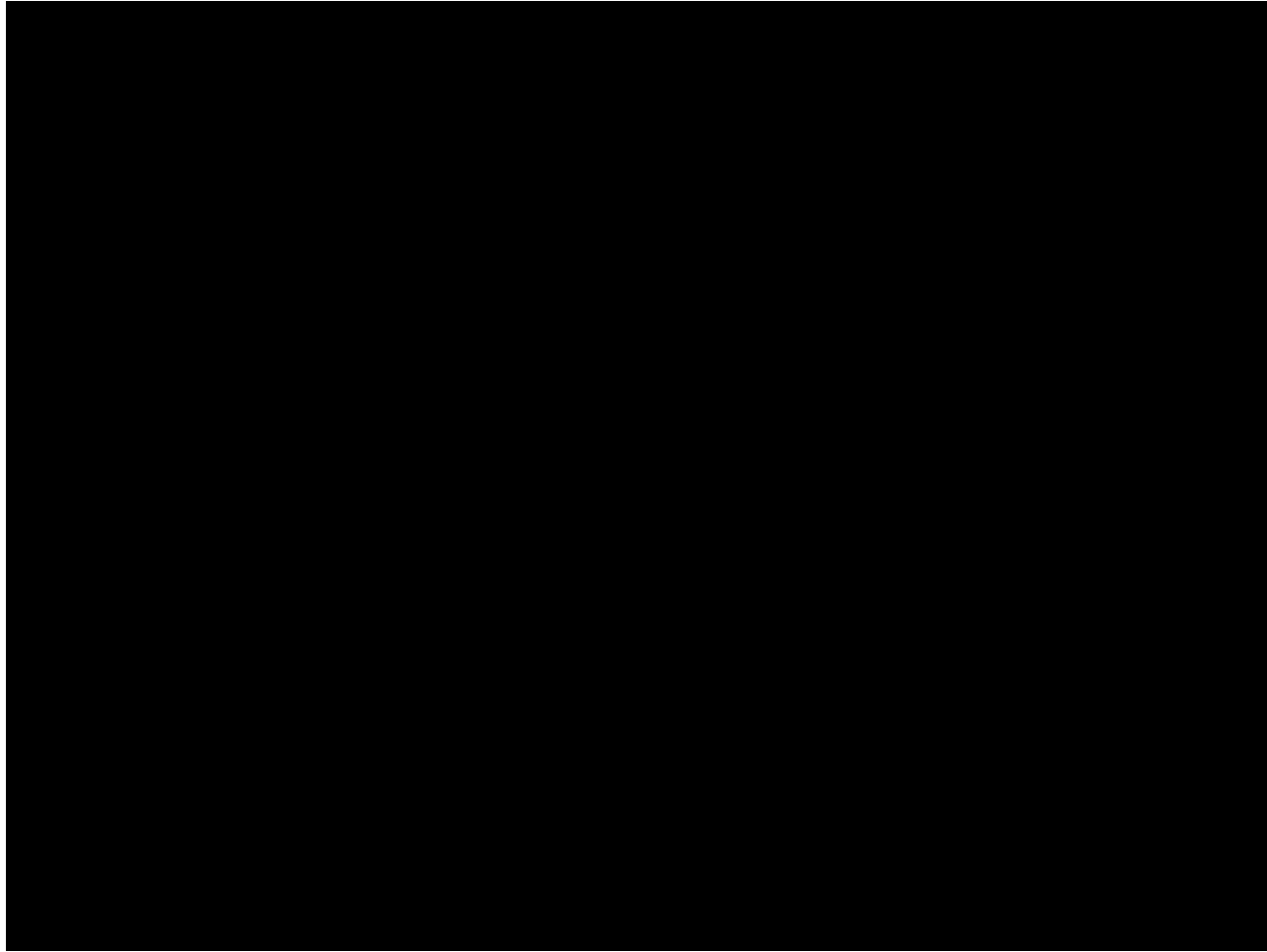


Optimization of Feeder Configurations

- Improper Selection of components can affect resultant RSD and flow rates
- Lower Rates are highly influenced by component selection
- Addition of screen at outlet of feeder helps with back pressure and resultant screw fill for some products
- For poor flowing products – screw fill is affected
 - Requires Proper screw type configuration
 - FDA Coatings available
 - Sometimes blend of flow aids will help



How does a Gravimetric Loss in Weight Feeder work during Refill



Extrusion Technology



Advantages of Steam Injection.



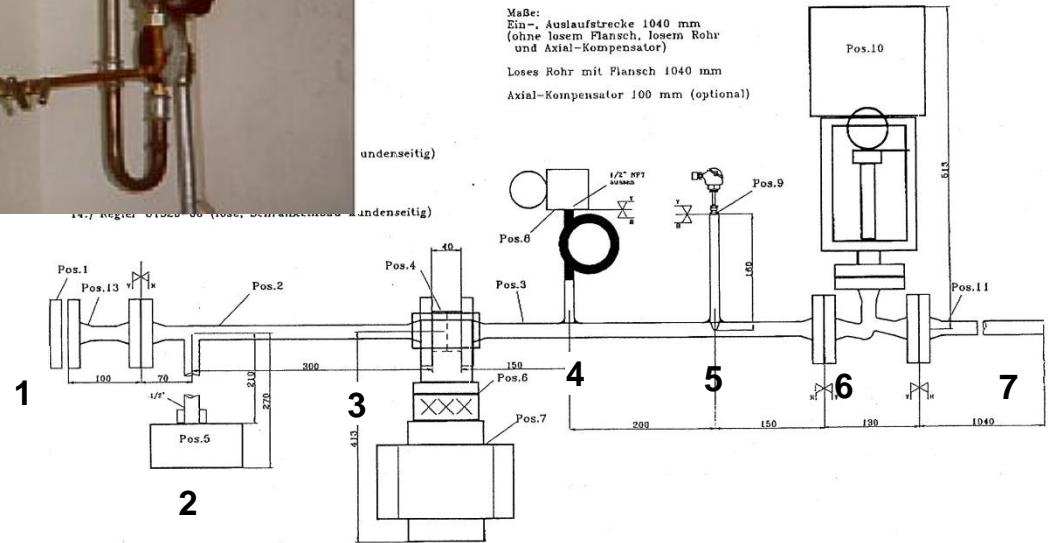
- Single-stage process
- No preconditioning required
 - Reliable production
 - Direct thermal energy input
- Reduction of specific mechanical energy input
 - Low energy cost



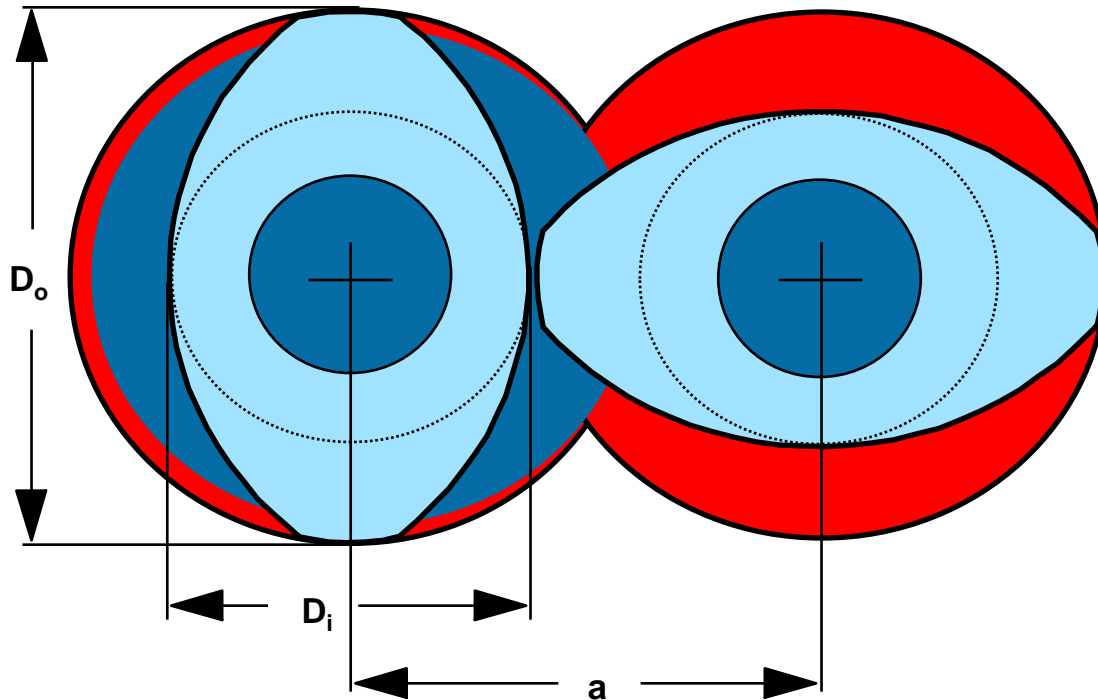
Steam injection.



- 1 Steam inlet (6-7 bar)
- 2 Steam trap (condensate)
- 3 Flow meter
- 4 Steam pressure probe
- 5 Steam temperature probe
- 6 Powered valve
- 7 Steam outlet to extruder



2-Flighted Profile



Diameter ratio: D_o/D_i
= indication of the free volume

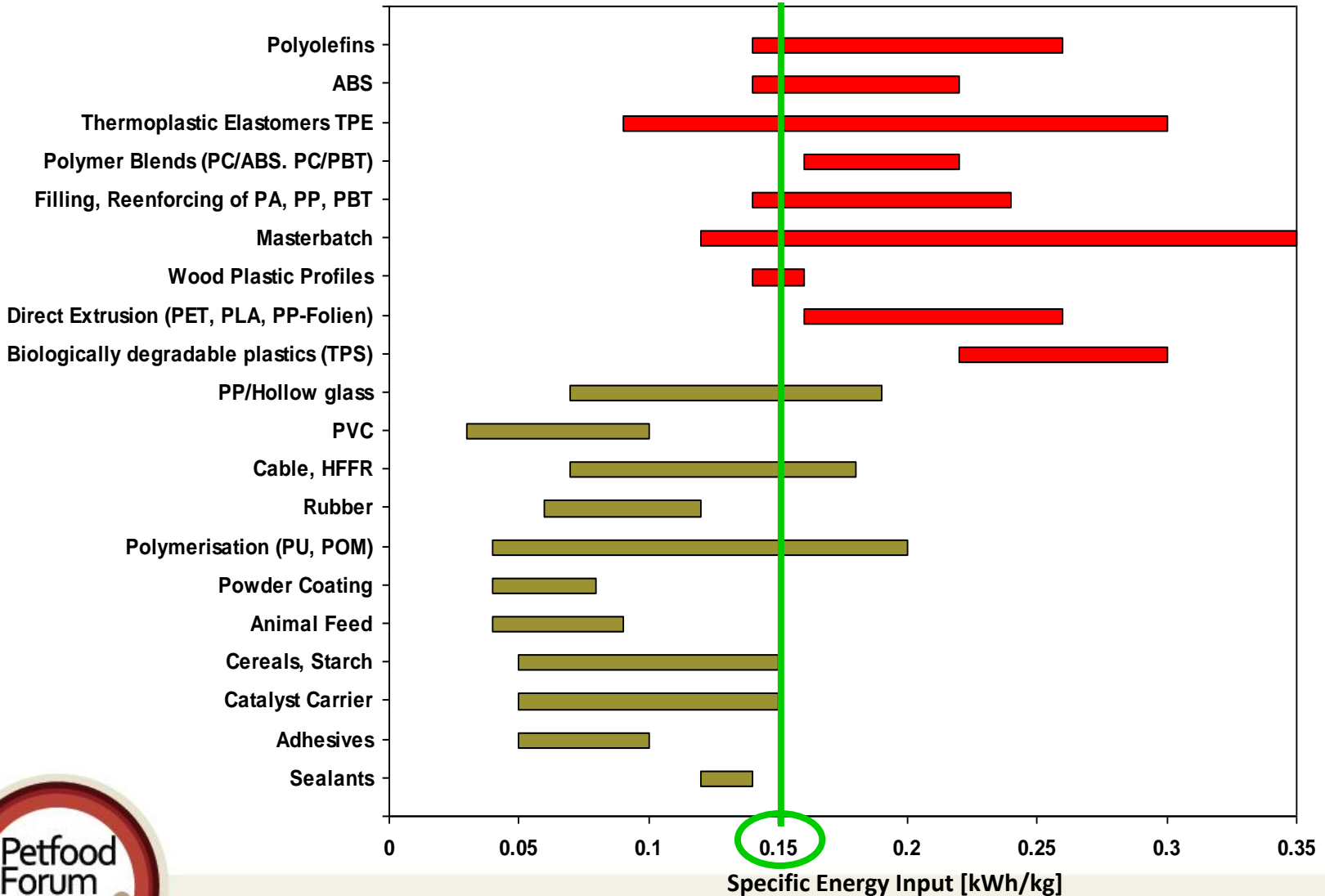
Specific torque: M_d / a^3
= indication of drive power per unit volume

D_o = Outer screw diameter

D_i = Inner screw diameter

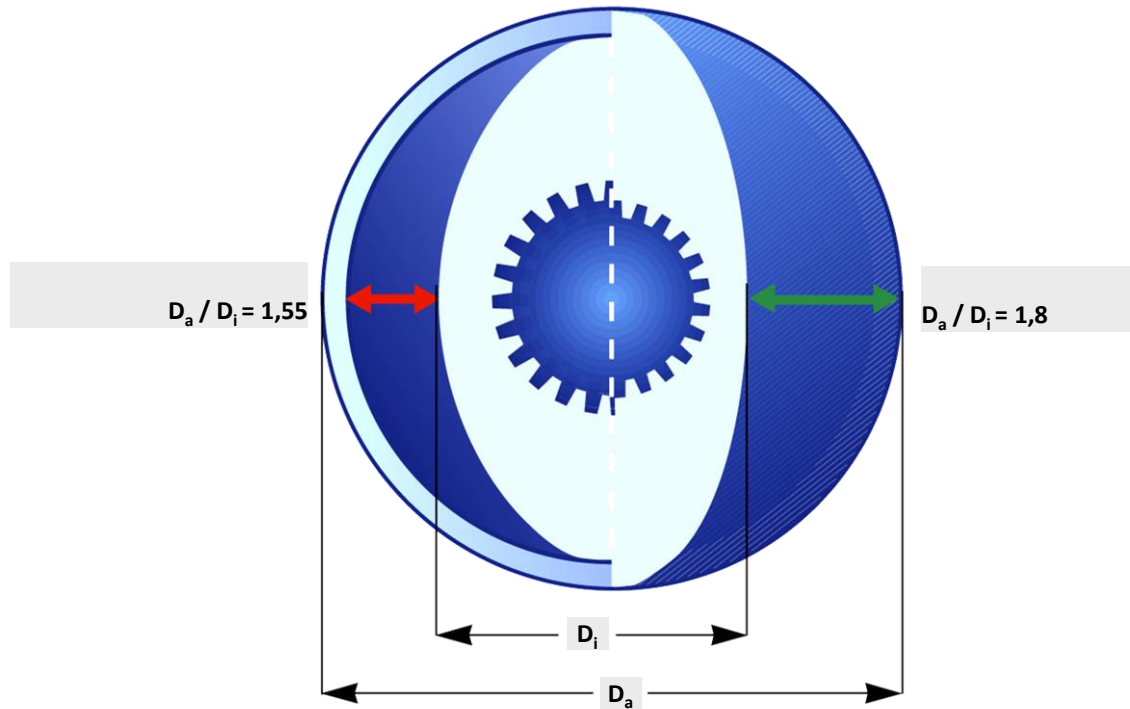
a = Center line distance

Specific Energy Input for 1.55 OD/ID and 1.80 OD/ID.

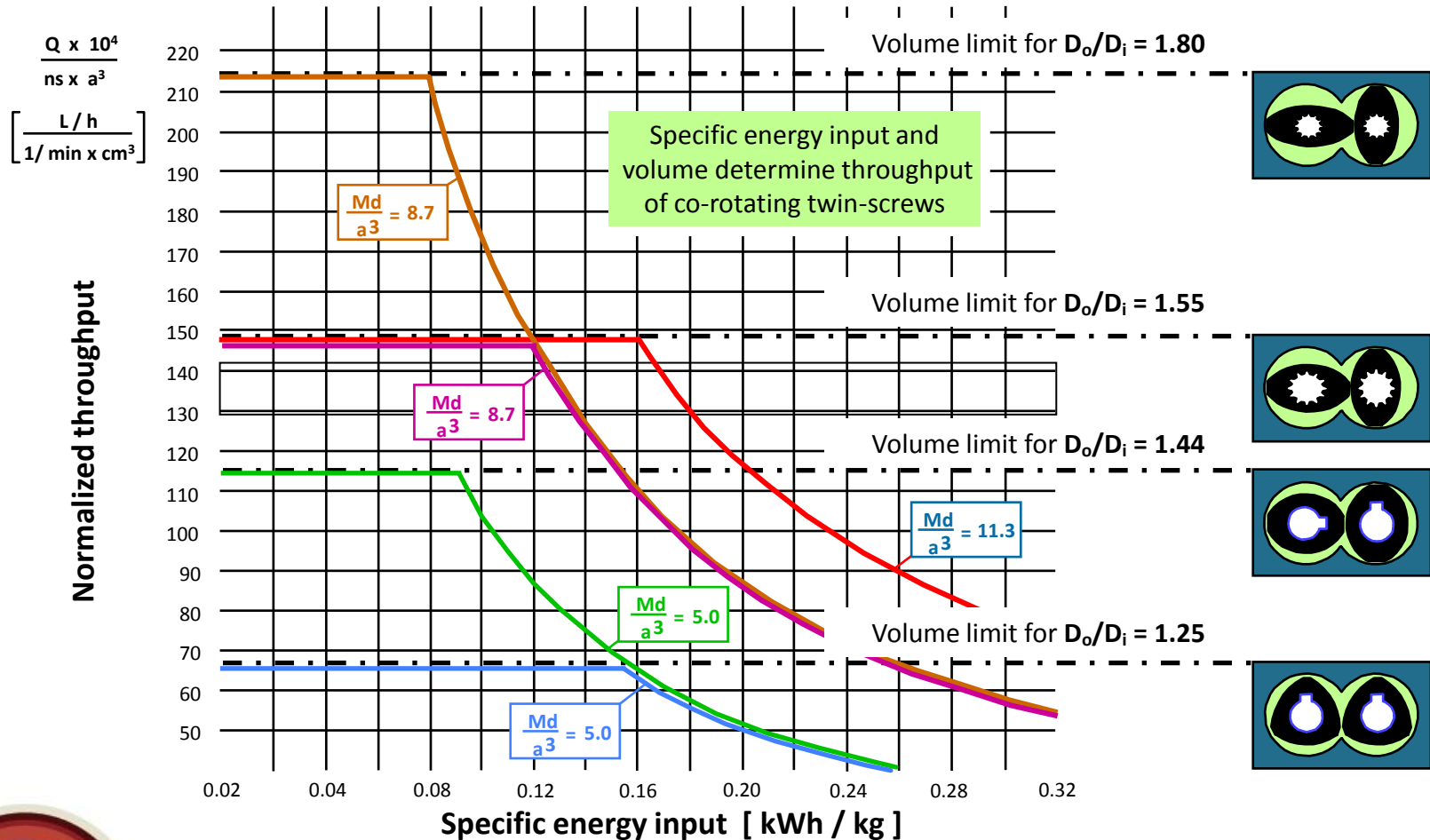


Changes in Screw Geometry

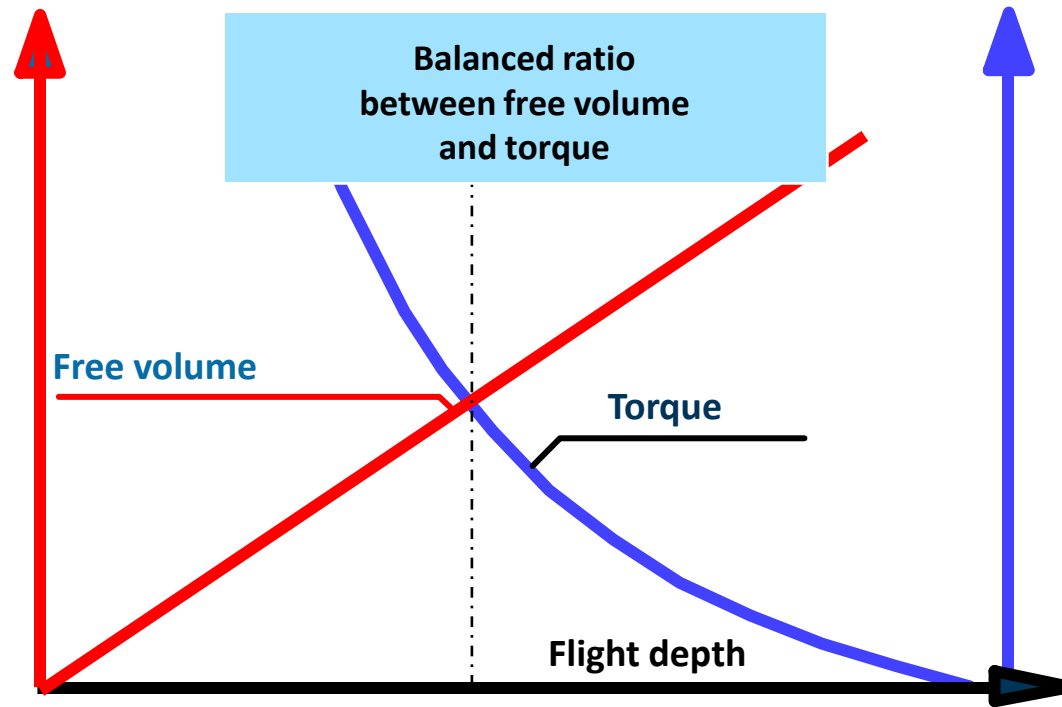
- Larger channel volume has been achieved by increasing barrel bore and deeper screw channels



Rate, Specific free volume and drive power



Free screw volume and torque have to be balanced

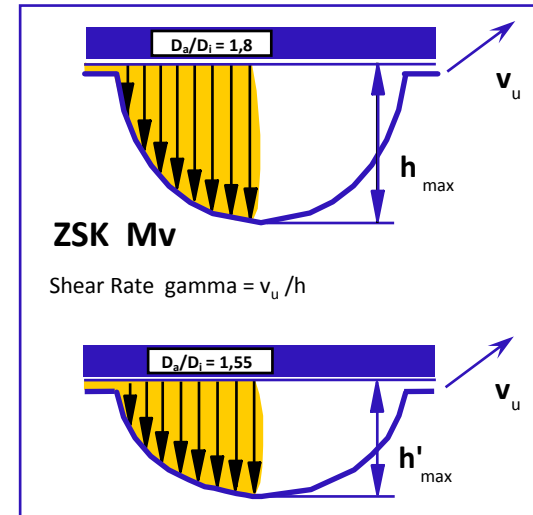


Free volume and permissible torque as a function of flight depth



Deep Screw Channels will offer Advantages

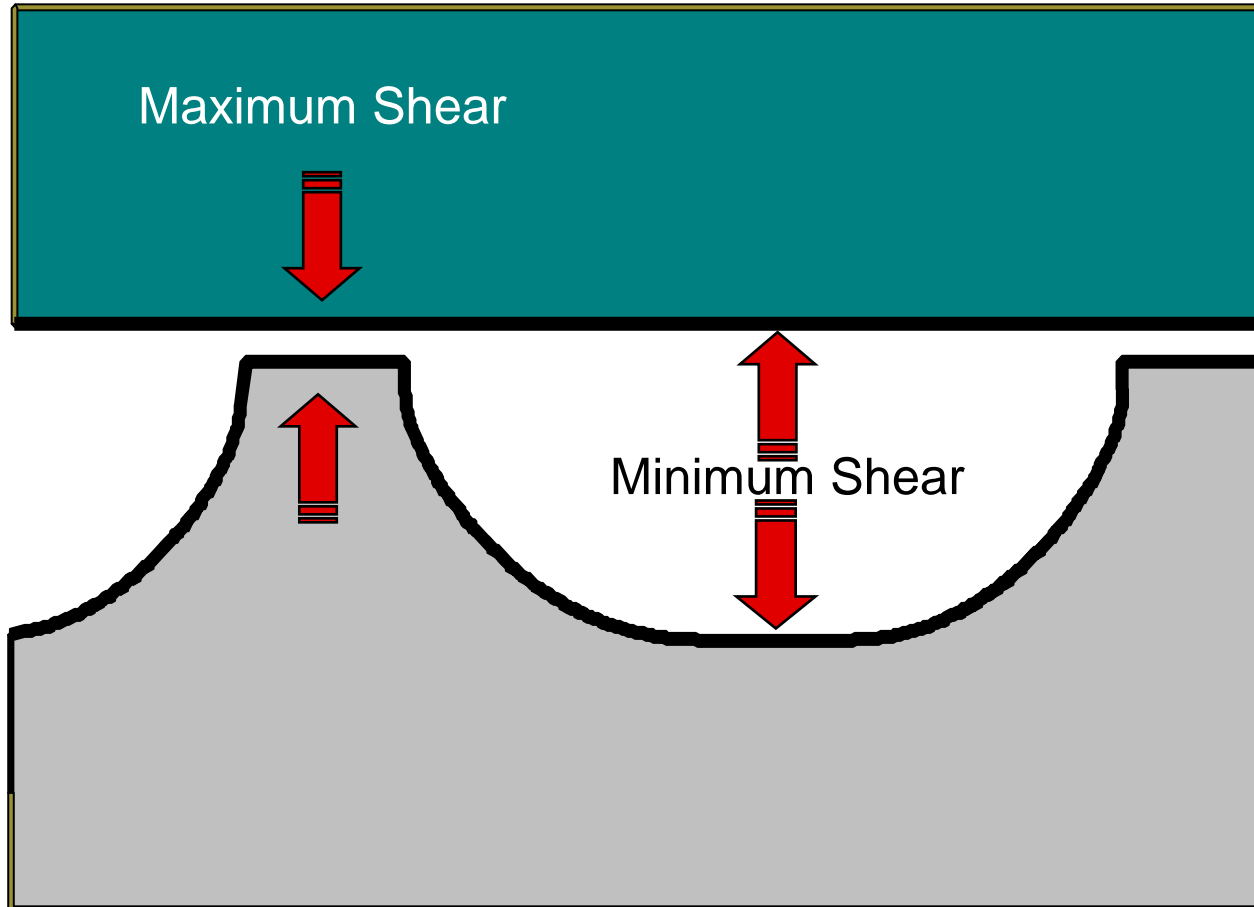
- Improved Intake
- Reduced Shear Input
- Lower Stock Temperatures
- Lower Product Stress, Improved Quality depending on Product and Process
- Safer Venting Operation



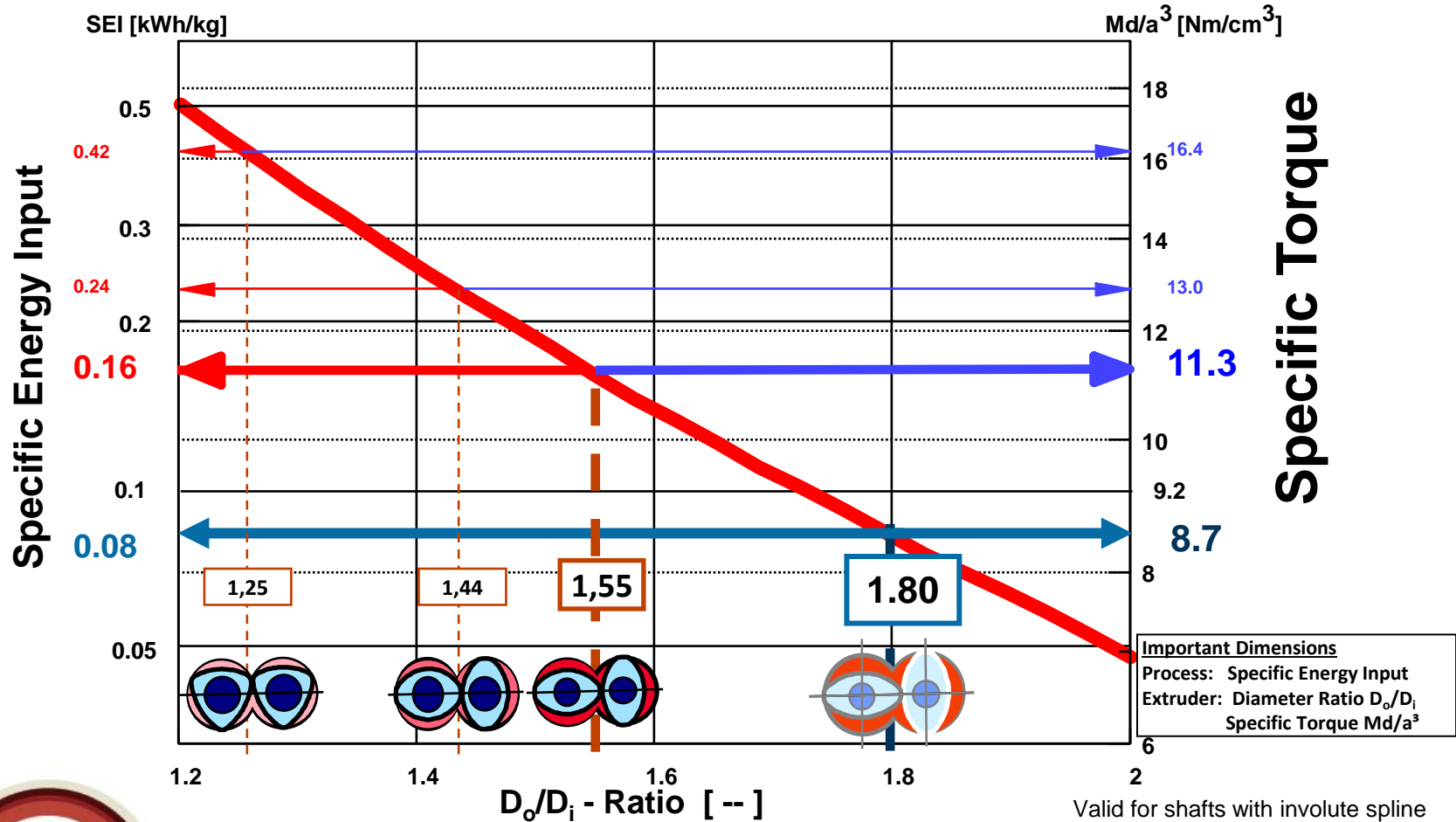
**Result: Deeper Screw Channels
allow for higher Screw Speeds**

Deep Screw Channels with identical D_o/D_i in entire Process Section ensure overall identical clearances

Shear rate distribution

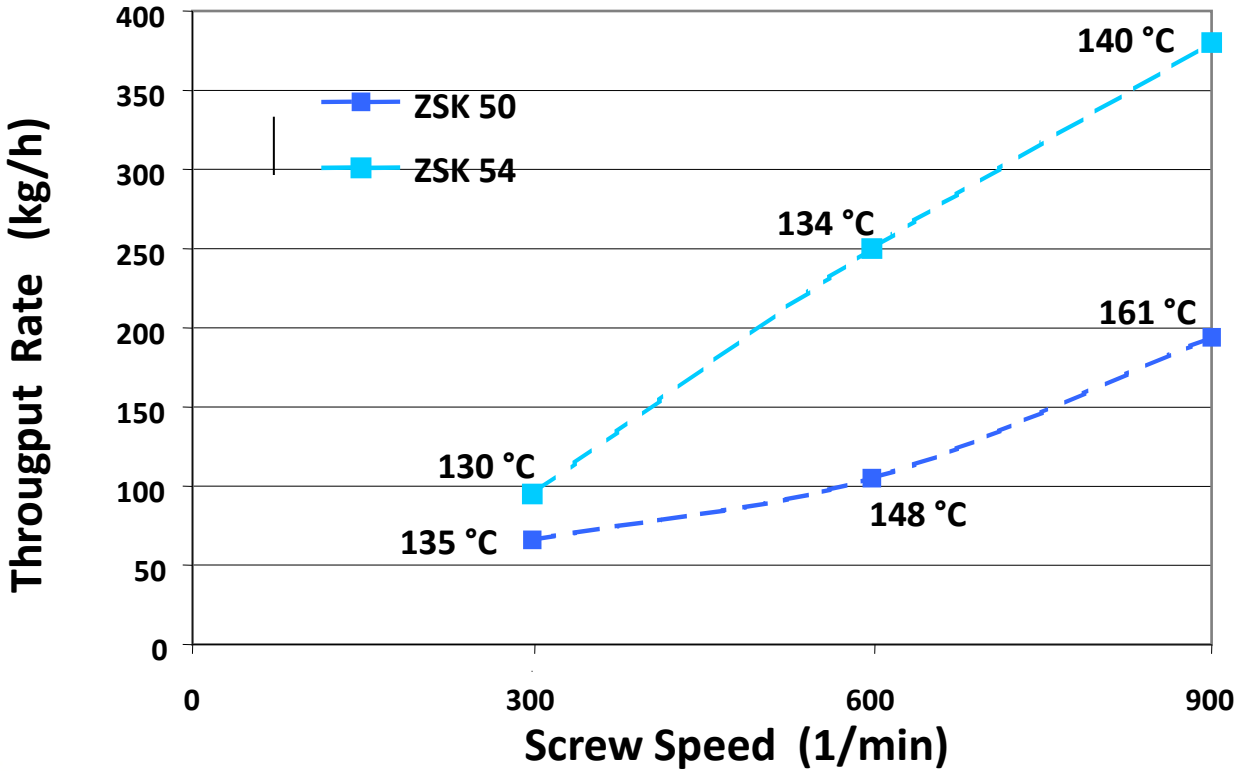


Mastergraph for Co-rotating ZSK-Twin Screw Extruders

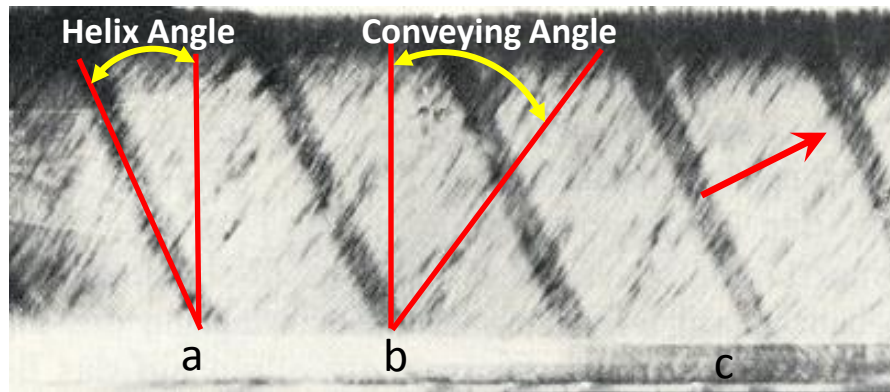
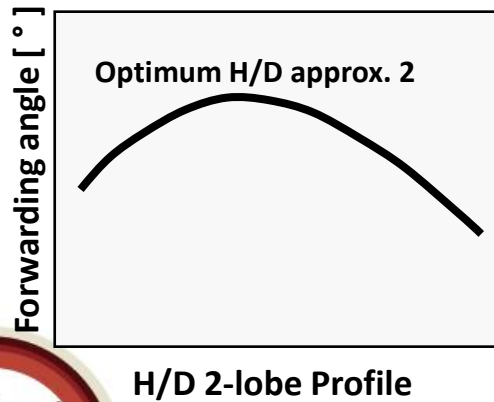


Cooking Extrusion

Increasing screw speed
will yield higher rates and lower stock temperatures



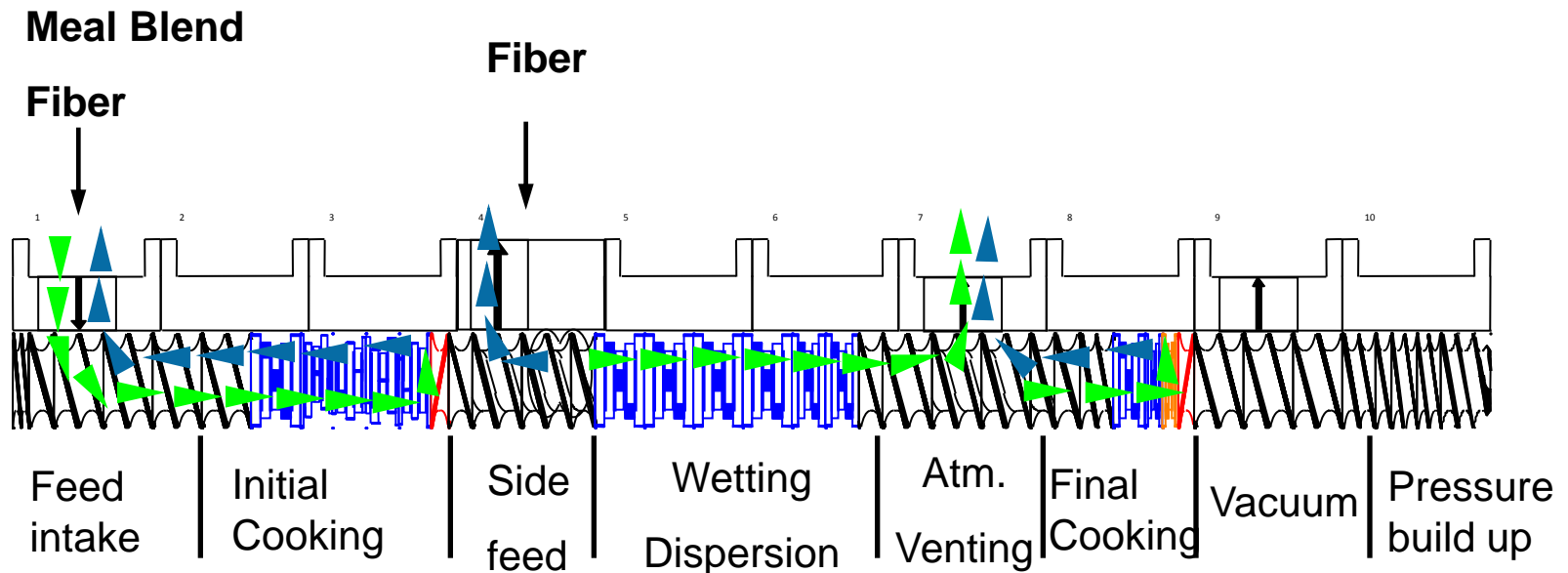
Solids conveying in a Twin-screw Extruder



Process configuration

Dog Treat/Snack and Fiber Addition

Processing sections and gas streams inside the Extruder

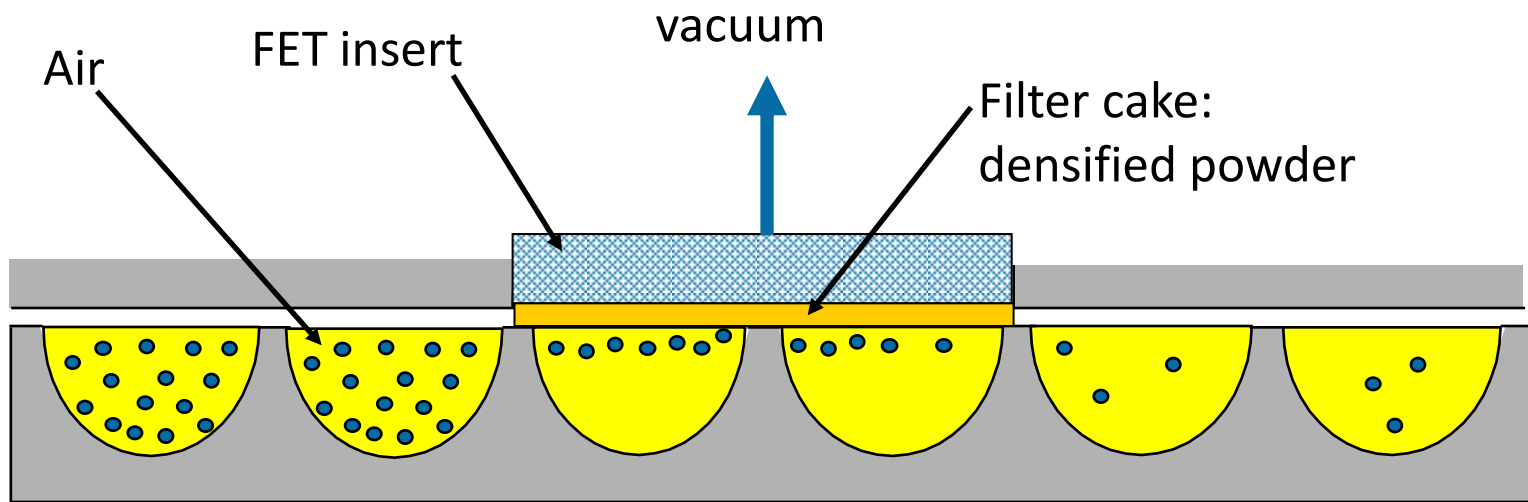


▲▲ Gas streams inside Twin-screw Extruder



Feed Section Design: Feed Enhancement Technology (FET):

Solids conveying is improved by applying vacuum in the feed zone to a wall section which is porous and permeable to gas.



Effects:

- air is removed → higher bulk density
- friction is changed in the area of insert

FET: Working Principle



Angle of conveying approx. 20°

low

Friction and higher bulk density increase the conveying angle:

Conveying angle ↑ → capacity ↑

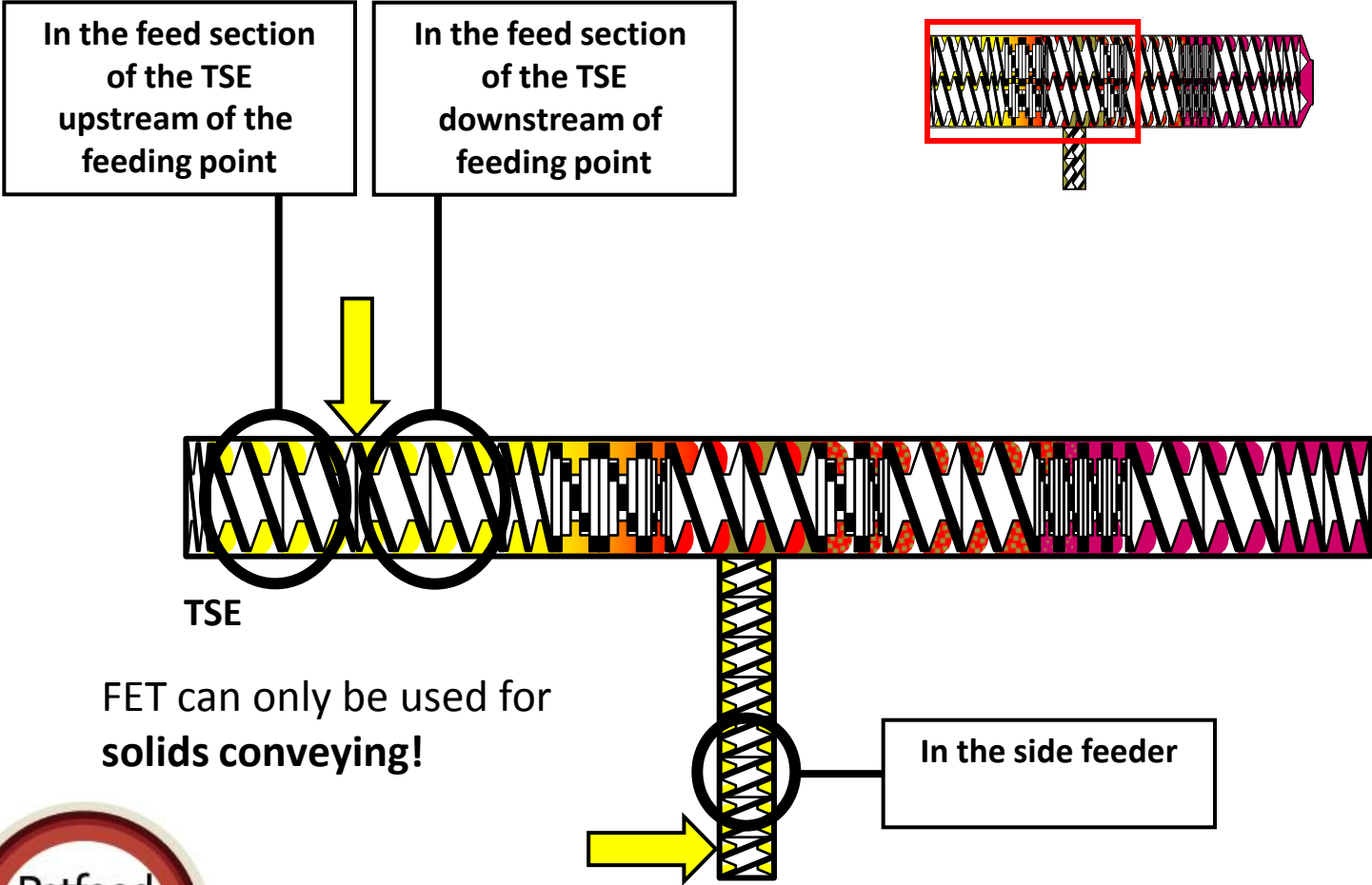


Angle of conveying approx. 40°

high

$$Q = F * H * n * \epsilon * \eta * \gamma$$

Installation Options for FET

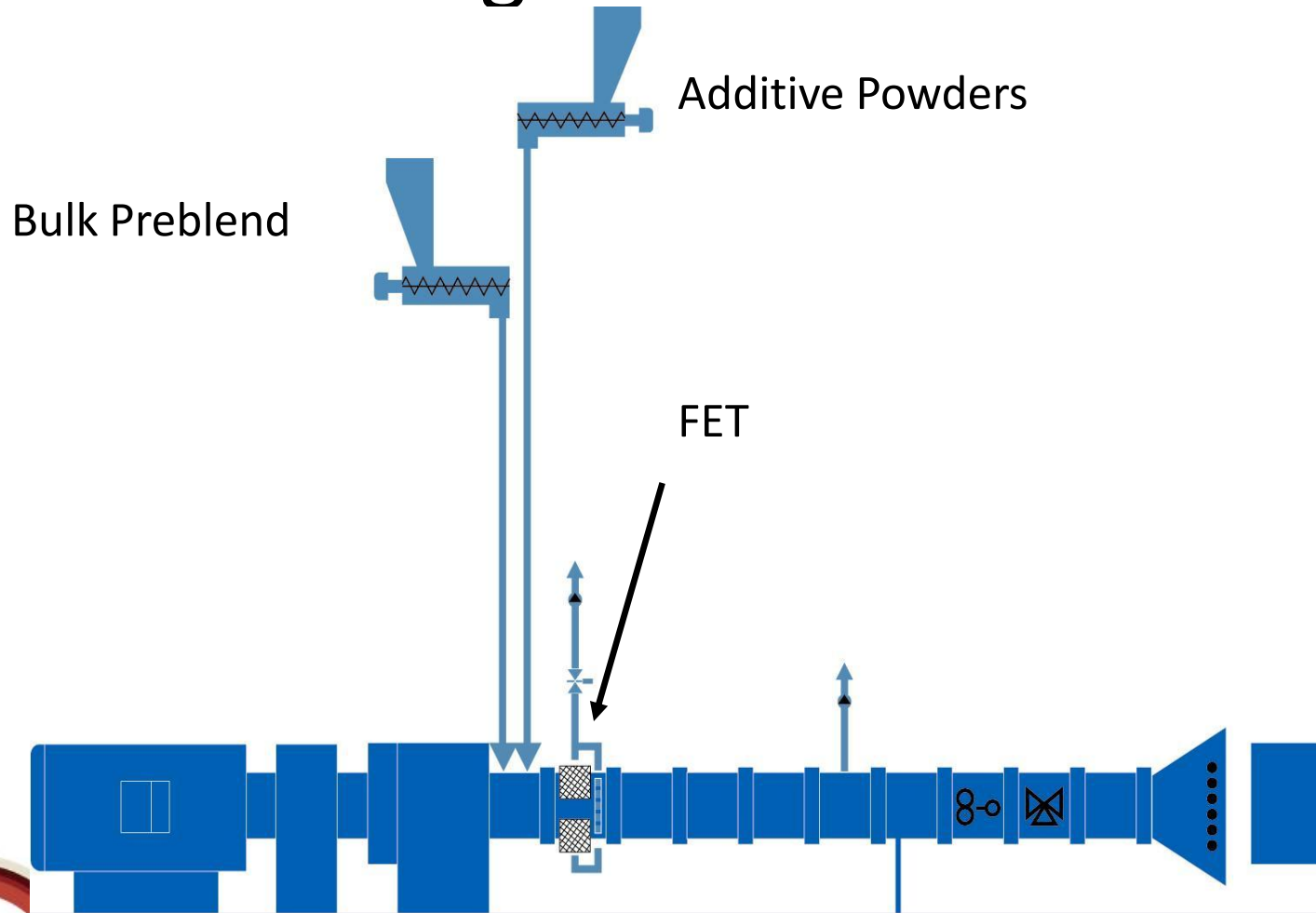


TSE

FET can only be used for **solids conveying!**

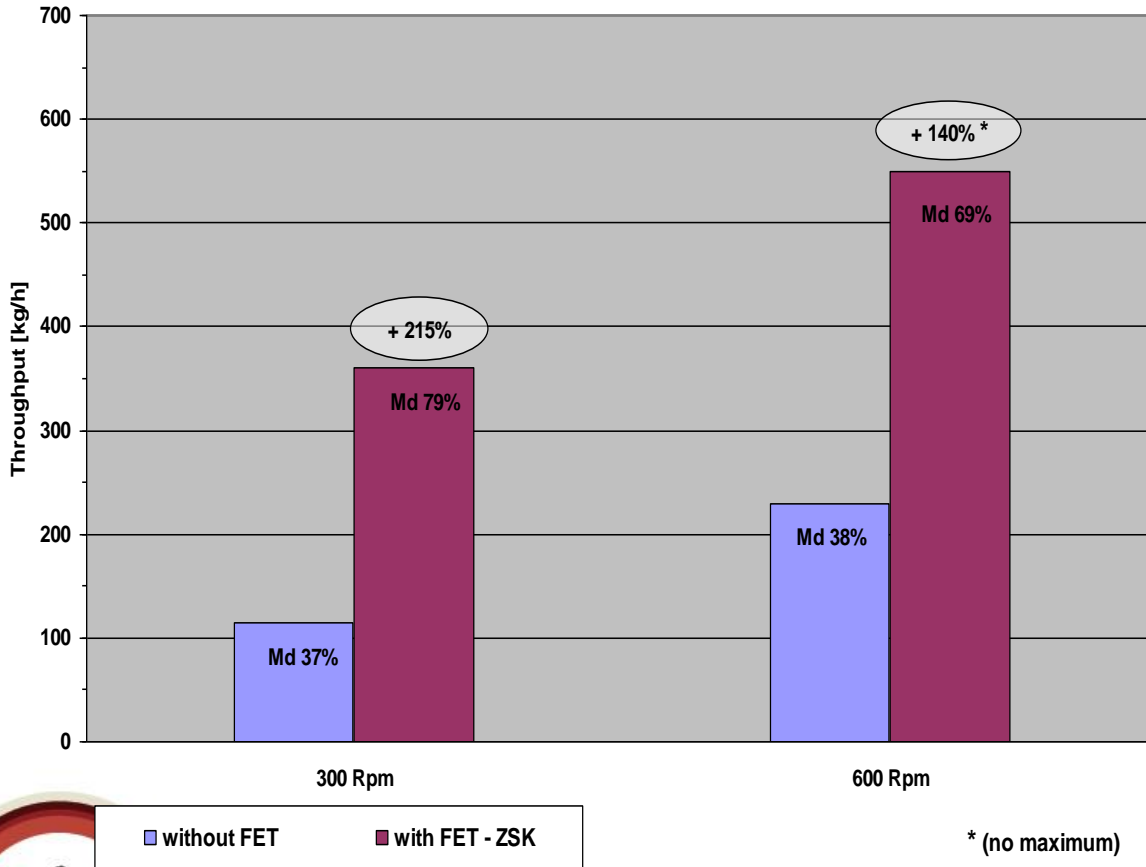


FET Configuration: Main Feed



Experience with FET – ZSK

wheat starch with 8% water added



- Extruder:
- ZSK 50 Mc

- Wheat starch:
- Bulk density: 0,55 g/cm³
- Particle size distribution:

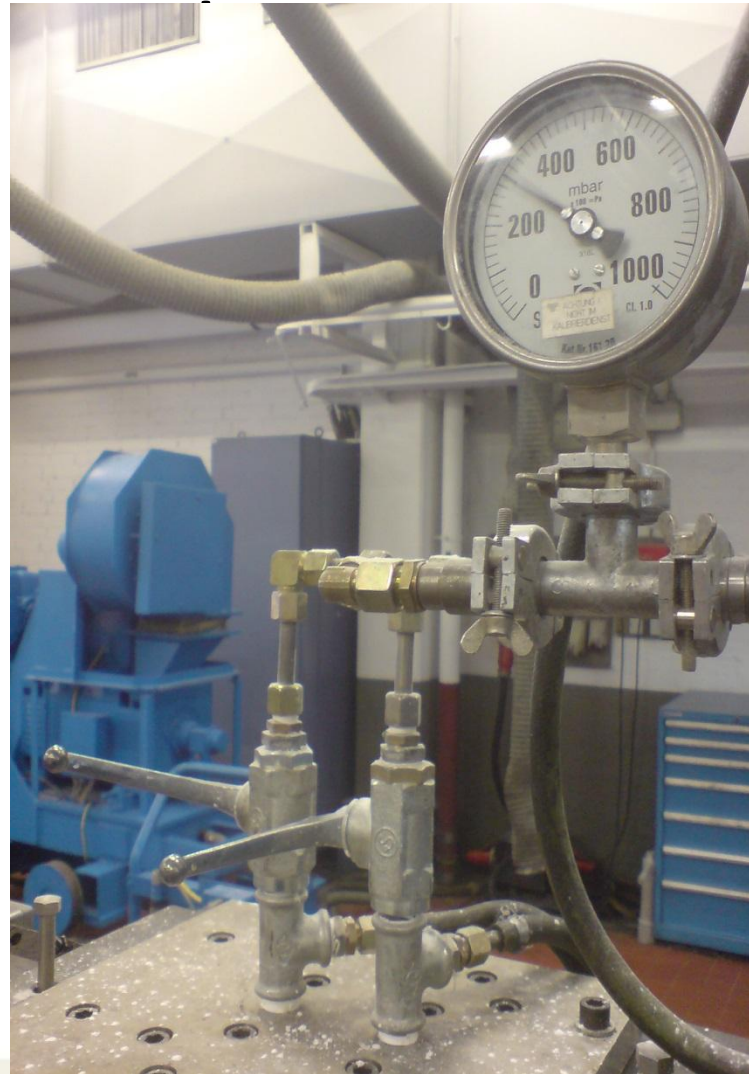
–90% of all particle between 30-40 µm
–10% of all particle between 2-15 µm



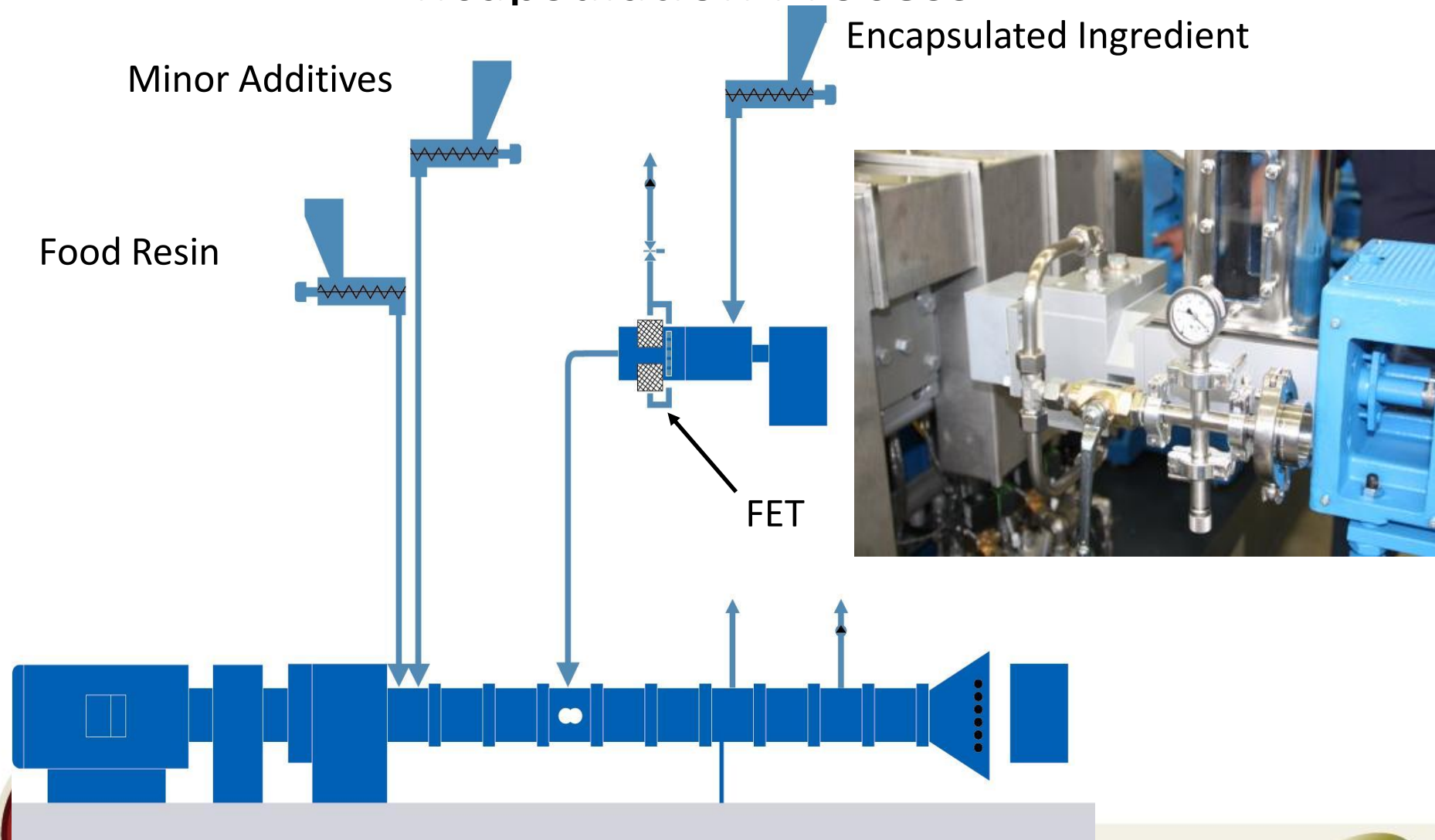
Experience: FET Configuration for Main

Production experience:
Fine powder (wheat starch)
50 mm Twin screw

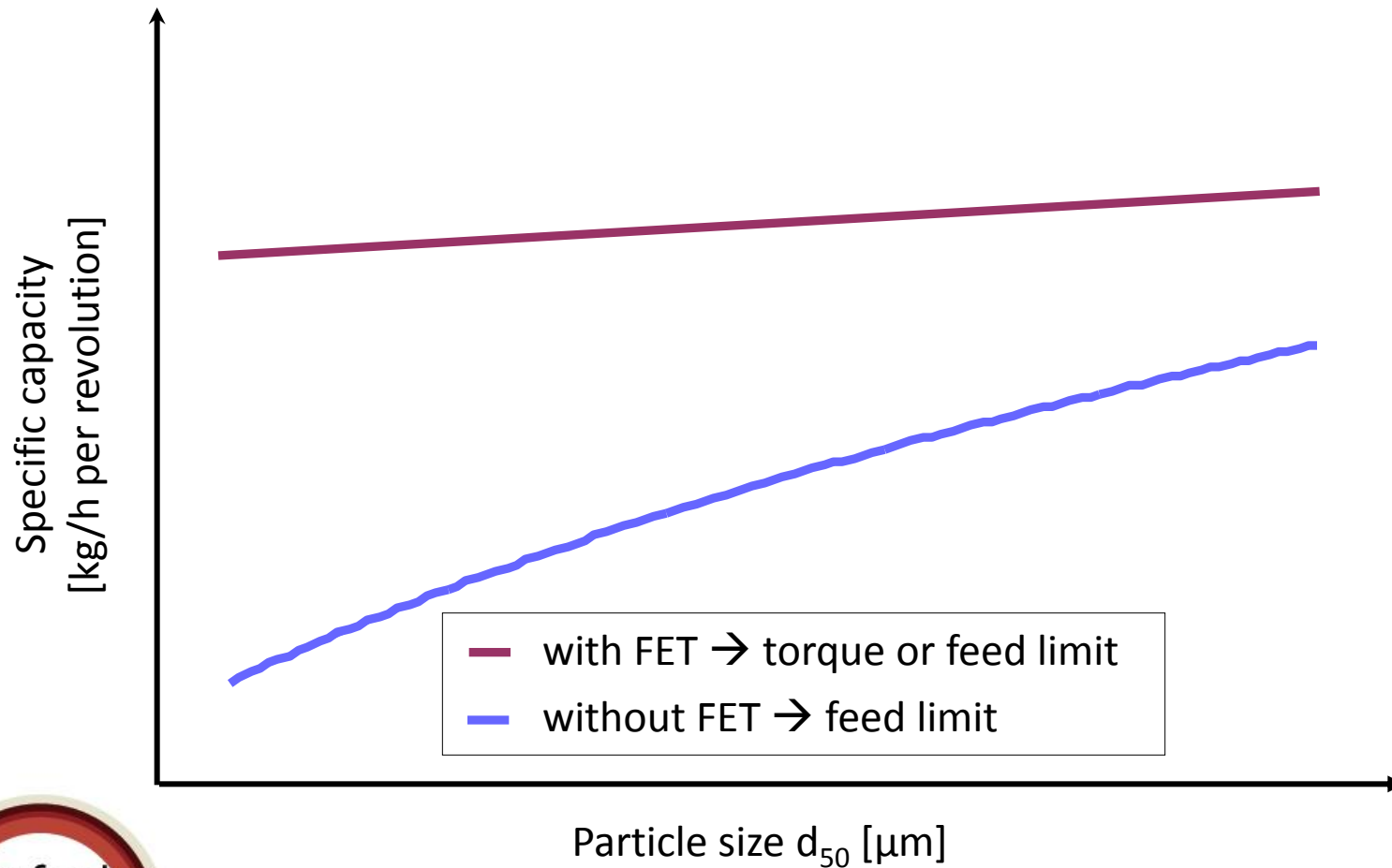
Capacity increase
From 214 kg/hr to 550 kg/hr



Typical setup for FET: Downstream feeding Encapsulation Process



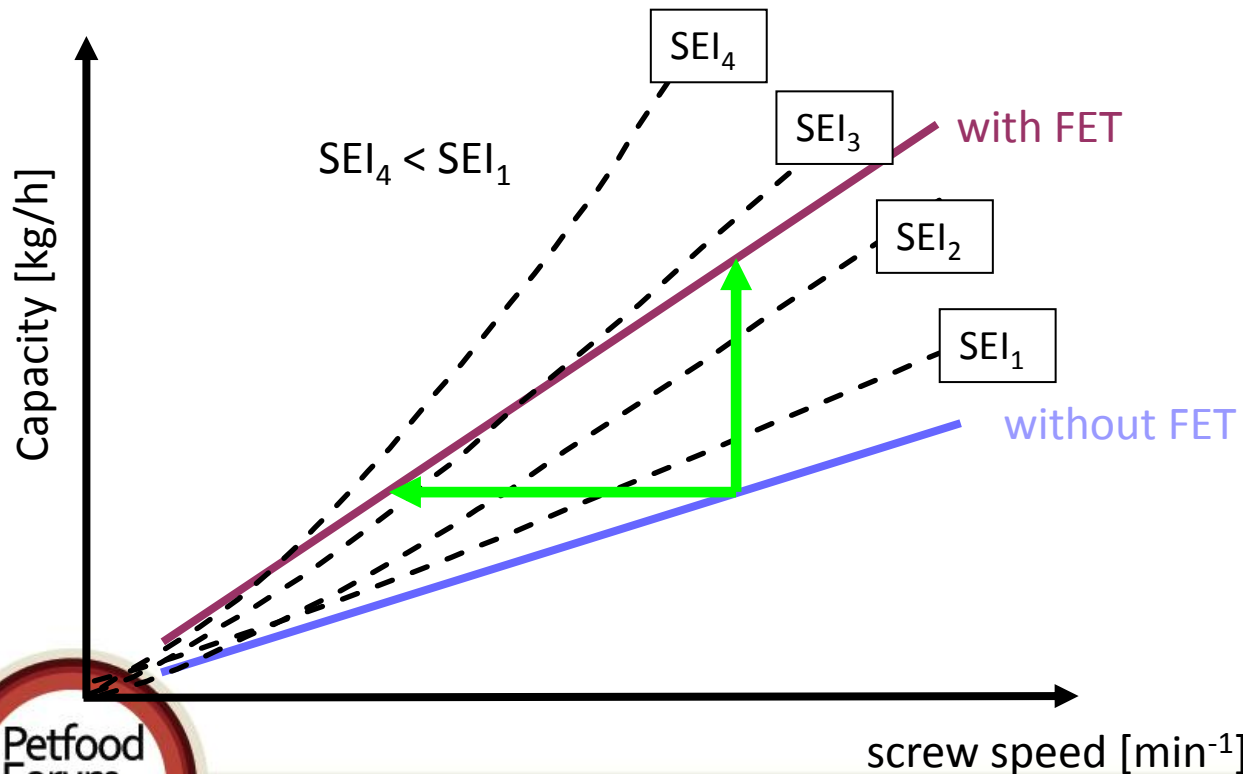
Advantages of FET: higher capacity even with finer powders



Advantages of FET: reduction of specific energy (SEI)

SEI can be reduced by:

- Increasing capacity at same screw speed
- Reducing screw speed at same capacity



FET Characteristics

- If necessary, filter membrane can be easily replaced
- Insert can be cooled to avoid melting of filter cake components
- Required vacuum depends on particle size and shape of the product
- Not suitable for melts or “wet” products



FET Considerations:

- Effect of FET always depends on the type of product, its particle size distribution and the particle shape
- The extruder and its auxiliaries have to be adapted to higher capacity, e.g.
 - installed motor power,
 - screw design,
 - feeding system,
 - degassing system,
 - pelletizer,
 - pellet cooling, conveying and handling system



Summary FET

- Advantages for feed limited processes:
 - Capacity can be increased
 - Specific energy can be reduced
 - Use of finer / non compacted powders is possible
 - Processes can be stabilized
 - Smaller machine size possible



Thank You for attending!

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For more information see:

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