

# **“Auxiliary Equipment Design for Natural Resins”**

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# Challenges for Melt Processing

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- Low melt viscosity
- Thermal sensitivity
- Sensitivity to shear
- Corrosive
- Low melt strength
- Raw materials expensive and limited supply

# Types of Screen Changers

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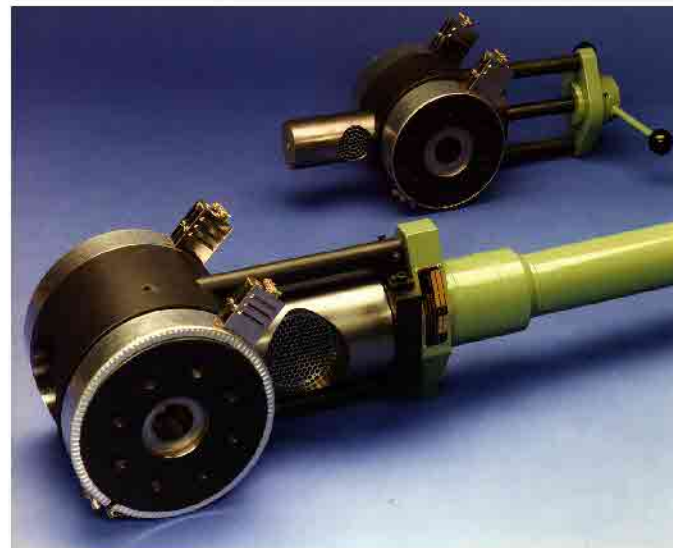
- Manual Screen Changer
- Hydraulic Screen Changer
- Dual or Single Piston
- Continuous Belt/Ribbon Type
- Multi-Segment Rotary Disc

# Basic Design Considerations

- Stainless steel construction
- High open area to minimize shear
- Streamlined passages
- Low residence time
- Proper sealing against leaks
- Continuous operation where justified

## Manual Screen Changer - *Strengths*

- Sizes: 30 mm to 150 mm
- Low capital costs
- Low operating costs
- Streamlined flow paths
- Minimum residence time
- Small in size



## Manual Screen Changers - *Weaknesses*

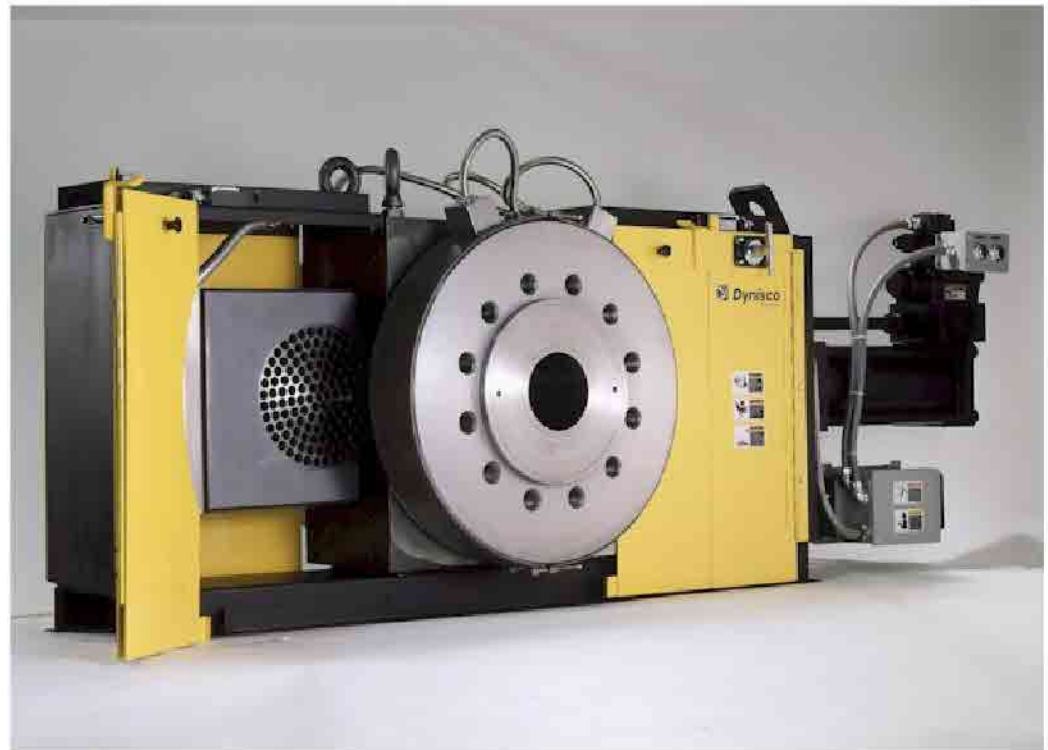
- Process Interruption
- Line shutdown
- Air entrapment
- Limited open area
- Seal leakage/replacement





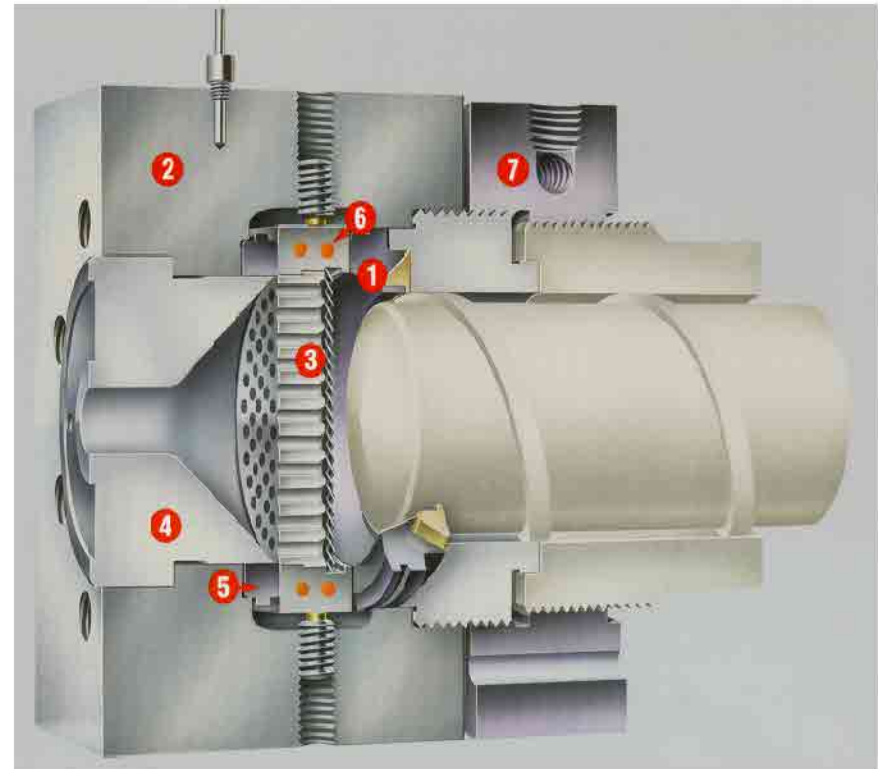
## Hydraulic Screen Changer - *Strengths*

- Sizes: 70 mm to 380 mm
- Low operating costs
- Low capital costs
- Streamlined flow paths
- Minimal residence time
- Industry acceptance



## Hydraulic Screen Changer - *Weaknesses*

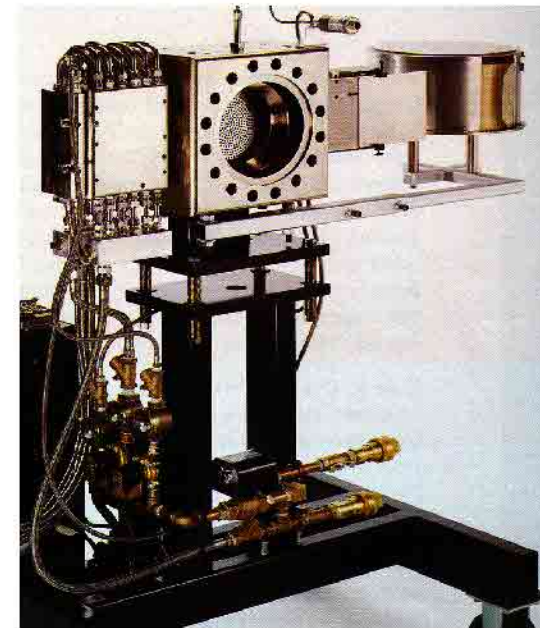
- Process interruptions
- Air entrapment
- Heated standby screen
- Limited open area
- Complicated hydraulics
- Seal leakage/replacement





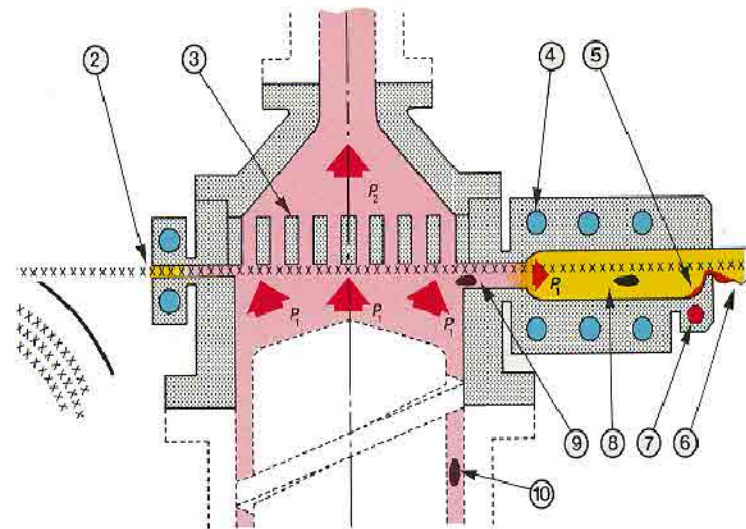
## Belt Type Screen Changer - *Strengths*

- Constant differential pressure
- Streamlined flow paths
- Minimal residence time
- Low operator intervention



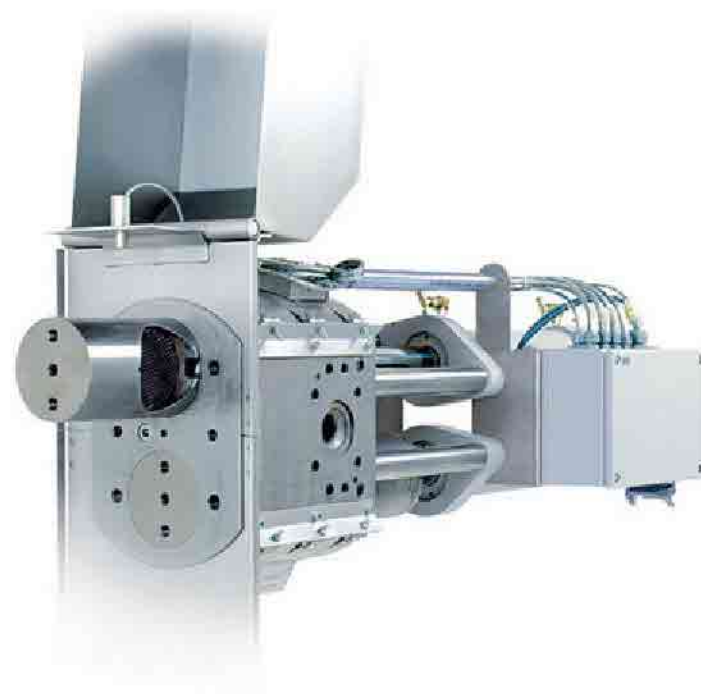
## Belt Type Screen Changer - *Weaknesses*

- Limited size ranges
- Capital costs
- Operating costs
- Sophisticated controls
- High contamination
- Temperature dependent sealing
- Head/differential pressure limitation
- Limited applications with Natural Resins



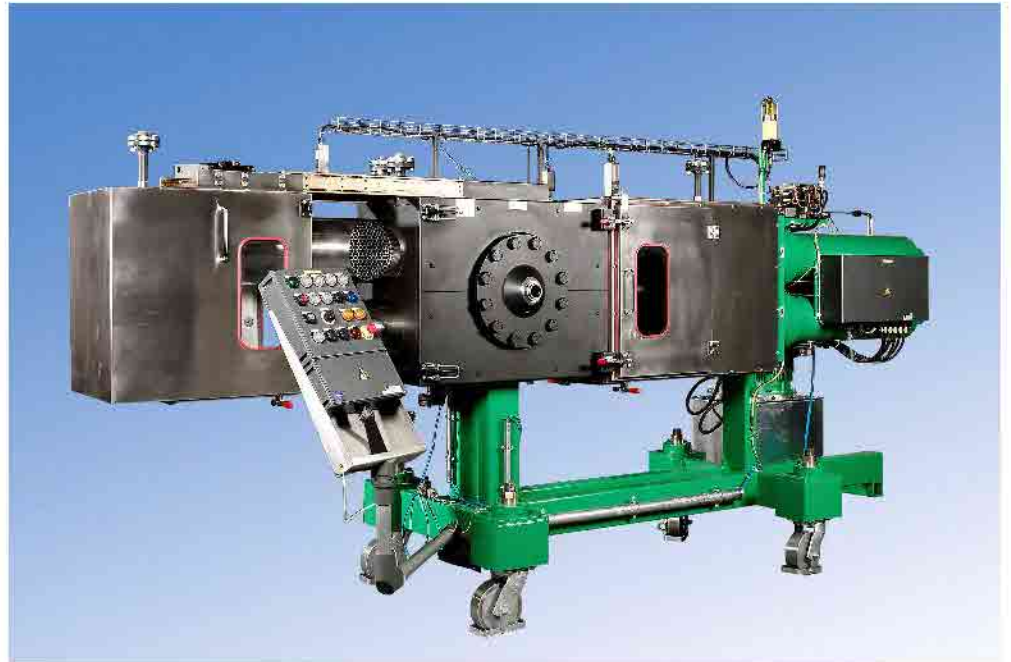
## Piston Screen Changer - *Strengths*

- Sizes: 30 to 450 mm
- Continuous filtration
- Sealless design
- High open area
- Uses round screens
- Low capital & operating costs
- Variety of special applications



## Piston Screen Changer - *Weaknesses*

- Cost relative to hydraulic
- Some pressure variations
- Increased residence time
- Operator skill level
- Size and installation



## Rotary Screen Changer - *Strengths*

- Sizes: 30 mm to 250 mm
- Very constant pressure
- Streamlined flow paths
- Minimum residence time
- High automation
- Low operator intervention





## Rotary Screen Changer - *Weaknesses*

- Too loose - leakage
- Too tight - lockup/galling
- High capital cost
- Sophisticated controls
- High differential pressure
- Pressure/viscosity dependent bolt torque





# Application Factors

- Required level of filtration – 80 to 125 mesh
- Screen change frequency/on stream life
- Effect of pressure variation on process
- Frequency of normal line shutdown
- Material waste & downtime during start-up
- Overall process pressures

# Understanding “Mesh” Sizes

## Square Mesh

Mesh	Wire dia	% Open area	Opening	Micron Retention
20	0.014	46%	0.035	900
20	0.02	36	0.029	750
100	0.004	38	0.0062	160
100	0.0045	31	0.0055	140
150	0.0026	34	0.0041	91
200	0.0021	29	0.0029	69

# **Gear Pumps - Basic Design Considerations**

- Stainless steel construction
- External purge of lubrication material
- Water cooled housing
- Tight rotational clearances
- Lower rotational speeds
- Streamlined flow passages

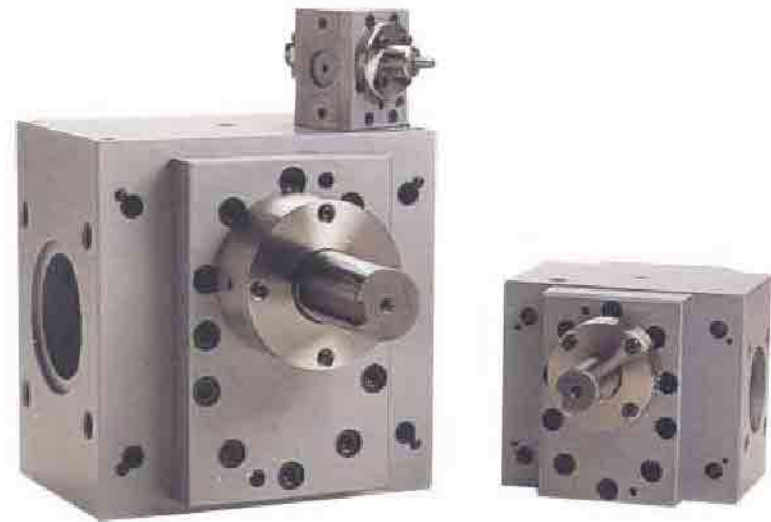
## Gear Pump Systems - *Strengths*

- Controls surging
- Reduces backpressure & increases output
- Volumetrically accurate metering



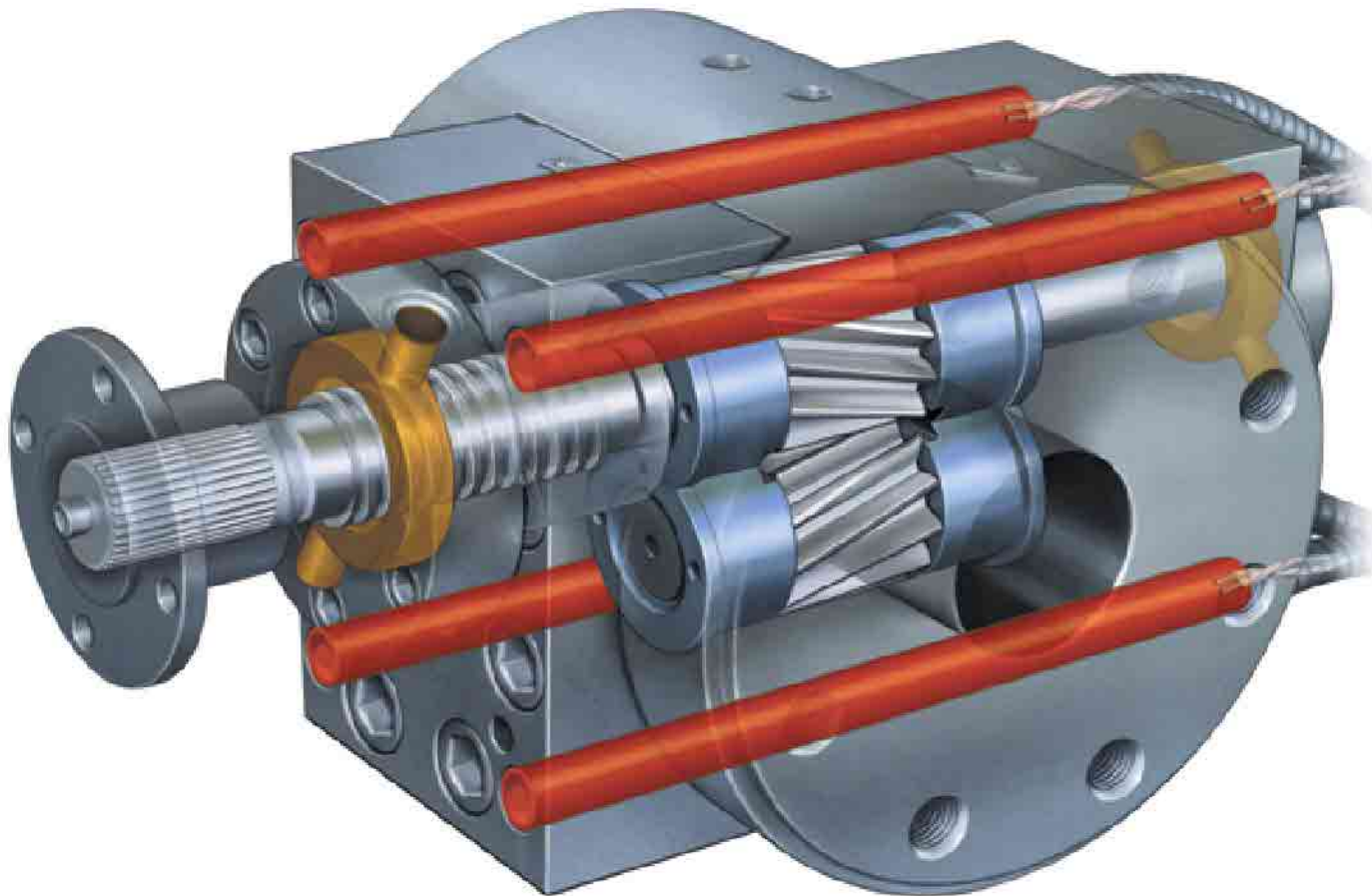
## Gear Pump Systems - *Weaknesses*

- High cost system
- Relatively maintenance intensive
- Difficult to install
- Machine direction only, no traverse gauge control



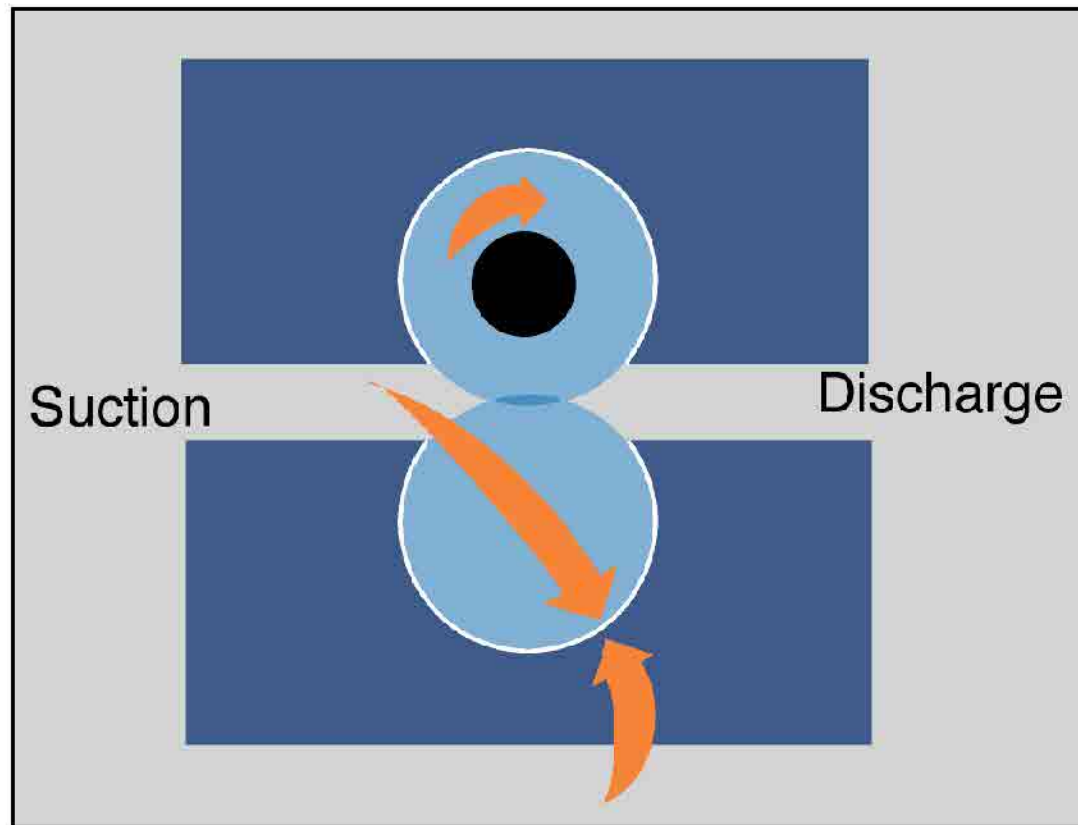


## What is a Gear Pump?



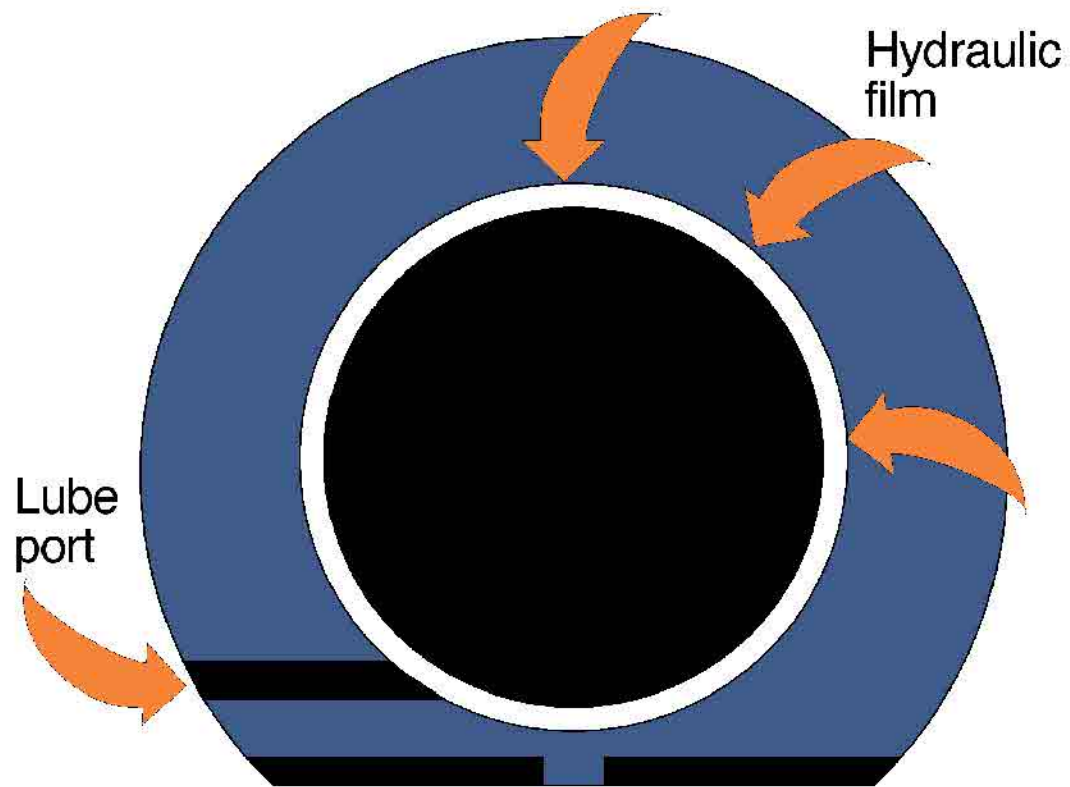


# Tight Rotational Clearances

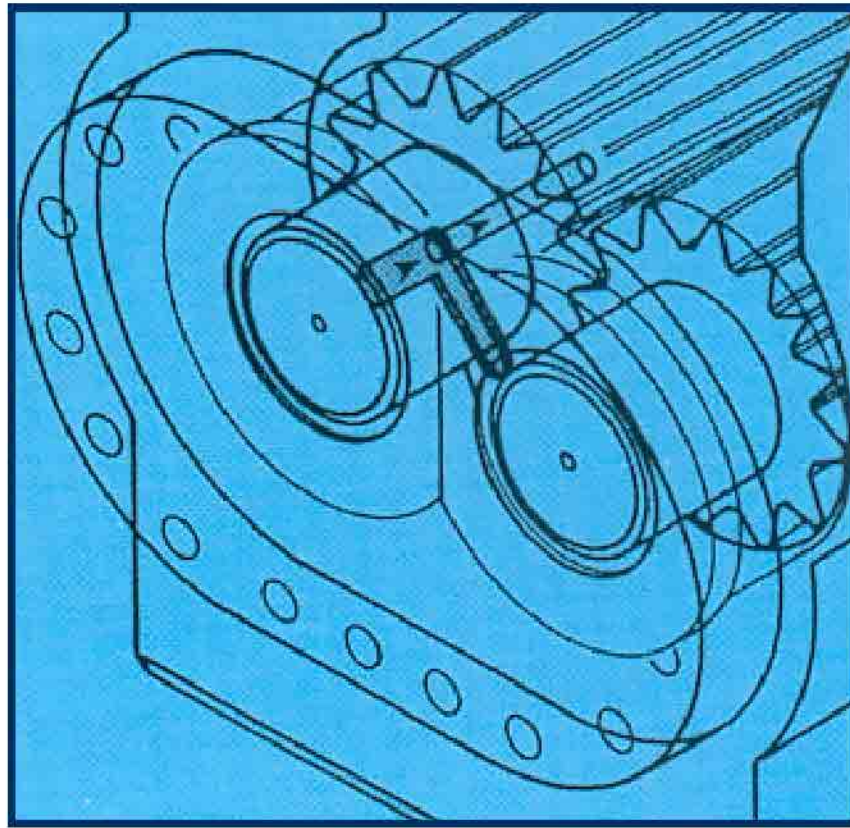


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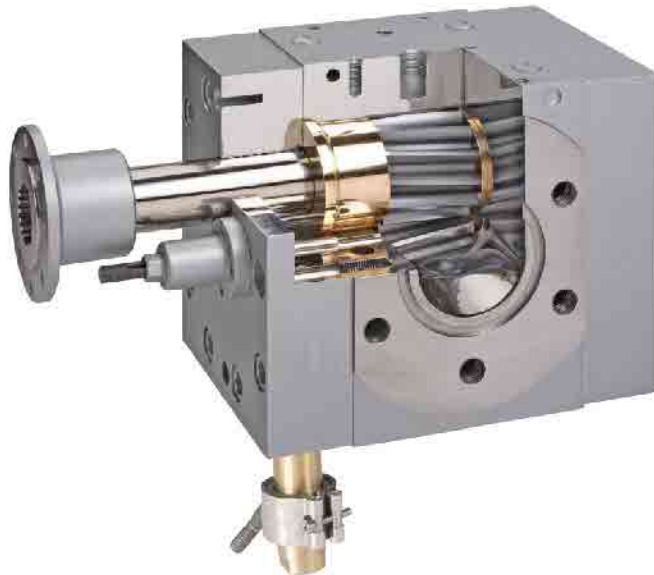
# Bearing Lubrication



# Lubrication Return Grooves



# External Purge for Shear Sensitive



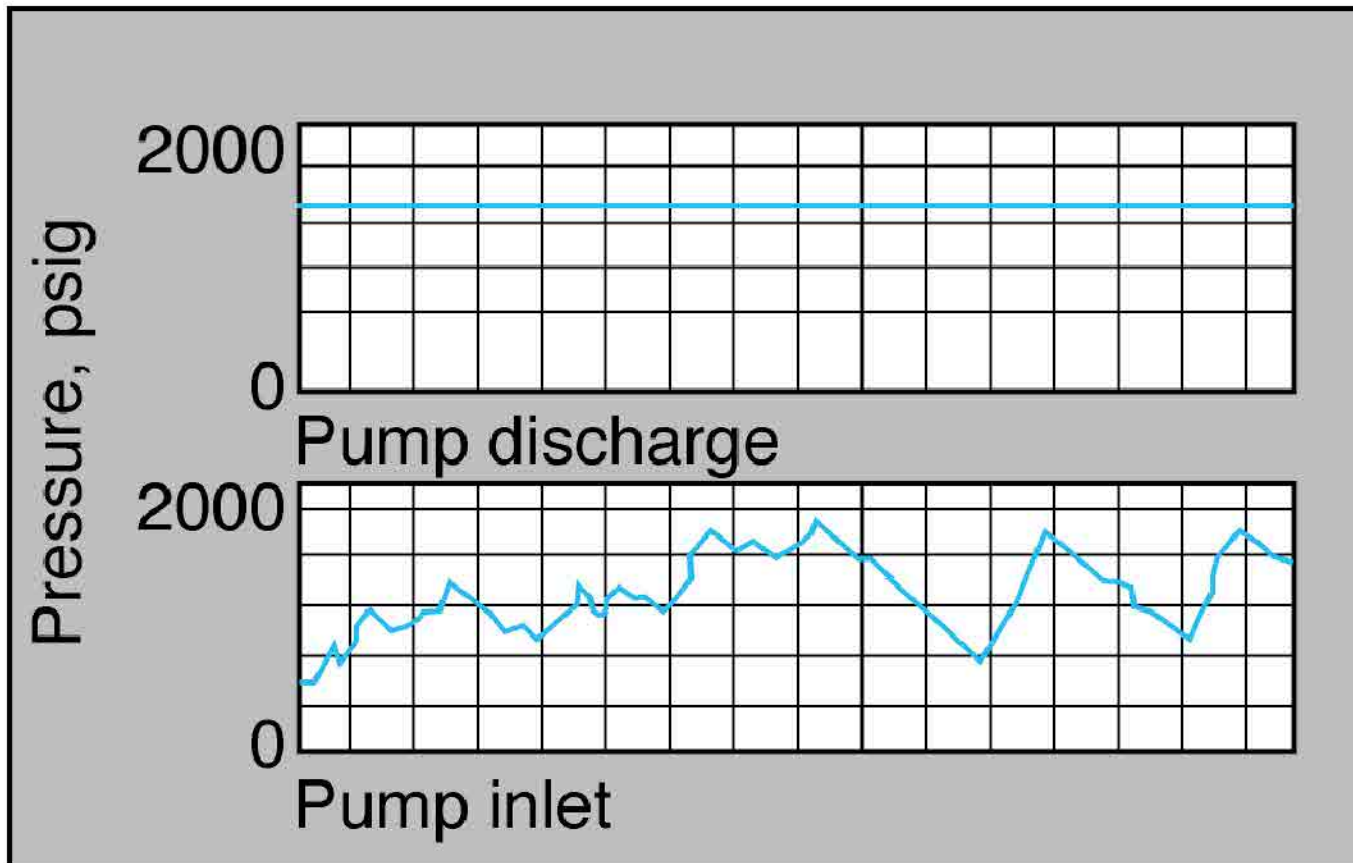
Courtesy of Kreyenborg GmbH



## Benefits of the Pump in the Extrusion Process

- Elimination of surging and surge related defects in extrudate quality, resulting in higher yield per pound
- Faster start-ups and repeatable linear output flow
- Ability to run higher concentrations of regrind and off-spec materials
- Multiple profiles from the same extruder
- Generation of pressure needed by downstream devices

## Pressure Before and After Pump Installation

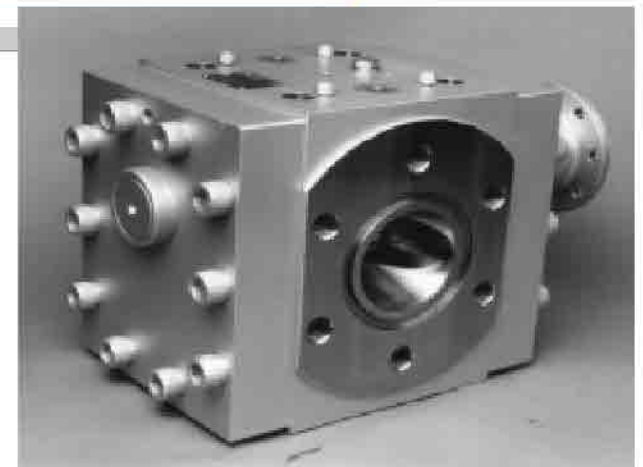
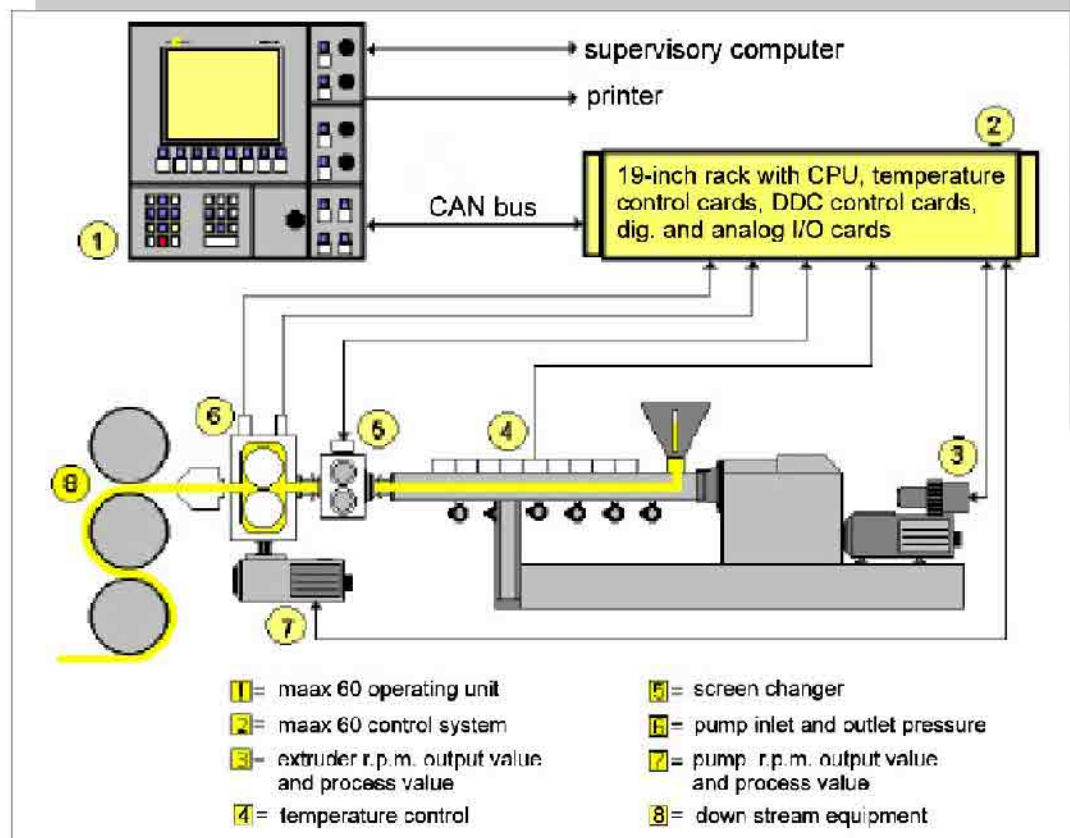




# System Components

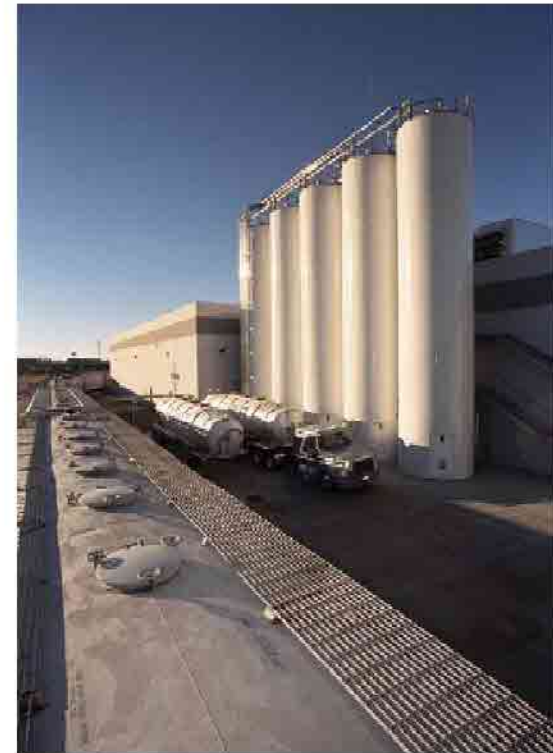
- Gear Pump
- Variable speed drive package
  - AC or DC...1 HP/100PPH
- Support cart/frame
- Process adapters
- Control system
  - Discrete instruments, PLC or combination

# Control Packages – Line, cont.



# Storage and Conveying

- Most BioPolymers are supplied in gaylord boxes or super sacks
- Soon, resins will be shipped by bulk truck and railcar
- Virgin pellets can be stored in conventional silos, where storage of amorphous regrind requires special consideration



# Storage & Conveying, cont.

- Virgin pellets can be dilute phase conveyed either by pressure and/or vacuum
- Lower conveying velocity (5000 feet/minute) and “scored” tubing to minimize degradation



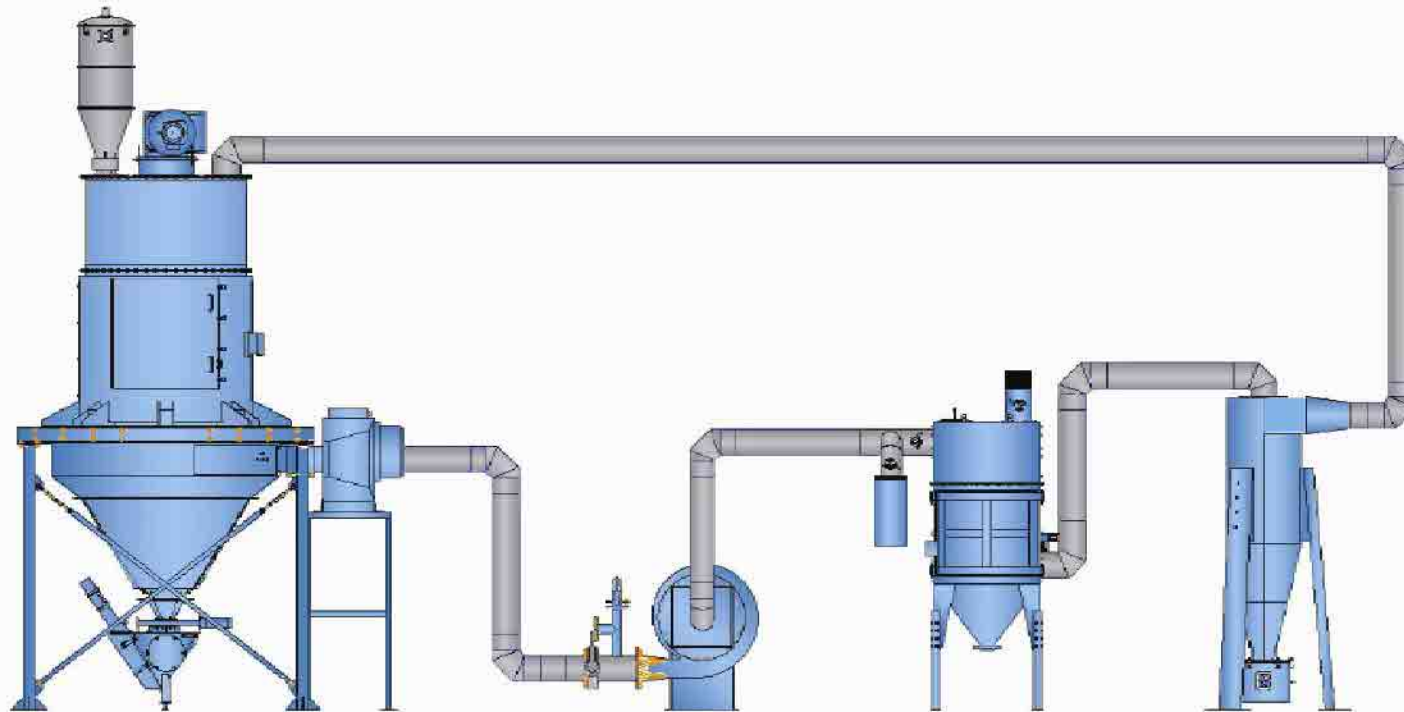


# Crystallizing

- Crystallization is required to change resin from amorphous to crystalline state
- Temperature must be raised above Glass Transition temperature, while gentle agitation avoids agglomeration



# Crystallizing System



Courtesy of Universal Dynamics Corporation



# Drying

- Process drying is the most critical stage of material preparation
- Must remove moisture from resin to 200 PPM or less
- Requires dehumidifying hopper drying with low temperature options to avoid over heating material



# PET versus BioPolymers

- Simple changes allow BioPolymers to run in PET systems
- Proper drying temperature settings are required
- All traces of PET must be removed to prevent contamination coming through un-melted
- BioPolymers, such as PLA melt at approximately 200°F -lower than PET
- Styrene purge is recommended in both directions of change

# References

- NatureWorks PLA Processing Guides for Film and Sheet
- PLA Solutions for Sheet Extrusion
  - Bob Crawford, Universal Dynamics, Inc

***Extrusion  
Auxiliary Services***

*Your Extrusion Process & Equipment Experts*