Melt Pumps and Screenchangers for Blown Film Extrusion

ABSTRACT

Gear pumps in combination with screenchangers can produce a number of positive benefits in new blown film lines or as retrofits on existing lines. Gear pumps and screenchangers s used in the blown film industry will be reviewed in detail. Also reviewed will be the benefits of each along with the potential challenges with each piece of equipment.

GEAR PUMPS

Gear pumps are positive displacement devices, producing a consistent flow regardless of discharge pressure. (*See examples # 1, 1a)* Installed between the extruder and blown film die, the pump takes on the job of generating pressure and does so at efficiencies approaching 98% versus approximately 40% for an extruder. This leaves the extruder responsible for only feeding, melting, and mixing *(See example #II).* The gear pump's tight clearances also greatly dampen the pressure pulsations generated by the extruder. This provides a much more consistent die pressure, enabling closer tolerances, which in turn permits higher yields. The gear pump will also cause a lower net product temperature by lowering the extruder head pressure. This temperature drop will more than offset any temperature rise through the gear pump. (See dt rise on figure 2).

PUMP BENEFIT REVIEW IN BLOWN FILM

The three key benefits of adding a gear pump to an extrusion line are:

1. Reduction of Extruder head pressure fluctuations *(see example 3)*
- isolation of downstream equipment from the extruder
- increased level of regrind usage possible
- less scrap due to off spec at start up
- raw material savings
2. Increased Throughput
- for every 1,000 psi reduction in head pressure a 1-4% increase in throughput can be achieved
- rate increases of up to 25% have been seen
3. Reduction of melt temperature to the die (less residence time = lower temperature = higher rates)
- potential increase in throughput can be found for situations where output is limited due to melt temperature

Additional Benefits:

- reduced extruder barrel and screw wear, resulting in lower maintenance costs
- faster start up, requiring less manpower
- reduced energy requirements, typically appx. 20% *(see example IV)*

PUMP CHALLENGES IN BLOWN FILM

1. Increases in throughput can vary, depending on head pressure required to produce a good homogeneous melt
2. Downstream limitations: on a retrofit can the equipment be moved?
3. Gauge variations may already be at a optimum level with the use of the right combination of cooling, screw design and take off equipment
4. Added floor space (about 3')
5. Initial cost of pumps and auxiliaries

SCREENCHANGERS

Continuous screenchanger are recommended for blown film filtration. A two bolt or piston design is usually preferred. The standard two piston screenchanger incorporates two pistons, each containing one filter pack. *(example V)* It is used for continuous filtration. At the inlet, product is divided into two streams. During normal operation each screen pack handles one half of the total flow. After exiting the filter packs,

the two streams, now filtered, are recombined at the outlet. During screen change, one piston moves out of the housing for screen pack removal, blocking the melt stream. After the dirty screen pack is replaced, the off-line piston is moved to a venting position to eliminate process upsets and then returns to the normal position. Automatic controls are highly recommended for the venting and screen change procedure.

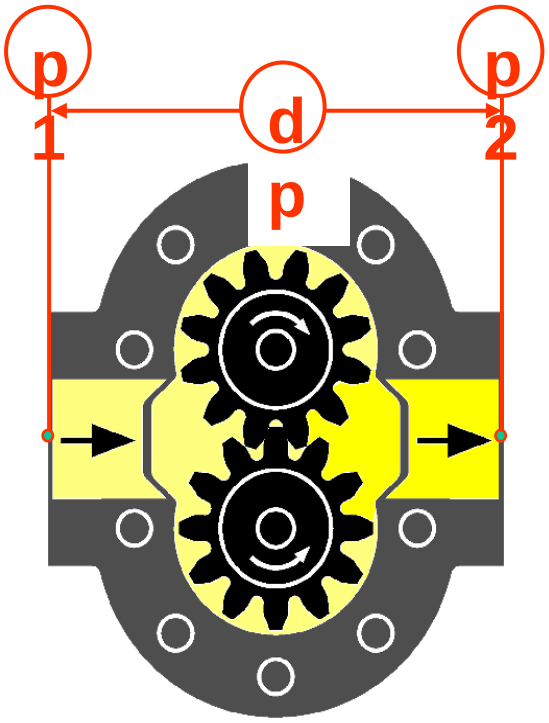
BENEFIT REVIEW OF CONTINUOUS SCREENCHANGERS IN BLOWN FILM

1. Throughput, viscosity and temperature remain practically constant
2. The screen surface available is regulated so that the pressure can also be kept fairly steady
3. Filtration is continuous
4. Screenchangers and pumps can be combined on one common stand for optimum space efficiency

SCREENCHANGER CHALLENGES IN BLOWN FILM

1. Continuity does not refer to pressure, speed of flow or viscosity, it refers to the process
2. Care must be taken in the venting process as not to create bubble issues (as in loss of)

Example I



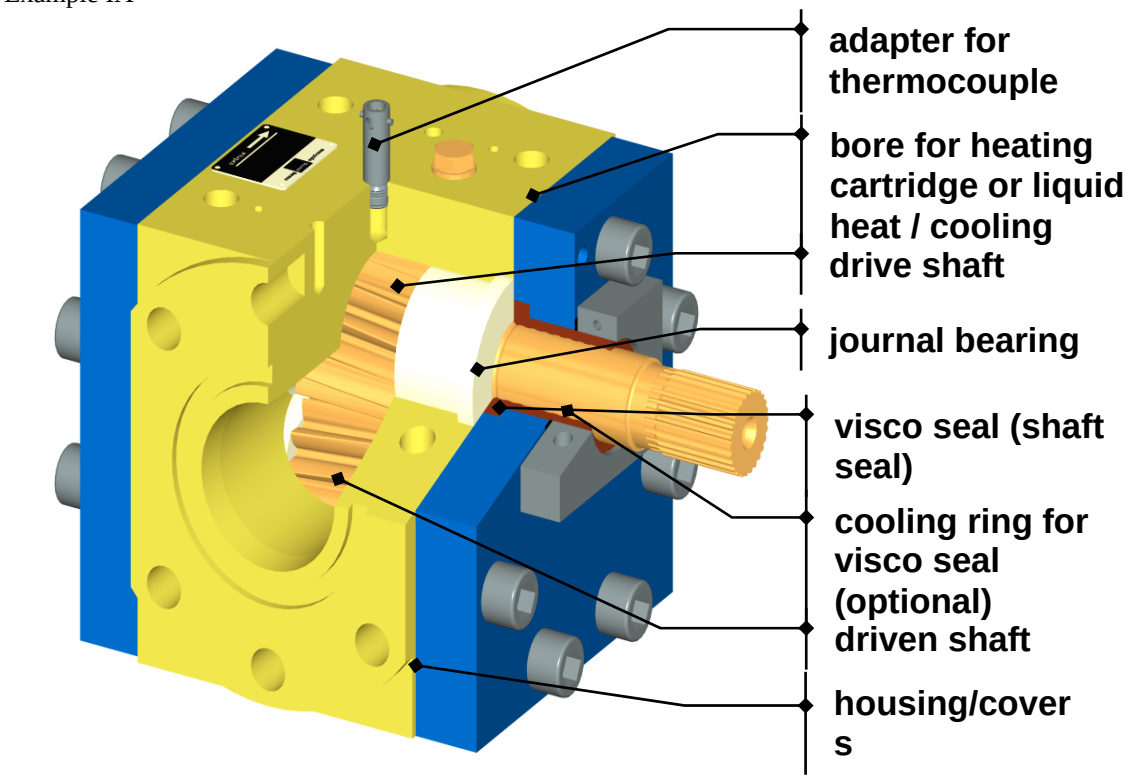
function:

- **generating suction on the inlet side**
- **transport of the pumping medium from the inlet to the suction side**
- **displacement of the medium at the outlet side**
- **sealing between the inlet and the outlet side**
- **transmission of half of the drive torque from the driving to the driven shaft**

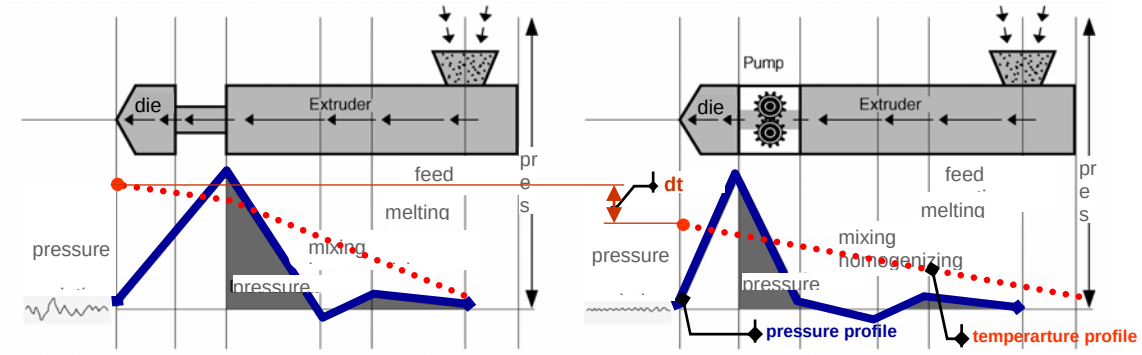
effect of pressure:

- **p1: stress on housing, covers and bolts for covers. It is also the pressure across the seal**
- **p2: stress on the outlet flange and its bolts**
- **dp: axial and radial load on the bearings (lubricating film). Load on the teeth flanks bending stress on the teeth, bending and torsion stress on the shaft as a whole**

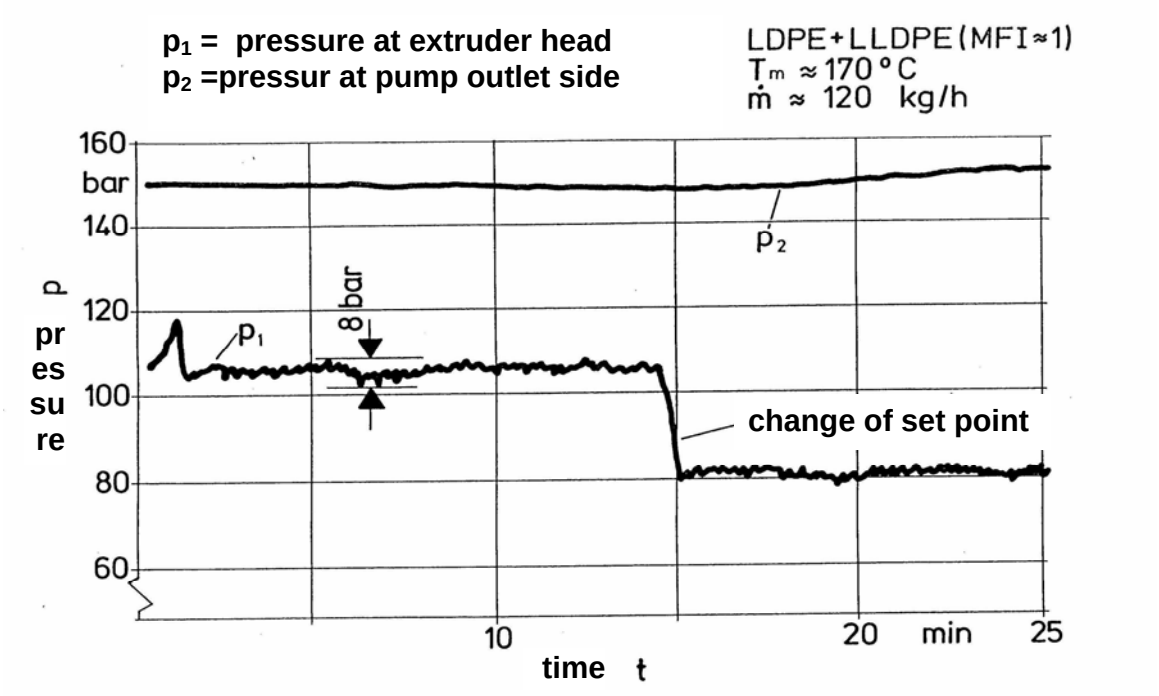
Example IA



Example II



Example III

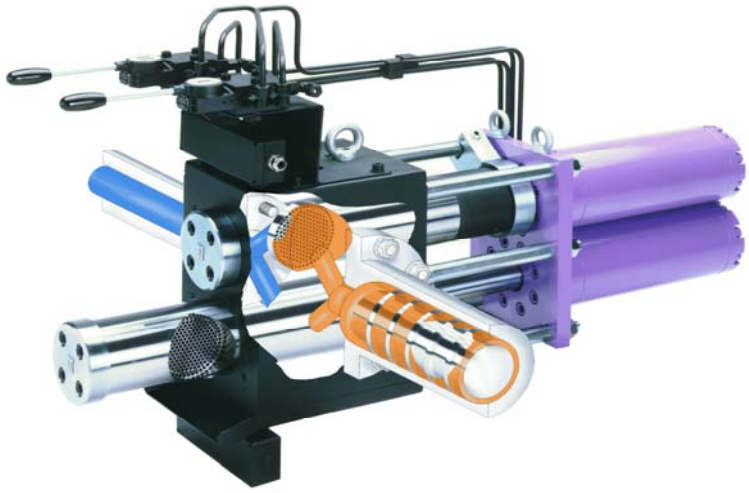


*Example IV Case History

MI – 0..3	Extuder Only	Extruder + Gear Pump
Melting	0.15 KWH/KG	0.15 KWH/KG
Pressure building in Extruder	0.08 KWH/KG	0.01 KWH/KG
Pressure building in Pump		0.02 KWH/KG
TOTAL	0.23 KWH/KG	0.18 KWH/KG

* from AN ECONOMIC AND TECHNICAL OVERVIEW RETROFITTING PELLETIZING LINES WITH GEAR PUMPS, by Andreas Imthrun, Engineering Manager, Maag Pump Systems, Polyolefin's IX International Conference, Houston TX Mach 1, 1995

Example V



Typical Dual Piston Continuous Screenchanger

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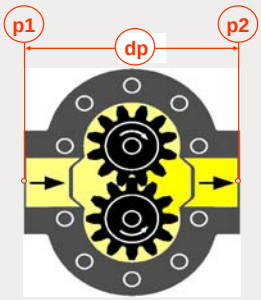
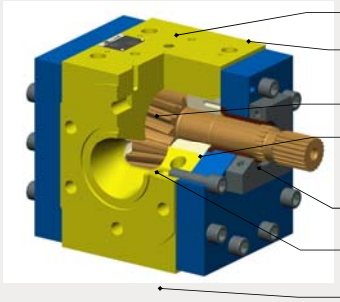


Gear Pump Basics

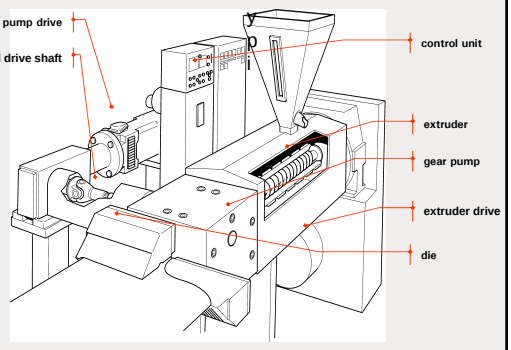
"*Positive Displacement Device, producing a consistent flow regardless of discharge pressure*"

- generating suction on inlet side
- move medium from inlet
- displace medium to outlet
- sealing between inlet and outlet
- transmission of half drive torque from driving to driven shaft

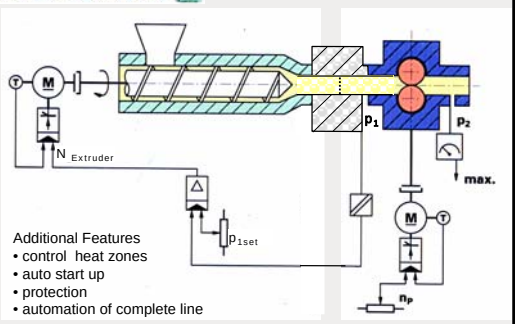
Typical Extrusion Pump



Typical Extrusion System



Synchronizing pump and Extruder



Additional Features
- control heat zones
- auto start up
- protection
- automation of complete line

Two Key Benefits of Pumps in Blown Film

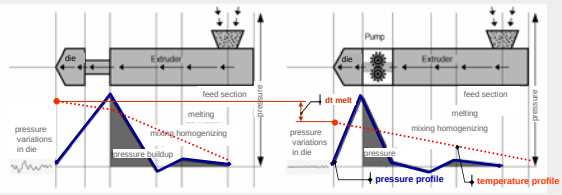
1. Reduction of Melt Temp by lowering head pressure
- less residence time = lower temp = higher rates
  (25-30% reported, especially with off line master rolls)
  Note: for every 1,000 psi reduction a 1-4% increase in rate can be achieved
- lower temp can produce a stronger film (thin film <1mil)

2. MD gauge variation reduced
- downstream equipment is isolated
- consistent volumetric output = consistent die pressure and tighter tolerances

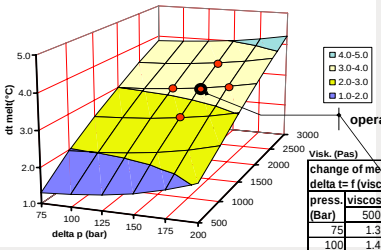
Reduction of Pressure Variations and Melt Temp

without pump

with pump



Temperature rise (typical)



change of melt temperature for Ex 70 bei 70 rpm.
delta t= f (visc, delta p)

press.	viscosity (Pas)					
(Bar)	500	1000	1500	2000	2500	3000
75	1.3	2.0	2.5	3.0	3.4	3.8
100	1.4	2.0	2.6	3.0	3.5	3.9
125	1.4	2.1	2.6	3.1	3.5	3.9
150	1.6	2.2	2.7	3.2	3.6	4.0
175	1.8	2.3	2.8	3.3	3.7	4.1
200	2.1	2.5	3.0	3.5	3.9	4.3

Additional benefits of Pumps in Blown Film

- reduced extruder energy requirements (up to 20%)
- increased level of regrind usage possible
- less scrap due to off spec product at start up
- faster start ups, using less manpower
- raw material savings
- Reduced extruder barrel and screw wear

Case History: Energy Consumption of Extruder vs. Pump and Extruder

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Pump Challenges/Considerations

1. downstream limitations must be considered: In-line bag machines may be maxed out, thus limiting throughput

2. groove feed extruders can be very efficient pumping devices with good MD gauge control

3. pumps take up space (appx 3'), must be considered on retrofits

Pump challenges and considerations cont….

4. added up front costs of pump and drive

5. actual data (positive or negative) tends to be extremely difficult to obtain from pump users in the blown film market

6. all extruders have a critical amount of head pressure required to produce a good homogeneous melt

Screen Changer Basics

Two models typically used in Blown Film

1. Dual Piston Continuous
- Two pistons, each containing one filter pack

(this technology is preferred in blown film applications)

2. Discontinuous
- Single piston design, with one filter pack

Screen Changers
(dual piston continuous)

Rate (lb/hr)	10 to 65,000
Viscosity (Pas)	up to 30,000
Temperature (°F)	850
Outlet pressure (psi)	up to 14,500

Screen Changers
(single piston discontinuous)

Rate (lb/hr)	10 to 7,250
Viscosity (Pas)	up to 30,000
Temperature (°F)	850
Outlet pressure (psi)	up to 14,500

Benefit Review of Screenchangers

- Throughput, viscosity and temperature remain practically constant (continuity refers to the process as a whole)
- Screen surface available is regulated resulting in steady pressure
- Filtration is continuous
- Screen Changer and pump can be combined to optimize space

Screen Changer Challenges in Blown Film

1. Some pressure variations seen
(note: recent technology in some designs offer constant pressure feature)
2. Venting process can cause processing issues
3. Operator skill level (if w/o control system)
4. Increased residence time
5. Size, installation, up front costs

Thank You

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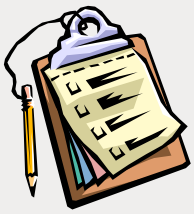

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