October 18, 2016

Processing Guide
Achieve ™ 6936G2 Polypropylene

Energy lives here™

Provided to: Channel Prime Alliance's Technical Service Team
From: Jim Luce, *James.T.Luce@ExxonMobil.com*

Extrusion system

L/D of at least 30:1 (non-vented)

- Provides a longer residence time, greater melting capability and higher output rate.
- Good powder seal at the shank of the screw

Heating and cooling

- Air cooling for barrel zones is sufficient
- High watt density heater is desirable
- Extruder throat jacket should be cooled to assist feeding and prevent melting when the extruder is shutdown.

Drive system

- The low melt viscosity requires very low torque and low HP (e.g., 150 HP for a 4/5” extruder)
- High maximum screw speed (e.g., >150 rpm) to achieve high output rate

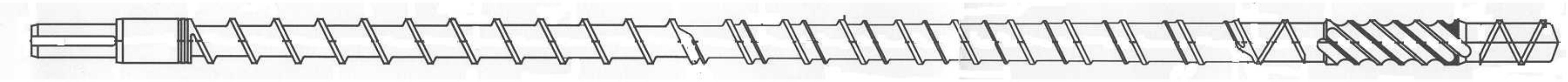
Extrusion system (cont)

Melt filtration

- An automatic or manual screen changer is a must
- Screen of at least 325 mesh should be used

Screw design

- A deeper feed section should be used for better feeding
- A shallower metering section for shear and better pumping "compression ratio" > 3.5
- Chrome plating with normal flight tip hardening
- Transition/melting section
  - ◆Barrier flight can improve melting rate and melt quality
- Mixing section:
  - ◆A "twisted" Maddock section is very effective in dispersion pigments while providing some pumping capability (and less polymer hangups)



Barrier flight section

"twisted" Maddock Mixing section

Material Handling of Achieve™ 6936G2

- Achieve™ 6936G2 polypropylene is supplied as a granular product

- It is produced using metallocene catalyst technology and has both high melt flow rate and narrow molecular weight distribution.
  - No peroxide is added to the resin.

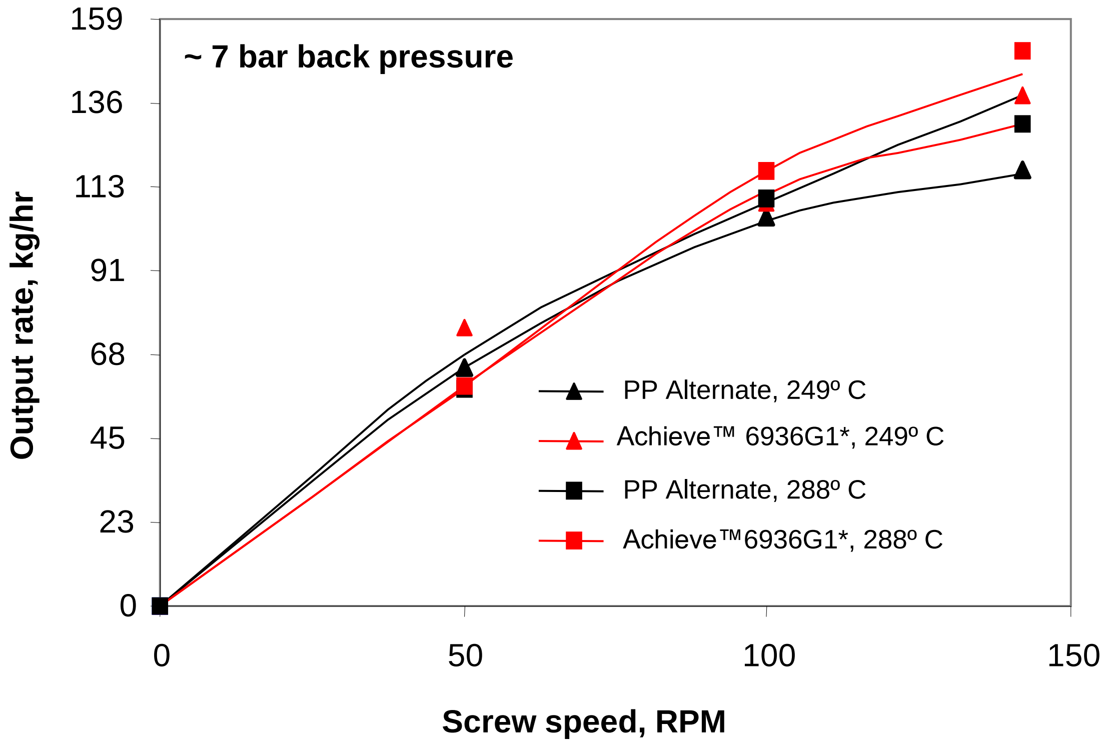
- The average particle size is approximately 1200 to 1800 µm

- Achieve™ 6936G2 polypropylene can be handled using most air conveying systems that have been designed for granule handling..

Extruder Output Rate for Achieve™ 6936G2

Achieve™6936G2 polypropylene processes well on extruders designed to process ultra high melt flow rate polypropylene granules

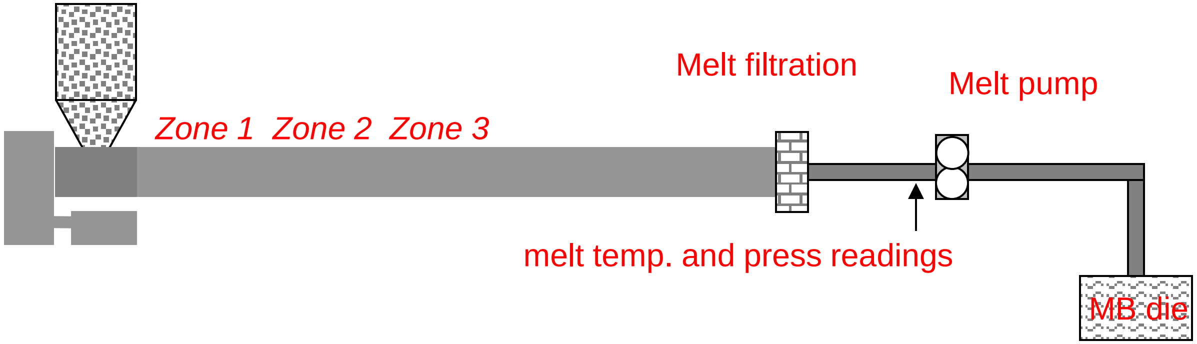
- For a given screw design, the output rate depends on the screw speed, screw design, barrel temperature setting and head pressure.
- Example shown below:



* Achieve 6936G1 and G2 are the same product grade

Melt Temperature Control with Achieve™ 6936G2

- An immersion type melt thermocouple with exposed junction at the adaptor downstream of the screen changer is preferred for measuring the true melt temperature.
- The melt temperature is controlled by the barrel heating zone temperature settings and the output rate.
- Zones 1-3 should be used to ramp up the temperature and the last few zones to bring the melt to the desired temperature
- Achieve™ 6936G2 polypropylene resin does not generate viscous shear heating. <u>Barrel temperature should be higher than the target polymer temperature to provide conductive heating.</u>

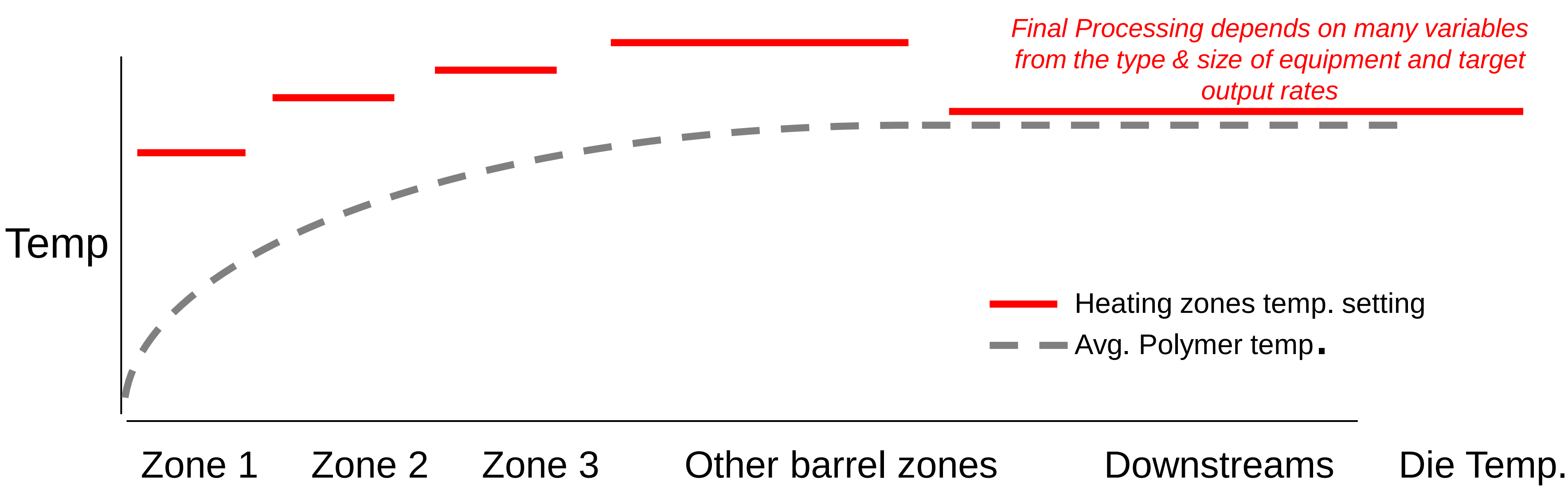


ExxonMobil

Melt temperature control with Achieve™ 6936G2

- The mixing section in the screw homogenize the melt and reduces temperature gradient in the melt stream.

- Once the material leaves the screw, the flow is nearly laminar and little further mixing occurs (except at the metering pump and static mixer, if installed). Therefore, the downstream transfer line and die should be kept at the same temperature as the melt to avoid temperature gradient in the melt stream.



Effects of polymer viscosity on melt temperature

Simplified extrusion energy balance:

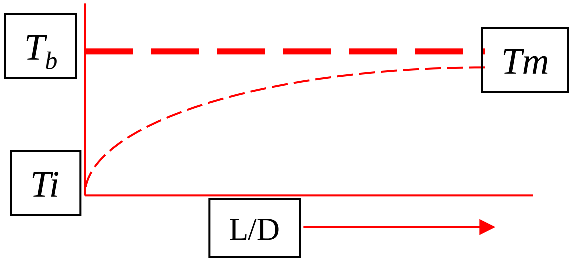
- Newtonian fluid, constant screw geometry and physical properties, etc.

Polymer temperature raise = Heating from barrel + Viscous shear heating (from drive)

$$Q\ Cp\ (Tm - Ti) = K\ C_1\ (T_b - T_p) + C_2\ N^2\ \mu$$

$$C_3\ N\ \ Cp\ (Tm - Ti) = K\ C_1\ (T_b - T_p) + C_2\ N^2\ \mu$$

$$Tm = K\ C_4\ (T_b - T_p) / N + C_5\ N\ \ \mu$$



Where:

Q: Output rate, Cp: polymer specific heat, Tm: Final melt temp. Ti: initial polymer temp.

K: Thermal conductivity, T_b : Barrel temp., T_p: Local polymer temp.

N: Screw RPM, ***μ****: Melt viscosity, C_1 , C_2 , C_3 , C_4 , C_5 : physical and geometrical constants*

If the melt viscosity is very low (such as 1550 MFR Achieve™ 6936G2)

- The viscous shear heating is small compared to conductive heating
- Most of the energy for melting the polymer will come from barrel heating
- Melt temperature could decrease with increasing screw speed/output rate
- Melt temperature could be substantially below barrel temp. setting

ExxonMobil

Disclaimer