



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

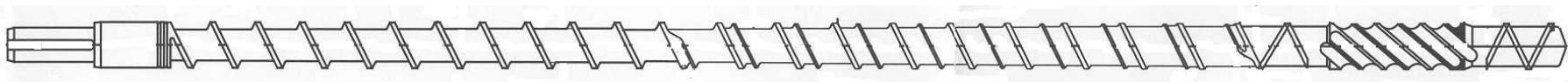
Extrusion system (cont)

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

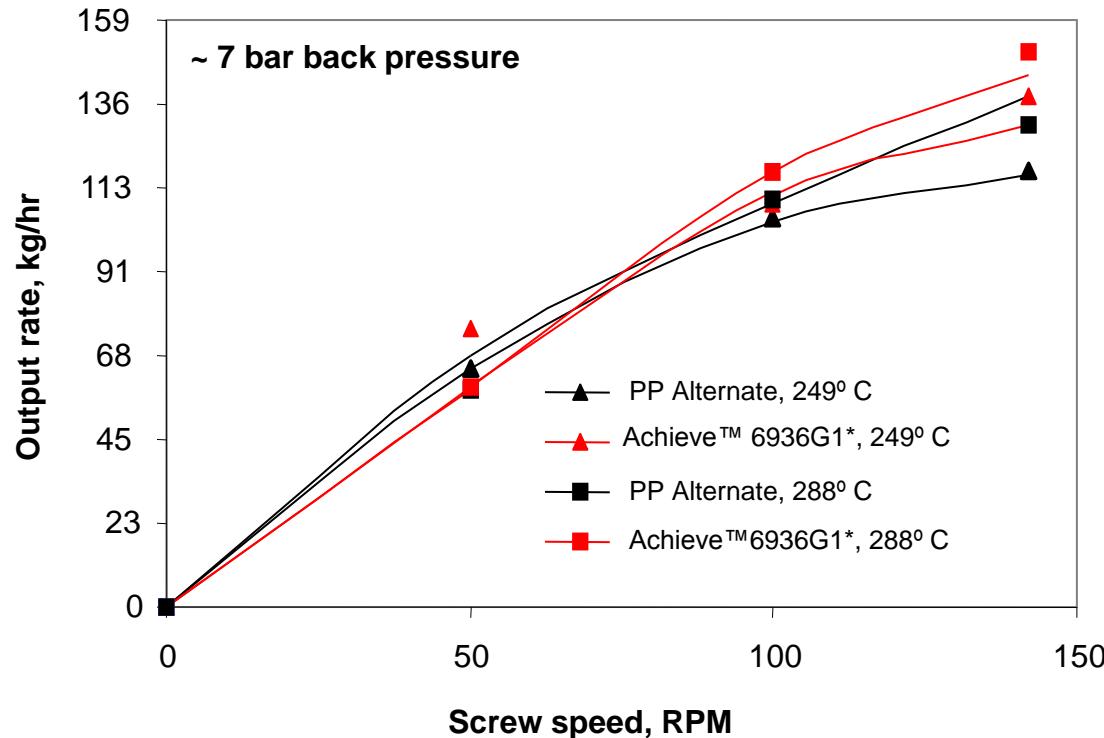
Material Handling of Achieve™ 6936G2

- 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

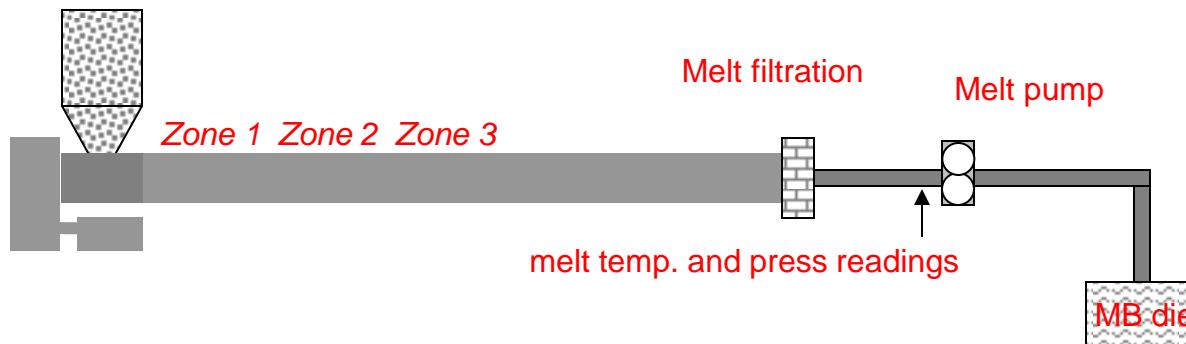
- For a given screw design, the output rate depends on the screw speed, screw design, barrel temperature setting and head pressure.
- Example shown below:



* Achieve 6936G1 and G2 are the same product grade

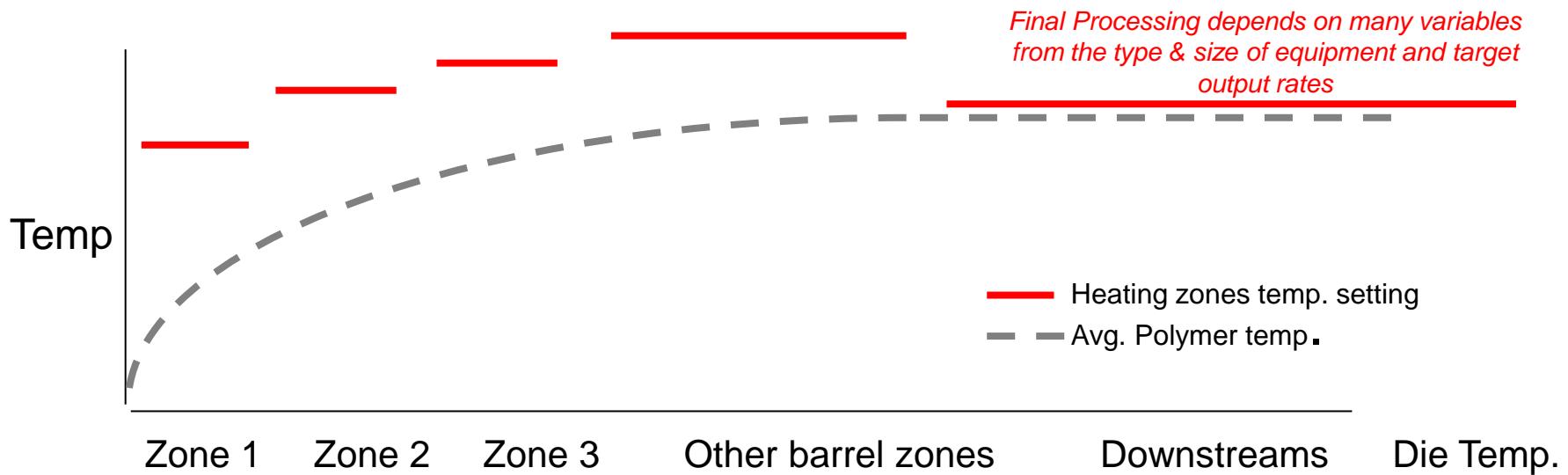
Melt Temperature Control with Achieve™ 6936G2

- 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. Barrel temperature should be higher than the target polymer temperature to provide conductive heating.



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.



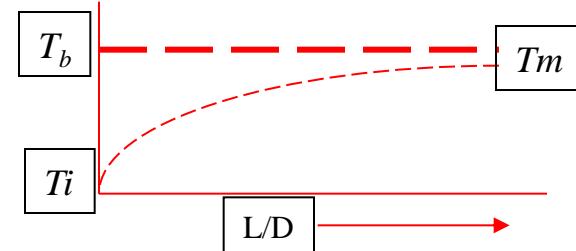
Effects of polymer viscosity on melt temperature

Simplified extrusion energy balance:

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

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

$$\begin{aligned} Q \cdot Cp \cdot (T_m - T_i) &= K \cdot C_1 \cdot (T_b - T_p) + C_2 \cdot N^2 \cdot \mu \\ C_3 \cdot N \cdot Cp \cdot (T_m - T_i) &= K \cdot C_1 \cdot (T_b - T_p) + C_2 \cdot N^2 \cdot \mu \\ T_m &= K \cdot C_4 \cdot (T_b - T_p) / N + C_5 \cdot N \cdot \mu \end{aligned}$$



Where:

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

K: Thermal conductivity, Tb: Barrel temp., Tp: Local polymer temp.

N: Screw RPM, μ: Melt viscosity, C₁, C₂, C₃, C₄, C₅: 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



Disclaimer

©2016 ExxonMobil. ExxonMobil, the ExxonMobil logo, the interlocking "X" device and other product or service names used herein are trademarks of ExxonMobil, unless indicated otherwise. This document may not be distributed, displayed, copied or altered without ExxonMobil's prior written authorization. To the extent ExxonMobil authorizes distributing, displaying and/or copying of this document, the user may do so only if the document is unaltered and complete, including all of its headers, footers, disclaimers and other information. You may not copy this document to or reproduce it in whole or in part on a website. ExxonMobil does not guarantee the typical (or other) values. Any data included herein is based upon analysis of representative samples and not the actual product shipped. The information in this document relates only to the named product or materials when not in combination with any other product or materials. We based the information on data believed to be reliable on the date compiled, but we do not represent, warrant, or otherwise guarantee, expressly or impliedly, the merchantability, fitness for a particular purpose, freedom from patent infringement, suitability, accuracy, reliability, or completeness of this information or the products, materials or processes described. The user is solely responsible for all determinations regarding any use of material or product and any process in its territories of interest. We expressly disclaim liability for any loss, damage or injury directly or indirectly suffered or incurred as a result of or related to anyone using or relying on any of the information in this document. This document is not an endorsement of any non-ExxonMobil product or process, and we expressly disclaim any contrary implication. The terms "we," "our," "ExxonMobil Chemical" and "ExxonMobil" are each used for convenience, and may include any one or more of ExxonMobil Chemical Company, Exxon Mobil Corporation, or any affiliate either directly or indirectly stewarded.