Purging Extruder Systems

Purging Extruder Systems
Vol. 33 #1, Summer 2006

Purging extrusion systems during product or resin change over can be a trying and time consuming process. Always the goal is to clean the system of one resin while changing to another. In some instances this can be accomplished with a straightforward swap for the second resin and in this case it will only be a matter of time and resin before the change is complete. However, there are some resin pairs, which should never be followed by one another such PVC and acetal resins, which will react violently together. When the range of polymers covers both "high temperature" polymers such as Nylon and PET a "low temperature" polymers such as polyethylene and polypropylene then special purging practices need to be followed to prevent freezing polymers in the system before they are completely purged.

In general, purging is a viscosity driven change from one resin to another and will begin from the rear of the machine going forward as material against the metal surfaces is swept forward by the new material replacing it at the metal surface. If the second material is lower in viscosity than the first, then the transition to the new material will be slower than if a high viscosity material is replacing a lower viscosity material. Therefore it is advisable to replace one class of materials with a higher viscosity resin of the following resin type. Then once the first material is removed by the high viscosity material, the high viscosity material can be replace by the new polymer and the "contamination" of the lower viscosity resin by the high viscosity resin will not be noticed.

When transitioning from a high temperature resin such as PET or Nylon, it is possible to freeze the high temperature rein in the system if it is cooled to rapidly to the lower process temperatures of the "low temperature" resin. If for some reason the first polymer it is not removed due to low process temperatures (such as nylon followed by PP) it may stay frozen at cold points in the system and slowly degrade and eventually breaks lose to disrupt production.

When purging from a polar polymer (PET, Nylon, EVOH) to a non-polar polymer (PP, PE) it is often time helpful to add an intermediate step of purging with a compatible resin such as an anhydride modified tie layer. This acts as soap to aid in removing the polar polymer prior to the purging of the tie resin with the non-polar polymer.

What follows next are several examples of purge sequences and several purging combinations for transitioning from high temperature incompatible resins to low temperature resins and back again.

As an example, consider the following equipment configuration, a twin or single screw extruder, melt pump, filter housing and a melt pipe and die to be used for all polymers to be used on the line, as well as a removable filter element which is to be used to make films from Nylon, PET, polypropylene and polyethylene. After the production of a film product and at change over to a new material the following general purging sequence will occur:

- 1. The line is cut back to the die and the extrusion system purged of any remaining original polymer in the hopper and extruder.
- 2. The extruder is then purged with a specific polymer chosen for the material just completed, selected to aid in subsequent cleaning and to improve polymer oxidative stability.
- 3. The purge valve is turned to the purge position to isolate flow thru the filter element, melt pipe and die
- 4. The filter element is removed from the line and removed to the die shop for cleaning or disposal.

- 5. A purge blank is added to the filter body to permit purging of the filter body, as well as the purge of down stream flow channels, melt pipe and die in preparation for the new polymer.

- 6. The extruder, melt pump filter body, melt pipes and die are purged with special purge polymer selected based on the polymer transition to remove traces of the previous polymer.

- 7. The purge blank is removed and the filter element, are attached to the line in preparation for product start-up

- 8. The new resin is purged into the extrusion system to remove the intermediate purge material and flush the filter, melt pipe and die combination of any remaining stabilized shut down purge or to fill a clean system in preparation for the change over.

(The above sequence is based on the assumption that the process equipment from the extruder flange to the die exit are heated in a manner to eliminate the formation of internal metal surfaces which can drop below the freezing point of the polyester and Nylon resins selected for the film manufacture. Failure to prevent freezing of PET or Nylon during the transition to polyolefin temperatures will result in slow degradation of the frozen Nylon and PET followed by polyolefin contamination and an increased incidence of splits. (May occur after several days to weeks.))

The selection of polymers for the two-step purge cycle will be dependent on:

- 1. The direction of product change
  - a. Polyester (Nylon) to Nylon (polyester)
  - b. Polyester (or Nylon) to Polypropylene (or polyethylene)
  - c. Polyethylene (or polypropylene) to polyester (or Nylon)
  - d. Polyethylene (or polypropylene) to polypropylene (or polyethylene)

- 2. Cleaning system capabilities for die, melt pipe and filters

- 3. Relative viscosities of the PET, Nylon, PP and polyethylene chosen for film manufacture

In general, the purging transition from PET or Nylon to PP or PE will consist of the following sequence:

- 1. Film grade polyester (Nylon) is purged by high IV, specially stabilized grade of amorphous polyester (Nylon) and the die, melt pipe and filter element are removed for cleaning or purged in place.

- 2. While maintaining the PET or Nylon extrusion temperatures, the extruder, melt pump and filter body are purged with polypropylene based maleic anhydride grafted polymer (tie layer) such as Mitsui QF500A. After a fixed quantity of purge (based on volume and surface area of equipment), the processing temperatures are set to the level required for the next material (PP or PE) to be extruded.

- 3. A fixed quantity of a blend of linear low density polyethylene (LLDPE) and maleic anhydride grafted polymer (tie layer) chosen from the grade of poly- olefin material next to be extruded.
  - a. Polypropylene based material such as Mitsui QF500A if going to polypropylene
  - b. A polyethylene based material such as EVA if going to polyethylene

- 4. Purge of material to be extruded next, polypropylene or polyethylene.

In general, the purging sequence for going from PET to Nylon (or Nylon to PET) will be as follows:

- 1. Film grade polyester (Nylon) is purged by high IV, specially stabilized grade of amorphous polyester (Nylon) and the die, melt pipe and filter element are removed for cleaning or purged in place

- 2. While maintaining the PET (Nylon) extrusion temperatures, the extruder, melt pump and filter body are purged with amorphous Nylon (PET). After a fixed quantity of purge (based on volume and surface area of equipment), the processing temperatures are set to the level required for the Nylon (PET) next to be extruded.

- 3. Purge of Nylon (PET) material to be extruded next

In general, the purging sequence for transitioning from polypropylene or polyethylene to polyester or nylon will be as follows:

- 1. Film grade polypropylene or polyethylene are purged by a specially stabilized grade of polypropylene (perhaps HDPE depending on plant inventory constraints), while increasing heats to polypropylene extrusion temperatures if necessary, and the die, melt pipe and filter element are removed for cleaning or purged in place.

- 2. While increasing to or maintaining the polypropylene extrusion temperatures, the extruder, melt pump and filter body are purged with polypropylene based maleic anhydride grafted polymer (tie layer) such as Mitsui QF500A. After a fixed quantity of purge (based on volume and surface area of equipment), the processing temperatures are set to the level required for the next material (PET or Nylon) to be extruded while maintaining the purge at low rate.

Once proper processing temperatures are reached, a purge mixture of amorphous polyester or Nylon and the Nylon or PET material next to be extruded are used to remove traces of grafted polypropylene and then transition to the next material, polyester or Nylon. (With some experience it may be possible to delete the amorphous materials in the purge but this will depend some what on the relative viscosities of the PET, Nylon, polypropylene and polyethylene are)

With experience with each changeover it may be possible to modify the purging sequence to minimize steps with a goal of minimizing the number of purging materials needed for the various transitions. This can only be determined based on locally available materials to be used for each film manufacture and the number and frequency of material changeovers.

– Eldridge Mount III, Emmount Technologies

Return to Consultants Corner