S2.3.2 CAUSES OF GEL FORMATION IN POLYMER PROCESSING & HOW TO PREVENT AND REMOVE THEM

Robert Smith, Asco Filtri

Gels are a common quality problem in extrusion of resins and polymers. Frequently they are present as visual defects caused by discreet domains of material immiscible within the bulk resin/polymer processed. Typically they come from higher molecular weight materials within the bulk feed or insitu contamination but also due to crosslinked material caused by overheating, long residence times in localized areas, fines in recycled products, catalyst residues, thermally unstable additives, or other organic/inorganic contamination. While presence of gels is often seen as visual defects, their presence can lead to physical as well as optical performance problems.

Since presence of gels in raw materials, fines in recycled products, catalyst residues or their formation due to thermal stability of additives are beyond the scope of this paper, this discussion will primarily focus on formation due to residence time issues associated with the general melt system, it's design and manufacture including discussion of critical post filtration extrusion equipment design issues and selection of filter medium to improve capture/removal capability of the filter system while maintaining maximum online performance. When gels result due to excluded areas of this discussion, the manufacturer should work with his suppliers and vendors to minimize impact of these sources.

If gels are a problem and develop within the processing equipment, it is the authors experience that this is due to physical issues within piping and equipment that result in long residence times of materials. To explain further, residence time is calculated and understood from an overall flow rate/void volume perspective which is a relatively good measure of average residence time as opposed to absolute residence time. Small differences in internal diameters of pipes joined together, transition pieces or abnormality of cross sections create areas within the melt system where material can reside with extremely long absolute residence times. Low laminar flow combined with high viscosity of materials result in relatively thick boundary layers at pipe, pump, transitions, filter housing outer boundaries. This in turn increases the volume and length of the absolute residence time within any area with a high void volume/flow rate ratio or mismatch in transitional cross section (e.g. ledge or lip at intersection). In other words, if there is a high void volume down stream of the final filter or if there is a ledge or mismatch in piping diameters, the absolute residence time of the total volume of the system will increase. The result can lead to increased gel generation due to crosslinking or degradation and subsequent quality issues. Therefore, it is important to understand these potential problems when designing or modifying the melt system should gel formation be foreseen as an issue. In addition, the selection of filter medium, filter configuration and sizing (i.e. flux rate) should be taken into consideration should the elimination or minimization of gels be of importance. The filter medium design can have a significant impact on the ability to capture gels regardless of their origin. Typical physical characteristics of various medium will be discussed in detail.