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Dynamar™ Polymer Processing Additive Evaluation Guidelines

Introduction

Dynamar Polymer Processing Additives (PPAs) form a thin coating on the metal surfaces of equipment used to process polyolefins and other polymer systems. This coating acts as a lubricant to reduce apparent viscosity of the host resin. The reduction in viscosity provides a variety of processing advantages: reduced back pressure and torque, reduced gels, minimal die build-up, reduced wear at the die head and improved throughput, to name a few.

The specific benefits of Dynamar PPAs to a polymer system can be determined through evaluation. However, because these effects typically result from use levels as low as 50 to 1000 ppm (0.005 to 0.1%), obtaining reliable comparative data can be difficult. These guidelines are offered to help obtain accurate evaluation results.

Equipment Preparation

The effect of Dynamar PPAs in a polymer system is often evaluated by using extrusion-type equipment. This equipment may range from small capillary rheometers in laboratories to large industrial size processing machines. Modifications to the equipment are not necessary.

Evaluation equipment must be clean. Carbonized polymer build-up on metal surfaces can impair the performance of the additives and result in unreliable evaluation data. Also, Dynamar PPAs may act as a purging agent the first time they are processed through equipment. The purging may result in visible black specks, gels, and residual pigment in the extrudate during the first hour of testing, or until these contaminants have been flushed from the system. This cleaning phenomenon is an added benefit of using Dynamar PPAs.

Removing Dynamar additives from the test equipment also is important to obtaining accurate evaluation results. Without thorough cleaning, the additives will adhere to the metallic surfaces for some time, imparting process improvements to the control resins.

Dynamar additives can be removed by using a purging compound consisting of a low melt index resin containing an abrasive inorganic filler, such as 5-10% silica. If the equipment can easily be dismantled, scouring with a light abrasive pad or powder is also effective. Some surfaces can be wiped with cloth dampened with a solvent like MEK or acetone (It is important to remember that these two solvents are flammable. Appropriate safety and industrial hygiene practices should be followed).

The evaluation equipment is free of the process aid when a control resin is extruded which contains no Dynamar PPAs and the operating parameters return to the known values.

Addition of Dynamar™ PPAs

Dynamar PPAs may be added to the test resin via a concentrate or directly by melt blending at the levels wanted for study. Adequate dispersion of the Dynamar additives is essential. A single screw extruder will usually provide adequate mixing when adding Dynamar PPAs via a 2-3% concentrate. Direct addition requires more rigorous plastic melt mixing equipment, such as a Banbury or twin screw mixingextruder.

Refer to Dyneon Literature Methods, "Concentrate Preparation," "Direct Addition During Resin Manufacture," and "Optical Microscopy Method for Dispersion Analysis in Polyolefins", for detailed information.

If Dynamar PPAs are added via a concentrate, it is important to recognize changes in processing that might be attributed to the host resin of the concentrate. It may be desirable to prepare a control by adding the same amount of host resin without the Dynamar PPA, or by using a host resin identical to the resin system under evaluation.

If Dynamar PPAs are added directly to the resin by melt blending, it is important that the processing benefits are compared to a resin system that has had exactly the same heat history. In this case it is recommended that a control be prepared by running through the exact same mixing cycle.

Benchmarking

The processing limits of the control resin system should be determined. This provides a basis for comparing the potential process advantages of Dynamar PPAs. Usually, throughput rates versus pressure or product defect limitations, such as the onset of melt fracture, are established as limits.

Running the control resin between evaluations ensures that operating conditions of the system return to the original known values. This indicates the equipment has been properly cleaned between evaluations and test results are more reliable.

Dynamar PPA Comparisons

The effects of Dynamar PPAs become apparent after the additive has coated the metal surfaces in the equipment. The evaluation should begin at process conditions slightly above the processing limits determined for the control and typically at the throughput rate where surface imperfections are seen. Depending on the equipment and conditions, 15-60 minutes of running time may be required to complete the coating process. This is termed the "conditioning time," as observed by the elimination of surface defects and a drop in instrument amperage and/or pressure.

Once this conditioning phenomenon has occurred, the limits of the system should be tested by increasing the throughput rate until surface imperfections, or other rate-limiting parameters, are again observed. The difference in operating parameters between the resin containing a Dynamar PPA and the control will be the benefit contributed by the Dynamar additive.
Evaluations should be conducted at several levels of a Dynamar PPA to determine the full functional benefits of using a Dynamar PPA versus the control.

The conditioning time is generally short in high shear rate conditions and longer in low shear rate conditions. The effects of Dynamar PPAs in very low shear rate conditions can be observed more rapidly by preconditioning the equipment with a 2%concentrate. However, this will only show gross effects and can

cause problems such as screw slippage and die build-up. In addition, the extrudate formed will probably exceed the amount of Dynamar PPA allowed for food contact regulations. This procedure is not recommended for making comparisons of Dynamar process aids or for determining maintenance levels.

Determining the Appropriate Level

After the required processing parameters have been determined, the next step is to determine the "maintenance level", i.e., the level of Dynamar PPA necessary to achieve those criteria. The maintenance level is the amount of Dynamar additive for a given resin and piece of processing equipment that will keep the dynamic coating system in an equilibrium of being replenished and ensure good processing under the required criteria. Once the maintenance level of a Dynamar PPA is determined, there will be no functional benefit of using a higher level in a particular system.

To determine the maintenance level, start with very clean equipment to ensure reliable results. Use the same or very similar commercial production processing equipment for which the resin is intended. Maintenance level information determined in small equipment (e.g. capillary rheometer) does not necessarily translate well to large production size equipment.

The level of a Dynamar PPA should start low (200-400 ppm) and then be increased in 100-200 ppm increments every 30-60 minutes, or until processing criteria have stabilized and are finally met. This will be the maintenance level.

It is not necessary to clean the equipment between different evaluation levels using this procedure.

Other Additives

The evaluation resin should contain enough antioxidant so that thermal degradation will not cause rheological changes during the evaluations. Most other additives in the resin are compatible with Dynamar PPAs and usually will not interfere with its performance, or vice versa. Examples of these are antioxidants, slip additives and acid scavengers.

However, some additives may interfere slightly with Dynamar PPA performance, and at high levels these additives may have a significant impact on the anticipated performance of Dynamar PPAs. These additives would include stearates, antiblocking agents, inorganic pigments and hindered amine light stabilizers. The Dynamar PPA technical staff has studied these interactions in detail and have developed products and process guidelines to help avoid interferences. If there are questions regard- ing the compatibility of a particular additive package with a Dynamar PPA, contact the Dynamar PPA laboratory.

This evaluation guide is intended only as a reference to help ensure reliable evaluation results. Please call the Dynamar PPA technical staff for additional information or assistance.

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