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Screw and Barrel Construction

Ryton® PPS processing guidelines

Introduction

When injection molding Ryton® PPS (polyphenylene sulfide) resins, certain procedures should be followed, as outlined in the Ryton® PPS Processing Guide. Additional information on screw and barrel construction is addressed in this document.

Barrels

The heating cylinders of injection molding machines have their internal bore finished by either nitriding or adding another metallic liner. Cylinders for nitriding are made of a special steel with a high aluminum content and chromium and molybdenum. The steel is first hardened and the surface completely cleared of all traces of decarburization. If this step is not performed the nitriding layer will be very brittle and peel while in use. The cylinder is heated from 499 °C to 649 °C (930 °F to 1,200 °F) in an atmosphere of ammonia, resulting in a hardened layer that is approximately 0.5 mm (0.02 inch) thick. The surface requires additional finishing, and the final depth of the hardness may be considerably less. The hardness of the lining decreases with depth; thus, wear further reduces the surface hardness and is self-accelerating.

The corrosion resistance of a cylinder depends primarily on the chromium content of the steel, ranging from 9–32 % in bimetallic cylinders to a maximum of 2 % in nitrided ones. Field surveys indicate that most bimetallic cylinders outlast nitrided cylinders by a ratio of approximately 3 to 1. Although they are more expensive, bimetallic cylinders are recommended for this reason.

Bimetallic cylinders can be made in two ways. In one case, the sleeve is produced separately, then shrunk into a prebored barrel. This method allows for high operating pressures. The second technique involves centrifugally casting the molten lining at speeds up to 75 G. While welding techniques can deposit lining material, they are not used for injection cylinders.

The manufacturer of the most widely used lining material is Xaloy, Inc., New Brunswick, NJ. Xaloy's standard material is an iron based alloy, used for abrasion resistance. Xaloy 306 and Xaloy 800 are nickel cobalt based alloys chosen for corrosion resistance. These alloys are cast into a low carbon steel shell or an alloy steel shell. The alloy steel shell is strongly recommended because it almost doubles the tangential bore stress. The standard lining has a hardness of 48–52Rc, and the alloys have a hardness of 60–63Rc. In addition, the cylinder bore can be chrome plated.

Screws

Most screws are made from 4140 steel and then flame hardened and chrome plated. They can also be carburized and nitrided, and a hard surface obtained by spraying on a layer of metal. Worn screws can be rebuilt several times, providing that there is not excessive wear.

Major causes for screw/barrel breakdown include:

1. Fatigue failure, primarily caused by thermal shock conditions, aggravated by improper starting and stopping procedures
2. Corrosion from the thermoplastics used
3. Damaging materials (trash) fed into the hopper and then the barrel
4. Prolonged use of high injection pressure
   (The use of two-stage injection profiles will substantially reduce this type of failure)

Corrosion

If there is to be a prolonged shutdown period, purging should occur. A fractional melt high density polyethylene is recommended for purging Ryton® PPS compounds. Chrome plating and chemically deposited electroless nickel coating of the cylinder can help minimize the corrosive effect of thermoplastics.

Considerable wear often occurs when molding glass and mineral filled thermoplastics in screw machines. It was thought that the wear came from erosion at the feed end of the screw; however, evidence has shown that wear occurs more in the return valve section at the front of the screw.

Repair Techniques

Cylinders in need of repair may be disassembled and inspected for surface imperfections where material hang-up is occurring. Smoothing of the surface should correct the problem. Any small cracks can be welded and finished. Wear caused by the sliding of the non-return valve has not been found to be a major problem. Worn barrels can be re-bored and the screw size increased to the necessary dimensions. The barrel is best cleaned with a wire brush attached to a long broom handle. Screws are relatively easy to disassemble and clean.

Start-Up/Shut-Down Procedures

When a machine has a cold start-up, it is important to allow enough time for the heating cylinder to completely reach molding temperature. Many molders allow an additional period of approximately 20 minutes past the pyrometer indication of molding heat. This will substantially reduce the stress in the barrel and screw when starting. Purging at start-up should be done at low pressure. When the machine is shut-down, it should be purged until no more material comes out, and the screw left in the forward position.

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