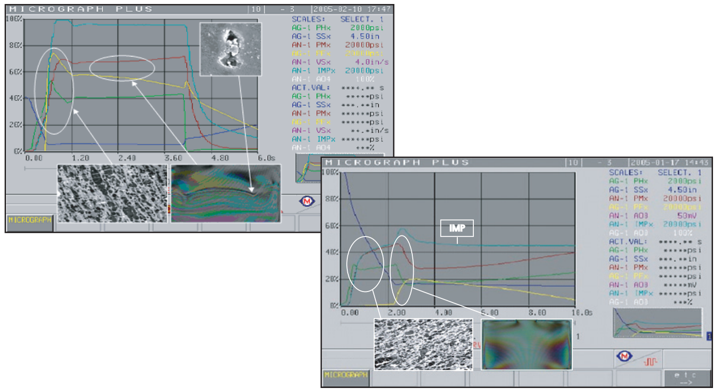
intellimold™

Closed Loop Control



Melt Pressure Control

Specification Sheet

Intellimold™ closed loop control is a complete real time system that controls molding processes based on recommended processing conditions for the material. Controlling to these conditions reduces material degradation and deformation, which correlates to better parts. The processing conditions are:

1. Injection pressure (dynamic fill, and pack & hold)

2. Melt temperature

3. Injection time

Melt temperature and injection time are easily achievable, since they are fixed values that can be directly entered into an operator interface on the machine. Injection pressures are a different story. Conventional molding techniques attempt to achieve recommended injection pressure by means of a velocity profile. But a constant velocity does not correlate to a constant internal melt pressure due to the non-linear behavior of material. This results in linearization of the polymer during the dynamic fill stage up to 10:1 in comparison to the pre-molded spherical structure; residual stress and micro cracks from the pack and hold stage; and excessive shear (see Figure 1).

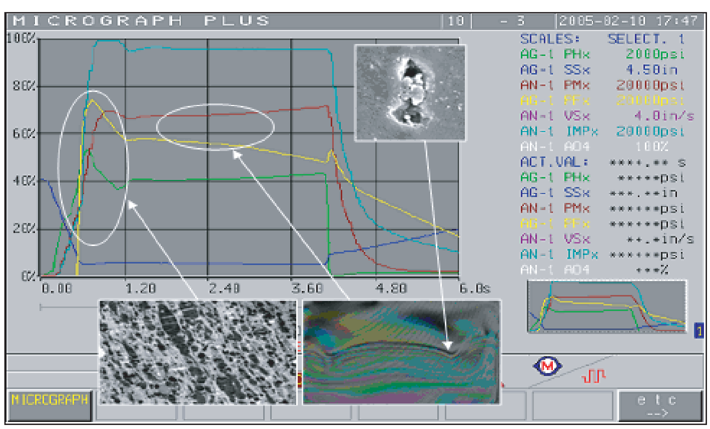


Figure 1.

The key to good molding is to control the internal melt pressure in real time in order to give the material optimal molding conditions to solidify in a state of designed morphology. Internal melt pressure is the result of four dynamic components. These components are shrinkage forces, resistance of the mold, resistance of the air trapped in the tool, and partial solidification of the melt. Since these forces vary throughout the cycle, so does the internal melt pressure.

Intellimold compensates for these variations in real time by oscillating the proportional control valve, allowing more flow when there is a drop in pressure and restricting flow when there is an increase in pressure, thus maintaining a constant internal melt pressure.

MODEL

- **Fast start-up**
- **Reduced Cycle Time**
- **Real time control**
- **Less scrap**
- **Improved surface quality**
- **Consistent part density**
- **Improved repeatability**

invensys

EUROTHERM

Once the flow front reaches the last place to fill, the degree of reduction in applied pressure at the nozzle is controlled through a process factor. This is done to equalize the pressure at the nozzle and the last place to fill, which satisfies the 2nd stage pressure recommendations. The process factor provides compensation for the non-linear behavior of the material and variances in complex part geometries, which is required in order to achieve the most effective conditions for the material to relax into its designed low stress environment while still in the molten state (see Figure 2).

Real time pressure readings are acquired either from pressure, or pressure and temperature transducers. One transducer is placed in the nozzle body and another is placed in the cavity (at last place to fill).

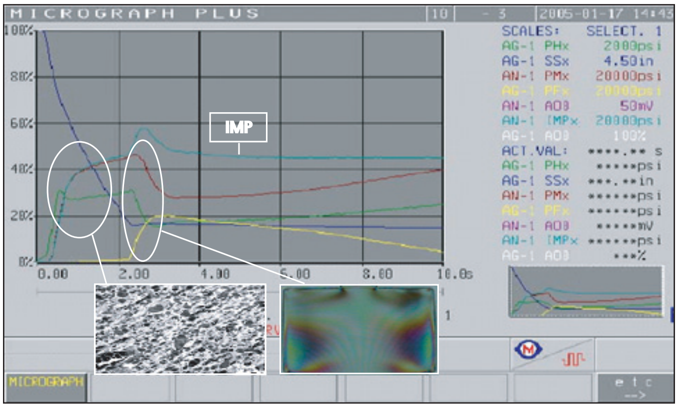


Figure 2.

Piezoelectric transducers or strain gauge transducers can be used. Internal melt pressure is mathematically derived from these inputs. This variable is then compared to a setpoint and a signal is sent to the proportional control valve to compensate for changes. Intellimold updates the internal melt pressure once every millisecond. Leaving injected material unattended for more than 30 milliseconds while subjected to temperature and pressure during fill, pack, and hold is permanently damaging (see Figure 3). When carrying out a cycle it is necessary to have concurrent feedback from the material to compensate for the skin layers passing through the Tg (glass transition). A conventional cycle disregards this occurrence, further linearizing the molecular structure of the surface causing irreversible degradation and deformation to the skin. Skin degradation, skin deformation and micro cracks created from conventional molding are stress concentrators that adversely affect part performance.

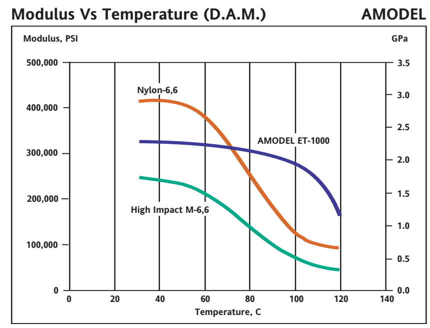


Figure 3.

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Part No. HA136761USA Issue 2