Designing Parts for Ultrasonic Degating

General Description

The separation of injection-moulded parts from their runner systems through the introduction of ultrasonic energy into the area of the gate is referred to as ultrasonic degating*. These gate sections, when ultrasonically excited, reach high temperatures and melt due to a high degree of intermolecular excitation and internal friction.

This information sheet describes ultrasonic degating and provides design guidelines for its use.

The advantages of ultrasonic degating include:

- Speed of operation, with a typical cycle time of less than one second.
- No stress developed in plastic component.
- A clean break at the part surface.
- Many parts may be degated and automatically separated into bins.

M echanics of Ultrasonic Degating

The vibrating horn contacts the runner as closely to the part as possible with relatively light force, generally 20 to 40 pounds, imparting maximum energy into the runner system. The mechanical vibrations generate a standing wave of energy down the runner through the gate area and into the part. (Refer to Figure 1.)

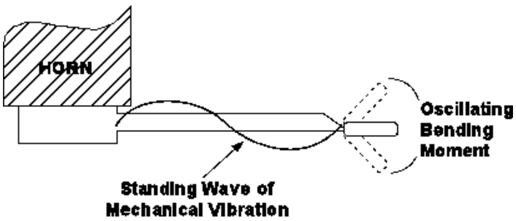

Figure 1 Standing wave of mechanical vibration during degating

The freely resonating part goes through cyclic bending moment with the gate area acting as the fulcrum. This bending induces stress into the already highly-stressed gate area and generates internal molecular friction (hysteresis losses) which rapidly elevates the temperature of the material at the localized area of the gate. Once the melt temperature is reached, the part falls free of the runner.

* Ultrasonic degating patent number 4,585,152, April 29, 1986, assigned to Branson Ultrasonics Corporation.

Primary Factors Influencing Design

The following questions should be addressed prior to designing for ultrasonic degating:

What type of material is to be used?

- Rigid thermoplastic materials (polystyrene, ABS, polycarbonate, acrylic, nylon, etc.) work best. They transit the mechanical energy more efficiently.
- Lower stiffness (modulus) thermoplastics such as polyethylene and polypropylene absorb the mechanical energy and do not give good consistent results.

What is the part size/mass?

- Generally parts of smaller size and mass are better suited for ultrasonic degating. Large, massive parts require excessive energy to overcome inertia.
- Brittle thermoplastics tend to fracture from the mechanical vibrations instead of melting. Thermosets, of course, do not melt at all, but a mechanical break is still possible.

Major Design Characteristics

In order to obtain acceptable, repeatable results, these general guidelines must be followed:

1. The gate area must be designed to focus the vibratory energy to a point tangent to the surface of the part. See Figure 2. The design shown in Figure 3 does not properly focus the energy and could allow a section of the gate to remain on the part.

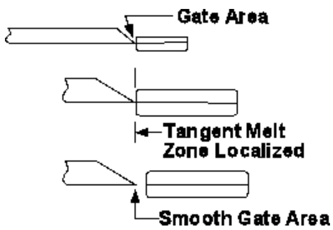

Figure 2 Correct gate design

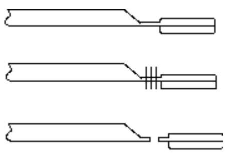

Figure 3 Incorrect gate design

2. Any gate cross-section that can fit into an 0.080 inch (2.03 mm) diameter circle can be ultrasonically severed. (See Figure 4.) Circular gates give the best results due to their uniform melt. Rectangular gates should not exceed 0.015 inch (0.4 mm) thickness by 0.080 inch (2.03 mm) width.

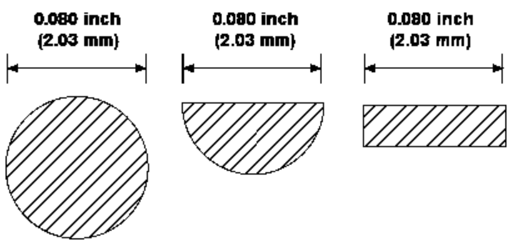

Figure 4 Gate size

Horn Design and Placement

Standard horns can be used for some degating jobs, but best results usually are obtained with a horn that is custom-made for use with a particular runner system. Contact between runner and horn should be maximized, so that energy is transferred efficiently.

Horn width should at least equal runner width. Flat-faced horns are recommended for flat-topped runner systems such as those with rectangular or trapezoidal cross-sections. Round or oval runners require horns that are contoured to that shape. Some horns also have to be relieved in spots to accommodate bosses or other raised areas on the runners. (Figure 5.)

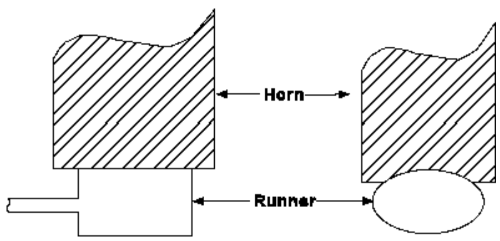

Figure 5 Maximizing horn--to--part surface area for best results

Horn length should ideally equal the length of the runner leg being degated, because most plastics do not transmit ultrasonic energy well enough to permit degating at points over 3 to 4 inches from the horn extremities. Many runner systems are small enough to be handled with a single placement of a large bar horn. For large runner systems, or those with several branches (balanced runner systems), more than one horn placement may be necessary (see Figure 6).

This could be done automatically by using a sliding fixture that moves the runner relative to the horn. Alternatively, more than one horn can be used simultaneously, or a non-rectangular horn face can be used.

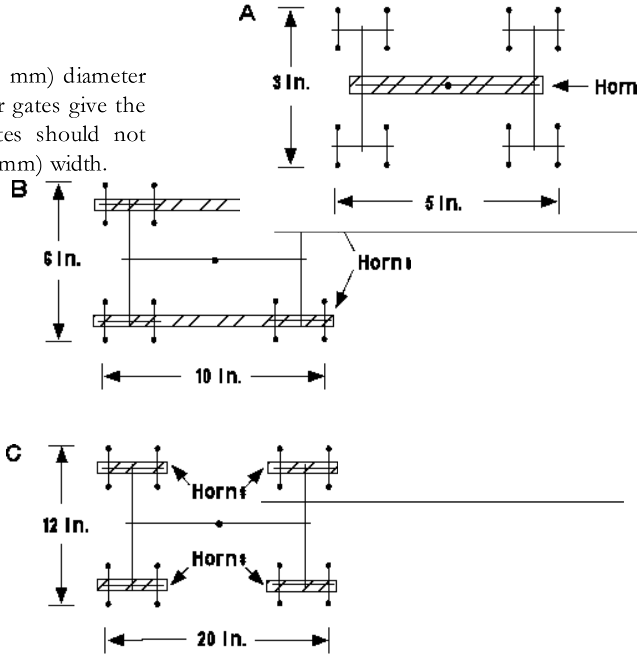

Figure 6 Horn size and placement

For example, a circular horn has been used to remove parts from a radial runner system.

General Operating Parameters

Fixturing - Along with the horn, fixturing is a very important process variable. The fixture must support the runner system properly, so that it does not interfere with the transmission of the mechanical vibration; in some cases the fixture may enhance transmission. Rigid support materials such as aluminum and steel can be used to construct the fixture.

In many cases a sheet of resilient material such as urethane is placed beneath the runner system to insure an out-of-phase relationship between the runner and horn surface. If this sheet is not used, the part vibrates in phase with the horn, and very little heat is generated. The durometer of the material can also influence the results, making it necessary to try different materials to optimize the process.

Equipment Parameters - Some development time may be necessary to arrive at the equipment parameters that will produce the desired results. In general, however, a good starting point would be:

Weld time:	0.250 ms
Hold time:	0.050 ms
Force:	20 - 40 pounds
Horn downspeed:	Slow to medium
Triggering:	Pretrigger
Amplitude:	75 - 125 microns