

1

Overview of Runners, Gates, and Gate Positioning

In many cases, the mold design dictates the gating position, although ideally, the optimum gate position should be determined based on part requirements and afterwards the mold design selected to provide for the desired gate position. Available gating positions, and gate designs, are significantly influenced by whether the runner travels along the primary parting plane of the mold (the parting plane where the part forming cavity is defined) or whether it *does not* travel along this plane.

This chapter provides only a brief introduction and orientation of basic runner types and their influence on gate design and gating location. More detail on each of these subjects is presented later in the book.

■ 1.1 Primary Parting Plane Runners

In the dominant runner type used in the industry the runner and part forming cavities are located along the same primary parting plane. Primary parting planes, often referred to as the parting lines, are where the mold opens and closes to allow ejection of the molded part and/or of the runner. The primary parting plane is the one where the molded part is formed and ejected. The *primary parting plane runner* is used in *two plate cold runner molds*. A cold runner mold is defined as a mold in which the plastic material in the runner is cooled and ejected from the mold during each mold cycle. Molten plastic material is injected through the runner, the gate, and then into the part-forming cavity. This molten plastic is then cooled by the mold, and when sufficiently solidified, the mold opens and the runner, gate, and part are ejected along the same primary parting plane. Figure 1.1 illustrates the position of the runner within the mold and its ejection from the primary parting plane. Notice that the part and runner are formed and ejected along the same parting plane.

After the molded part and runner are ejected, the mold again closes, creating a flow channel (runner path) between the injection molding machine nozzle to the part forming cavity. As the primary parting plane runner is located along the same parting plane as the part forming cavity, gating into the part is limited to its perimeter, or very near its perimeter. Sub gates, such as the tunnel, cashew, and jump gates, allow gating to be positioned within a short distance from the actual perimeter of the part (for gate designs see Section 8.4).

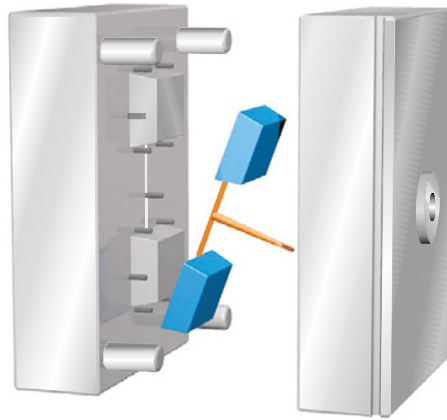


Figure 1.1 2-plate mold open and ejecting parts and runner

■ 1.2 Sub Runners

A second runner type does not travel along the primary parting plane of the mold. This *sub-runner* generally travels parallel to the primary parting plane, but not along it. The sub-runner can be used in either a cold runner or a hot runner mold.

1.2.1 Cold Sub Runners

In a cold runner mold, the sub-runner travels along a second parting plane other than the primary parting plane where the part is formed. The two parting planes are normally parallel to each other and are separated, and partially defined, by at least one mold plate. The sub-runner and part forming cavities are connected by an extension of the sub-runner referred to as a *secondary sprue*. The bridging secondary sprue passes through the at least one separating mold plate and connects to the part-forming cavity through a small gate opening. The secondary sprues are normally parallel to the opening direction of the mold and perpendicular to the sub-runner (see Figure 1.2).

During molding, after the plastic melt in the runner and part forming cavity solidify, the mold will open along the two parting planes. The part is ejected from the opened primary parting plane and the runner (which includes the secondary sprue and gate) is ejected from the opened second parting plane as seen in Figure 1.3.

This type of mold is commonly referred to as a *three-plate cold runner mold*. The terms two-plate and three-plate cold runner molds refer to the minimum number of mold plates required to form and to allow removal of both the part and the solidified runner. With the two-plate cold runner mold, the part and runner are formed and removed between at least a first and second mold plate. With the three-plate cold runner mold, the part is formed and removed between at

least a first and second plate and the runner and gate are formed and removed between at least a third plate and often the same second plate used to help form the part.

This type of mold is used when it is desirable to gate the part in a location other than the perimeter. It is commonly used for molding gears where it is desirable to gate in the center hub of the gear.

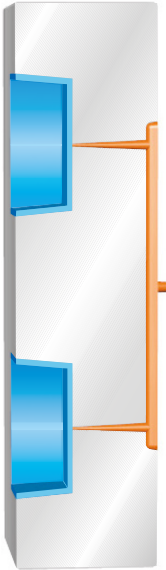


Figure 1.2 Cold runner with secondary sprue feeding the part forming cavities in a 3-plate cold runner mold

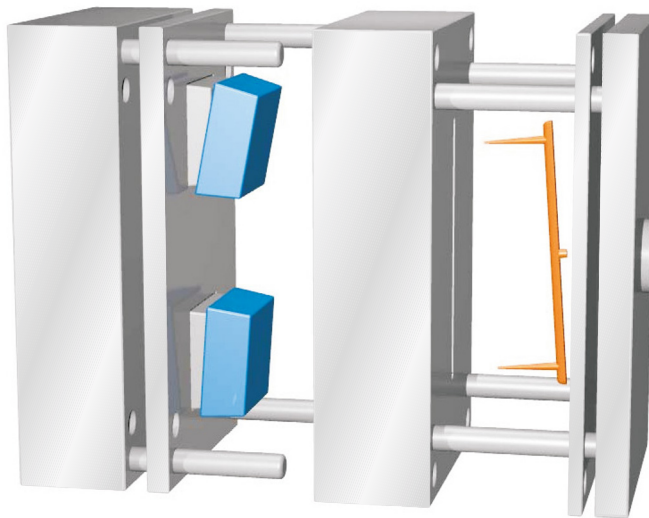


Figure 1.3 Typical 3 plate cold runner mold open and ejecting parts off the primary parting plane and ejecting the cold runner along the secondary parting plane

1.2.2 Hot Sub Runners

A second variation of the sub-runner mold is the *hot runner mold*. This type of runner provides the same gating flexibility as the three-plate cold runner mold. However, unlike a cold runner mold, the melt that travels through the runner remains molten, and is not ejected between molding cycles. The design of hot runner systems is more complex than that of cold runners. Their design and contrast to cold runners are discussed later in Chapter 9.

Two variations of a hot runner are illustrated in Figure 1.4. Here the melt travels in a *hot manifold* along a path, which is normally parallel with the platens of the molding machine. A hot drop, or nozzle, is then used to deliver the melt from the manifold to the part-forming cavity. Special attention is required to isolate the heat from the hot manifold and drop from the part-forming cavity, which requires good cooling. This figure illustrates both a valve gated nozzle (top) and a more conventional open gated nozzle (bottom).

Unlike the cold runner molds, the runner in the hot runner mold remains molten during processing and is not ejected each cycle. Like the three plate cold runner mold, this type of mold provides more gating options than the two-plate cold runner mold.

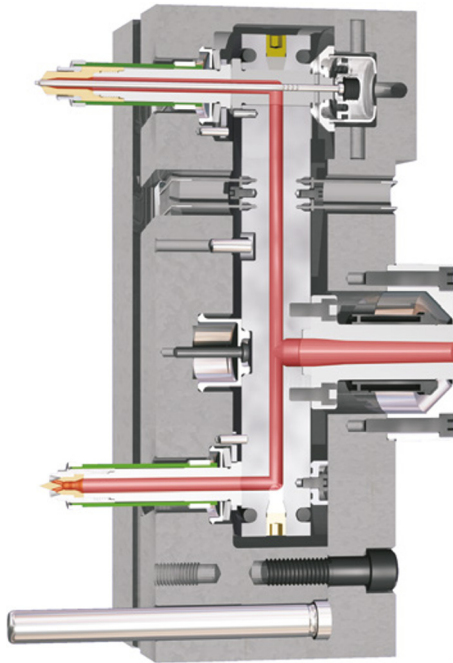


Figure 1.4 Externally heated hot runner illustrating manifold and drops. The figure illustrates two types of nozzles: the top nozzle is valve gated and the bottom nozzle has a more conventional open gate design (Courtesy: Husky)

■ 1.3 Hybrid Sub-Runner and Parting Line Runner

It is common for a mold to contain both a sub runner and a parting plane runner. This is most common when a hot runner is used. Here, the hot runner would deliver the melt to a cold runner, or gate, along the primary parting line. An example is a two-cavity mold, used to produce the flat donut shaped part shown in Figure 1.5. The hot drop delivers the melt to a cold runner located within the center region of the part. The cold runner then radiates out and gates the part along its inner edge.

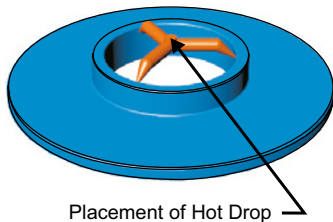


Figure 1.5 Round part internally gated by a sub-runner which is fed by a hot drop

■ 1.4 Gate Designs

Parting line runners are the most restrictive on gating position but provide the greatest flexibility in gating design. The three-plate cold runner mold is limited to restrictive pin point gates, which must allow the gate to be separated, or torn, from the part as the mold opens. Parting line runners can use similar restrictive gates to provide for automatic degating during mold opening, but they are *not required* to use these types of gates. Parting line runners provide for gates to be formed along the parting plane of the mold. This provides significant flexibility in their design to achieve a desired effect. Some of these gates include fan, film, tab, edge, and diaphragm gates. The effects that can be achieved with these gates could include keeping the runner and gate attached to the part to facilitate post-mold handling, using broader gates to limit shear rates and gate region shear stress during mold filling, using broader gates to improve flow patterns across a cavity, and using thicker gates to improve packing.

The hybrid sub-runner and parting plane runner, presented above, increases gating opportunities. An example where this hybrid design might be used is when molding a cylindrical part, where a diaphragm gate is desirable (see Figure 8.31 in Chapter 8). Here, a hot drop feeds directly into a diaphragm gate, which in turn feeds the cavity. The above-mentioned gates, as well as additional gating options, such as valve gates used in hot runners and gates providing automatic degating in cold runners, will be presented in Chapters 8 and 11.

Though a vast majority of hot runner molds have restrictive gates, there are additional options available. These options include valve gates and edge gates.