Dr. Die Cast

To “Sprue” or Not to “Sprue”?

There is an old story, probably mostly legend that tells of a young daughter watching her mother prepare a holiday ham. She noticed her mother carefully measuring and cutting off two inches from the end of the ham. When she asked her mother, “Why?” her answer was, “That’s the way her mother taught her to prepare a ham.” That didn’t satisfy the curious youth so she asked again, “Why did she do that?” They called Grandma to ask her about this recipe. Grandma responded with, “That’s the way my mother - your great grandmother - taught me.” Now they were indeed fortunate because Great Grandmother was still alive and they called her on her cell phone at the retirement village where they interrupted her golf game. When they asked, “Why did she cut two inches off the ham?” she immediately replied, “The roasting pan was too small.” Sometimes we’re guilty of repeating processes or procedures that may have started out serving a good purpose but have evolved to be nothing more than habitual repetition.

In many parts of the world it is common practice to use a sprue in cold chamber tools. Wait a minute! You might be thinking only hot chamber dies and plastic molds use sprues. Probably, you are already using a sprue but call it by another name.

Figure 1 – Hot Chamber sprue (not this one).

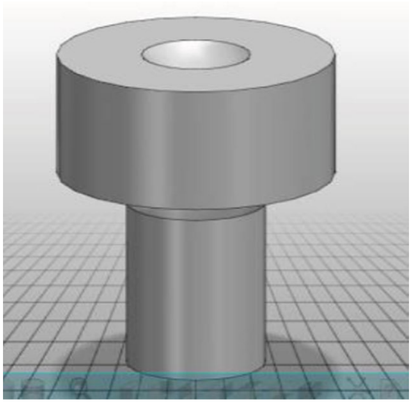

Figure 2 – Plastic sprue (not this one either).

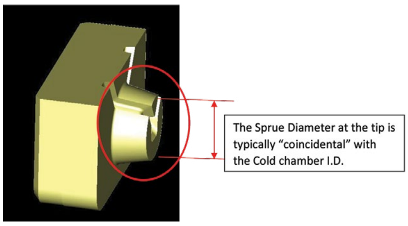

Figure 3 – Cold Chamber sprue (This is the one).

(See figure 3 above). I have heard the above component referred to by a variety of names including “Riser”, “Podium”, “Hog nose”, “Spreader Block”, “Pick up block” and “sprues”. Perhaps there are others names you could add. The point is you probably already have one in your shop but never heard it called a sprue.

Figure 4 – Standard Shot Spreader Block. (Zero rise) This may be the most common design used in North America.

Why does it matter which style I use? There are several reasons to avoid the use of a sprue if it is unnecessary.

- **Reason #1: Increases initial tooling and maintenance cost.** Producing the sprue adds complexity by adding components. In addition, the fit between the sprue has been known to expand more than the other half and hold the die open causing the die to flash. (See note below on recommendations regarding fit between the sprue and the cover half.)
- **Reason #2: Locks you in to a fixed size on your cold chamber diameter.** The small diameter at the tip of the sprue is only slightly larger than the plunger tip. (See figure 3 above). If you decide to increase the cold chamber diameter you may have to increase both the male and female sprue components to accommodate the larger cold chamber and shot tip.
- **Reason #3: It adds Length and weight to the runner and therefore increases the demand on the remelt furnace.** Any time we can reduce remelt, we improve the bottom line.
- **Reason #4: It may require additional die open stroke in order to clear the offset biscuit and runner.** This may also interfere with using an extractor.

Construction Tip: If you must use a sprue, be sure to allow for expansion. As mentioned in Reason #1 above the sprue generally expands more than the sprue Bushing and can hold the die open resulting in flash. It may even be necessary to allow it to flash around the diameter of the sprue a little during the warm-up cycle in order to eliminate the larger problem of flash in the entire die during casting production. A clearance of 0.001 to 0.0015 inch/inch of diameter would be a good place to start.

So the question is, "Why use a sprue in cold chamber die casting and when is it appropriate to use one"?

- **Reason #1: The machine shot stroke is insufficient to eject the biscuit.** The shot tip must "follow through" past the end of the cold chamber in order to push out the biscuit. This is often due to having a thicker than normal cover half. In other words, if the effective stroke is not enough to eject the biscuit then a "sprue" is necessary to make up for the lack of follow-through stroke.

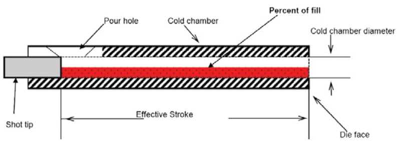

Figure 5 – Diagram of effective stroke.

- **Reason #2: To standardize the cold chamber and shot stroke.** This is one of the better reasons. By standardizing the shot stroke and cold chamber you can reduce cold chamber inventories and hopefully maintain better control.
- **Reason #3: We've always done it that way.** This is perhaps the most frequent reason that people have a sprue. They simply haven't considered the costs and disadvantages of the sprue. I experienced this first hand on a high volume part. We had two dies that ran around the clock and cavities were replaced every few months. We were preparing to build a complete new tool and while reviewing the designs to see if there were any improvements to be made I asked, "Why does this tool have a sprue?" After digging into the history of the tool it was discovered that at one time the part included "submarine cores" in the cover half. The "submarine core" slide carriers required extra holder block thickness and this was the reason the cover half was extra thick. (And of course the extra thickness exceeded the shot stroke of the machine. This created the necessity for the sprue.) We were able to reduce the cover half to normal thickness and eliminated the sprue while improving the process and reducing the tooling costs.
- **Reason #4: It increases my percentage of cold chamber fill.** (Or the inverse of that, "It reduces the amount of air in the cold chamber" and therefore in the casting.) **This is actually a poor reason to use a sprue but is probably one of the more common reasons.** Reducing the air in the cold chamber is a philosophy that developed following the research by Dr. L.W. Garber on "Slow Shot Celerity". While the research didn't directly promote reducing gas porosity by "increasing the percentage of fill" that is exactly what a great number of die casting engineers "assumed" as the end-all solution and began to both shorten and reduce cold chamber diameters in an effort to reduce the amount of air in the system. This created its own set of problems including increasing cavity pressures to uncontrollable levels while increasing cavity fill times due to the inability of the machine to achieve the necessary fast shot velocity. (For additional background on the pros and cons of cold chamber sizes read the article at www.drdiecast.com/DCM_December_2003.pdf)
- **Reason #5: It reduces turbulence in the runner by reducing the angle.** Sorry, the simulations I have seen don't support this conclusion. The radius would need to be significantly larger than would be practical. The difference between a runner with a 1/4" (6.35 mm) radius at the base of the sprue and that from a conventional spreader block is negligible. Simulations demonstrate there is still cavitation due to the sharp radius in the runner even when using a sprue. (See Figure 6.)

Figure 6 – The arrow points to cavitation caused by a sharp turn in a sprue.

- **Reason #6: It is in the die design standards. Repeat after me, "Why, why, why".** Be sure that the die design standards apply to your current machinery and methods. Tooling standardization is a necessary step when implementing S.M.E.D. (Single Minute Exchange of Dies) philosophy. The more die (and machine) features you can standardize the easier and faster you will make it for your set-up team. Simplification is also a major step. Take a look at the applications and the reasons behind the components.

In short, a sprue in cold chamber can be necessary to solve a problem, however don't hesitate to ask why it is being specified. All die components are important but make sure when you include a sprue in your design that it is there for the right purpose. It just might save everyone some money and improve productivity all at the same time.

References

Garber, L.W., "Theoretical Analysis and Experimental Observation of Air Entrapment during Cold Chamber Filling". Die Casting Engineer, The Society of Die Casting Engineers, May/June 1982.

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