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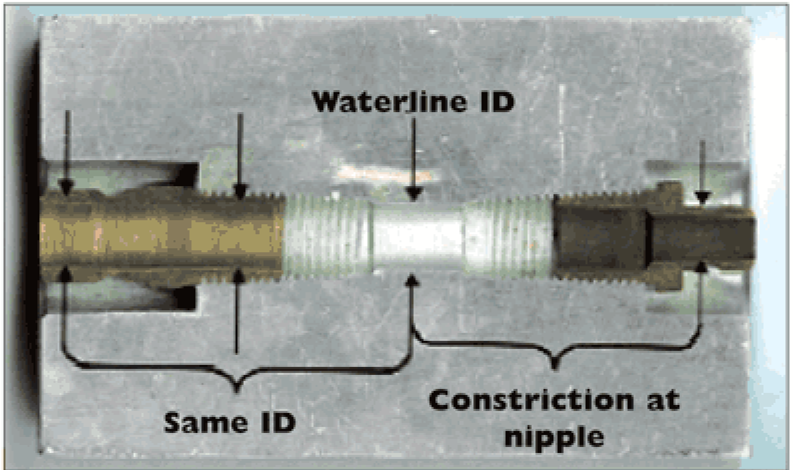
Tooling Corner: Strangle the flow, strangle your profits

By: Bill Tobin, president, WJT Assoc.

Water in turbulent rather than laminar flow achieves the optimum heat exchange in a mold. The best possible heat exchange is mandatory to optimize the mold's cycle. Everyone knows what to do to make this happen. If you put 120°F water into the mold, you'd like to think the mold temperature would stabilize at 120°F.



This hardware illustrates choices that result in laminar rather than turbulent flow. The female attached to the left connector will preserve the ID of the flow path into the hose that is feeding it. The female attached to the right connector will constrict flow.

But then again, we'd like to think the Yankees know what to do and would win the World Series sometime. But the Yankees don't win, and our mold cycles aren't optimized. The Yankees we can't help, but here's how to improve our cycle times.

The fact is that we go out of our way to do things that work against turbulent flow inside a mold. Here are some of the typical ways we do so:

1. Loop all the circuits together. This usually bends the hoses (note that we use hydraulic hose with thick walls that kink easily for water lines) and restricts the flow. As the loops rub against the machine's door and fray, we cut the hose shorter and reattach it, usually guaranteeing it will kink.

2. Don't use anything other than straight-through connectors. Molders tend to complain about the cost of 45° bend waterline connectors. These connectors can take the kink out of a hose and do it all for a premium of only a few dollars per connector. It's amazing how many shops never get to that page in the catalog.

3. Allow the mold builder a one-time shortcut that will cost you in profits every time the mold opens. When a mold is designed and specified, bubblers and baffles tend to be daisy chained — one feeding into another— instead of having one line feeding the baffles and bubblers and one line accepting the discharge. Parallel lines are more complex for the mold builder. The mold builder doesn't want to do them because they are tricky. The molder should insist on parallel bubbler designs because it will save time every single cycle.

4. Restrict your flow with the waterline connectors. Many molders specify that the mold be built without the male waterline connectors. This is because each shop tends to have its own size of female connectors. This is another example of silly savings that seriously erode profits.

Look at the picture above: I had this made from a block of aluminum. We started by drilling a 7?16-inch sample waterline. This is the most common size, since it conveniently happens to be the drill size for a pipe tap. We then tapped and counterbored so that the fittings would be subsurface and therefore protected from being knocked around. Then we put in two different male nipples. Notice the one on the left has an ID the same size as the waterline. The one on the right has a nipple that causes its own constriction. Even worse, the female that attaches to the male usually has a pronged end that is jammed into the hose and held on with a pipe clamp. The female that attaches to the connector on the left will preserve the ID of the flow path into the hose that is feeding it. The female that attaches to the connector on the right will further constrict the flow into its hose.

5. Use no-drip connectors. A puddle on the floor, mixed with a cocktail of grease and hydraulic oil, will allow you some world-class ballet moves as you fall flat on your back. It is neither funny nor painless. The floor is hard and the machine has a lot of sharp edges. It is desirable to have the floor at least free of water, hence the seductive appeal of no-drip connectors. Here again we opt for the cheap one-time fix that costs us in profits each time the mold opens. No-drip connectors have a highly restrictive valve in them to keep the water from dripping. This in turn impedes flow. Enough said.

To keep the mold from dripping all over the floor, use a compressed-air flushing unit that shuts off the inlet water and fills all the hoses with compressed air, forcing the water into the outlet system then shutting off the outlets so that the lines won't backfill with the back pressure. For a few hundred bucks, the mold is blown dry before it's unhooked. If you can't buy this equipment, your setup technicians can learn to drain the water into a bucket, and then mop the area dry afterwards.

6. Not realizing you need turbulent flow. Go buy a flow meter and measure. Usually 1.5-2.0 gpm in any size circuit will give you turbulent flow. This way you can accomplish cooling with the actual recommended temperature. If you're not getting this kind of flow, look at the input and output temperature of the coolant. If it's more than a 5 deg F difference, the restrictions are making each cavity a different temperature. This could be the reason each cavity produces a part of a different size or why one cavity is consistently sticking or not filling out. Look at the pressure of the coolant going into the mold and exiting the mold. Seeing more than a 10-psi drop is also an indication of poor flow.

The problem with calculating the highly elusive Reynold's number that ultimately reflects turbulent flow is that it requires a diameter and a line resistance to do the calculation. Simplicity tells us that minimizing line restrictions affords the least amount of resistance, the highest flow, and therefore, achieves turbulent flow.

However, engineers have never been deterred by something as simple as bad designs, kinked hoses, and designed-in restrictions. "If you can't make it flow easily, crank up the pressure!" is the battle cry of the floor engineer. I have actually been in a highly regarded medical molding facility where the average line pressure in a cooling system was 120 psi. The molds worked beautifully but the setup techs constantly complained about broken hoses and the waterlines slipping off the fittings.

Since it was a Fortune 500 company nobody particularly complained about the huge utility bills, the fact that each heat exchanger had a booster pump on it, or that the temperature control unit's life span was about half of those that didn't have booster pumps.

Today's secret: The cost of the mold is usually less than 20% of the overall project's lifetime cost. So, doing everything you can to improve the productivity of the mold will yield huge savings in the long run.

If you increase the mold's cost by 2% to improve its productivity, you tend to improve the overall profitability by more than 5%. If you look at the ratios you'd be silly not to take advantage of this.

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