【国外资料】缩短注塑成型周期的 50 种方法（中英文版）-上下集

50 ways to cut yourinjection molding cycle time.

《缩短注射周期的 50 种方法》By JosephOgando

Time ismoney. Opportunities to save some of both are often overlooked. Try outthesetips from experts who spend their time trimming the fat off moldingcycles.

时间就是金钱。其实节约时间与金钱的机会无所不在，但是常常为我们所忽略。请试试以下观点，看看专家们在注射过程中如何节约时间的。

Whatmolder doesn't want to reduce cycletimes? No, not the kind of shortcuts thatsacrifice part quality. We're talkingabout cycle-time improvements that feedyour bottom line, not your grinder.'Just about anyone can cut their cycletimes

. The real trick is doing sowithout ruining the part,' says DonnSeres, president of Injection MoldingIndustries, a vendor of mold-cooling systemsin Lake Orion, Mich.

什么样的成型商不愿意缩短循环周期？不，并不是以牺牲产品质量为代价去缩短成型周期。我们所说的是通过改进，使循环周期达到最小，而不是像现在磨洋工的方法。注射工业公司是一家位于 Lake Orion，Mich 的销售模具冷却系统的公司，该公司总裁 Donn Seres 说：“我们缩短循环周期，真正的诀窍在于并不需要对制件有任何的伤害。”

Withthat challenge in mind, take a look atthe following collection of time-andcost-saving tips. It was put together withthe help of technical-serviceprofessionals and auxiliary-equipment vendors whospend much of their timecoming up with the kind of cycle-time strategies thatcan help your processfly.

记住这样一点，然后请看一看下边这样一些专家的忠告。这是一些技术服务专家和辅助设备销售商花费大量时间和精力对各种不同的成型周期战略进行研究总结出来的，我们相信这将有助于您的加工业突飞猛进。

Theirrecommendations are organized by topicareas: the mold, the press, thematerial, and the auxiliaries, among others.When looking for savings, keep inmind this rule of thumb: injection moldingcycle times are 5% injection, 80%cooling, and 15% ejection.

这些忠告共分为五部分：模具、注射机、材料、辅助设备、其他。在看以下条目之前，请记住这样一条准则：注射成型周期是由 5%注射、80%冷却和 15%射胶组成的。

Much ofwhat the experts offer is commonsense, pure and simple. But there's probably anugget or two of gold here foreven the most experienced molders. Anyone canoccasionally overlook some of thebasics.

大多数专家的观点都是最普通，最简洁的。但是其中也不乏几条堪称为金科玉律的观点，甚至对经验丰富的注射成型人员也是如此。同样，任何人也都可能忽略了一些最基本的原则。

Keep inmind that most of these tips work'best as part of a comprehensive strategy. 'Youcan never really separatethe contributing factors of cycle time. They arealways related,' explainsBlair Souder, manager of injection molding at GEPlastics' Polymer ProcessDevelopment Center in Pittsfield, Mass.

GE 塑料聚合物加工开发中心注射成型经理 BlairSouder 解释说：“你决不能脱离注射周期相关的一些因素而单独谈某一条忠告如何如何。各种影响因素常常是相关的。”因此，我们应该记住，这些观点大多数都是整体战略非常有效的一部分。

In fact,some of the items here don't havemuch of a direct influence on cycle time -but their indirect influence can behelpful or harmful. To take a commonlycited example, some molders compensatefor improperly dried resin by addingexcess heat to the process, which in turnextends cycle times. Or considerscrew selection: Rich Lair, product supportmanager at Hoechst TechnicalPolymers in Summit, N.J., points out that moldersmay try to overcome poormixing by increasing barrel heat or backpressure, bothof which can needlesslylengthen cycle times. 'Many molders

stick with thegeneral-purpose screwall the time, but they may need to choose the right screwfor a given application,'says Lair.

事实上，有一些建议对循环周期并没有直接的影响，但是这些间接因素对缩短成型周期可能有利也可能有害。我们引用一个常见的例子，有些成型商为了补偿物料干燥的不足，在加工时额外的增加热量，从而导致成型周期加长。再如，螺杆的选择，Hoechst Technical Polymers 产品支持经理 Rich Lair 指出，成型商常常通过增加螺筒温度或背压来改善混合的不足，但是这两种方法常常都会无谓地延长注射周期，他说："许多成型加工商不管在什么时候都使用普通螺杆，对于某些特定的用途他们可能需要选择正确的螺杆。 "

Giventhe vast differences among moldingapplications, every tip here won't applyacross the board, but the bulk of themcan make a difference in just about anyprocess. John Morine, director ofengineering for M.A. Hanna ResinDistribution, Lemont, Ill., believes that thebiggest and most accessiblecycle-time reductions come from improvements in moldcooling, barrel heating,and resin drying, as well as from holding to propertemperature settings.'Making sure you have these things right can solvemost of yourproblems,' he advises.

不同的注塑过程有许多区别，并非每一条建议都可以直接应用，但是其中大多数建议在任何加工过程中都可以有不同的应用。M. A. Hanna 树脂部工程经理 John Morine 认为，缩短注射成型周期最易于实现的途径来源于模具冷却、螺筒加热和树脂干燥系统的改进以及保持正确的温度设置，"确保这些部分的正确设置可以解决大多数的注射周期问题。"

Afterexhausting the quick fixes, you mightstill find yourself up against thecycle-time wall. You might then be ready totry more involved and costlymeasures to achieve savings. These factors comeinto play when you build a newtool or retrofit an old one. Brand-new or rebuiltmolding machines and upgradedauxiliary equipment can also remedy long cycles inmany cases.

在筋疲力尽的快速检修过后，你可能发现还是要面对成型周期的问题，这时你终于下定决心还是做一些复杂而昂贵的测量以节约注射周期。这些因素当你借助一种新的工具时它们又会发生新的变化。采用新型号或更换一台注射机，升级辅助设备在很多情况下都能解决成型周期过长的问题。

Onceyou've identified and eliminated allthe big time wasters in your process,there are still incremental gains to behad by focusing on material selection,screw choice, and process optimization.'That last tenth of a percent ofimprovement will be the toughest,'notes Morine.

当你识别并消除了加工过程中浪费时间的所有主要因素后，继续关注物料选择、螺杆选择以及加工过程的优化，你还可以有新的收获。Morine 说：“最后 10%的改进将是最艰苦的。

KEEPING COOL

保持冷却

1. Loweryour mold temperature if you can.All the technical-service professionalsinterviewed tell of instances where theyfound mold temperatures higher thanwere needed to provide good physicalproperties.

1. 如果可以，尽量采用较低的模具温度。所有的技术服务专家都举过这样的例子：即采用较高的模具温度（高于实际需要温度）可以达到较好的物理性能。

2. Whenprocessing amorphous resins,experiment with colder molds, says Rich Lair ofHoechst. Users of crystallineresins, on the other hand, need to be aware thatthey could reduce crystallinity- and part properties - if the mold temperaturedrops too much. Citing nylon asan example, Lair says, 'We recommend atemperature of 150-170 F, but thereare cases where molders can get by with acooler mold if they're not concernedabout losing crystallinity.'

2. Rich Lair 用较冷的模具进行无定形树脂的成型实验。而结晶型树脂则不同，若模腔温度太低，可能减少晶化，降低制件性能。他说：“对于尼龙加工，我们推荐的模腔温度为150-170F，但是当有时减少晶化对制品质量影响不大时也可以选用较低的模具温度。”

3. Newmetallocene poly-olefin plastomersand elastomers run well at colder-than-usualtemperatures, according to WendyHoenig, a research leader at Dow Plastics,Midland, Mich. She says a cool moldcan cut cycle times by 25-30% with theseresins. The target mold temperature,she says, is 50 F on both core and cavityside - as opposed to the 80 F youmight expect for standard polyethylenes (seePT, April '95, p. 60).

3. 根据 Dow 塑料公司 WendyHoenig 的研究，新的茂金属塑性体和弹性体可以在比通常的成型温度低的模具内成型良好。她说，对于这些材料，采用冷模具注射周期可以缩短 25-30%。芯型和型腔的温度都可以采用 50F，而不是标准聚乙烯的 80F。

4.Address cooling early in the tool-designprocess. People too often think ofcooling after the fact,' warns Seres.You may want to perform a coolinganalysis with one of the mold-filling simulationsoftware packages.

4. Sere 提醒说，人们经常在发现问题后才考虑冷却问题，这一问题应该在机械设计阶段就及早考虑。你可能希望利用一套充模软件进行一次冷却分析。

5. Makesure you have a high enough coolantflow velocity in your mold. The coefficientof heat transfer can be 10-20 timesgreater when coolant velocity is highenough to generate turbulent rather thanlaminar flow, according to dataprovided by AEC, Inc., Wood Dale, Ill. Therequired velocity to achieveturbulent flow is a function of channel diameterand coolant viscosity. Sinceantifreeze raises cooling-water viscosity, it maybe counterproductive to runyour molds colder at the expense of lower flow rate.Cooling-equipmentsuppliers can help you determine whether you have sufficientpumping capacity.

5. 确保模具内的冷却液有足够高的流动速率。根据 AEC 公司提供的数据，若冷却液的流动速度足够大产生紊流时，传热系数要比层流时高 10-20 倍。达到紊流需要的速度是冷却通道直径和冷却液粘度的函数。由于防冻剂可以提高冷却水的粘度，对于在较低的流动速率下想要获得较低的模具温度是不利的。从冷却系统供应商可以了解冷却系统的功率是否足够。

6. Makesure you have enough coolant flowand that it is directed to the right place.'Why overcool a thin part ofthe mold when you have a heavy boss with nowater going to it?' asks DonnSeres of Injection Molding Industries,pointing out a common mistake.

6. 确保在真正需要冷却的位置得到足够的冷却。DonnSeres 指出了人们最常见的一个错误：“为什么要给制件较薄的地方过渡冷却，而制件相当厚的部位一点冷却水也没有？”

7. Don'tforget to bring water to slides,lifters, or any area of the mold that comes incontact with the melt.'You're missing the boat if you leave any uncooledareas in the path of themelt,' says Seres.

7. 不要忘记冷却型腔侧壁、顶出附近以及其他任何与熔体接触的部位。“如果在熔体的流动路径上有一些部位没有冷却系统，实际上你是失去了你的小船”，Seres 说。

8. Bigbaffle holes are best. 'Peoplehave a tendency to make their baffle holesand flow holes the same size,'says Seres. That arrangement will result ina pressure loss and diminishedcooling capacity. Seres says a good rule ofthumb is to make the baffle hole 40%larger than the flow hole in order to getthe same flow rates throughout thesystem.

8. 最好选用大的折流孔。“人们习惯于把折流孔和流道加工成同样的尺寸”，Seres 说，这种设计会造成压力损失，降低冷却能力，把折流孔设计成比流道孔大 40%是一种非常好的设计准则，以保证整个系统具有相同的冷却速率。

9. Treatyour cooling water to prevent scaleformation in molds and cooling systems.Just 0.006-in.-thick scale can decreaseheat-transfer efficiency by 30%, saysan AEC source (see PT, Oct. '93, p. 54).

9. 做好冷却水的处理，避免模具与冷却系统内形成水垢。根据 AEC 公司提供的数据，仅仅 0.006in 厚的水垢就可能使传热效率降低 30%。

10. Bewareof a low pressure differentialbetween supply and return in the cooling system.'Supplementaldevices,' says Seres, 'can mess up the returnpressure.' He saysthis flow-inhibiting condition typically occurs whenbeside-the-press moldchillers or heaters are temporarily turned off but stillconnected: They candump high-pressure water back into the water circuit. Sereshas seen extremecases where 'the water was almost flowingbackwards.' A good rule ofthumb, he adds, is at least 5 psi differentialpressure, though he recommends20-30 psi or more.

10. 注意冷却系统进水和回水之间应有一个很小的压差。Seres 说，“补压设备，可能造成回压紊乱。”他说这种流动过程中禁止发生的现象，当临时关闭模温机却仍然与系统连接时就可能发生。这可能导致高压循环水反向流会系统。Seres 曾经看到过这种现象，“水几乎在往回流了”他最后给出了一个重要的规则，至少应保持 5psi 的压差，而他推荐的压差为 20-30psi 或更多。

11. Molddehumidification is one way to getto a lower mold temperature withoutsuffering moisture condensation that can maryour parts.

Dehumidificationsystems pave the way to cycle-time cuts of as muchas 30%, according to MarioRanieri of Cargocaire, a maker of desiccantdehumidifiers in Amesbury, Mass.(see PT, July '96, p. 100).

11. 保持模具干燥是采用较低的模具温度并避免湿气压缩造成制件缺陷的有效途径。Cargocaire 公司（位于 Amesbury 的一家除湿干燥器制造商））Mario Ranieri 提供三资料，除湿系统可以使成型周期缩短 30%。

12.Consider pulsed cooling, which canrapidly switch between heating and coolingcycles. Seres and others argue thatit gives you the best of both worlds as faras cycle-time goes: Faster heatextraction reportedly lets you run molds hotterso they fill faster (see PT,Oct. '95, p. 49).

12. 考虑脉冲形式冷却，以便实现加热和冷却之间的快速切换。Seres 和其他一些研究人员给出了实现循环时间节约最好的两个方面：较快的热量排出可以实现在较热的模具中实现快速充模。

13. Forbetter cooling, replace tool steelwith a more thermally conductive alloy. Nowthat wrought, machinable berylliumcopper comes in 20 and 30 HRC, it offers thesame hardness as P-20 tool steelwhile providing five times the thermalconductivity. For example, the cycle timefor a minivan radiator end tank fellfrom 50 to 35 sec when P-20 mold cores werereplaced with Moldmax BeCu fromBrush Wellman Inc., Cleveland. That time savingsoccurred even though the

moldtemperature was raised by 40 [degrees] F, reportsBrush Wellman product managerScott Smyers.

13. 为了得到较好的冷却效果，用导热更好的合金钢代替工具钢。现在精炼的铍铜合金硬度可以达到 HRC20-30,可以达到与 P - 20 工具钢同样的硬度，可是热传导率是该工具钢的 5 倍。例如，当成型小货车散热器尾箱时，若用 Brush Wellman 公司提供的 Moldmax BeCu 代替 P - 20 钢型芯，成型周期可以由 50s 缩短到 35s。根据 Brush Wellman 公司产品部经理 Scott Smyers 的报告，即使模具温度升高 40 度，同样会缩短成型周期。

14. Makesure your water lines are as closeas possible to the areas of greatest heatconcentration. Smyers cites a cup as asimple example: 'At the interfacebetween the base and side wall (tip andcore), the thermal energy is threetimes more concentrated than in othersections of the cup,' he says.

14. 确保冷却水道尽可能接近热量最集中的区域、Smyers 以一个杯子为例，他说：“在杯子的底部和侧壁（尖部和中心）的结合处，热量最为集中，可以达到其他部位的 3 倍。”

15.High-tech cooling systems and highlyconductive alloys can provide even morebenefit when used together.'Combine pulsed cooling with beryllium-copperinserts, and you have ananimal of a tool,' says Smyers.

15. 当同时使用高技术的冷却系统和高传导率合金时效果更好。Smyres 说：“同时使用脉冲式冷却系统和铍铜插件，你仿佛拥有了一个活的工具。”