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镶套多向顺序抽芯及自动脱螺纹注塑模具设计

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摘要: 某塑料接头内部设计了3组互相垂直贯通孔的结构。在塑件一个端面,分布的2个贯通孔、2个盲孔方向一致,与另外1个贯通孔方向呈一定夹角,为此设计了镶套2个方向的复合抽芯机构,解决了空间狭小、抽芯运动受限、机构相互干涉的问题,利用斜导柱、弯销分别驱动两组抽芯机构运动,实现了准确的顺序控制。在塑件另一垂直端面,分布了3个方向一致的贯通孔,一个为阶梯孔,另2个孔内有Rc1/8-LH管螺纹,为此设计了液压马达驱动自动脱螺纹机构。为防止螺纹型芯、料头杆旋转时,与其支撑件的配合面摩擦而磨损,设计了动模板与脱模机构固定板之间第1次开模距离1 mm,使得启动脱螺纹时,螺纹型芯、料头杆能够快速后退1 mm,与其支撑件的配合面脱离;定模板与动模板之间第2次开模距离为7 mm,达到解锁定距开闭器目的,使得脱模机构固定板可活动;塑件对阶梯型芯的包紧力与脱螺纹作用力方向相反,为解决脱螺纹时塑件被拉坏的问题,设计了在脱模机构固定板与动模垫板之间第3次开模距离6 mm,让固定于动模垫板的阶梯型芯脱离塑件;在定模板与动模板之间继续第4次开模,驱动复合抽芯机构完成抽芯动作,直至开模完成。为保证模具的各项功能实施,设计了纯机械结构控制的3位4次开模顺序,加工制造成本低,安装调试简单方便。塑件材质为质量分数60%玻璃纤维增强聚己内酰胺,其表面容易产生浮纤,为此设计了合理的进浇系统、排气系统及冷却系统,以保证塑件产品质量。

关键词: 多向顺序抽芯;自动脱螺纹机构;注塑模具

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Design of injection mould with nested multi-directional sequential core pulling and automatic thread-unscrewing

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Abstract: The internal design of a plastic connector features a structure with three sets of vertically intersecting through holes. On one end face of the plastic part, there are two through holes and two blind holes oriented in the same direction, which are set at a certain angle to another through hole. To address this, a compound core-pulling mechanism with nesting in two directions was designed to solve the problems of limited space, restricted core-pulling movement, and mutual interference of mechanisms. The accurate sequential control of the two sets of core-pulling mechanisms was achieved using an angled guide pillar and an angular cam respectively. On another vertical end face of the part, there are three through holes oriented in the same direction: one is a stepped hole, and the other two with Rc1/8-LH pipe threads. For these, a hydraulically motor-driven automatic thread-unscrewing mechanism was designed. During the rotation of the threaded core and the sprue puller, to prevent the mating surfaces between them and their supporting components from wearing out due to friction, a first mould opening distance of 1 mm was designed between the moving plate and the ejection mechanism retainer plate. This ensured that when the thread unscrewing started, the threaded core and the sprue puller could quickly retreat 1 mm and separate from the mating surfaces of the supporting components. The second mould opening distance of 7 mm between the fixed plate and the moving plate was served to release the limited opening-closing device, allowing the ejection mechanism retainer plate to become movable. The clamping force of the plastic part on the stepped core acted

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in the opposite direction to the thread-unscrewing force. To prevent part damage during unscrewing, a third mould opening distance of 6 mm was designed between the ejection mechanism retainer plate and the moving plate backing plate, enabling the stepped core fixed to the backing plate to detach from the plastic part. The fourth mould opening stage involved continued opening between the fixed plate and the moving plate, driving the compound core-pulling mechanism to complete the core withdrawal until mould opening was finished. To ensure the implementation of all mould functions, a purely mechanically controlled 4-stage and 3-position mould opening sequence was designed, offering low manufacturing cost, simple and convenient installation and debugging. The material of the plastic part is polycaprolactam with 60 wt% glass fiber, which is prone to surface fiber floatation. Accordingly, a reasonable gating system, venting system, and cooling system were designed to ensure the plastic part product quality.

Keywords: multi-directional sequential core pulling ; automatic thread-unscrewing mechanism ; injection mould

对于具有倒扣特征、难以脱模的塑件制品,在设计注塑模具时,在满足一定条件(塑件材质性能及结构)下,可设计强制脱模结构,大多数情况下会设计滑块抽芯、斜顶等机构;在抽芯运动方向相互干涉且空间有限的情况下,可将抽芯机构镶套设计为复合抽芯机构,并选择机械与电控协同[1]、纯机械等控制方式[2−5],严格控制抽芯顺序;对于具有螺纹特征的塑件制品,小批量注塑生产可采用人工手动脱螺纹结构[6],否则需设计自动脱螺纹机构,其动力可以由开模力[7]、液压缸[8−9]、液压马达[10−11]、气缸或电机提供[12−14]。如上所述,对注塑模具进行设计时,在结构、动力方面有很多选择,作为设计师应该选择技术成熟、加工制造成本低及安装简单的方案,以保证安装调试时,最大程度减少人为因素对模具的损坏。

自动脱螺纹时,塑件止转及螺纹是否会被破坏[15−17]、螺纹型芯与其支撑件配合面摩擦而发生磨损等细节问题都需认真对待,否则会直接影响塑件成型质量及模具使用寿命。注塑模具浇注系统、模具温度、排气系统及成型工艺,会直接影响塑件品质及成型效率[18],对于纤维含量较高的复合材料,还会产生浮纤、表面光泽不均匀等缺陷。笔者以含3组互相垂直贯通孔的塑料接头注塑模具设计为例,对该类型模具的各项细节、开模动作控制进行合理设计,以达到模具安装调试简单、运行安全可靠的目的。

1 塑料产品及模具设计要点分析

1.1 塑料性能及产品结构特点

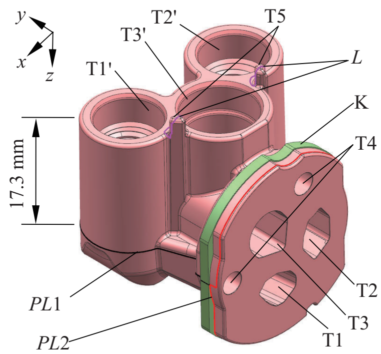
该塑料接头应用于液压传动系统,承受的最高压强可达5 MPa,故选用材质为质量分数60%玻璃纤维(GF)增强聚己内酰胺(PA6+60%GF)复合材料。该材料拉伸强度为220~250 MPa,弯曲模量为16 000~18 000 MPa,在某些应用场景可替代金属;与矿物油、植物油、润滑油等接触时的稳定性较好,可在较高温度环境下使用;其缺点是塑件对缺口较为敏感,容易产生应力集中,导致材料的冲击强度下降,因此对塑料制品的设计和成型要求较高。由于材料硬度和刚性较大,在注射成型等加工过程中,材料对模具腔体磨损较大,塑件表面容易产生浮纤。

该塑件的最大外形尺寸为32 mm×34 mm×25 mm,体积为8 313.7 mm^3,属于小型零件。如图1所示,不锈钢(型号201)嵌件K需包裹成型在塑件中,以保证安装固定强度;T1与T1'、T2与T2'、T3与T3'相互垂直贯通;T1、T2、T3设计为异形孔,以加强其结构强度;T1'、T2'特征内设计了Rc1/8-LH管螺纹,螺纹没有起始点控制要求;T3'为阶梯孔;T4为2个Ø3.3 mm、深3 mm定位盲孔;T5为2根高出主体2.5 mm的扇形柱。

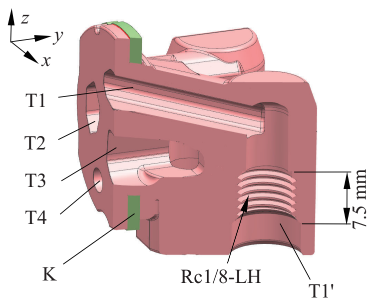
1.2 模具设计要点分析

根据塑件结构,按照图2中*PL*1线所示设计动定模分型面,*PL*2所示动模滑块抽芯分型线设计抽芯机构。

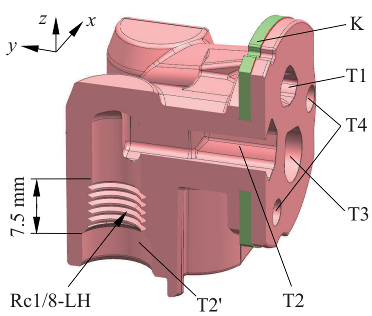
该模具设计要点在于:(1)T2、T3、T4孔特征抽芯方向为y−方向,而T1孔特征抽芯方向与xy平面呈13.5°夹角、yz平面呈19.5°夹角,故需分别实施抽芯,解决运动干涉问题;(2)设计自动脱螺纹机构时,需解决螺纹型芯旋转时与其支撑件配合面摩擦而发生的磨损问题;(3)塑件以*PL*1为界,z−方向均成型于动模型芯的腔体之内,在启动脱螺纹之前,T3'阶梯型芯在脱模方向必须脱离塑件(为保证安全可靠,以T3'阶梯型芯小端完全脱离塑件为准,即脱模距离>6.2 mm,见图1d),以防止塑件同时受到脱模力(即脱螺纹力)与包裹T3'阶梯型芯力的相反作用力而被拉坏;(4)T1与T1'、T2与T2'、T3与T3'型芯之间碰穿,形成相互贯通结构;(5)须合理设计模具各项动作顺序,并严格进行准确的控制,以免影响模具正常使用及寿命;(6)须合理设计模具浇注、排气



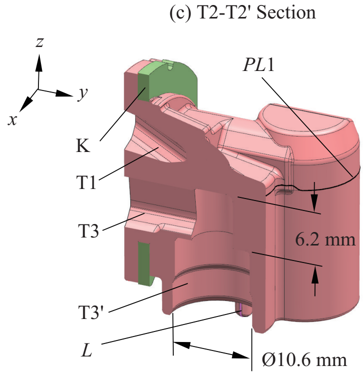
(a) Axonometric drawing



(b) T1-T1' Section



(c) T2-T2' Section



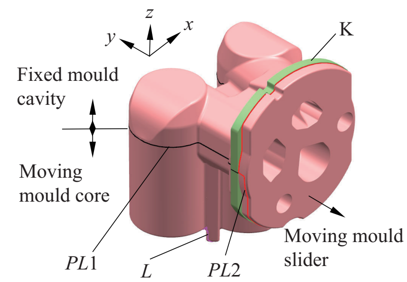
(d) T3-T3' Section

*PL*1—Main parting line;*PL*2—Slider parting line;K—Stainless steel insert;*L*—Venting insert split line;T1'—First threaded pipe interface;T2'—Second threaded pipe interface;T3'—Third through hole interface;T1—First through hole;T2—Second through hole;T3—Third through hole;T4—Blind hole;T5—Sector-shaped column

图1 塑件3D图

Fig. 1 3D Drawing of plastic part

及冷却系统,保证塑件成型质量,特别是原材料GF含量很高,需要避免塑件表面形成浮纤。



*PL*1,*PL*2,K,*L* are the same as Fig. 1

图2 模腔分型示意图

Fig. 2 Schematic diagram of mould cavity parting

2 模具成型关键结构设计

2.1 模腔布局、浇注及排气系统设计

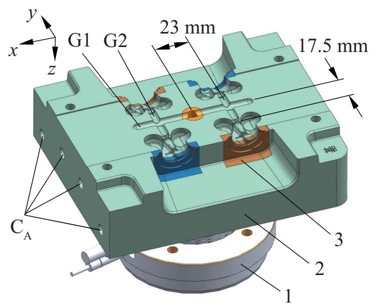
模具设计为一模四腔的布局。为提高塑胶原料利用率及成型效率,浇注系统设计为热流道转冷流道、侧浇口直接进胶。

在注塑充填过程中,GF增强复合塑料中的GF出现翻滚、打转等不稳定流动行为是造成浮纤产生的最主要原因,浮纤现象随熔体流动距离的增加(即从靠近浇口到远离浇口位置)而逐渐加重,塑料基体熔体流动性的提高有利于GF在注塑过程中向制品芯层扩散,减少制品表面区域的GF含量[19]。经前期实验表明:在成型GF增强复合塑料制品时,浇注系统流道截面宜大、流程宜平直而短;排气系统不仅利于气体排出,以免造成熔接不良、积气及烧焦等缺陷,还有利于塑料熔体快速流动。以上说明优化模具结构、注射成型工艺可以改善塑料制品表面浮纤[20]。

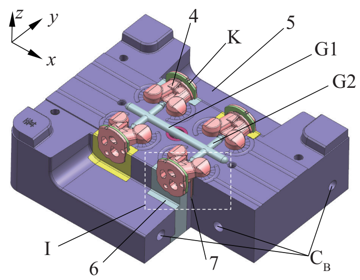
对浇注及排气系统进行了优化,如图3所示,设计了较短的主流道(23 mm)和分流道(17.5 mm),流程平直而短;流道截面取值较大(相较于塑件体积),主流道截面尺寸为Ø6 mm、分流道截面尺寸为Ø5 mm;设计了粗大的腰形侧浇口(2.4 mm×1.5 mm、半径0.75 mm),流道表面进行镜面抛光[21],使其粗糙度Ra≤0.2 μm,以减少GF断裂,使料流混乱、GF扩散并减小取向。为了保证能及时排出型腔内及GF表面处理剂挥发产生的气体,有利于塑料熔体快速流动,在注塑填充的末端,于主分型面上设计了多条深0.015 mm、宽2.8 mm的阶梯式排气槽,在扇形柱的末端,按照图2中的分割线L,设计了排气镶件7。

2.2 镶套多向顺序复合抽芯机构设计

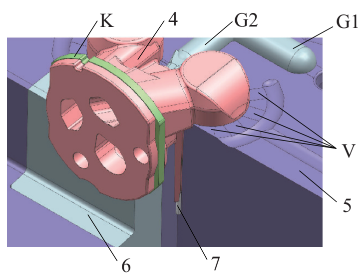
如图1所示,由于塑件T2、T3、T4孔特征抽芯方向为y−方向,而T1孔特征抽芯方向与y−方向呈一



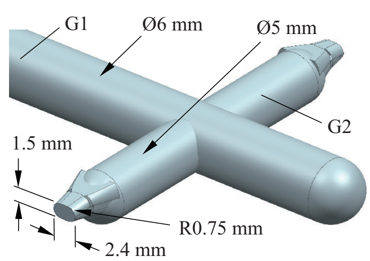
(a) Fixed mould cavity & hot runner system components



(b) Moving mould core (partial section view)



(c) Enlarged view of Zone I on the moving mould core



(d) Runner and gate

G1—Sprue;G2—Runner;C_A,C_B—Cooling channel;I—Detail area;K—Stainless steel insert;V—Vent slot;1—Hot runner system components;2—Fixed mould cavity;3—Fixed mould insert;4—Plastic part;5—Moving mould core;6—Moving mould insert;7—Vent insert

图3　定模型腔及动模型芯

Fig. 3　Fixed mould cavity and moving mould core

定夹角,即与*xy*平面呈13.5°夹角、*yz*平面呈19.5°夹角,故设计子滑块抽芯机构实施T1孔特征的成型与抽芯,母滑块抽芯机构实施T2、T3、T4孔特征的成型与抽芯。由于塑件小、模腔布局紧凑,造成两向抽芯机构活动空间受限,且运动方向干涉,故将两套滑块机构镶套组装,形成斜导柱驱动子滑块机构+双弯销驱动母滑块机构的复合抽芯机构,并控制其抽芯顺序。

2.2.1　抽芯机构成型零件设计

如图4a所示,T1型芯13与T1'螺纹型芯8碰穿,成型T1斜向异形孔;T2型芯11与T2'螺纹型芯9碰穿,成型*y*−方向T2异形孔;T3型芯12与T3'阶梯型芯10碰穿,成型*y*−方向T3异形孔;型芯17成型*y*−方向T4盲孔、塑件相关部位及其外形特征。T2型芯11、T3型芯12脱模角为0.4°;T1型芯13整体斜度为0.2°,在保证脱模的同时,减少其在型芯17内的滑动摩擦力;型芯17设计为6°的合模配合斜度,以减少母滑块抽芯滑动摩擦力。

2.2.2　抽芯机构结构组成及安装

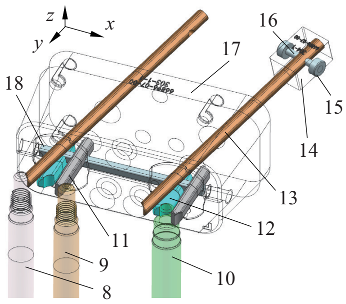
图4a、图4b为母滑块机构组成及装配关系。T2型芯11、T3型芯12插入型芯17内,由侧面插入定位锁紧销18固定形成一个整体,称为母滑块成型组件;该组件由M6螺栓固定于母滑块座21侧面。母滑块机构在滑块压板24与动模板组成的*y*方向滑槽内运动。驱动弯销20、母滑块锁块19均由M6螺栓固定于定模板。

图4a、图4c为子滑块机构组成及装配关系。T1型芯13插入固定块14,并在外侧放置一对滚轮15,圆柱销16从销孔插入穿过形成一个整体,称为子滑块成型组件;为保证T1型芯13在与*xy*平面呈13.5°夹角情况下,能正常滑动抽芯,在子滑块座28上加工了垂直于T1型孔的滑槽。抽芯运动过程中,子滑块成型组件的滚轮15可以在滑槽内上下滚动,并带动T1型芯13做抽芯运动。驱动子滑块抽芯机构的斜导柱26装配于固定座27后,由2支M6螺栓固定于定模板。锁模耐磨块30由2支M6螺栓固定于定模板。

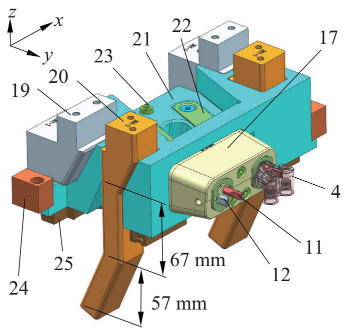
在母滑块座21顶面加工子滑块机构运动的T型滑槽,其与*yz*平面呈19.5°夹角、与*xy*平面平行。子滑块机构于T型滑槽内滑动,其T1型芯13穿过母滑块座21(间隙配合)、型芯17精密配合导向滑孔(与*xy*平面呈13.5°夹角)。子母滑块组成复合抽芯机构,如图4d所示。

2.2.3　复合抽芯机构工作原理

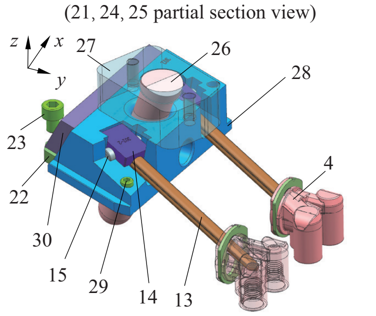
动、定模板分离时,固定于定模板的斜导柱26驱动子滑块机构斜向抽芯,当分离距离达到61 mm(由斜导柱26安装角度及长度控制),子滑块机构完成抽芯;当分离距离达到67 mm(由弯销20直身段长度决定,图4b),固定于定模板的2只弯销20驱动母滑块机构开始抽芯,当分离距离达到124 mm,母



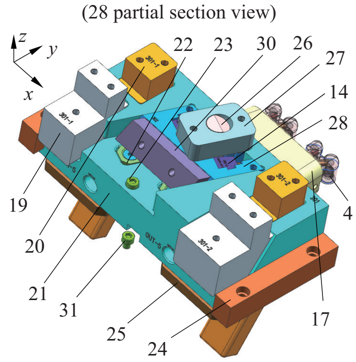
(a) Molding components and assembly



(b) Primary slider core-pulling mechanism
(21, 24, 25 partial section view)



(c) Secondary slider core-pulling mechanism
(28 partial section view)



(d) Assembly drawing

8—T1' threaded core; 9—T2' threaded core; 10—T3' core; 11—T2 core; 12—T3 core; 13—T1 core; 14—Fixed block; 15—Roller; 16—Cylindrical pin; 17—Core; 18—Locating & locking pin; 19—Primary slider locking block; 20—Angular cam; 21—Primary slider carrier; 22—Sliding wear plate; 23—Secondary slider limit screw; 24—Slider hold-down plate; 25—Sliding wear plate; 26—Angled guide pillar; 27—Fixed seat; 28—Secondary slider carrier; 29—Locating pillar; 30—Mould-locking wear plate; 31—Primary slider limit screw;
Ref. to previous drawing for unspecified parts

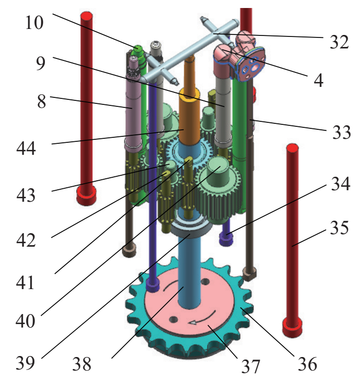
图 4　复合抽芯机构

Fig. 4　Compound core-pulling mechanism

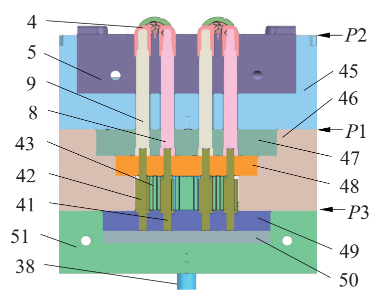
滑块机构抽芯完成;合模时,子滑块机构、母滑块机构动作顺序与开模相反。由斜导柱、弯销结构控制两向顺序抽芯。

2.3　自动脱螺纹及塑件顶出机构设计

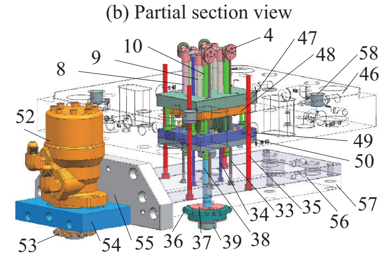
模架设计为大水口非标直身模架,去掉定模座板,增加了脱模机构固定板 46,用于固定脱螺纹传动齿轮轴等组件,如图 5 所示。液压马达作为自动



(a) Sub-assembly drawing



(b) Partial section view



(c) Assembly drawing

$P1$—First mould opening position; $P2$—Second & fourth mould opening positions; $P3$—Third mold opening position; 32—Sprue; 33—Flat ejector pin; 34—Sprue ejector pin; 35—Safety pin; 36—Driven sprocket; 37—Ratchet mechanism; 38—Drive gear shaft; 39—Bearing; 40—Driven gear shaft; 41—T1' gear shaft; 42—T2' gear shaft; 43—Idler gear shaft; 44—Sprue rod; 45—Moving plate; 46—Ejection mechanism retainer plate; 47—Upper gear shaft retainer plate; 48—Gear shaft retainer plate; 49—Gear shaft support plate; 50—Lower gear shaft retainer plate; 51—Moving mould backing plate; 52—Hydraulic motor; 53—Drive sprocket; 54—Hydraulic motor clamping plate; 55—Hydraulic motor retainer plate; 56—Ejector retainer plate; 57—Ejector plate; 58—Polyurethane spring; Ref. to previous drawing for unspecified parts

图 5　自动脱螺纹及塑件顶出机构

Fig. 5　Automatic thread-unscrewing and plastic part ejection mechanism

脱螺纹动力,由液压马达座板54、液压马达固定板55安装在动模垫板51、垫块63(见图7a)侧面;塑件螺纹为左旋螺纹;动力传动顺序及旋向为:主动链轮53(连接液压马达、左旋)→从动链轮36(与主动齿轮轴38同轴、右旋)→从动齿轮轴40(左旋)→T1'齿轮轴41(右旋)→过渡齿轮轴43(左旋)→T2'齿轮轴42(右旋);T1'、T2'齿轮轴及主动齿轮轴38的端部设计为腰形凸台,与之对应装配的T1'、T2'螺纹型芯及料头杆44的尾部设计为腰形孔,实现滑动配合装配并能传递旋转扭力。自动脱螺纹关键细节问题及解决方案如下。

(1)塑件止转问题。如图1所示,塑件有17.3 mm直段成型在动模型芯5腔体内,而螺纹长度只有7.5 mm,故T1'、T2'螺纹型芯旋转脱螺纹时,可以保证塑件止转作用;也表明脱螺纹后,通过顶出动作才能使塑件离开模具腔体。

(2)拉料及料头顶出问题。在料头杆44的冷料井内设计加工了螺纹,其螺距、螺纹长度与塑件相同,开模时起到拉料的作用,脱螺纹时,主动齿轮轴38带动料头杆44旋转,使料头与塑件同步脱模。

(3)螺纹型芯、料头杆旋转时与动模型芯配合面摩擦而产生磨损,影响模具使用寿命问题。T1'、T2'螺纹型芯与动模型芯5配合面设计了0.2°的斜度,料头杆44与动模型芯5配合面设计了0.5°的斜度。开模时,在4只聚氨酯弹簧58的作用下,在$P1$处开模,动模板45与脱模机构固定板46分开1 mm;脱螺纹时,T1'、T2'螺纹型芯、料头杆44边旋转边后退1 mm(因其与对应的齿轮轴为滑动配合),实现与动模型芯配合面快速脱离,避免摩擦而产生磨损,接下来的T1'、T2'螺纹型芯、料头杆44旋转动作,将塑件、料头整体推出动模型芯5腔体6.5 mm(螺纹长度7.5 mm去除螺纹型芯、料头杆后退1 mm)。

(4)塑件对T3'阶梯型芯的包紧力与脱螺纹作用力方向相反,脱螺纹时会将塑件拉坏。T3'阶梯型芯固定于动模垫板51,在脱螺纹之前,使其与塑件脱离6.2 mm(见图1d);故在$P3$处(脱模机构固定板46与动模垫板51之间)设计开模距离6 mm,加上在$P1$处开模1 mm,T3'阶梯型芯脱离塑件7 mm(>6.2 mm),可避免拉坏塑件。

(5)液压马达左旋,脱模机构才能正常运转。在从动链轮36内套装了棘轮机构37,保证脱螺纹动作只能按照设计的方向单向旋转,即使工人误接了液压油进出口管,也不会损坏模具。

(6)顶出机构复位保护。扁顶针33(顶在塑件不锈钢嵌件K的侧面)、料头顶针34及保险针35固定于顶针固定板56与推板57,构成塑件及料头顶出机构;合模时,如果顶出机构没有复位,4只低压合模保险针35会阻挡复合抽芯机构复位并报警,相比行程开关复位保护,其结构简单、成本低,安装调试受人为影响较小。

完成开模后,由扁顶针33、料头顶针34将塑件及料头整体顶出。

2.4 冷却系统设计

为保证塑件成型质量及效率、控制表面的浮纤现象,需设计合理的冷却系统以控制模具温度。如图6a所示,在定模侧,设计了从定模板潜入定模型腔2进2出、直径8 mm的冷却水道。如图6b所示,在母滑块设计了1进1出、直径6 mm的冷却水道,在型芯17设计了2条串联的直径11 mm隔片式水井进行冷却;由于T1、T2、T3型芯尺寸太小,采用自然冷却。如图6c所示,设计了从动模板潜入动模型芯1进1出、直径8 mm的冷却水道。如图6d所示,在脱模机构固定板上,设计了2进2出、直径8 mm的U形冷却水道;在动模垫板上,设计了2进2出、直径8 mm的直通冷却水道。

3 模具整体结构及开模顺序控制设计

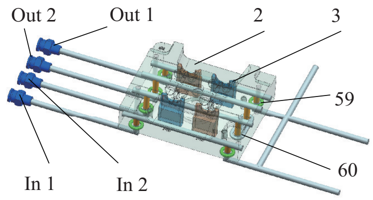
模具整体外形尺寸为450 mm×370 mm×430 mm,结构及装配关系如图7所示。为保证模具安全可靠地正常工作,并使安装调试简单化,设计了纯机械结构控制的3位4次开模顺序。定距开闭器67的长插销固定于定模板62侧面,树脂扣71插入定模板62锥孔。开模顺序控制设计如下。

(1)在$P1$处第1次开模:在4只聚氨酯弹簧58作用下,动模板限位螺钉70控制动模板45与脱模机构固定板46分开1 mm。

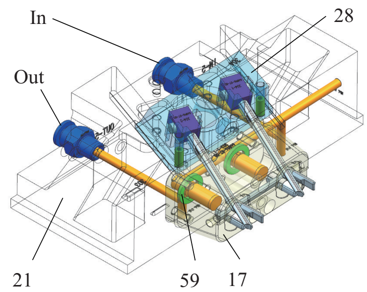
(2)在$P2$处第2次开模:当此处开模距离达到7 mm时(拉杆74滑动间距8 mm去除$P1$处已分开1 mm),定距开闭器67解锁,脱模机构固定板46可活动。

(3)在$P3$处第3次开模:树脂扣71通过拉杆74拉动脱模机构固定板46开模,脱模机构固定板限位螺钉75控制开模距离6 mm。

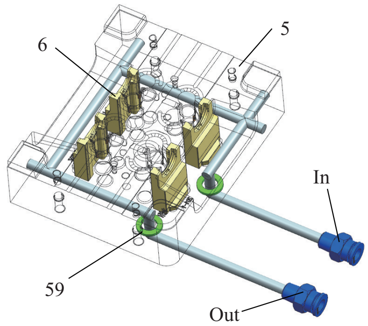
(4)在$P2$处第4次开模:树脂扣71开始脱离定模板62锥孔,直至复合抽芯机构完成抽芯,并达到



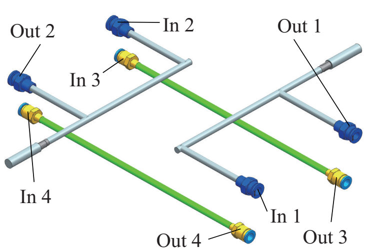
(a) Fixed mould cooling system



(b) Primary slider cooling system



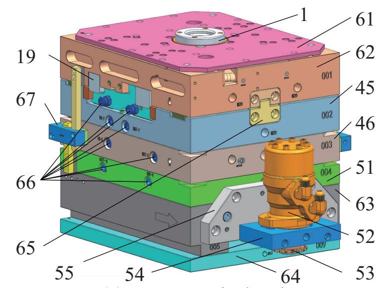
(c) Moving mould cooling system



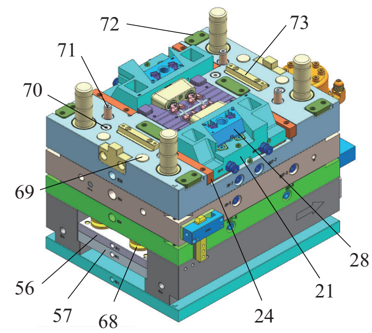
(d) Cooling system for ejection mechanism retainer plate and moving mould backing plate

图6 冷却系统

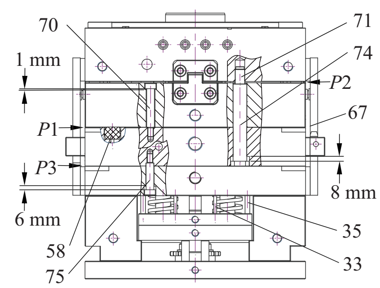
Fig. 6 Cooling system



(a) Axonometric drawing



(b) Moving mould isometric view



(c) Broken section view

61—Fixed mould insulating plate; 62—Fixed mould plate; 63—Spacer block; 64—Moving mould base plate; 65—Precision locating block; 66—Cooling water port; 67—Limited opening-closing device; 68—Return spring; 69—Return pin; 70—Moving plate limit screw; 71—Resin buckle; 72—Wear plate; 73—Precision locating block; 74—Pull rod; 75—Ejection mechanism retainer plate limit screw; Ref. to previous drawing for unspecified parts

图7 模具装配图

Fig. 7 Mould assembly drawing

塑件、料头能安全顶出距离,开模完成。

(5)启动自动脱螺纹机构,塑件、料头整体被推出动模型芯5腔体6.5 mm,脱螺纹动作停止。

(6)顶出机构顶出塑件及料头后,在复位弹簧68作用下复位。

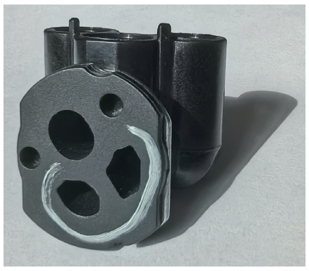
(7)合模顺序为$P2 \rightarrow P3 \rightarrow P1$。复合抽芯机构的开合模顺序与控制见2.2节。

4 实际生产应用

模具已投入生产应用,安装时,只需要插入热流道加热及控制线路、接入液压油管即可,没有出现由于技师粗心、技术不熟练等人为因素造成的模具损坏情况。图8是生产3万模次时抽检的照片,图8a的标识面、图8b的端面及2只扇形柱的顶面有非常轻微的浮纤,复合抽芯机构的型芯、螺纹型芯及阶梯型芯合模线位置出现毛边及浮纤,且尺寸出现超差,更换了相关磨损件;模具腔体磨损造成的尺寸改变在允许误差范围内。维修保养后,模具继续在生产应用中。

5 结语

(1)针对含3组互相垂直贯通孔的塑料接头结构特点及材料特性,设计了镶套两个方向的复合抽芯机构,利用斜导柱、弯销分别驱动两组抽芯机构运



(a) Core pulling view

(b) Thread-unscrewing view

图8 成型塑件实物

Fig. 8 Photos of molded plastic part

动,实现了准确的抽芯顺序控制,解决了多向抽芯空间狭小、运动受限并相互干涉的问题。

(2)为保证螺纹型芯使用寿命、复合抽芯机构正常工作及塑件正常顶出,设计了纯机械控制的3位4次开模顺序,控制机构技术成熟,加工制造成本低,安装调试简单方便,最大程度地减少了人为因素的影响。

(3)塑件材质中GF质量分数高达60%,成型时表面容易产生浮纤,设计了合理的进浇系统、排气系统及冷却系统,以保证塑件产品质量。

(4)设计了液压马达驱动自动脱螺纹机构,在从动链轮内套装了棘轮机构,脱螺纹动作只能按照设计的方向旋转,即使操作工人误接了液压油进出口管,也不会损坏模具。

(5)模具设计制造的细节会影响模具正常使用及寿命,应该引起足够的重视。

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