挤出模头的新技术：成本降低，产品质量提升

第二部分.

New die technology cuts costs and improves part quality in extrusion

Part 2

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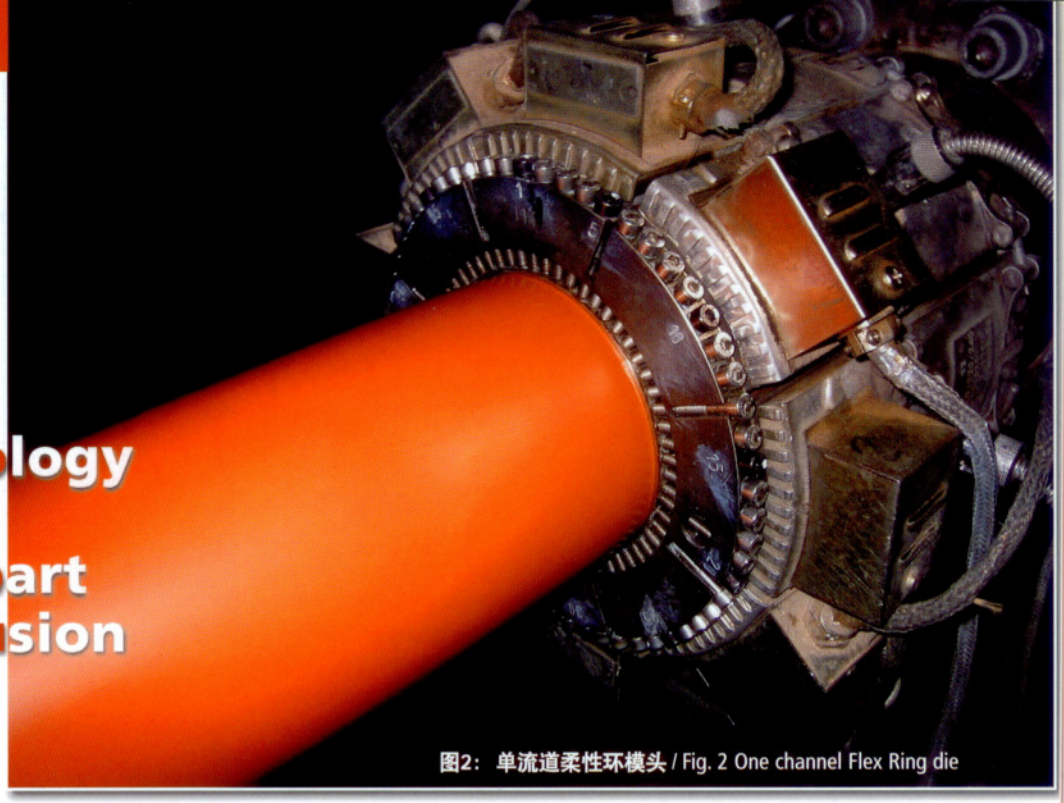

图2：单流道柔性环模头 / Fig. 2 One channel Flex Ring die

采用平缝模头生产挤出薄膜和片材

如前面所提到的,柔性膜唇平缝模头非常适合于生产厚度公差很窄的薄膜。 在片材挤出时，当前的技术是使用带节流杆的模头。节流杆控制起来很不容易。对于这种应用，具有柔软口唇的平缝模头要好得多，非常适合于精细地调整融体分布。不用说，这种模头的优点是可以极其灵敏地调节流道间隙，它不会产生流道“死角”，而死角会产生融体挂料并随着时间而降解。此外，维护工作很容易，因为薄唇模头只是由两件半块大部件组成（图14）。

共挤薄膜和片材领域里,全新的加工可能性大门已经开启。 已经首次实现了在生产线运行时，在薄膜或片材的整个宽度上,对共挤层的不同厚度进行灵敏的优化。 不管是使用进料块还是多流道平缝模头都可以这样做。 这样，只要满足前提条件，即各独立层厚度可以在线测量，那么就可以对整个宽度不同的共挤层实现闭环的厚度

Film and sheet extrusion using slit dies

Flexlip slit dies are well suited to reach very narrow thickness tolerances in flat films as already mentioned. In sheet extrusion it is state of the art to use dies having restrictor bars which are difficult to control. For this application slit dies having a flexible membrane are much better suited to fine tune the melt distribution. Apart from the advantage that they allow for a very sensitive adjustment of the flow channel gap they do not create dead zones in the flow channel where melt can hang up and degrade by time. Additionally the maintenance is easy as membrane dies consist only of two solid halves (Fig. 14).

Completely new processing possibilities are opened up in the field of co-extruded films and sheets. For the first time the individual thickness over the width co-extruded layers in films or sheets can be sensitively optimised while the line is running. This can be done as well when using feed blocks as well when

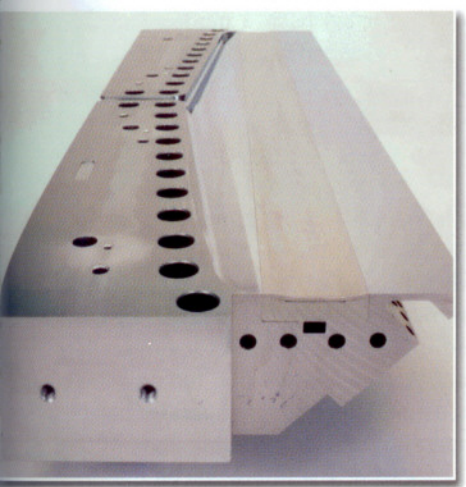

图14:薄唇型片材模头的一半，柔性流道壁取代了常规的限流杆(EDI照片) /
Fig. 14 One half of a membrane type sheet die where the conventional restrictor bar has been substituted by a flexible flow channel wall (photo EDI)

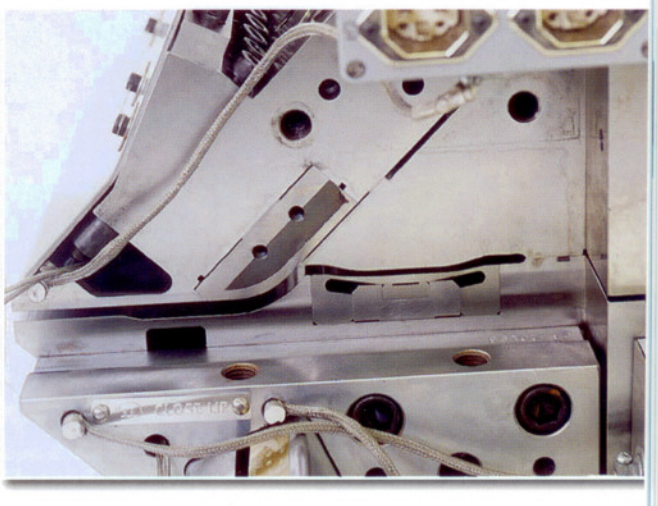

图15: 双流道模头,每一流道的整个宽度上的特殊位置都有薄唇以优化流道间隙(Bayer AG照片) /
Fig. 15 Two channel die having a membrane for each flow channel to optimise the flow channel gap at special locations over the width of the channel (photo Bayer AG)

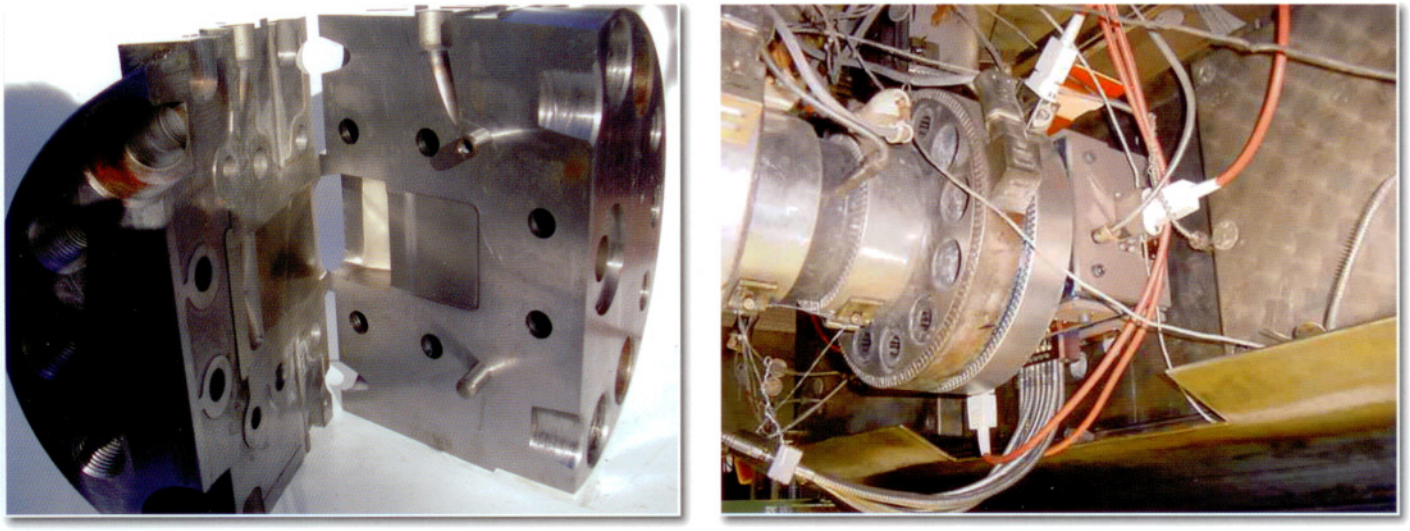

图16: 三流道进料块,在内部零件和一个外部零件之间的模缝线处打开,带有柔性可调节流道壁(左)和安装在生产线的平缝模头前面的三流道进料块(右)
Fig. 16 Three channel feed block opened in the parting line between the inner part and one outer part, with the flexible adjustable flow channel wall (top) and mounted in front of the slit die during operation (below)

控制。 这样，任何时候流道的几何形状将来都可以和改变了的生产条件相适应。例如，从新的生产商购买的原料的粘度改变了，或者生产线速度加快因而产量相应改变，采用同一个进料块或者同一个多流道模头就可以加工粘度已经变化了的不同原料。图15显示双流道模头，在模头工作时，各层的流道的几何形状可以精细调节。在此情况下，重要的是在各层都实现极小的厚度公差。图16显示三层进料块(类型:A-B-A)生产紫外线防护PC片材。片材的两面都有特殊的薄层聚碳酸酯，这种特殊树脂的紫外线吸收剂含量很高。这种情况下，减小两面表面层的厚度公差显得尤为重要，因为紫外线吸收剂相当昂贵。这就是为什么在进料块的两表层流道都具有可调流道壁的原因。尽管两表层的融体分布可以灵敏精细地调整，整个进料块只由3件部件组成。中间部件和具有多壁柔性流道的两边外层相同的两个部件，在生产过程中可以灵敏地变形。

未来的方向

在生产线的运行中精细调节模头流道的几何形状，这种可能性为挤出领域开启了新的加工前景。 模头设计者的工作现在已变得更为舒适了,因为他不再需要被迫设计模头的流道准确到某一点。他只须简单地将某一点设计到模头工作窗口的中间某个位置就可以了。 而其它的事情,即精细调整,将在开始加工时完成。采用这种方式，操作者可以对工作点的变化或者是被加工的特殊物料的变化作出反应。

30年前，当第一家公司提供带有壁厚控制的薄膜生产线时,在专家之间引起了激烈的争论: 这一技术有没有意义。现在，厚度控制技术对于已经实现的那些加工领域如薄膜加工，已经被认为是绝对必要的了。对于许多加工对象来说，要想实现厚度控制，带有柔性可调节流道区域的挤出模头成为了几乎所有现有挤出工艺的先决条件，甚至对于独立共挤层也是如此。更新的闭环控制挤出加工工艺将会越来越多地出现。 管材挤出系统可能成为先锋,因为目前许多管材挤出生产线已经将在线壁厚测量集成到了控制系统中。在这

using multi-channel slit dies. So now it is possible to establish a close-loop control for the thickness over the width of individual co-extruded layers. Precondition is that the thickness of the single layer can be measured on-line. So at any time the flow channel geometry can be adapted to changed production conditions in the future. If for instance the viscosity of a resin changes because it was bought by a new producer, or the throughput rate change as consequence of an increased line speed. It will also be possible to process different materials having varying viscosity's using one and the same feed block or multi-channel die.Fig. 15 shows a two channel die where the geometry of flow channel for both layers can be fine tuned while the die is in operation. In this case it is important to reach extreme small thickness tolerances in both layers. Fig. 16 shows a three layer feed block (type A-B-A) to produce UV-protected PC-sheets having on both surfaces a thin layer of a special PC resin containing a high amount of UV-absorber. In this case it is important to mainly reduce the thickness tolerances on both covering layers as the UV-absorber is rather expensive. That is the reason why the feed block has an adjustable flow channel wall in the flow channels of both covering layers. Although the melt distribution can be sensitively fine tuned for both covering layers the feed block consists only of three solid parts, a middle part and two identical outer parts which again have a multi-walled flexible flow channel which can be sensitively deformed during operation.

Future aspects

The possibility to fine tune the geometry of a flow channel within a die while it is in operation opens up many new processing possibilities in the field of extrusion. Already the job of the die designer becomes more comfortable as he is no longer forced to design the flow channel of a die exactly to the point. He simply needs to design it somewhere in the middle of the operating window of the die. The rest that means the fine tuning will be done while starting the process. Doing this the operator can react on variations of the operating point or on variations of the special material which is processed. The future will be that this

种情况下，管材生产者不必要另行购买昂贵的厚度测量系统来实现管材的壁厚调节控制。第一套管材厚度控制系统可能在下一次德国杜塞尔多夫K展出现。

采用动态调节柔性环模头来改变型坯整个圆周上的厚度已经证明，不仅模塑部件的厚度分布更好，而且可以用经济的方式生产更为复杂的部件。与模头的直径无关，与模塑部件的尺寸无关，将来，在部件的几何形状与型坯的圆周形状发生差异时，对整个型坯外廓实行动态轮廓厚度控制是绝对必要的。那些继续使用传统静态流道轮廓的模头的公司，将会从市场上很快消失或逐渐消失。

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膜片和柔性环技术系德国 Rossdorf 的 Heinz Gross 博士私人所拥有（Heinz-gross@t-online.de）。该技术已在全世界许多国家包括中国取得了专利。Gross 博士是一位真诚的研究者，致力于改进挤出工艺。他正在寻找那些有兴趣得到这类专利并从该技术的优势中获取利益的公司。

Membrane and Flex Ring Technology are privately owned by Dr.-Ing. Heinz Gross, Rossdorf, Germany (heinz-gross@t-online.de). The technology is patented in many countries over the world including China. Dr. Gross is a pure researcher who works on improving extrusion processes. He is looking for companies who are interested in taking a licences in order to profit from his advantageous technologies.

will be done automatically for all different extrusion processes. When, 30 years ago, the first companies offered film lines with wall thickness control heated debates were initiated among experts whether that makes sense or not. Thickness control is now regarded as absolutely essential for all processes where it has already been realised like in film lines. Extrusion dies with flexibly adjustable flow-channel regions are for many processes the prerequisites to be able to establish a thickness control for nearly all existing extrusion processes including even for individual co-extruded layers. So further close-loop controlled extrusion processes will more and more come up. The pioneers will probably pipe systems since online wall-thickness measurement is already integrated into many pipe extrusion lines today. In these cases the pipe manufacturer does not need to purchase an expensive thickness measurement system in addition to the control system to regulate his pipe wall thickness. The first pipe thickness control systems could possibly be available at the next K-show in Düsseldorf/Germany.

Using dynamically adjusted Flex Ring heads to vary the thickness of the parison over its circumference have proved not only to result in better thickness distributions in blow moulded parts but also to allow for an economic production of more complex parts. Independent from the diameter of the head or of the size of the blow moulded part in future it will be absolutely necessary to dynamically profile the thickness over the circumference of the parison in the moment when the geometry part differs from the round shape of the parison. Companies which continue to operate heads having still a conventional static profiled flow channel will disappear sooner or later disappear from the market.

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