

## **piston and rider rings**

### **活塞环和支撑环**

#### **Why are some piston rings one piece and some multipiece?**

#### **为什么有些活塞环是单片式结构，而有些是多片式结构？**

The main reason for selecting either a single or multipiece piston ring design is the flexibility of the material that the piston ring is being manufactured from, some materials, both metallic and non-metallic are not flexible at all and when rings are produced from these, two or three piece designs are necessary. Consideration also has to be given to the size (cylinder diameter) and axial and radial dimensions of the rings because even with flexible materials, small piston rings can be difficult to expand over the piston diameter.

无论是选择单片式活塞环还是选择多片式活塞环，其主要原因是为了适应制造活塞环的材料。一些材料既有金属的特性又有非金属的特性，它们根本没有柔韧性。当活塞环用这些材料制造，必须使用两片或三片式的设计。此外，汽缸直径、活塞环的径向和轴向尺寸同样需要考虑。因为，对于小的活塞环，即使使用了柔韧性很好的材料，其张开后的尺寸也很难超过活塞直径。

#### **Do piston ring gaps need to be checked and corrected on site prior to installation into the compressor?**

#### **在安装活塞环之前，需不需要测量和校正活塞环的切口间隙？**

All piston rings produced by LEAH are manufactured with the correct end gap to suit cylinder diameter and operating conditions that the ring is going to be used in.

LEAH提供的所有活塞环在制造的时候，已经选择了恰当的切口间隙来符合汽缸直径和运行参数的要求，因此它可以立刻装在压缩机上使用。

#### **Can I check piston ring gaps by placing the piston ring in the cylinder?**

#### **能不能把活塞环安装到汽缸中后再检查它的切口间隙？**

Not without a great deal of difficulty. When piston rings are installed into a cylinder without gas loading it is very difficult to ensure that the O.D. of the ring contacts the cylinder all the way around and that the ring is exactly perpendicular to the axis of the cylinder. Also the temperature on site is often different from the controlled conditions in LEAH's manufacturing facilities. The only accurate way of checking piston ring gaps is to lay the ring flat on a surface plate and to set the ring to cylinder diameter. This must be done at the same temperature that the ring was manufactured using a pi tape, the gap can now be checked using slip gauges.

这是很困难的。当将活塞环安装到汽缸中的时候并没有压缩气体，这时很难确保活塞环的外径紧密贴合在汽缸内壁四周，并让活塞环与汽缸中轴线完全垂直。此外，这时的环境温度也常常与LEAH生产工厂控制下的温度不同。检验活塞环切口间隙唯一正确的方法就是把活塞环平放在平板上，然后将活塞环外径调整到汽缸直径。这个调整必须在制造时相同的温度条件下，用圆周尺来测量调整，切口间隙用滑规来测量。

#### **Do piston rings need to be pressure balanced?**

#### **活塞环是否需要压力平衡的结构设计？**

Pressure balancing was thought to help reduce the wear rate of piston rings in both lubricated and non-lubricated applications, however there is no evidence that this solved what was basically a piston ring material wear problem. With today's modern materials pressure balancing of piston rings is not necessary and in fact experience has shown that it can weaken the ring.

压力平衡结构被认为有利于减少活塞环的磨损，但没有证据可证明，压力平衡可以解决活塞环材料的磨损难题。对于当今先进的材料，活塞环的压力平衡不再是必不可少的。事实上，经验证实压力平衡结构会削弱活塞环的强度。

## Do non-metallic piston rings need an expander spring to work well?

### 非金属活塞环是否需要弹性涨圈？

All piston rings are gas loaded onto the cylinder wall and do not need the addition of a metal expander spring to push them onto the cylinder wall. Expanders can damage the piston ring grooves and the cylinder if the piston ring wears and the expander ring breaks and gets out between the piston and cylinder. In some very special applications expander springs can be beneficial, but the expander spring and its effect on other components in the cylinder should be the subject of a thorough design review.

所有活塞环都是依靠气体的压力，使它紧密贴合在气缸内壁上，而不需要额外的金属弹性涨圈来推动它与气缸内壁贴合。假如活塞环磨损后，弹性涨圈断裂并进入活塞与气缸间的空隙，弹性涨圈就会损害活塞环槽和气缸。在一些非常特殊的工况下，弹性涨圈是有用的。此时，弹性涨圈及它对气缸内其它部件的影响应该作一个全面的设计检查。

## How are the number of piston rings used on a piston selected?

### 如何确定活塞上的活塞环数量？

The number of piston rings selected for a particular application is calculated taking into account the following:

- A. Gas molecular weight
- B. Pressure differential
- C. Whether the cylinder is lubricated or non-lubricated
- D. Rotative speed of the compressor
- E. Space available on the piston

A considerable amount of the emphasis placed on these factors is based on empirical experience and consequently it is possible to get significant variation in the number of piston rings recommended by different manufacturers and compressor builders.

对于一个特定的工况，活塞环数量的计算通常考虑以下这些参数：

- 气体分子量
- 压差
- 气缸有油/无油润滑
- 压缩机转速
- 活塞有效长度

在这些因素中，很多是完全基于经验的，因此不同的密封件生产商或压缩机主机厂所推荐的活塞环数量有显著地差异。

## When should I change the piston rings?

### 活塞环应该什么时候更换？

There is no firm answer to this question, each application must be looked upon separately. The main function of piston rings is to provide a seal between the moving piston and the static cylinder, and provided this seal is still being achieved, piston rings can be allowed to wear until they virtually disappear. However, in most applications a reduction in cylinder performance is noticed before this situation occurs and a good rule is that piston rings should be changed when they have worn between 30% - 50% of their original radial thickness.

对于这个问题是没有特定的答案的，每一种工况都必须单独地看待。活塞环的主要的作用是在运动的活塞和静止的气缸间提供一个密封，只要这个密封仍然有效，活塞环就可以一直使用直至它完全磨损消失。在大部分的工况中，在压缩机性能开始降低前就应该注意这个问题了。通常当活塞环的径向厚度被磨损到只有它原始的30%~50%的时候，活塞环就应该更换了。

## Can rider rings run at higher loadings than that recommended by API 618?

### 支撑环能否在比API618推荐的更高的负荷下运行？

The rider ring loadings advised in API 618 are really only a guide for filled PTFE materials and do not cover

materials such as LEAH Polymer Alloys that are able to operate at significantly higher loadings.

API618建议的支撑环运行负荷实际上只是针对填充聚四氟乙烯材料，它并没有覆盖LEAH的**聚合物材料**。相对于API618的建议值，LEAH的聚合物材料的运行负荷有非常显著地提高。

### Why do some piston rings have straight cut and some angle cut gaps?

#### 为什么活塞环一些是直切口，一些是斜切口？

The function of the gap in a piston ring is to allow the ring to flex and move as it wears also to allow for circumferential expansion of the ring. The gap should take into account both of these functions whilst allowing the minimum amount of leakage and the angle joint is best from this standpoint. However as gas passes through the angled gap the piston ring has a tendency to turn in the groove and if the piston material is soft, the groove can wear. In these applications a straight cut gap is preferred. Also the straight cut gap is stronger and is preferred for some very small diameter rings.

活塞环切口的主要作用是在活塞环磨损时允许它可以弯曲和运动，并允许它的外圆表面可以自由撑开。切口的设计应该重点考虑这两个作用，同时也要顾及它的最小泄漏量。综合考虑这些因素，斜切口连接正是最好的型式。但是，当气体通过这些斜切口的时候，会引起活塞环在槽内转动。假如活塞的材料比较软，活塞环槽会被磨损。在这些工况下，直切口是更好的选择。另外，直切口更牢固，是那些直径非常小的活塞环的首选。

### Do the piston rings support the piston?

#### 活塞环是否可以支撑活塞？

The primary function of piston rings is to provide a dynamic seal between the moving piston and the static cylinder wall with piston support being provided by separate rider rings. However, recent material developments have enabled piston rings to be designed to perform both the guiding and sealing function in cylinders where the space available on the piston is restricted. This however is a design compromise and it is preferred that piston rings only perform the sealing function.

活塞环的首要作用是在运动的活塞和静止的气缸内壁间建立一个动态密封。支撑活塞的是单独的支撑环。随着新材料的发展，当气缸内的可用空间受到限制的时候，活塞环能够被设计成能够同时承担导向和密封的作用。不过，这只是一种折中的设计，首选的还是活塞环仅仅承担密封的作用。

### Should piston rings and rider rings spin on the piston when in operation?

#### 当活塞环和支撑环在运行的时候，它们是否可以转动？

No, piston and rider rings should not spin whilst in operation and all aspects of design should be utilised to prevent this. Ring spinning causes unstable high wear rates.

当活塞环和支撑环运行的时候，它们不应该转动，应该利用设计的各个方面去阻止它们的转动。活塞环和支撑环的转动能够引起不稳定的高磨损率。

### In non-lube service how does the liner material and its condition affect the performance of piston and rider rings?

#### 在无油润滑工况下，气缸套的材质和表面状况是如何影响活塞环和支撑环性能的？

The ability of piston and rider rings to work well in non-lubricated service is to an extent affected by the cylinder liner material and its condition. LEAH Polymer Alloys are less sensitive to these conditions than filled PTFE's but the chemical composition, hardness and surface finish of cylinder liners need careful study in some applications if good non-lubricated performance of the piston and rider rings is going to be achieved.

活塞环和支撑环是否能够在无油润滑工况下运行良好，受到气缸套的材质和表面状况的影响非常大。相对于填充聚四氟乙烯材料，LEAH的聚合物材料受到这些条件的影响更小。但是，假如想让活塞环和支撑环在无油润滑工况下达到取得更好的效果，必须仔细考虑气缸套的材料化学成分、硬度和表面粗糙度。

### **What is the minimum safe standout of a worn rider ring?**

**在确保安全运行的条件下，支撑环的表面凸出活塞的那部分的最小尺寸是多少？**

This will vary with cylinder size and the clearance between the piston rod and packing case but as a guide when the rider ring stand out from the piston O.D. is reduced to 20% of its original then the rider rings should be changed.

这个尺寸随着气缸直径和活塞杆与填料盒间的间隙的不同而变化的。作为参考，当支撑环表面凸出活塞外径的那部分的尺寸磨损到只有原来的20%时，这个支撑环就应该更换了。

### **Why do some cut rider rings only have grooves on the shoulders?**

**在一些压缩机中，为什么一些切口式的支撑环只有侧向卸压槽？**

Some pistons, have been designed to use split rider rings which have a reduced radial thickness closer to that used for stretch-on rings and on these designs the face relief grooves cannot be used as they will weaken the rings, causing them to break in service. For these rider rings shoulder relief grooves are the only type of pressure relief that can be used.

有些活塞设计使用的支撑环为切口式，但它的径向厚度不大，与整环结构的支撑环接近，这些支撑环无法使用表面卸压槽，因为它们会削弱环的强度，使其在使用的过程中容易断裂。对于这些特殊的支撑环来说，侧向卸压槽是唯一能用的卸压结构。

### **Why do some rider rings have to be stretched into the rider ring groove?**

**在一些压缩机中，为什么支撑环只能用整环结构？**

Originally the first non-lubricated compressors were adaptations of existing lubricated machines. In these applications the rider rings were installed on the ends of the pistons overrunning the valve ports and cylinder counterbores, if split rider rings were used they could drop into the valve ports and break, consequently stretch-on (solid uncut) rider rings were the only design that could be used.

这些压缩机通常原先是有油润滑，后来才改为无油润滑。在这些压缩机的运行过程中，安装在活塞末端的支撑环会越出缸套连续长度。如果所使用的支撑环是切口式的，这些支撑环会掉进阀窝和气缸倒角并且断裂。故在这些压缩机中，支撑环只能使用整环结构。

### **Do split rider rings need to be pegged to stop them turning on the piston?**

**是否需要用销钉将切口式的支撑环固定在活塞上，使两者之间没有相对转动？**

It is important that split rider rings are stable on the piston and do not spin, this however is normally achieved by the correct design of pressure relief grooving but can also be achieved by pegging the rider ring. This pegging also allows the rider ring to be turned on the piston enabling its life to be effectively doubled.

切口式的支撑环要能与活塞环相互稳定且没有相对转动，这一点极其重要。这经常通过恰当的布置卸压槽的方向来实现。也可以通过销钉将支撑环固定在活塞上来实现。这种固定方式还允许把支撑环磨损比较严重的一边换到另外一边，从而使支撑环的使用寿命加倍。

### **Do the piston and rider rings always need to be in the same material?**

**活塞环和支撑环是否总是需要使用相同的材料？**

In lubricated service the material of the piston rings can be different to that of the rider rings if there is a good technical reason but in non-lubricated cylinders, except in very special applications, it is preferable to have the piston and rider rings manufactured from the same material as both will have to operate on the same transfer film.

在有油润滑的工况下，如果在技术上有好的理由，活塞环和支撑环的材料可以不同。但是，在无油润滑的工况下，除了一些非常特殊的应用外，用同一种材料来制造活塞环和支撑环更可取，这样活塞环和支撑环可以在同一个镀膜层上工作。

### Why do rider rings have grooves on the face and shoulder?

#### 为什么支撑环上有表面卸压槽和侧向卸压槽？

The grooves on the side and face of rider rings are designed to prevent the ring from acting as a piston ring. The grooves on the face also help to distribute oil around the cylinder wall in lubricated service and are angled in alternate directions to help prevent the ring spinning and ensuring that the entire cylinder surface is swept for a uniform transfer film on the cylinder surface.

支撑环上的表面卸压槽和侧向卸压槽主要是为了防止支撑环承担活塞环密封气体和承受压力的工作。在有油润滑的工况中，表面卸压槽还能有助于润滑油均匀的分布在气缸内壁上。此外，表面卸压槽成角度的错列布置，可以防止支撑环的转动，确保整个气缸内壁形成一个完整统一的镀膜层。

## packing and oil wiper rings

### 填料和刮油环

#### What is the maximum rod undersize that can be used when using standard size packing rings?

当使用标准尺寸的填料环时，活塞杆的最大负公差为多少？

Providing the piston rod is still concentric, the maximum undersize that a standard size rod packing can be used on is 0.1 % of the original rod size. For example a set of piston rod packings designed for a 3.000" (76.2mm) diameter piston rod, could be used on a piston rod reduced in size to 2.997" (76.12mm). This guide applies only to segmental type packing and not to triple circle designs. With regard to oil wiper packing any undersizing of the piston rod is not technically acceptable.

假如活塞杆还是同轴的，要使用标准尺寸的填料环，那么活塞杆的最大负公差为活塞杆原始尺寸的0.1%。例如，为直径是3.000"（76.2mm）的活塞杆设计的一套填料环，能够在直径是2.997"（76.12mm）的活塞杆上正常使用。这个方法只能应用于分段结构的填料环，不适用与三环结构的类型。对于刮油环，活塞杆的负公差在技术上是不能接受的。

#### Do radial tangent cut packings share the sealing function through the packing case?

填料盒中的所有径向切向填料环组是不是共同承担了密封的工作？

Traditionally it was believed that with radial/tangent packing rings the seal was shared between all of the seal sets in the packing case and consequently the greater the number of packing ring sets, the longer the life. This theory has been disproved in recent years by both field experience and controlled development tests, and it is clear that in the majority of applications only one set of seals performs the seal with the others shuttling backwards and forwards in the grooves. In this knowledge it would be possible to design one vent seal.

通常认为，填料盒中所有由径向环和切向环组成的密封环组共同承担了密封的工作。因此，填料环组越多，它们的寿命越长。但是近些年来，现场试验和可控的研究证明这个理论是有误的。在大多数工况中，很明显只有一组填料环承担了密封的工作，而其它的填料环只是在被槽中来回的移动。根据这个理论中，有设计使用一组密封环是有可能的。

#### Why is the vent seal normally double acting?

为什么漏气密封环通常是双作用密封？

The vent seal performs two functions:

A. It is the final seal in the packing case ensuring that any gas that has permeated to the vent position passes into the vent system and not into the distance piece.

B. If the vent pressure falls below atmosphere then the vent seals in the alternative direction prevent air or distance piece purge gas from being sucked into the vent system.

漏气密封环有两个作用：

- 它是填料盒中最后一道密封环，确保泄漏到漏气排放口的所有气体能够进入漏气排放系统，并阻止泄漏气体进入中体。
- 当泄漏气体的压力降到低于大气压力的时候，漏气密封环要阻止空气或中体中的保护气进入漏气排放系统。

#### Will plastic packings/wipers wear the piston rods?

非金属的填料环和刮油环是否会磨损活塞杆？

No, providing non-abrasive packing/wiper materials are selected and the piston rod is manufactured from suitable material with the correct surface treatment and finish for the application.

假如选用的是非磨蚀性的填料环和刮油环，以及活塞杆选用合适的材料制造，并经过恰当的表面处理和抛光，在这种情况下是不会磨损活塞杆的。

### **What is the main function of a pressure breaker and when should it be used?**

#### **减压环的主要作用是什么？应该在什么时候使用？**

Pressure breakers are used in packing cases that seal gases compressed at medium to high ratios. In these applications the pressure breaker smooths out some of the peaks in the compression cycle and protects the main packing rings from being damaged. A second application for pressure breakers is on dirty gas service where it is used to reduce the amount of dirt entering the packing case.

在压缩中高压气体的时候，在填料盒中应该使用减压环。在这种工况下，减压环可以消除压缩循环中的压力峰值，保护主密封环免受损坏。需要减压环的第二种工况是压缩含有杂质的气体的时候，这时使用减压环可以减少进入填料盒的杂质。

### **Why do some packings use coil springs as garter springs and some use solid wire springs?**

#### **为什么一些填料环使用螺旋弹簧，而另一些使用实心圆线弹簧？**

Solid wire springs are stronger than garter springs and consequently less prone to breakage, however, they do have to be accurately matched to the O.D. of the packing ring, but as the packing ring wears, only touch in 3 positions. In gases containing dirt or heavy polymers, coil springs can get clogged, but for the majority of applications the coil spring is the best design as it provides uniform loading and is better able to compensate for wear.

实心圆线弹簧比螺旋弹簧更牢固，从而更少发生断裂。可是，实心圆线弹簧的直径必须精确地与填料环的外径相匹配，且当填料环磨损的时候，它仅能接触填料环的三个点。对于螺旋弹簧，当气体中含有杂质或高分子聚合物的时候，它会被这些杂质堵塞。但是在大多数工况中，螺旋弹簧还是最好的设计，因为它能提供均匀分布的载荷。同时，它还能更好的补偿填料环的磨损。

### **How can you calculate leakage to the vent system?**

#### **怎样计算进入漏气排放系统的气体泄漏量？**

None of the accepted formula for calculating vent gas leakage have been found to be accurate and provide only guesses as to what the leakage might be. This is an area of packing design that requires considerably more study.

没有一个公式被认为可以用来精确地计算气体的泄漏量，一般仅是提供推测可能的泄漏量。这是一个还需要进行更多研究的填料设计领域。

### **Does the surface finish of the piston rod effect packing and wiper ring life?**

#### **活塞杆的表面粗糙度是否会影响填料环和刮油环的寿命？**

Yes, particularly in non-lubricated service and as a guide the harder the rod surface the finer the surface finish required.

是的，有影响，特别是在无油润滑的工况下。通常的建议是，活塞杆表面越硬，就需要更好的表面粗糙度。

### **Do the garter springs provide the force to load the packing ring onto the piston rod?**

#### **是不是弹簧提供的抱紧力使填料环紧压在活塞杆上？**

Like piston rings, the main cylinder packing rings are gas loaded onto the piston rod and work best in a cyclic loading situation. The main function of the garter springs is as an assembly device holding the rings in place on the piston rod prior to gas load being applied.

同活塞环一样，主密封环是通过气体的压力紧压在活塞杆上的。在周期性载荷下，主密封环的工作状态最好。填料用螺旋弹簧的主要作用是组装填料环，并在气体压力开始作用前，将填料环调整到合适的位置。

### **Must back up rings always be metallic?**

#### **阻流环必须是金属的吗？**

No, with today's improved polymer alloys the pressure which back-up rings are required is much higher compared to filled PTFE rings and also these polymer alloys can be used as back-up rings, in place of metal back-up rings, in all but the most demanding of applications.

不是。现今，随着聚合物材料性能的提高，这些材料能够承受比填充聚四氟乙烯材料要高的压力，这些压力正是阻流环所要求的。除了苛刻的工况，在其他所有的工况下，这些聚合物材料可以代替金属材料用在阻流环上。

### **The higher the discharge pressure the greater the number of packing rings required?**

#### **排气压力越高，所需要的填料环数量是否越多？**

This is now known not to be correct as already mentioned, in fact most hyper compressors used in low density polyethylene plants seal pressures up to 3000 bar with one pressure breaker and 3 main seals.

正如已经提及的，这是错误的。实际上，在大多数用在低密度聚乙烯工厂的超高压机器中，密封压力达到3000 bar，却只用了一个减压环和三个主密封环。

### **Why are back up rings used?**

#### **为什么要使用阻流环？**

Back up rings are also known as anti extrusion rings, and are designed to prevent the sealing element of the seal set, usually the tangent cut ring, from extruding into the gap between the piston rod and the I.D. of the packing cup. This extrusion is caused by a combination of gas pressure, temperature and the drag effect of the rod moving backwards and forwards through the packing case. “

阻流环也被称作防挤出环，它的作用是防止填料环组中的密封环发生挤出变形，通常是切向环，发生在活塞杆和杯槽内径之间的间隙位置。这个挤出变形是由气体压力、温度和作往复运动的活塞杆的摩擦力一起作用引起的。

### **How do you know that packing rings are fitted the correct way round?**

#### **怎么知道填料环是按照正确的顺序来组装的？**

All segmental packing rings have their faces either drill marked or stamped to ensure correct assembly and these marks should always face towards the pressure.

填料环的每一瓣都在它的表面上用锥子或印章做了标记，以确保正确的组装。这些有标记的一侧应朝向高压侧。

### **Does the hardness of piston rods effect packing ring and wiper ring life?**

#### **活塞杆的表面硬度是否会影响填料环和刮油环的寿命？**

Yes, particularly in non-lubricated service, as a guide the higher the discharge pressure the harder the required rod surface and in general the minimum rod hardness for good packing ring life is 40 RC.

会的，特别是在无油工况下。排气压力越高，所需要的活塞杆表面硬度也越高。通常，要达到好的填料环寿命，活塞杆表面硬度最小需要40RC。

### **Should the oil wipers always be changed when the main packings are changed?**

#### **当更换主填料环时，刮油环是否需要同时更换？**

Yes, although this is rarely done and is probably one of the main causes of oil leakage from the crankcase.

是的。尽管这个很少做到，但它或许是引起曲轴箱润滑泄漏的主要因素。

### **Is it necessary to have a gas seal in the wiper packing?**

#### **在刮油环组中，是否有必要加上一个气体密封环？**

Yes, the gas seal in the wiper assembly is normally double acting, sealing the pulsations caused by the function of the crosshead and also preventing gas that leaks from the compressor cylinder or distance piece purge gas from entering the crankcase and damaging the crankcase lube oil.

有必要的。在刮油环组中，气体密封环通常是双作用环，可以减小由十字头活动引起的气流脉动影响。此外，它还能阻止气缸泄漏出的气体或者中体的吹扫气进入曲轴箱并污染润滑油。

### **Do the packing rings support and guide the piston rod?**

#### **填料环是否支撑和导向活塞杆？**

No, the packing rings should always be able to float freely in the packing case and should not support or guide the piston rod under any circumstances.

没有。填料环应该能够在填料盒中自由浮动。在任何情况下，它都不起支撑或导向活塞杆的作用。

### **Does the groove size affect the type of packing rings that can be installed in them?**

#### **杯槽尺寸是否影响填料环的结构形式，并影响它们的安装？**

Yes, the axial width of a packing ring groove used for segmental packing should be a minimum of 16mm, narrower grooves significantly reduce the alternative designs of rings that can be utilised.

会的。对于分段式填料环，杯槽的深度应至少为16mm。过于狭窄的杯槽深度会明显减少可供选择利用的填料环结构形式。

### **In non-lube gas service why do the packing rings tend to last longer than the piston and rider rings?**

#### **在无油工况中，为什么填料环的使用寿命比活塞环和支撑环更长？**

In non-lube gas service the packing rings have to seal against a piston rod that is affected by both the gas in the compression cylinder and air or purge gas in the distance piece whereas the piston and rider rings see only the process gas. This means that in general the job of the piston and rider rings is more difficult than the packing rings, particularly in difficult gas service such as bone dry nitrogen and bone dry hydrogen. The packing rings also have considerably more material available for wear compared to the rider ring which tends to be the governing component with respect to when piston and rider rings should be changed.

在无油工况下，填料环既要受到气缸中的流程气体的影响，又受到中体的空气或者保护气的影响。而活塞环和支撑环只是受到了流程气体的影响，这意味着活塞环和支撑环的运行条件要比填料环恶劣得多，特别是在那些极端恶劣的气体工况中，例如极干性氮气和极干性氢气。与支撑环相比，填料环还有更多的材料可供选择用来减轻磨损。至于活塞环的更换时间，可由支撑环来决定。

### **Some cast iron packing and wiper rings are tin plated, why is this?**

#### **为什么要在一些铸铁填料环和刮油环上镀锡？**

Tin plating is an attempt to prevent scuffing between the bore of the packing or wiper ring and the piston rod. 镀锡是为了防止填料环或刮油环与活塞杆间出现刮伤。

### **Is it better to install packing rings around the piston rod or plunge the rod through a completely assembled and installed packing case?**

#### **把填料环分组的依次安装在活塞杆上，或把活塞杆插入完整的已经预先组装好的填料盒，哪一种安装方式更好？**

Providing the piston rod has a bullet to cover the rod threads that has an O.D. the same as the piston rod, then it is preferable to plunge the rod through a packing case with rings that have already been assembled in the workshop. Installing packings around a piston rod is difficult and requires considerable care.

假如活塞杆上的螺纹有与杆径相同的锥形套筒保护，那么把活塞杆插入已经在工厂组装好的填料盒是更可取的安装方式。把填料环分组安装在活塞杆上是很困难的，并要非常仔细。

### **Why are non-metallic oil wipers better than metallic wipers?**

### 为什么非金属刮油环的效果比金属刮油环的好？

Unlike the main cylinder pressure packing, oil wipers rely on the garter springs to load them onto the piston rod, consequently if the wiper packing material is flexible this helps to get good wiping action. The preferred wiper packing material today is plastic, typically LEAH grade 100 which is a non-abrasive complex carbon filled PTFE.

与主填料环不同，刮油环主要通过卡紧弹簧来使它们抱紧在活塞杆上，因此，如果刮油环的材料有好的柔韧性将有助于获得好的刮油效果。目前，刮油环首选的材料是塑料，典型的如LEAH Y01，它是一种非磨蚀性的填充石墨的聚四氟乙烯。

### How much oil leakage from the crankcase is acceptable?

#### 从曲轴箱泄露的润滑油可接受的量为多少？

None.

无论多少都是不可接受的。

## packing cases

### 填料盒

#### What is the main function of the packing case?

##### 填料盒的主要作用是什么？

The main function of a packing case is to act as a housing for the free floating packing rings (seals). The packing case is sealed by a gasket with the compressor cylinder and can be produced with vent and purge lines for improved sealing.

填料盒的主要作用是为自由浮动的填料环提供一个托架。填料盒和压缩机气缸之间的密封由垫圈提供。此外，漏气回收和保护气的使用可以改进填料盒的密封效果。

#### Some packing cases are called stuffing boxes, what is the difference?

##### 一些填料盒被称作填料函，这有什么不同？

The name stuffing box comes from the old steam engine/ compressor days when the piston rod was sealed with soft packing that was stuffed into the annular space (box) between the rod and the cylinder. In today's machines, stuffing boxes and packing cases are the same component.

填料函这个名字来自于过去的蒸汽机时代。那个时候，活塞杆的密封是通过在活塞杆和气缸间的环形空间填充柔软的填料进行密封的。在现代机械中，填料函和填料盒是指同一种部件。

#### Is it necessary to cool packing cases?

##### 是不是一定要冷却填料盒？

This is a very complex question and cannot be answered in a straight yes and no manner. Traditionally it was felt that cooling was necessary on all types of packing cases at all pressures in both lubricated and non-lubricated services.

However, with the development of LEAH Polymer Alloys most lubricated packings do not need to be cooled and even non-lubricated packings can be operated at up to 100 bar discharge without cooling in some applications.

这是个非常复杂的问题，不能直接用“是”或者“不是”来回答。传统上，在有油和无油润滑工况下，一切压力范围内，所有的填料盒都有必要进行冷却。然而，随着LEAH聚合物材料的发展，大多有油工况下的填料盒不需要冷却。甚至在排气压力不超过100 bar，有些无油工况下的填料盒也是不需要冷却的。

#### Is it possible to manufacture packing cases in separate units for easier handling?

##### 为了更容易的操作，填料盒是否能够作为一个独立的整体来加工？

Yes, packing cases are increasingly being manufactured as cartridge units with the flange as a separate component for ease of handling.

可以的。填料盒日益倾向于模块化加工，而法兰作为单独的部件另行加工。

#### What are the recommended materials of construction for packing cases?

##### 填料盒推荐的制造材料是什么？

For lubricated applications the preferred material is either cast iron or alloy steel AISI 4140 and for non lubrication applications 13% chrome stainless steel AISI 400 series.

对于有油润滑工况，填料盒首选地材料是铸铁，或者是合金钢AISI 4140。对于无油润滑工况，首选的材料是含有13%铬的不锈钢AISI 400系列。

#### How do you ensure that the packing case cups are always assembled in the correct sequence?

##### 怎样确保填料盒杯槽是按照正确的次序组装的？

All packing cases should have the cups numbered in sequence starting at the gasket end and should only be assembled in this way. This ensures that all vent lube and purge lines are directed to the correct position within the case.

从有垫圈的末端开始，所有的杯槽都被依次编号，它们只能按照这个次序进行组装。这样确保了润滑油回收孔和保护气管路都在填料盒内正确的位置上。

### **In cooled packing cases which is the preferred design of cup?**

对于带冷却的填料盒，下面哪一个是首选的杯槽设计？

A. Plate and 'O' ring.

B. Cast/Welded cups.

The plate and 'O' ring arrangement providing the 'O' ring grooves are designed to support the 'O' rings on their inside diameter is by far the best as it allows the cooling water channels to be cleaned thoroughly when the packing case is being reconditioned. Cast or welded designs can become blocked easily particularly as plant cooling water is not always as clean as it should be.

- 金属板和O型圈
- 铸造/焊接杯槽

对于金属板和O型圈布置，金属板上带有O型圈槽，用来安放O型圈。到目前为止，这种布置是最好的设计，因为在修复填料盒的时候，冷却水道能够被彻底的清洗。而在冷却水没有达到所要求的纯净程度时，铸造或焊接杯槽设计的冷却水道特别容易被堵塞。

### **How many cooled cups should there be in a packing case?**

在整组填料盒中，应有多少个带冷却的杯槽？

In order to achieve the correct water flow pattern and position of the inlet and outlet connections on the flange there should always be an odd number of cooled cups in a cooled packing case.

在整组填料盒中，应该始终有奇数数量的杯槽被冷却，这是为了在法兰上获得恰当的冷却水进出口接头布置和位置。

### **How many lubrication points should there be in a lubricated packing case?**

在有油润滑的填料盒中应该有多少个注油点？

The number of lubrication points in a packing case depends on a number of factors including gas type, gas pressure, temperature and compression ratio. As a guide the higher the pressure the greater the number of points required.

填料盒中的注油点数量由很多因素决定，包括气体类型，气体压力，温度和压缩比率。作为指导，气体压力越高时，所需得注油点数量也就越多。

### **Is it possible for the flange material to be different from the main body of the packing case?**

填料盒法兰的材料是否可以和填料盒主体材料不同？

Normally the flange material is the same as the main case material but it is acceptable for it to be manufactured in less expensive materials, should commercial conditions dictate this.

通常法兰材料和填料盒主体材料相同。但是，法兰用比较便宜的材料制造也是可以接受的，并应在商务条款中指出这点。

### **What is the best type of gasket to seal between the packing case and the cylinder?**

密封气缸和填料盒的垫圈的最好类型是什么？

LEAH's recommended gasket material is soft iron. This material is resistant to corrosive attack by most refinery and petrochemical gases and will not creep with time.

LEAH推荐的垫圈的材料是软铁。这种材料可以抵御炼油和石化气体的腐蚀，并且不会随着时间而蠕

变。

### **What cooling water flow rates should be used?**

#### **冷却水流动速度应该是多少？**

This varies with rod size but typically ranges between 4.5 and 20 liters per minute.  
这个随着活塞杆尺寸而变化，典型的流动速度是每分钟4.5~20升。

### **What pressure should the cooling water be?**

#### **冷却水的压力应该是多少？**

Normal cooling water inlet pressure should be 3.5 bar.  
通常，冷却水的进口压力应是3.5 bar。

### **If the risk of any water entering the gas system cannot be accepted can the packing case be cooled with another fluid?**

#### **假如不能接受任何冷却水进入气体的风险，填料盒能否使用其他液体进行冷却？**

Yes, it is possible to use oil, anti freeze or even gases such as air or nitrogen.  
是的，可以使用冷却油、防冻剂甚至是气体，例如空气或氮气。

### **Where should the vent of the packing case be connected to?**

#### **填料盒的漏气回收管道应该连接到什么地方？**

The vent should be connected to either

- A. Flare system
- B. The suction side of a lower pressure cylinder

漏气回收管道应该连接到下面地方中一个：

- 火炬系统
- 低压气缸的进气侧

### **Is it possible to design a packing case that has zero leakage?**

#### **填料盒有没有可能达到零泄漏？**

With modern venting, materials and spring loading of vent seals it is possible to design packing cases that are essentially zero leakage!

用先进的漏气密封环排气系统、材料和弹簧载荷设计出的填料盒基本上可以达到零泄漏。

### **What are the main functions of tie rods?**

#### **连杆的主要作用是什么？**

The function of tie rods is to ensure that the cups are assembled in the correct annular position ensuring all the lube and vent lines are aligned correctly. Tie rods are not designed to support the cups when the packing case is assembled into the cylinder.

连杆的作用是使杯槽能够按照正确的环形角度进行组装，以确保注油和漏气回收管道得到正确的排列。在填料盒被装配到气缸中时，连杆不能用来支撑杯槽。

### **Should the packing cups always be lapped or is grinding acceptable for low pressures?**

#### **对于低压气体，填料杯槽是否都要进行研磨？或者只要进行符合要求的磨削加工？**

If possible all packing cups should be lapped but for low pressure air or high molecular weight gases, ground surfaces are acceptable providing the grinding is of a circular pattern.

如果可能的话，所有填料杯槽都应该被研磨。但是对于低压空气或是高分子量气体，倘若磨削加工以圆形进行的，那么磨削加工的表面是可以接受的。

### Some packing cases are externally cooled what is this?

#### 一些填料盒是表面冷却的，这指什么？

This is when the space between the O.D. of the packing case and the bore into which it is installed is a sealed chamber with cooling fluid circulated in it. This is not the most efficient cooling system and was used on high pressure machines before the development of improved packing ring materials.

这是指安装在气缸中的填料盒的外表面和气缸之间是一个密封的空间，冷却液体在这个空间中循环流动。这不是一种有效的冷却系统，它用在填料环材料还没改进发展之前的高压机器中。

### Some packing cases have a guide bush in the nose flange, is this a good idea?

#### 一些填料盒有一个导向环，这是不是一个好主意？

Guide bushes have been used in high pressure packing cases to guide the rod and prevent it from touching on the I.D. of the cups.

However, with correct rider ring design these guide bushes are now only needed on LDPE secondary compressor packings and in fact have been known to be the cause of piston rod breakage due to their multiple support effect, when combined with rider rings and crosshead supports.

导向环曾被用在高压填料盒中，用来导向活塞杆并防止活塞杆与填料盒杯槽内径表面接触。随着正确的支撑环设计的出现，现在这些导向套筒仅在低密度聚乙烯用超高压二次机的填料盒中需要用到。事实上，用于导向环、支撑环和十字头的多点支撑的影响，易导致活塞杆的损伤。

### Why do some packing cases have intermediate pressure take off points?

#### 为什么一些填料盒中有中间压力分接点？

This is an attempt, in packing cases that have to seal high pressure differentials, to share the sealing function between all the seals. It is questionable if it works sufficiently well to be justified.

这是一种尝试。当密封压差很高的时候，在填料盒中有中间压力分接点，可以让所有密封件共同承担密封的职责。但是，它能否让填料环很好的工作，这一点并未经过证明，是不能肯定的。

### When is a packing case worn out?

#### 填料盒能使用多长时间？

Normally when the stack height is reduced to such an extent that the correct amount of crush cannot be on the end gasket. When this happens exerted it is possible to re-establish the correct height using spacers but this is a technical compromise.

通常，当填料盒堆栈高度减少到不能让末端垫圈受到充分的挤压，此时填料盒应该更换了。当这种情况发生时，也可以用垫片来重新恢复恰当的高度，但这只是一种技术上的折中办法。

### Do LEAH recondition packing cases?

#### LEAH是否可以修复填料盒？

Yes, LEAH recondition all types of packing case.

是的，LEAH可以修复所有类型的填料盒。

### Why is there a wide variation in the number of seals used by different OEMs for the same application?

#### 不同的OEM厂家用于相同的工况的填料环数量为什么有很大的不同？

The selection of the number of packing rings required to seal relative to the pressure differential is based on the historical experience of different OEMs and component manufacturers and is clouded by other factors such as poor materials or incorrect design.

为了密封所对应的压力差，各个OEM厂家或密封件厂商根据自己的历史经验来确定填料环的数量。此外，它还受到诸如拙劣的材料和不正确的设计等其他因素的影响。

**Should there be 'O' rings between all the cups on both cooled and non-cooled cases?**

不管填料盒冷却与否，在所有的杯槽之间是否需要O型圈？

In order to ensure as good a seal as possible 'O' rings should be used between all the cups of both cooled and non-cooled packing cases.

为了确保更好的密封效果，冷却的填料盒和不冷却的填料盒都应该使用O型圈。

**Do LEAH pressure test new packing cases prior to shipment?**

LEAH是否在发货之前进行填料盒的压力测试？

Yes, we do have the facility to pressure test both new and reconditioned packing cases prior to shipment provided this service is requested by the customer.

是的。在发货之前，LEAH有专业的工具对新的填料盒和修复的填料盒进行压力测试。

## materials technology

## 材料技术

### LEAH calls its special materials “polymer alloys” - why is this?

#### LEAH称他们的特殊材料为聚合物材料，这是为什么？

Traditionally the material used for non lubricated compressors and some lubricated compressors was filled PTFE. In this family of materials there is no chemical bonding between the fillers and the PTFE, the PTFE basically encapsulates the fillers to hold the material together. With LEAH Polymer Alloys the situation is completely different. Chemical bonding does take place and in some of the grades that combine a number of different polymers, the polymers actually alloy together forming a completely unique material that has different chemical and physical characteristics from its constituent polymers.

传统用在无油润滑压缩机和一些有油润滑压缩机上的材料为填充聚四氟乙烯。在这个系列的材料中，填充物和四氟乙烯没有化学结合，四氟乙烯主要是压缩填充物并相互混合在一起。LEAH聚合物材料的情况确实完全不同，它们发生了化学结合。有些等级的材料化学结合时还产生了许多不同聚合物。这些聚合物完全融合在一起，形成了十分独特的材料，它们和原先的聚合物相比，有了不同的化学和物理特性。

### Is it possible to have one LEAH material that can be used in all non-lubricated compressors?

#### 有没有可能一种LEAH的材料能够用在所有无油润滑压缩机上？

The answer is both yes and no, if the goal is to achieve the maximum life from the components then there is no one material that will achieve this and each application will have to be studied and the optimum material selected. If operating life is not a concern then it is possible to utilise one material for a broad range of applications. However, operating life is increasingly the compressor operators main concern and consequently the application range of materials is narrowing with new materials being developed that are engineered to very specific applications.

对于这个问题既可以回答是也可以回答不是。如果目的是要让零部件达到最长的运行寿命，那么没有一种材料可以达到这个要求。每个工况都不得被仔细研究，然后选择最适合的材料。如果运行寿命不是很重要，那么使用一种材料去应对多种工况是可能的。然而，运行寿命日益受到压缩机操作员的关注，因此，随着新材料的发展，它们的应用范围正在变窄，只能应用在非常特定的工况下。

### In a non-lubricated compressor is it necessary to remove a previously established transfer film from a cylinder or piston rod when installing new components?

#### 在无油润滑压缩机中，当安装新的密封环时，是否必须要处理掉原先建立在气缸和活塞杆上的镀层？

If the new piston rings, rider rings and piston rod packings being installed are the same material as those being removed and the transfer film has not been damaged in any way, then it is not necessary to remove it from the piston rod or cylinder liner. However, over a number of years the transfer film can build up to a heavy thickness and it is a good idea to remove this and re-establish the surface finish using a glaze busting technique.

假如将被安装的新的活塞环、支承环和填料环和将被移除的旧环的材料相同，并且镀层完全没有被破坏，那么没有必要处理掉气缸和活塞杆上的镀层。然而，经过很多年后，镀层逐步增加变得很厚时，使用薄膜破裂法将镀层处理掉并重新加工表面是非常好的意见。

### Does LEAH supply filled PTFE materials?

#### LEAH是否供应填充聚四氟乙烯材料？

Yes, LEAH blends and molds its own formulations of filled PTFE materials and there is no doubt that this family of materials still is technically superior in a number of non-lubricated and lubricated compressor seal

applications.

是的LEAH根据自己的配方混合和烧结填充聚四氟乙烯材料。毫无疑问，对于许多无油和有油润滑压缩机，这个系列的材料仍然有不错的性能。

### **Are LEAH materials available from any other company?**

#### **LEAH材料能否从其他公司获得？**

No, all LEAH materials are produced in-house to proprietary formulations and are not available from any other source.

不能。所有LEAH材料都是根据自有配方在公司内部生产的，不可能从其它渠道获得这些材料。

### **How does LEAH decide on the formulation of its special materials?**

#### **LEAH是如何决定特殊材料配方的？**

LEAH has its own research and development facilities that are capable of producing small test formulations of new materials.

All LEAH's materials are a product of this test program and are wear tested in gas prior to any field trials. The test formulations that LEAH uses are based on field experience and data provided by the raw polymer manufacturers.

LEAH有自己的研发部门，他们可以根据新材料的试验配方进行小规模的生产。

所有LEAH的材料都是这个试验过程和在实际中进行的磨损试验的产品，随后才在实际领域中使用。

LEAH所使用的试验配方都是基于来自于聚合物原材料制造厂的实际经验和数据而研发出来的。

### **Can LEAH Polymer Alloys be used for both lubricated and non lubricated applications?**

#### **LEAH聚合物材料能否同时用在有油润滑和无油润滑工况中？**

Some of LEAH's Polymer Alloys can be used in both lubricated and non-lubricated service, others however, should only be used in non-lubricated service. Applications are reviewed for material selection.

LEAH的一些聚合物材料可以同时用在有油润滑和无油润滑的工况中。而其他一些材料只能用在无油润滑工况中。选择材料前应该仔细研究工况的具体情况。

### **Should the packing ring materials be the same as the piston and rider ring materials in the same cylinder?**

#### **对于同一个气缸，填料环的材料是否应该同活塞环和支承环的相同？**

With the increasing demand to optimise the performance of reciprocating compressor cylinders in both lubricated and non-lubricated service, it is now more common to have different packing ring and piston seal materials.

随着优化往复式压缩机气缸在无油和有油工况下的运行性能的要求的增多，目前填料环的材料不同于活塞环和支承环的情况变得更普遍了。

### **What is the largest piston ring or rider ring that LEAH is able to produce in its polymer alloys?**

#### **用LEAH的聚合物材料生产的活塞环和支承环的直径最大能够达到多少？**

The largest polymer alloy piston and rider rings that LEAH has produced today are for a 1600mm diameter cylinder, however, our molding plant is capable of producing raw material that will enable considerably larger piston and rider rings to be manufactured if the demand arises.

目前，LEAH生产的聚合物材料的活塞环和支承环最大直径能达到1.6米。不过，当有需要时，LEAH生产原材料的成型工厂能够制造更大的活塞环和支承环。

### **How long should piston rings, rider rings and piston rod packings in LEAH Polymer Alloys last, before they are changed, under normal operating conditions?**

#### **在正常的运行工况下，LEAH聚合物材料的活塞环、支承环和填料环在更换前能够使用多长时间？**

When LEAH Polymer Alloys were introduced to the market in 1984, the target was to operate reliably for 8000 hours in all non-lubricated gas services, since then LEAH's material development has continued partly encouraged by demands from compressor operators to further increase the life to 16,000 and even 24,000 hours. Today, many users of LEAH Polymer Alloys are achieving 16,000 hours between planned maintenance overhauls and in some instances lives up to and in excess of 24,000 hours are being achieved.

当LEAH聚合物材料被引入市场的时候，它们的目标是在无油工况下可靠地运行8000小时。从那以后，受到压缩机用户需求的鼓励，LEAH的材料研发持续进行着，使得这些聚合物材料的寿命进一步增加到了16,000小时，甚至达到了24,000小时。目前，许多LEAH聚合物材料的用户在计划维修检查中获得了16,000小时的寿命，一些案例甚至达到或者超过了24,000小时，

### **Are LEAH Polymer Alloys abrasive?**

#### **LEAH聚合物材料是不是磨蚀性的材料？**

All LEAH polymers are essentially non-abrasive.

所有LEAH聚合物材料本质上都是非磨蚀性的。

### **Are LEAH Polymer Alloys used by compressor builders?**

#### **LEAH聚合物材料是否被压缩机制造商采用？**

Yes, initially LEAH Polymer Alloys were only used when the operators of reciprocating compressors specified them on their purchase orders for new compressors but today compressor builders are increasingly selecting LEAH Polymer Alloys because of the improved and consistent performance that they provide, significantly reducing warranty claims.

是的。最初，在往复式压缩机用户在他们的新机器采购合同中指定的时候，LEAH聚合物材料才被使用。但是现在压缩机制造商也开始选择LEAH聚合物材料了，因为它们能够提供优异的可靠的性能，明显的减少了质量投诉。

### **Can LEAH develop materials for specific applications?**

#### **LEAH能够研发针对特殊工况的材料么？**

Yes, and in a number of very difficult applications this has been done. However, because of the small volume of production, the components produced could be very expensive when compared to standard materials.

可以的。LEAH已经为很多非常困难的工况研发了新材料。不过，由于这些材料是小批量生产，它们的价格相比标准材料来说是非常昂贵的。

### **Can polymer alloys be used for stretch-on rider rings?**

#### **LEAH聚合物材料能否用来制造整环结构的支撑环？**

Yes some can, but because of the high temperatures involved and the complex handling equipment needed for large diameter pistons it is preferable that this work is carried out by LEAH in its manufacturing and service facilities. If the piston is of a multipiece design where the rider ring can be stretched directly into the groove without having to pass over the piston O.D. then it is possible, with guidance from LEAH, to fit stretch-on rings on site.

一些是可以的。因为对于大直径活塞需要高温加热和复杂的操作工具，这些工作最好由LEAH的专业人员使用制造和维修设备进行安装完成。如果活塞是分段式设计，这些支撑环可以直接安装到活塞环槽中，而不需要越过活塞的外表面，可以在LEAH的指导下把整环结构的支撑环安装到位。

### **What is the smallest piston ring that LEAH can produce in its polymer alloys?**

#### **用LEAH聚合物材料制造的活塞环最小直径是多少？**

The smallest piston ring LEAH has produced in one of its polymer alloys is 10mm (0.394") diameter.

用LEAH其中一种聚合物材料制造的活塞环的最小直径为10mm（0.394”）。

## **Are LEAH Polymer Alloys always compatible with the full range of gases used in refining and petrochemical plants?**

### **LEAH的聚合物材料是否一直适用于石油化工厂的所有气体？**

Apart from some very unusual gases LEAH Polymer Alloys are chemically compatible with the full range of gases used in refining and petrochemical plants.

除了一些非常罕见的气体，LEAH的聚合物材料可以适用于炼油化工厂的所有气体。

## **Is the application of LEAH Polymer Alloys covered by API 618?**

### **LEAH聚合物材料的应用是否被API 618提及？**

No, the API 618 design guide only addresses the use of filled PTFE seals.

没有，API 618设计指南中仅仅提及了填充聚四氟乙烯的使用。

## **Are there any applications where LEAH Polymer Alloys cannot be used?**

### **LEAH聚合物材料在哪一些工况下不能使用？**

The only gas that LEAH Polymer Alloys cannot be used in is the compression of dry oxygen and for this application LEAH has a number of filled PTFE materials that are certified by all the major air separation companies for use in oxygen compressors.

唯一不能使用LEAH聚合物材料的气体是极干性压缩氧气。在这种工况下，LEAH有许多种填充聚四氟乙烯材料可用在氧气压缩机中，这些材料经过了主要空分公司的认证。

## **Do the wear tests that LEAH conduct in its R&D department mirror those experienced in the field?**

### **LEAH研究发展部门进行的磨损试验是否反映出从这个领域获得的经验？**

Interpretation of data obtained on a controlled rapid wear test machine requires many years of test data for comparison.

LEAH has more than 30 years of comparison test data and we can say that the wear test results obtained in our R&D department are generally similar to those experienced in the field.

从一个受控的快速磨损试验得到的数据表明，需要多年的试验数据来进行比较。

LEAH拥有超过三十年的比较试验数据，我们可以说我们研究发展部门获得的磨损试验数据和在这个领域获得的经验是相似的。

## **Is LEAH continuing to develop new materials and are new materials really necessary?**

### **LEAH是否在继续研发新材料？真的有必要研发新材料吗？**

Yes, in order to continue to improve the reliability of reciprocating compressors where the life expectancy of these types of components is increased.

是的，这是为了通过增加这些类型的部件的寿命预期，从而继续提高往复式压缩机的可靠性。

## **What are LEAH Polymer Alloys made of?**

### **LEAH聚合物材料是由什么组成的？**

All LEAH materials are proprietary formulations and details of their make up is not disclosed to any customers or consultants.

所有LEAH的材料是内部机密配方，它们组成成分的详细资料不对客户或者咨询者公开。