

钻探过程中的泄漏有时会造成很大的经济损失  
Downhole leaks can be costly

# 压力活性密封剂

## Pressure-activated sealants

压力活性密封剂，作为一种消除钻井井下泄漏现象的方法而被日渐广泛使用

**Pressure-activated sealants are finding increasing use as a method for curing downhole leaks**

**传** 统的处理井下泄漏的方法需要高昂的维修作业费用。如今，新开发出来的技术解决方案能够避免这种高昂的费用。

该技术采用了一种具有压力活性的液压液体添加剂，它可以在接触到泄漏点时，聚合成为一种具有柔韧性的固体。这种密封剂的独特之处在于，泄漏点持续的压力下降会使这种原为液体的密封剂聚合成一种柔韧的固体密封材料。该密封剂一般情况下会保持为液态，直到处于有压力差的环境中，才会向固态转化。

只有在产生压力差的那一点上，该密封剂才会发生反应，所以，只有发生泄漏的地方会被密封住。其它任何多余的密封剂并不发生反应，仍为液态，因此不会阻塞液压系统或其它设备。这

The conventional method for repairing downhole leaks involves expensive workover operations. A novel solution that avoids this requirement has now been developed.

The technique involves using a pressure-activated hydraulic fluid additive that polymerises into a flexible solid upon contact with the leak site. The sealants are unique in that a sustained pressure drop through a leak site causes the sealant fluid to polymerise into a flexible solid seal. The sealant remains fluid until exposed to a pressure differential.

Only at the point of differential pressure will the sealant reaction occur so only the leak is sealed. Any excess sealant remains inert, in a liquid form, and will not clog the hydraulic system or other equipment. The environmentally-approved sealant can be left in the system indefinitely or flushed out.

The monomers and polymers in the sealant solution are crosslinked by the polymerising chemicals. As the reaction proceeds, the polymerised sealant plates out on the edges of the leak site and simultaneously links across the leak site to seal the leak. The resulting seal is a flexible bond across the leak. The

rest of the sealant remains fluid and will not plug or damage any of the well components.

Because the sealant does not harden except in the presence of sufficient differential pressure to start the polymerisation process, concerns about the time to deliver the sealant, the temperature of the well (below 260°C), and the ambient pressure in the well have been eliminated. Sealant repair operations have been successfully performed to hold differential pressure in excess of 17,000 psi.

Recently, after extensive testing on an actual riser stack assembly to a maximum allowable working pressure of 15,000 psi, the developer of the sealant, Seal-Tite, was contacted to diagnose and repair a leaking drilling riser choke line in 5,795 feet water depth in the Gulf of Mexico.

The leak was identified as a connection at 4,275 feet by using dye and remotely-operated vehicle inspection. The leak rate was 8.5 gallons per minute at 2,000 psi injection pressure. The high leak rate was further aggravated by loop currents exceeding 2.6 knots.

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密封剂处于液态  
The sealant in liquid form

种“环保型”密封剂既可以随意留在系统之内，也可以加以冲洗清除。

这种密封剂中的单体和聚合物在有聚合性的化学物质的作用下交联。在反应的进程中，聚合的密封剂板结在泄漏点的边缘，同时在泄漏点处交联，密封住了泄漏点。最后形成的密封物质是一种盖在泄漏处的，具有韧性的联结物。剩余的密封剂仍保持为液态，不会堵塞或损害任何井的构件。

由于该密封剂只有在有足够压力差的条件下才会开始聚合过程而硬结，对于密封剂的注入时间、井内温度（260摄氏度以下）以及井内的环境压力等因素的担心都可以被消除。这种密封剂在压力差超过17000psi的条件下仍能成功地进行维修实施。

最近，经过在最大允许工作压力为15000psi的实际抽油管线中进行了广泛的测试，该密封剂的开发商——Seal-Tite公司在墨西哥湾5,795英尺深的水下，对一处发生泄漏的抽油钻井节流管线进行了实地诊断和修补。

通过染色法及遥控车的检查，确认该泄漏点位于4,275英尺深处水下的一个连接处。在注入压力为2000psi时其泄漏速度为每分钟8.5加仑。当海洋环流速度超过2.6节时，泄漏速度还会进一步恶化加重。

在节流管的循环作用下，2.5bbl的密封剂随同海水被注入到发生泄漏的连接处，并经过压井将其回收。一旦到位，防爆交换阀

就被关闭，密封剂就被挤入到发生泄漏的连接点封口处。在随后的12小时，密封剂承受的“喷出压力”逐渐上升，直至8000psi，密封就得以实现了。如此的压力再保持8个小时，使密封剂完全稳定，在此期间，将没有检测到压力下降的情况。然后，密封剂就从系统中被清除出来，节流管线的压力测定为7500psi，这样就可以恢复正常的钻井作业。

对泄漏完成了修补，客户就可以在以后的30日内完成钻井作业，再没有因抽油管发生泄漏问题而停工。钻井作业期间，节流管线每三日的压力测量值均为7500psi，且没有发现任何泄漏现象。

一旦钻井作业中止，抽油管就从发生泄漏的节流管线的连接点处被拔出，发生损坏的密封口在接受检查后就被取下接受检查。

Seal-Tite公司最初致力于修补控制管线的液压系统以及水上控制的水下安全阀液压系统的泄漏，现今公司已扩展业务，在超过1,300次的作业中，对多种类型的泄漏进行了成功的修补。

## 对泄漏完成了修补，客户就可以在以后的30日内完成钻井作业，再没有因抽油管发生泄漏问题而停工



在节流管线的连接处可能会发生泄漏  
Leaks can occur at choke line connections





## The leak was repaired and the client was able to complete drilling operations over the next 30 days with no further riser-related downtime

A 2.5 bbl sealant pill was displaced to the leaking connection with seawater by circulating down the choke line and taking returns on the kill line. Once in position the blowout preventor crossover valve was closed and sealant was squeezed into the leaking seals. Over the next 12 hours the sealant injection pressure was steadily increased until an 8,000 psi seal was achieved. This pressure was held for eight hours to allow the sealant to cure, during which no pressure bleedoff was observed. The sealant was then flushed from the system and the choke line tested to 7,500 psi, allowing normal drilling operations to resume.

The leak was repaired and the client was able to complete drilling operations over the next 30 days with no further riser-related downtime. The choke line riser was successfully tested to 7,500 psi every three days for the duration of the drilling operation with no leaks observed.

Once the well had been suspended, the riser was pulled to the leaking choke line connection and the damaged seals removed for inspection.

Originally developed to seal leaks in the hydraulic systems of control lines and surface-controlled subsurface safety valves, Seal-Tite's technology has expanded to fix many types of leak in over 1,300 operations. ■



节流管线密封口的损坏会导致泄漏  
Damage to choke line seals creates leaks

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