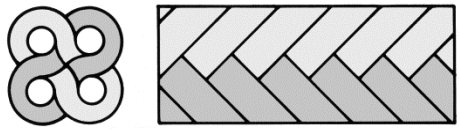
1.Product Description

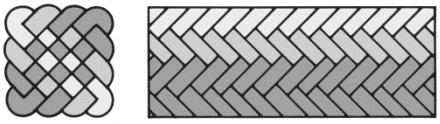
Braiding Technology Revolution

Braided packing technology started over 100 years ago when loose, twisted fibers were replaced by the first generation of braiding machines that make round braid. Round braid was primarily used to make rope and had many drawbacks for packing applications in valves and pumps due to the limited surface area. This changed with the invention of the square braiding machine, which allowed packing to have a more defined rectangular shape and increased its sealing capability. This was a major change in braided sealing technology and was widely adopted. The major drawback of square braiding was the limited number of bobbins (strands) used in the machine, creating a braid that had large gaps between the thick fibers that would allow solids to imbed into the packing and cause shaft wear. This would also significantly reduce sealablity. The large fibers would also flex when going into the stuffing box, becoming less dense and resulting in more consolidation.



Square braid construction

The next revolution in braiding technology came around 50 years ago with the invention of the “interbraid” braiding machine (also called a lattice braid). This new technology used more bobbins and created a more interlocking construction. The increase in bobbins allowed the braid to use smaller diameter yarns that resulted in smaller gaps between the packing. This made the packing denser and more flexible then the square braid construction. This was revolutionary and dramatically changed both valve and pump sealing. The only drawback of interbraid construction is that the manufacturing process requires a higher strength yarn. Most exfoliated graphite packings still need to be square braided because of this reason.



Interbraid construction

Since the invention of the interbraid machine, change in pump packing has been driven by new yarns. The fibers used in packing today use the latest in technology that allows pump and valve packing to seal the harshest of applications by using materials that have great sealing ability and strength. This new fiber technology combined with other

technologies such as the SpiralTrac has dramatically increased mean time between repair. But one issue that still remains is the ability to get benefits of multiple yarns in one application. Every yarn has its strengths and weaknesses and packing manufacturers have to settle with one fiber over the other, or in combinations dictated by the braid construction, such as corner reinforcement.

Chesterton has created a new packing construction type that is far different than ever seen before – DualPac™ technology. It is a process where two different types of yarns are braided together side by side. This results in a product that can combine features of the different yarns on the same piece of packing in a unique way. The first packing to utilize this technology is Chesterton 2211, which combines the strength of para-aramid and the conformability of expanded PTFE. Not only can the rings be rotated to result in different orientations for different performance, but it also creates a better sealing packing that needs fewer adjustments.

A main failure mode of Pump packing is when many adjustments have been made to the packing and the gland "bottoms out" against the stuffing box, at which point no more load can be applied to create a seal. This product changes that dynamic by using Chesterton 1740 yarn on the OD of the stuffing box to create a more dense packing that then "squeezes" the softer, more conformable graphite filled ePTFE. This creates longer-lasting sealing against the shaft by maintaining load with fewer gland adjustments. This packing also creates less shaft wear by removing para-aramid from the shaft. This addresses the major failure mode of packing, bottomed out glands that hen require repacking. DualPac 2211 seals longer by using the two materials' different properties to provide a longer, lower leakage packing life.

2.Slurry Pump Packing Market

In the slurry industry there are many applications where packing is still the main sealing device in rotating equipment. This is because of many factors, but one of the largest is the cost of mechanical seals for this type of service and pump condition. The pumps are frequently in poor condition because of the harsh service, resulting in worn bearings and a large amount of shaft movement. These conditions limit the life of mechanical seals, which combined with the large size of many slurry pumps results in very high costs.

The biggest area of concern in slurry pumping is downtime – time is money in slurry applications, including the mining industry. Bringing down a pump to repack takes time

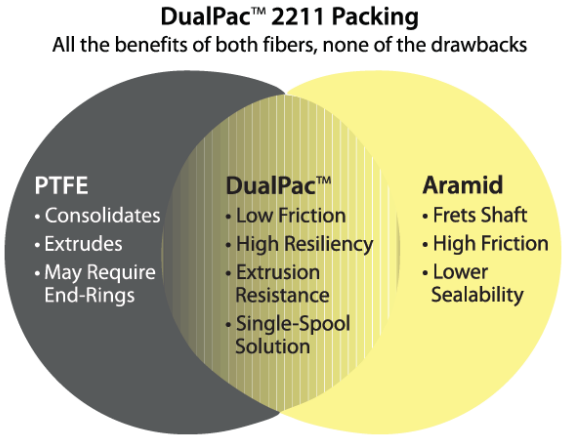
away from moving product and making money. In many systems the process stops when the pump is taken offline to repack.

One common packing set used in these severe slurries is a combination set using rings of different packing styles. An example of this is using end rings of para-aramid on the top and bottom (sometime called a bull ring) and softer PTFE type yarns in the middle. The problem that comes with combination sets of packing is less gland load transfer to the bottom of the box because of the difference in yarn properties, resulting in shaft wear. A common failure mode is people putting the wrong packing material in the wrong place, or more commonly, only using one packing throughout the stuffing box. Having a 5 ring set of a para-aramid packing is so destructive to the pump that it is not uncommon to have to replace sleeves after only a few days. This is a costly replacement in time and resources. The sleeve wear can be so bad that shafts have been cut in half by the extremely high-strength packing. Para-aramids, the same material bullet proof vests are made of, are excellent at resisting tearing from the rough solids in the slurry, but are also so strong that under gland load it can eat the shaft like a grinding wheel.

3.Features and Benefits

The 2211 product combines the strength of the para-aramid fiber with the sealability of ePTFE – A polymer that has tight bonds that create a very effective, low friction seal. The para-aramid fiber also has high extrusion resistance and extremely high resiliency to create a seal with little need for gland adjustments.

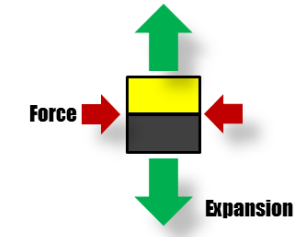
Taking these two products together is putting the best of both worlds into one packing.

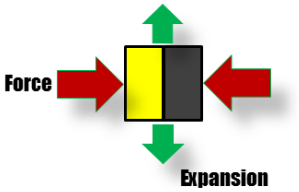


PTFE has a few downsides that revolve around the material's lack of strength – it has a tendency to extrude through gaps at the top of the gland and through the bottom of the stuffing box. It also has a higher tendency to consolidate than para-aramid fibers, taking valuable gland adjustments to keep gland load high enough to control leakage.

Most leakage comes from the ID in a packed pump because of the dynamic surfaces mating and misalignment of the shaft. PTFE's conformability and low friction make it a much better sealing material in these conditions than the para-aramid.

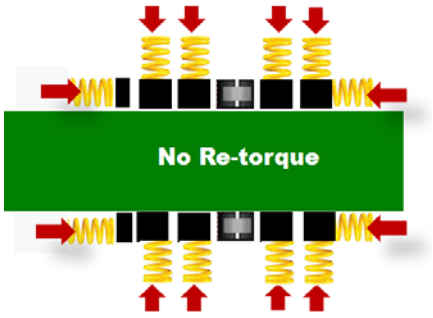
A key benefit of DualPac™ construction is that the packing ring responds differently to gland pressure depending on its orientation. When the ring is oriented for sealing, with the para-aramid on the OD of the stuffing box and the PTFE against the shaft, it expands easily under gland pressure. This allows the PTFE to create an effective seal. The para-aramid's resilience is also pressing down on the PTFE, maintaining load and extending the time required between adjustments and life of the packing.





When the rings are flipped to place the aramid against the top or bottom of the stuffing box, they do not expand easily under gland load. This prevents the para-aramid material from pressing hard against the shaft, wearing it. This is a major difference between any other packing on the market.

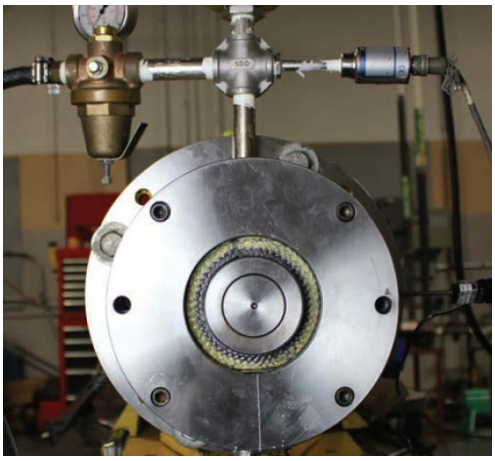
The end result of the way DualPac 2211 responds to gland pressure in different orientations and the unique way the two materials are combined is consistent sealing force against the shaft, comparable to "internal live loading". Both lab and field testing has shown DualPac 2211 to resist consolidation and require far fewer gland adjustments.



Internal Live Loading

When considering the total life-cycle cost of packing, one area that is often overlooked is the cost of power. Power is the largest cost over life of the pump, including acquisition costs. When looking at power costs, one major factor is packing friction – the frictional forces against the shaft and packing ID. Aramid fiber has a much higher coefficient of friction then ePTFE. This results in a major difference in power consumption. In comparative testing, a 3X improvement in power usage that results in reductions in overall cost of ownership. This coupled with lower repair costs from reduced shaft wear drastically lowers the life cycle cost associated with DualPac 2211 as compared to other packings.

4. Technical Data



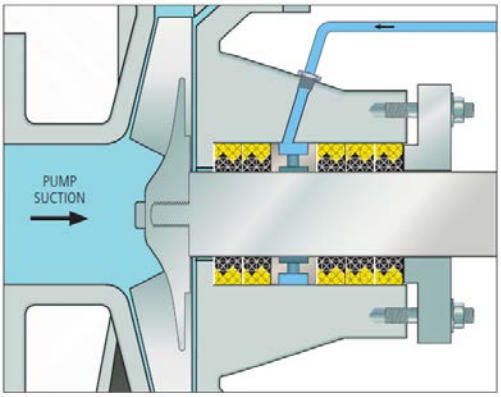
DualPac™ 2211 has been tested to FSA/ESA pump standards in the Chesterton state of the art testing facility. All new products are tested in real-world pump rigs that test the limits of the product. 2211 was also tested against common competitors the product might be compared with to see the vast differences in performance.

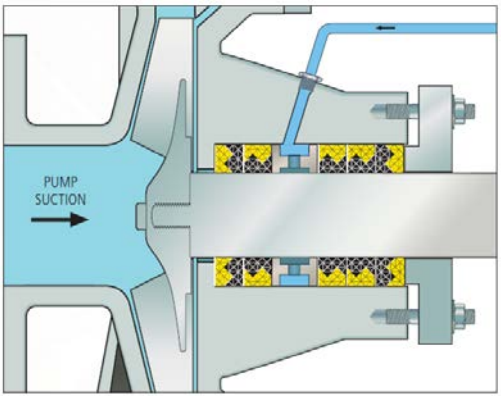
The packing product limits are the following:

Technical Parameters

Speed	10 m/s (2000 fpm)
Temperature	260°C (500°F)
Pressure	20 barg (300 psi)
pH	4-11

Installation Method





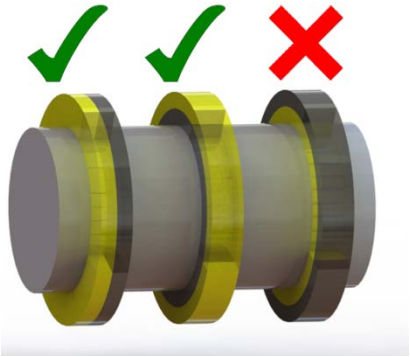
There are two main installation configurations for 2211 based on the application and condition of the pump.

All Sealing Set: The first set is used with smaller particle size and less aggressive slurries and with pumps with tight clearances at the bottom and top of the stuffing box. This set is oriented so that the PTFE material is installed against the shaft and the aramid is against the outer stuffing box for all rings. This configuration is also used in combination with a SpiralTrac to create the ultimate solution when sealing slurries. This configuration will also result in the least amount of shaft wear and power consumption.

Extrusion and abrasion resistance set: This second set uses the ability of 2211 to be inserted into the stuffing box in multiple orientations to place the stronger para-aramid against the bottom and top of the stuffing box. This is used in the bottom of the box to act like a “bull ring” that will keep the heaver solids out of the stuffing box if in an arrangement without a SpiralTrac. The end ring at the top is for

excessive extrusion due to worn gland tolerances. In this case a big benefit of this configuration is that you only need a single spool of packing to provide both end and sealing rings: This saves time during installation, as well as locating and inventorying packing. Another benefit of this set compared to other combination sets is only half a cross-section of aramid is used for extrusion resistance, resulting in much less shaft wear and friction then a full aramid ring.

As needed extrusion protection: In some cases, pumps might only need the extrusion resistance only on one end of the pump; for example a pump might have no clearance issue in the bottom of the box (or when using a SpiralTrac), but have poor gland follower tolerances and can see excessive extrusion at the top ring. Here is where using one “flipped” ring at the top will help fight the extrusion issue at the top but still give you the rest of the set in “sealing” position.

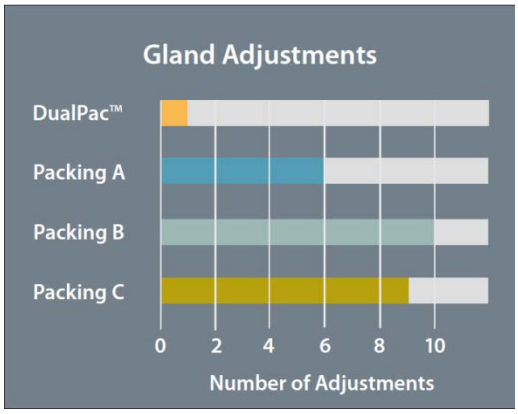


braiding style keeps the perpendicular forces against the shaft longer, resulting in longer leakage control without adjustments and with less shaft wear.

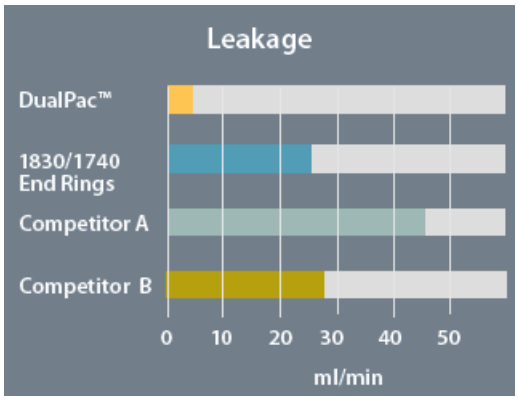
There is another type of combination packing where ePTFE is wrapped and folded over aramid on the bobbin. This product is still linked to all the same drawbacks as the original, but with some slight improvements in shaft wear. But when compared with 2211, it is dramatically out-performed.

2211 is a new technology and offers major benefits to customers. One of the best way to illustrate that difference is in laboratory testing. Chesterton conducted testing of DualPac™ against 3 other competing sets: 1) Standard AW Chesterton 1830/1740 combo set (Two rings of 1830 in the middle of two end rings of 1740), 2) Competitor A (Typical bumblebee material - corner reinforced), and 3) Competitor B (ePTFE-wrapped para-aramid material).

Gland Adjustments: The data demonstrated why customers will be able to save valuable time by not having to babysit the packing while it is in service. DualPac 221 showed a 9-10X improvement over both competitors, resulting in a significant amount of time saved. This will correlate to more time before the gland will bottom out and need replacement – making it a longer lasting set. Even compared to AW Chesterton combination set, 2211 showed a 6X benefit with only one spool needed.



Leakage: Besides needing drastically fewer adjustments, DualPac showed dramatically less leakage. Less leakage results in less housekeeping issues and longer sleeve life. This type of leak control is similar to or better than typical ePTFE packings, and better than typical slurry sets with para-aramids that trade sealing ability for extrusion and abrasion resistance. With DualPac 2211, you get the benefits of both without the downsides.



Power Consumption: The largest cost associated with a pumping system is power. Many studies have been done around LCC (life cycle costs), and have shown that the power costs are even larger then acquisition and repair combined. This cost of ownership can be directly related to the packing friction by looking at the power the pump motor drew during the testing. In the testing results, the result in overall power consumption was dramatic – a 2-3X savings while running the packing in the same pump for the same duration. This results in pocketed savings for the customer, coupled with longer running time and less leakage, making for a revolution in slurry sealing.