Compression packing: from natural fibers to hybrid composites

Control of fluid loss is essential to the successful operation of mechanical equipment used in fluid handling. Various sealing methods are utilized to control leakage at shafts, rods, or valve stems and other functional parts of equipment requiring containment of liquids or gases. The oldest and still most common of these sealing devices is compression packing.

By Manuel Seyrl

Compression packing finds its major use in the process industries such as petrochemical, paper and steel mills, and in the service industries like utilities, marine, water, sewage, food and nuclear.
They seal all types of fluids including water, steam, acids, caustics, solvents, gases, oil, gasoline, and other chemicals over a broad range of temperature and pressure conditions. They are used in centrifugal, rotary, and reciprocating pumps, valves, expansion joints, soot blowers, and many other types of mechanical equipment.
The variety of challenges and applications of compression packing also requires a wide range of suitable yarn materials. Natural fiber yarns such as flax, jute, ramie and cotton are the oldest but still used as raw materials for compression packing for basic water pump and valve applications. The main advantage is their low price in comparison to the synthetic fibers. Their chief disadvantages are their poor chemical and heat resistance. They have very poor resistance to acids but are generally resistant to alkalis.

Wide temperature tolerance

The biggest and most different raw material group used for packings, however, is synthetic or man-made-fiber. With this material collective, most of the applications in the process industry can be covered. These fibers can handle a pH range from 0-14, temperature resistance from -200°C up to 450°C and are still performing in abrasive media, as well as low friction applications. Well known materials are PTFE (Polytetraflourethylen), Novoloid, Aramid, polyimide, glass and carbon fibers. Packings made from PTFE (polytetrafluoroethylene) are a mainstay of the mechanical compression packing industry. PTFE is well known for its outstanding resistance to chemical attack, low coefficient of friction and wide temperature tolerance including cryogenic service. This wide flexibility makes PTFE packings a popular choice for those difficult applications where strong solvents, corrosive chemicals and oxidizing media require to be sealed.

Superior thermal resistance

Novoloid fibers are non-melting phenolic fibers with good resistance to chemicals including acids, bases, bleaches, solvents, oils, hot water and steam. The pH range for Novoloid fibers is 1-13. The fibers do not soften or shrink when heated and withstand temperatures above 250°C.
Polyimide fibers are dry spun from an aromatic polyimide. They possess excellent thermostability up to 260°C and good resistance to chemicals.
As with other textiles, PI fibers offer superior dimensional stability and extrusion resistance combined with minimal shaft wear. They are often blended with PTFE fibers and dispersions in compression packings to enhance performance.
Glass fibers have superior thermal resistance properties, dimensional stability, and tensile strength. They resist most chemicals and can be formulated to resist strong acids. Glass fibers are available in continuous filament yarn, staple fiber yarn, textured yarn, chopped strand and mats.

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Ideal steam valve packing

All fiber-based carbon yarns used in compression packings are made by a series of heat-treatments of some type of organic or synthetic precursor. Carbon yarns for compression packings are available with carbon contents ranging from roughly 63 to 99 percent+, depending on the precursor, the method of heat treatment and the time-at-temperature used in the manufacturing. Flexible graphite tape is manufactured by exfoliating, expanding, and then compressing natural graphite flakes to a specific density. Flexible graphite tape may be layered with adhesive and reinforcing fibers, such as cotton, glass, stainless steel, or carbon. It can be converted into a yarn, which can be braided into packings. Graphite tape packings have a low coefficient of friction a pH range of 0-14 and are noted for their excellent thermal properties, enabling them to be used in applications up to 2500°C in non-oxidizing atmospheres. Due to their temperature resistance and density, they make ideal steam valve packings.

Hybrid composite yarn

Of course, there are some applications where not only one material type can be used. In such cases the benefits of two different yarns are combined. Here the packing industry developed a wide range of hybrid or composite yarns and fibers. Hybrid composite yarn may be defined as an assemblage of high-performance fibers and / or filaments formed into continuous strands. This can be done using standard yarn processing techniques, such as fiber blending, core spinning, and twisting. A variety of yarns are used in packings and gasket products. Braided packings and twisted ropes are constructed by combination of properties generally unattainable in individual filament yarns. There are well known blends of PTFE with Aramid and Aramid with glass. Especially for fugitive emission service in high-temperature valves, a hybrid yarn made from graphite tape with an over knit of Inconel wire has been developed. Packings made from this yarn with additional graphite impregnation have a very low weight loss at elevated temperatures. The wire over knit reduces gap extrusion and has a good pressure resistance. These factures ensure low gland pressure losses and a prolonged low leakage performance. Above mentioned combinations are just a small example of the possible yarn and packing constructions currently used in the industry.