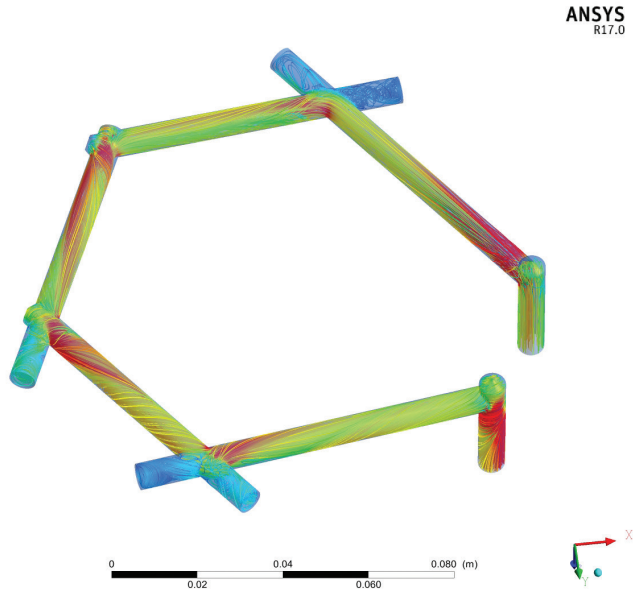


COOLED PACKING CASES: WHERE TURBULENCE IS AN ADVANTAGE

BY GAVON MANESH AND KRISTA BETTS

Computational Fluid Dynamics
(CFD) Model Of Turbulent Flow
In A Vortex Cooling Cup

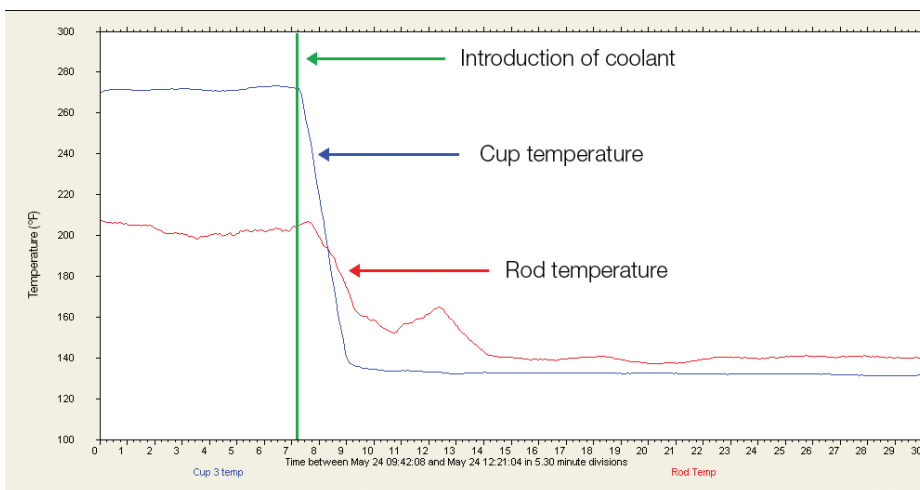
Velocity
Streamline 1
7.000e+000
5.250e+000
3.500e+000
1.750e+000
0.000e+000
[m s⁻¹]



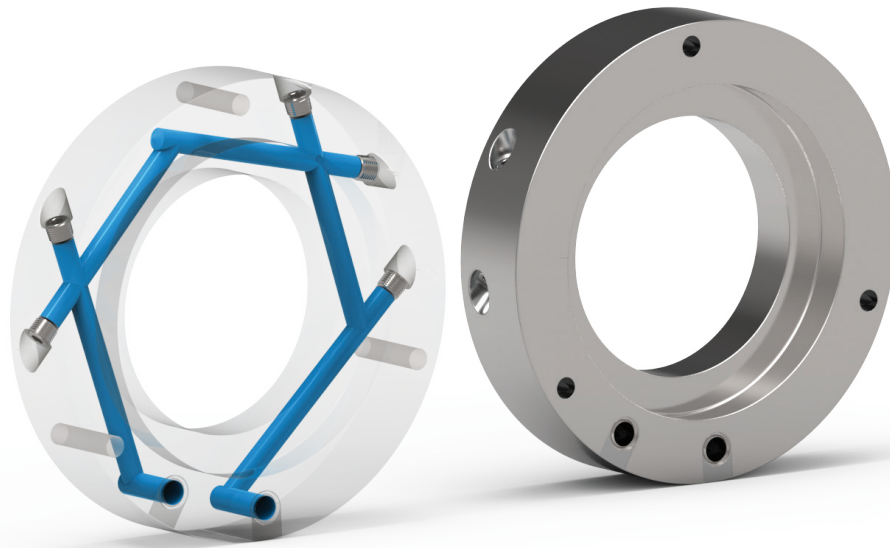
Increased demands on equipment in the energy industry has become a common subject, but that makes it no less true. For reciprocating compressors, high pressures and high speeds, as required for refining or enhanced oil recovery processes, for example, are becoming the norm, and original equipment manufacturers (OEMs) are increas-

ingly building to American Petroleum Institute (API) limits on piston rod linear speeds.

These high pressures and speeds threaten the structural integrity, sealing performance and longevity of compressor packing cases – risks that can be mitigated with the use of cooled packing cases. API 618, now in its 5th edi-



Rod And Packing Cup Temperatures At 1200 rpm And 1750 psi (120 bar) Discharge Pressure Before And After The Introduction Of Coolant Into A Vortex Cooling Packing Case



Single-Piece Vortex Cooling Cup Design And (At Left) A Transparent View Of The Cup Showing The Tangential Channels

tion, requires a cooling system for lubricated cases with non-metallic rings that have a maximum allowable working pressure (MAWP) above 500 psi (35 bar), lubricated cases with any ring material that have a MAWP above 1500 psi (103 bar), and all non-lubricated cases, regardless of pressure.¹ Beyond the API requirement, cooled packing cases are proven to reduce rod temperatures as well as packing case temperatures, extending component life and improving sealing.

While the preponderance of compressors requiring cooled packing cases is a relatively recent phenomenon, one of the leading cooling system solutions is celebrating close to 20 years on the market.

MORE THAN TANGENTIAL BENEFITS

Vortex Cooling packing cases, from Cook Compression, feature industry-exclusive tangential coolant channels to provide highly effective cooling in an API-compliant design. The tangential channels create a single flow path for the coolant. The entire volume of coolant passes through a continuous path from inlet to outlet, maximizing coolant flow velocity throughout the path. This high flow velocity, aided by the channel geometry, creates turbulence for superior heat removal.

Traditional cooled packing case configurations, including press-fit and plate-and-channel designs, use a closed loop path that creates parallel coolant flow. From the inlet, the coolant in each cup follows two separate paths to the outlet, which reduces the flow velocity and decreases the heat removal efficiency. Vortex Cooling technology, with its continuous flow, has achieved up to 30% greater efficiency as compared to a standard plate-and-channel design.

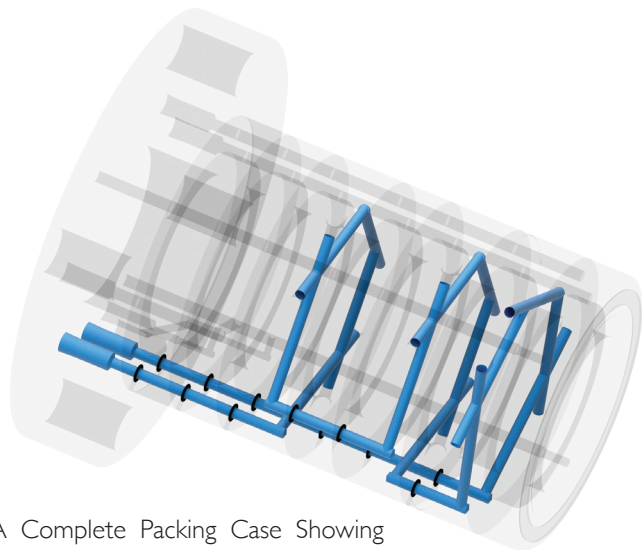
The Vortex Cooling design also introduced single-piece construction for water-cooled cases, reducing the chance of leakage. Press-fit cups are vulnerable to damage during assembly, at the O-rings used to seal the coolant channel at the interface of the two cups. Plate-and-channel cups

comprise two pieces as well, a plate and a cup, joined and sealed with two rod-encircling O-rings. Again, the O-rings create potential for failure. Even without O-ring failure, these two-piece designs present potential gas-to-coolant leak paths, particularly at high pressures, where the two pieces are joined. Admission of gas can damage the cooling system and allow the escape of potentially hazardous gas from the compressor.

In contrast, the single-piece cup of the Vortex Cooling design eliminates potential failure points and has a natural leakage path that flows outward into the box bore and the distance piece, preventing fugitive emissions. Two further benefits of the single-piece construction are API 618 compliance and easier maintenance. API 618 stipulates that with liquid-cooled packing cases, “O-rings that encircle the piston rod are not allowed.” The drilled coolant paths of the Vortex Cooling design require no rod-encircling O-rings.

When it comes to maintenance, the design reduces the amount of work required to recondition a packing case. Plate-and-channel cups have twice the number of surfaces to clean, grind, and lap, and more significantly, the O-ring grooves must be maintained precisely at the proper depth and size to prevent leakage. Press-fit cups can receive only limited maintenance: O-rings cannot be replaced, and the coolant channel cannot be accessed for cleaning.

In Vortex Cooling packing cases, the O-rings and associated maintenance have been eliminated, and the drilled coolant channels are straight, with exterior ports that make removal of buildup easy. While the high velocity of the coolant flow makes the case less susceptible to debris buildup, even the hardest deposits can be quickly removed with a hand drill. Where maintenance teams prefer to recondition packing cases on the rod, the exterior ports and elimination of O-rings makes that possible as well.



A Complete Packing Case Showing The Typical Use Of Multiple Vortex Cooling Cups In Series

EFFICIENT FOR DESIGN OR RETROFIT

Long used by OEMs, Vortex Cooling packing cases can be retrofit to just about any reciprocating compressor. The cooling efficiency and ease of maintenance of the packing case are frequent motivations to make the change, since it is reliable in preventing leakage.

In a non-lube conversion of a high-speed (5-m/s), high-pressure (1450-psi [100-bar]) compressor at a petrochemical plant in Russia, the cooling efficiency of the tangential coolant channel design helped maintain rod temperatures at roughly 122°F (50°C).

As part of a complete packing upgrade to reduce emissions, a global energy company is standardizing to Vortex Cooling packing cases across three of its European refineries. At the first refinery to pursue the upgrade, poor water quality was corroding water channels in the original plate-and-channel cups. The plates became so badly corroded that the lapped faces and O-ring seals failed, allowing gas to enter the water passages. This not only created emissions problems but pressurized the water system and resulted in overheating of the packing assembly. Catastrophic damage could have occurred had cooling water entered the cylinder gas compression chambers.

The sealing effectiveness of the Vortex Cooling design, backed by its efficiency, resulted in a plan for systematic upgrade of all water cooling components, in replacement and reconditioned packing cases, across all compressor types on-site, and then across an additional two sites.

In each application, years of successful experience is combined with geometry, heat transfer equations, and other proprietary guidelines to specify flow and coolant mixture for the given pressure range. Typically, several Vortex Cooling cups are used in series to provide optimum cooling performance.

COMPLETE PACKING

As cooled packing cases come ever more into demand, and face increased demands, reciprocating compressor designers and operators must evaluate packing case efficiency and lifecycle as part of the plant's overall productivity. The complete package will offer efficient heat transfer, ease of maintenance, elimination of failure points, and extended component life. 

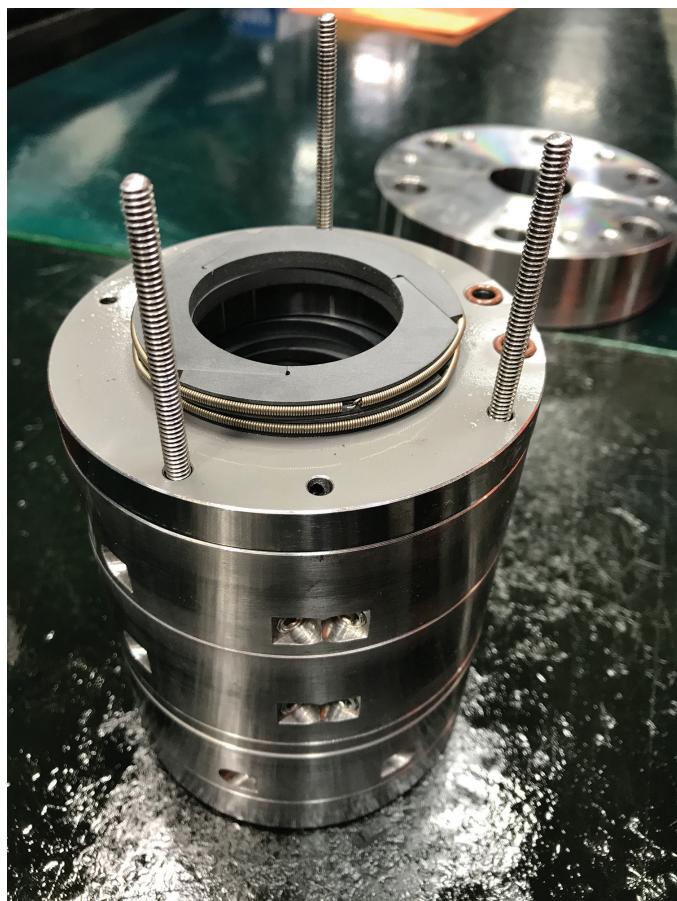
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'API Std 618 (R2016), "Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services," 5th ed., Includes Errata 1 and 2 (2009 and 2010) (Washington, DC: American Petroleum Institute, 2016)."



Vortex Cooling Packing Case Mid-Assembly