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Reducing Reciprocating Compressor
Emissions through Engineered Revamps

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**Burckhardt
Compression**

Wednesday October 25, 2023

DOW Centennial Centre - Fort Saskatchewan

Emission Management Solutions
Reducing rod packing leakage



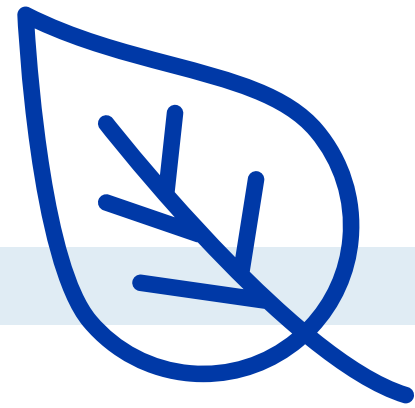
**NET
ZERO**

Fugitive emissions contribute to climate change

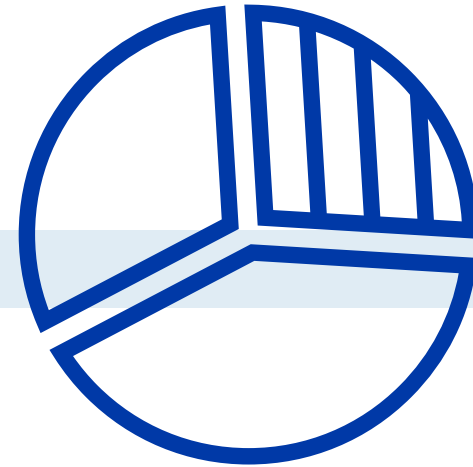
Burckhardt Compression specializes in providing advanced solutions that enhance the sealing of reciprocating compressors and tackle the issue of gas loss.

With our leading technology and expertise, we effectively reduce fugitive emissions from occurring at the rod. By implementing our solutions, you can significantly improve your operations, minimize environmental impact and contribute to the fight against climate change.

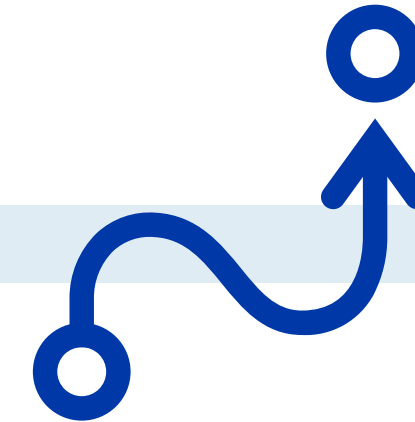
Emission Management Solutions Key Focus Areas



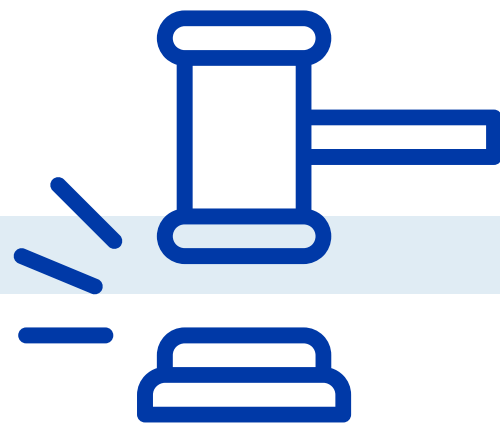
Improved rod packing for reduced emissions



Safer operations



Supporting the journey to “zero emissions”



Compliance with strictest regulations



Avoid environmental penalties



Optimize profit opportunities

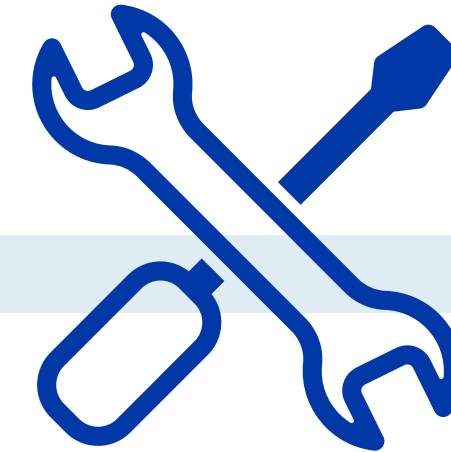
Emission Management Solutions Key Focus Areas



Local support via our global network



Improving compressor reliability



Reducing maintenance costs



Available now – easy to implement



Improve safety and minimize health risks



Supporting sustainability goals

Factors for consideration in Sealing system designs

Sealing system designs have evolved significantly in the past decade. when designing a new sealing system many factors need to be considered.

- Gas composition (Including possible impurities or particles)
- Gas conditions (Pressures, Temperatures, moisture, etc.)
- Reactivity of process gas to sealing materials
- Geometry and weights of piston and rod assemblies
- Compressor speed and stroke
- Lubricated or dry running
- Counter surface conditions (piston rod and liner surface finish)
- Liquid cooling availability
- Buffer and/or purge gas availability and reactions with process gas
- Number of connection ports in distance piece

Sealing Materials

Sealing systems in Reciprocating compressors typically are made from plastic blends. Other materials like bronze, brass, and cast iron can also be used.

Plastics commonly used in sealing systems are PTFE (Teflon®), Peek, molybdenum disulphide, and PPS. These materials are sometime blended with fillers like glass, graphite, carbon, to add strength and lubricity.

Gas composition and gas conditions commonly dictate the material selections.

This is why it is critical to use the most current operating conditions for sealing system retrofitting revamps



Sealing Materials

The next critical part of a sealing system retrofit revamp is the Geometry of the packing cases, piston rods, and cylinders. This combined with the speed and stroke of the compressor will help determine which designs are applicable for the most efficient solution.

Best practice is to physically measure the components that are to be used for sealing system retrofitting revamps.

Using old unverified drawings can lead to mistakes that can delay the project.



Lubricated vs. Dry running cylinders

Dry running compression comes with many environmental and operational benefits.

Operational benefits:

- No cylinder lube systems
- No post oil demisters
- Easier cleaning during maintenance

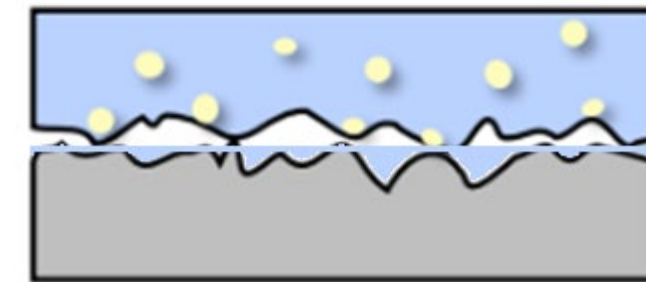
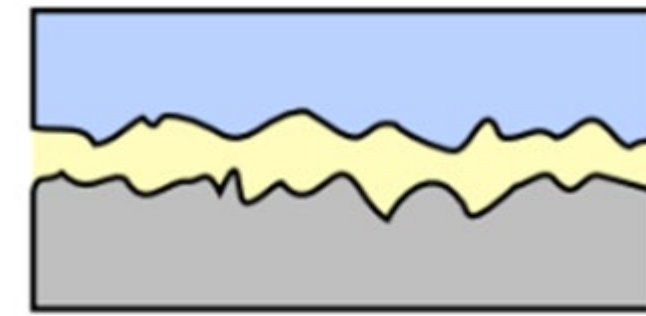
Environmental benefits:

- No cylinder oil required
- Less waste during maintenance for cleaning solvents

Depending on gas conditions, piston weight, geometry, and average piston speed many old systems can be retrofit to dry running

Dry running materials are designed to self lubricate by depositing a thin layer of the sealing material into the counter surface.

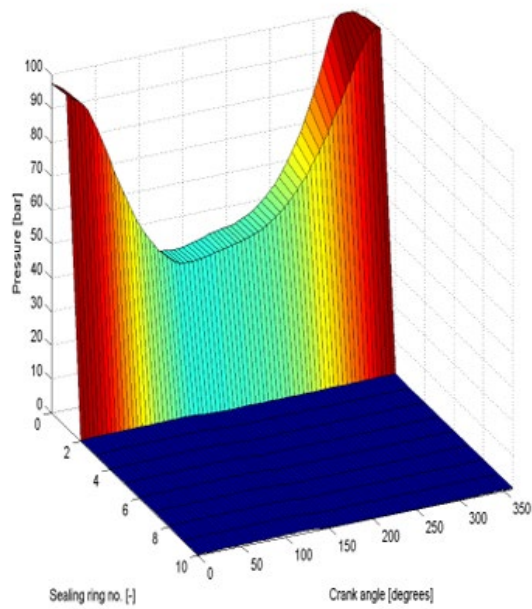
Dry running counter surfaces require a different surface finish than lubricated service



Dynamic vs Static Packing System Design

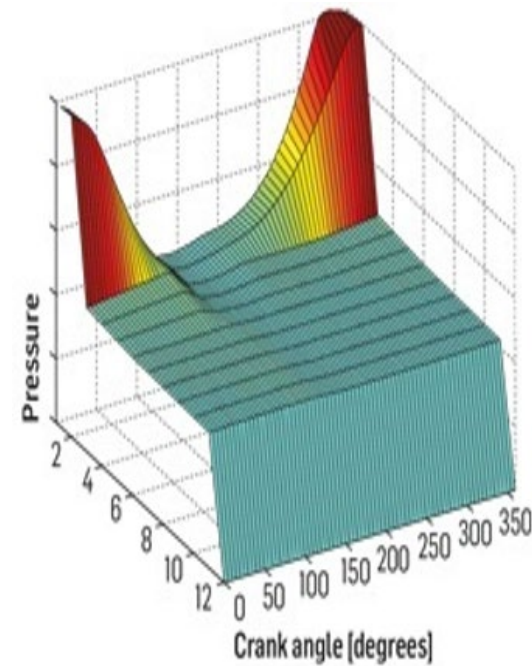
The "**dynamic pressure component**" is the difference between final pressure and suction pressure of the respective compression stage

The "**static pressure component**" is the difference between the suction pressure and the pressure after the last sealing element ambient pressure for a packing assembly suction pressure of the same or a lower compression stage



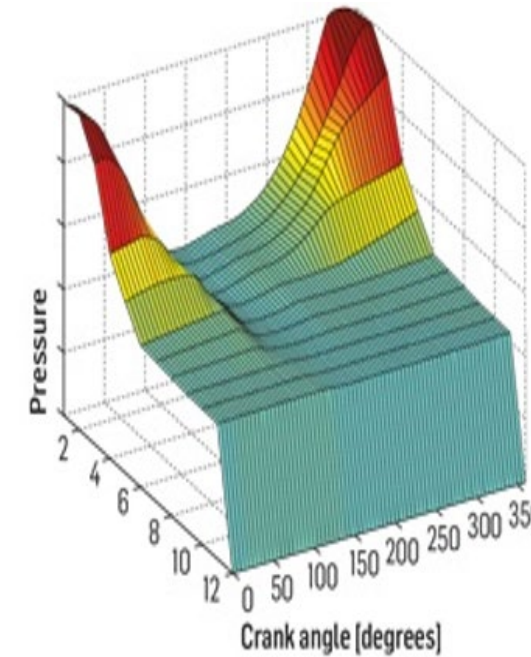
Gas-tight sealings:

Dynamic and static pressure component sealed by only one sealing element



Standard sealings:

Dynamic and static pressure component sealed by different sealing elements



Optimized sealings:

Dynamic pressure component distributed over several sealing elements

Distributing the two pressure components among various sealing elements can be used to optimize sealing systems

Piston ring selection

Piston Rings and Packing selection is a balance of function & cost.

Piston rings can be configured to have different functions such as sealing, guiding, and pressure breaking. They can be simple angle cut and quick to produce. It is also possible for more efficient sealing to have step-cut, step-joint, pressure balanced, spring backup, etc. Depending on the application and budget of the operation various configurations are possible.



Standard Angle Cut



Multi Piece



Step-cut



Rider ring with relief grooves

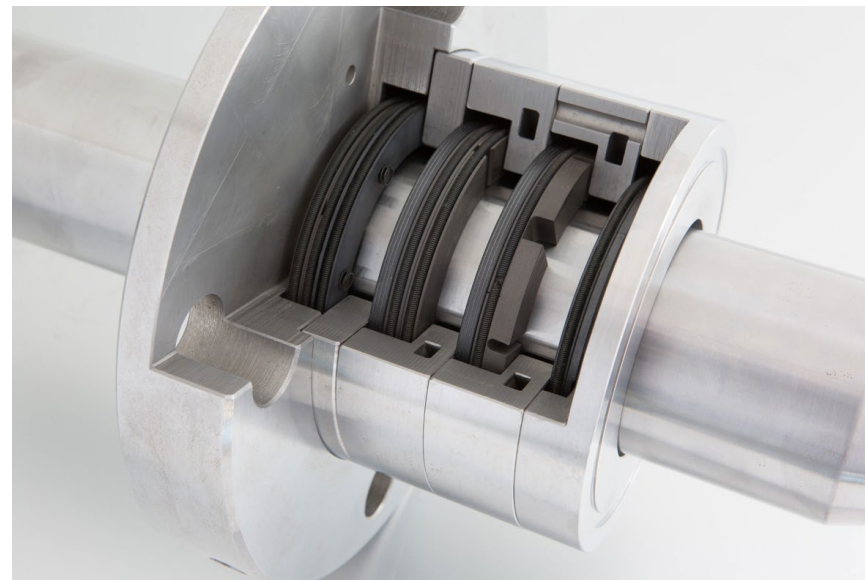


Over-lap & Pressure balanced

Packing ring selection

Packing selection is also balance of function & cost. Typically, there are more options in Packing designs.

Pressure breaking and sealing are the two main designs aspects of a packing ring. In a good packing design, the dynamic pressure that enters the packing case on a discharge stroke towards the crank case will be throttled to reduce pressure on the subsequent rings. This will reduction in dynamic pressure will take pressure off the sealing rings which will allow them to function as a radial seal against the piston rod.



Side loaded double tangent



6-Piece radial tangent sealing ring



Pressure Breaker



BC Multi-Piece Pressure Breaker

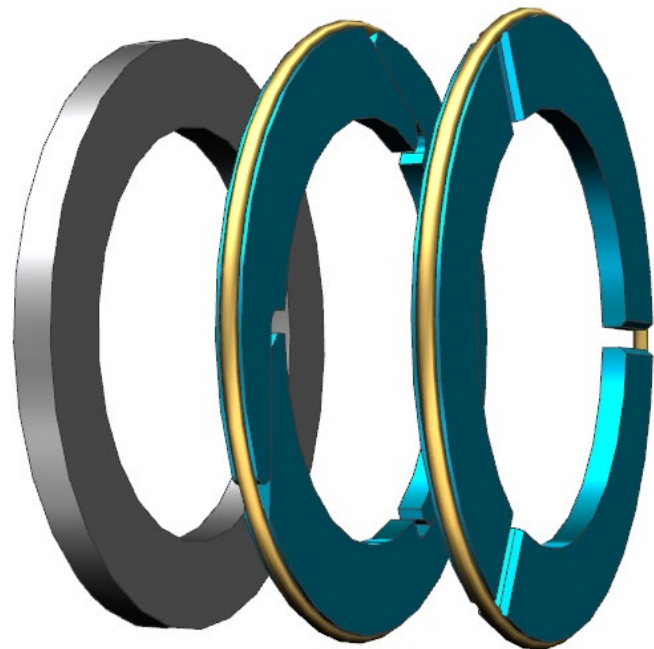
Success Story: Improve sealing efficiency, reduce leakage

A reciprocating compressor owner recognized a leakage rate of more than **7 Nm³/h (4.36 SCFM)** on their single-stage, non-lubricated process gas compressor for hydrogen.

It was suggested to **upgrade from a 3-ring to a much tighter 4-ring design** adding one more support ring as 4th barrier, no material change.

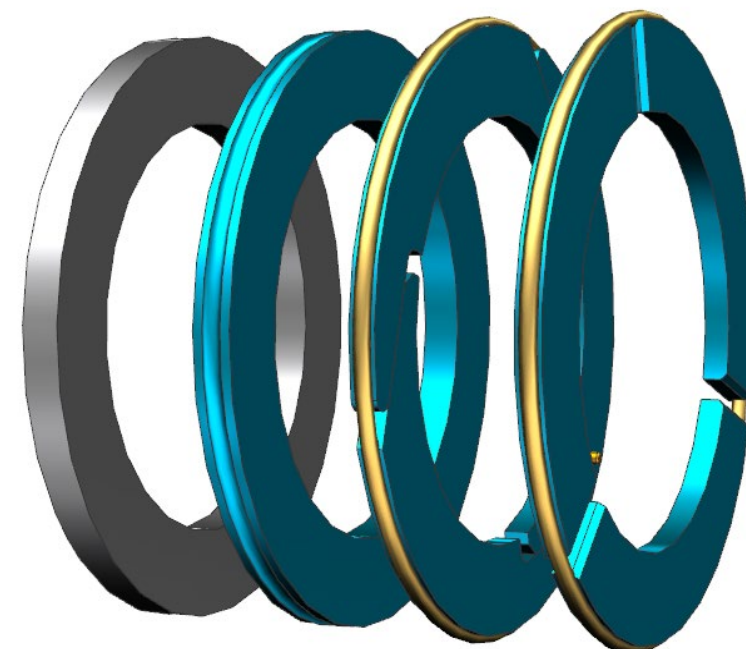
The result was amazing, a **reduction in leakage rate to 1.2 Nm³/h (0.75 SCFM)** (on average) even after **7'600hrs.** operation.

Original design



Traditional design

New design



Improved Reduced cross-section ring design

Increase sealing lifetime, reduce leakage

A dry-running process gas compressor which was compressing a gas mix of **90% H₂** and **10% CH₄** showed very early a high leakage rate resulting in a low lifetime of the stuffing box. It didn't match the customer's regular maintenance schedule of minimum **4'000 hours**.

A solution was discussed to trial proprietary MP (multi piece) rings in **Persisto[®] 850 material**, which are specifically designed for reciprocating compressors, in addition to a newly designed packing case to increase runtime.

With these changes, the compressor owner reached a stuffing box lifetime of minimum **8'000 hours** and reduced the leakage rate significantly.

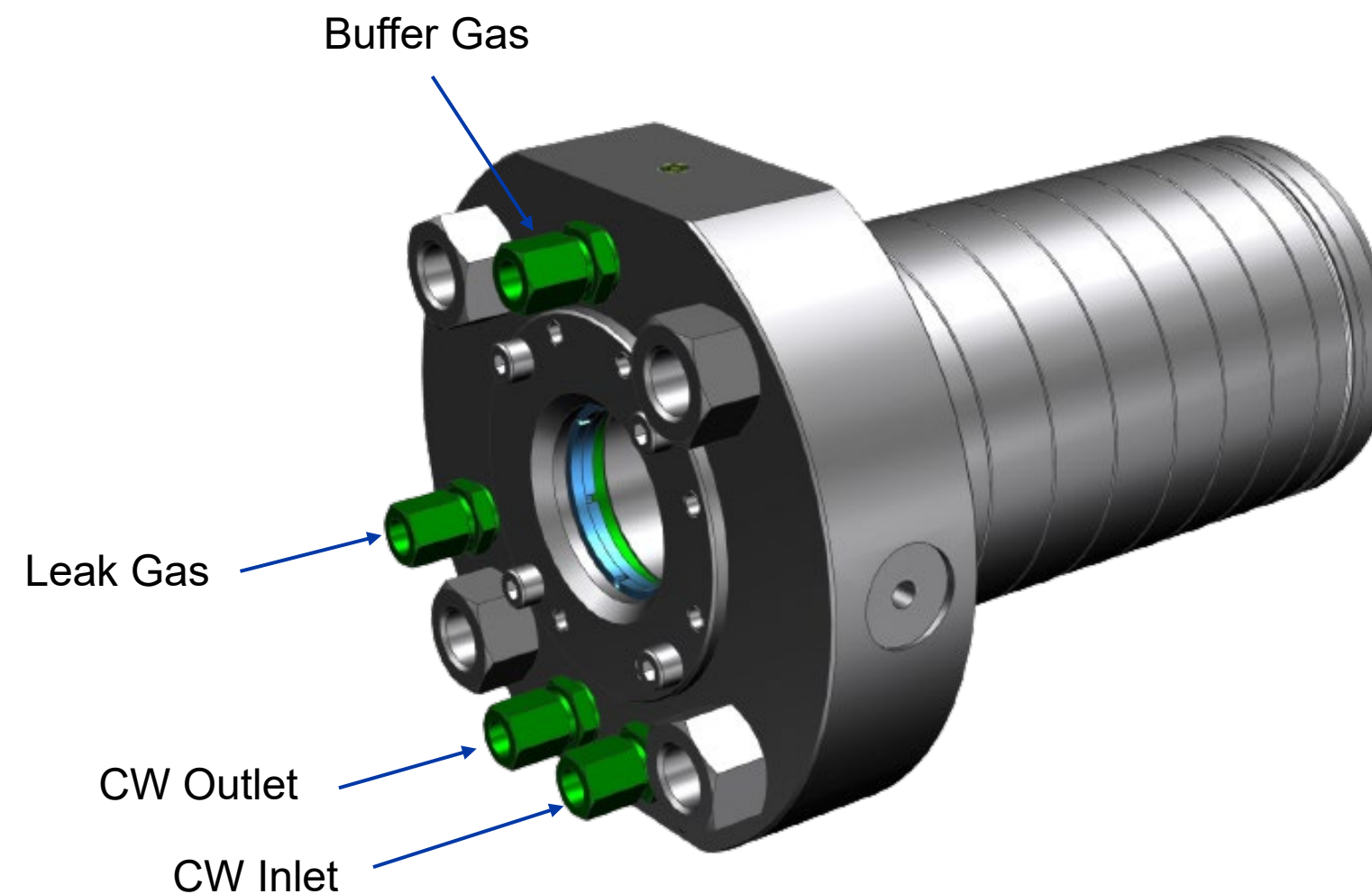


Reduce leakage and longer lifetime

When high leakage and a low lifetime of a piston rod sealing occurred on a hydrogen compressor, the compressor owner was in desperate need for a reliable solution.

Proposed were Redura[®] packing, rings and valves to be implemented in their buffer/purge system.

The end user reported zero leakage and a longer lifetime of the packing. Increased reliability and safety is key for our customer.

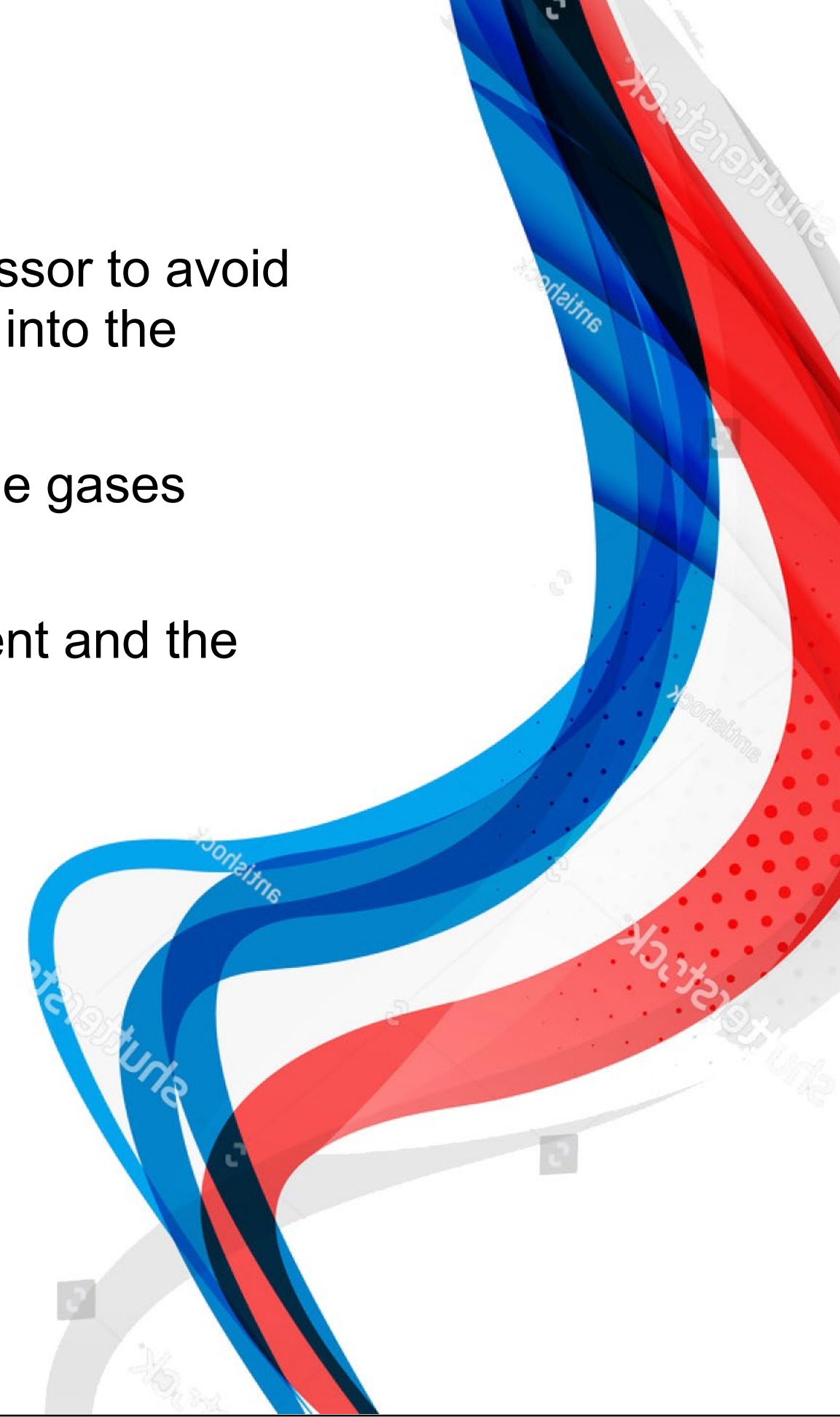
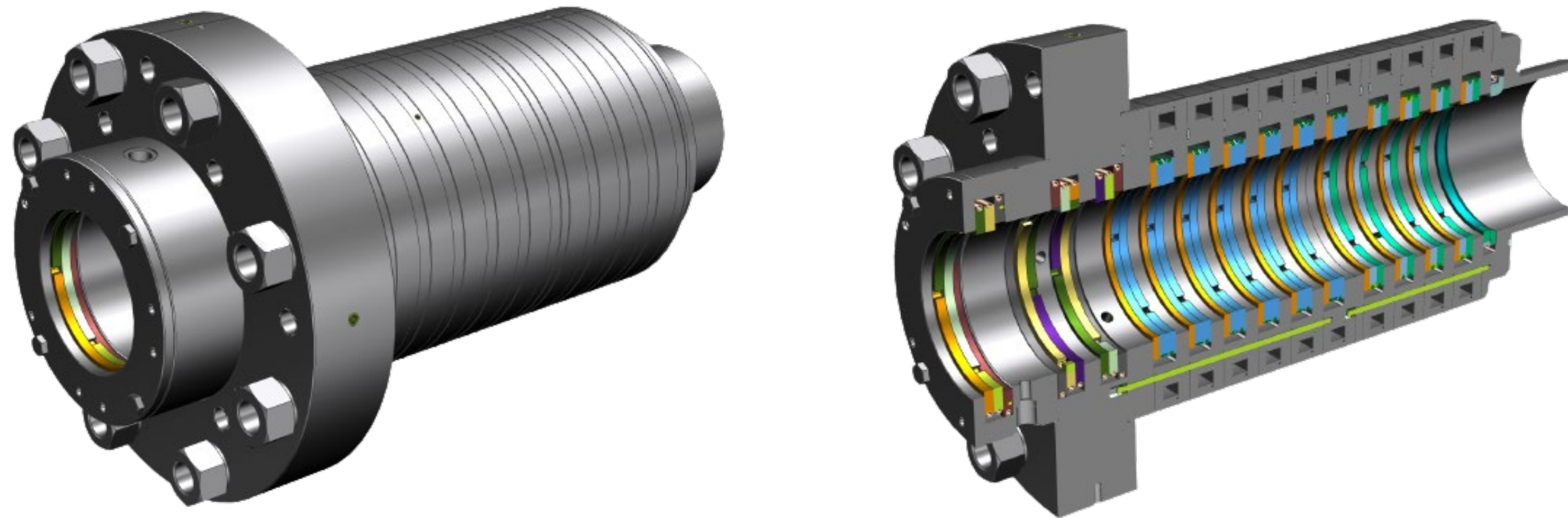


Improve safety with packing revamp

An additional buffer system was installed on a lubricated process gas compressor to avoid mixing of process gas with nitrogen. The clean process gas can be reinjected into the process, eliminating the need for flaring.

The buffer system was equipped with two leak gas connections to separate the gases properly.

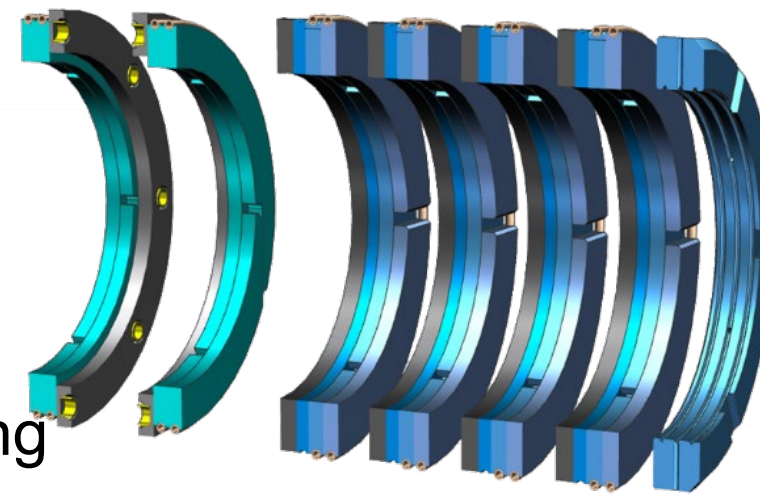
It not only made the compressor tighter but also much safer for the environment and the people.



Option 1: Sealing system upgrade

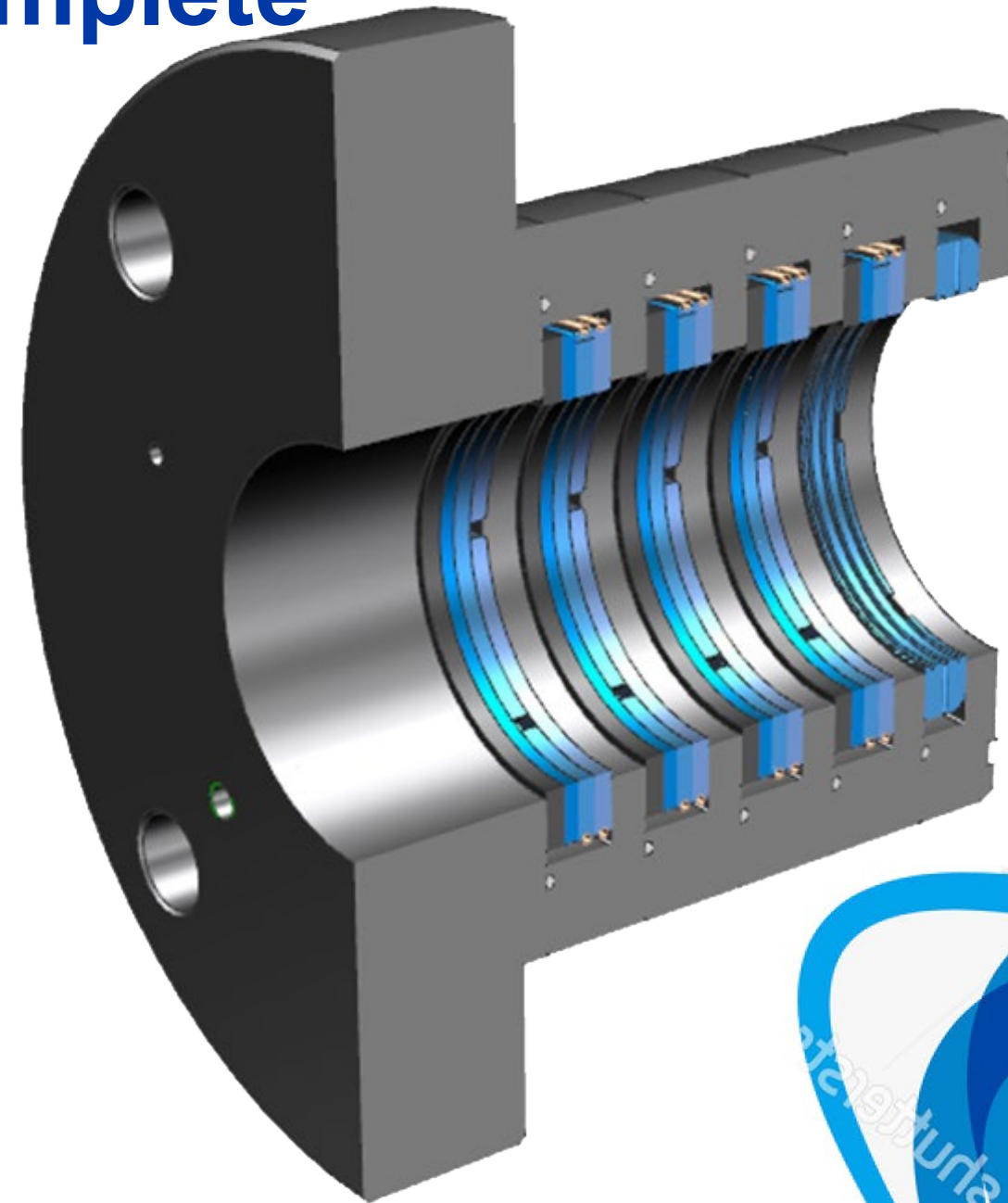


- Existing rings and sealing elements with newest design optimally combined using the optimal materials to allow lowest leakage
- Designs and ring technologies:
 - MP (multi –piece) rings
 - Optimized MP rings (new design)
 - 4-ring system
 - 6-pieced rings
- Materials:
 - **Persisto[®] 850** dry-running
 - **Persisto[®] 59/8400** for lubricated CH₄
 - **Persisto[®] 850/8400** for dry and bone dry CH₄



Option 2: New Packing Case Complete

- Completely new packing solution
- Combination of newest ring designs and material technology
- Nose cone seal with applicable materials creating a superior seal between the packing case and the cylinder
- O-rings between each cup will give an additional layer of protection from gas leaking between the cup faces
- Lapped sealing surfaces for all packing cups



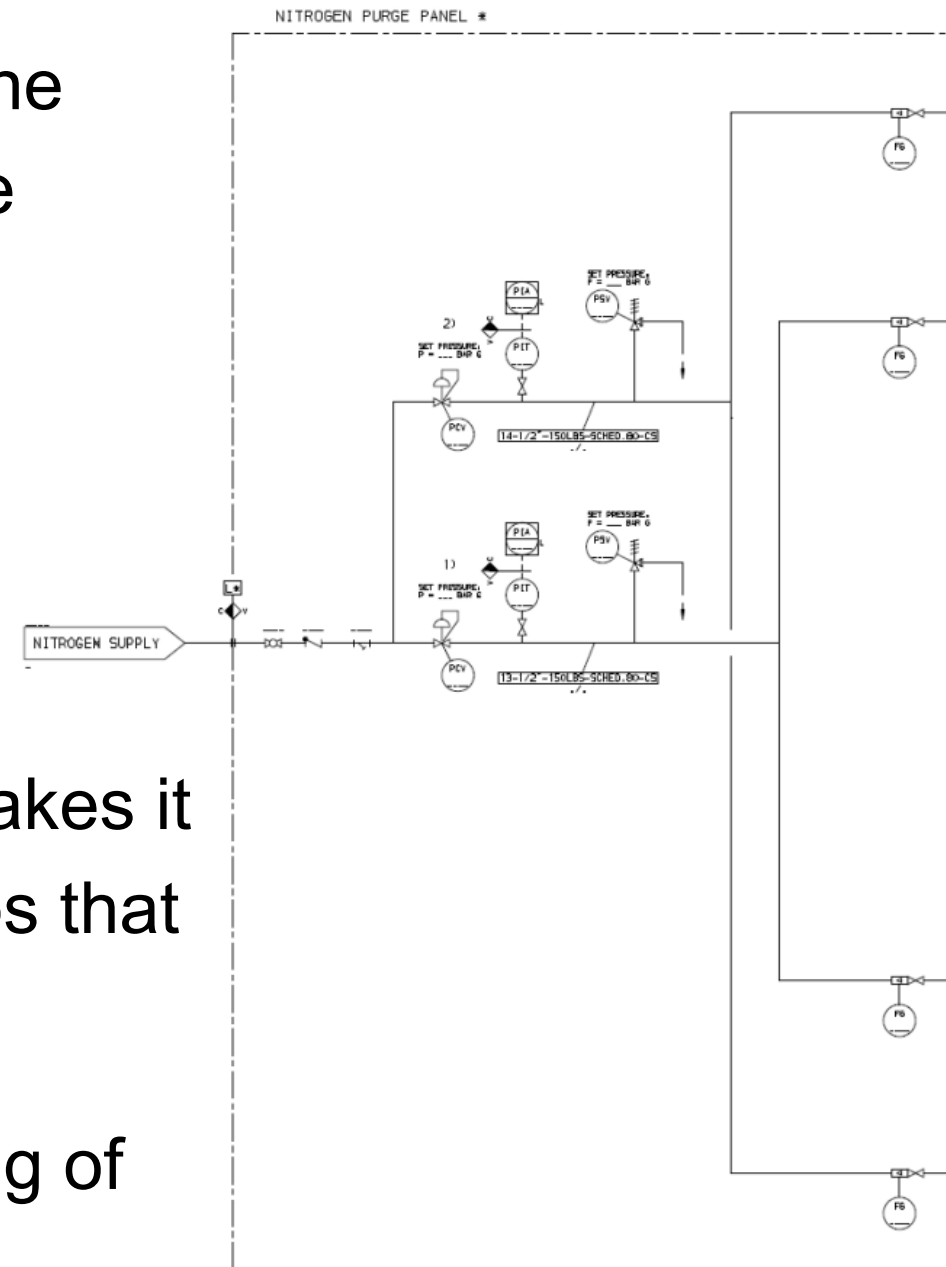
Option 3 (1 of 2): Purge and buffer panel

In order to prevent process gas from entering the distance piece, packing cases and intermediate packings can have buffer and purge added.

Buffer adds positive back pressure to the gas sealing elements. This assists in the sealing effectiveness of the system.

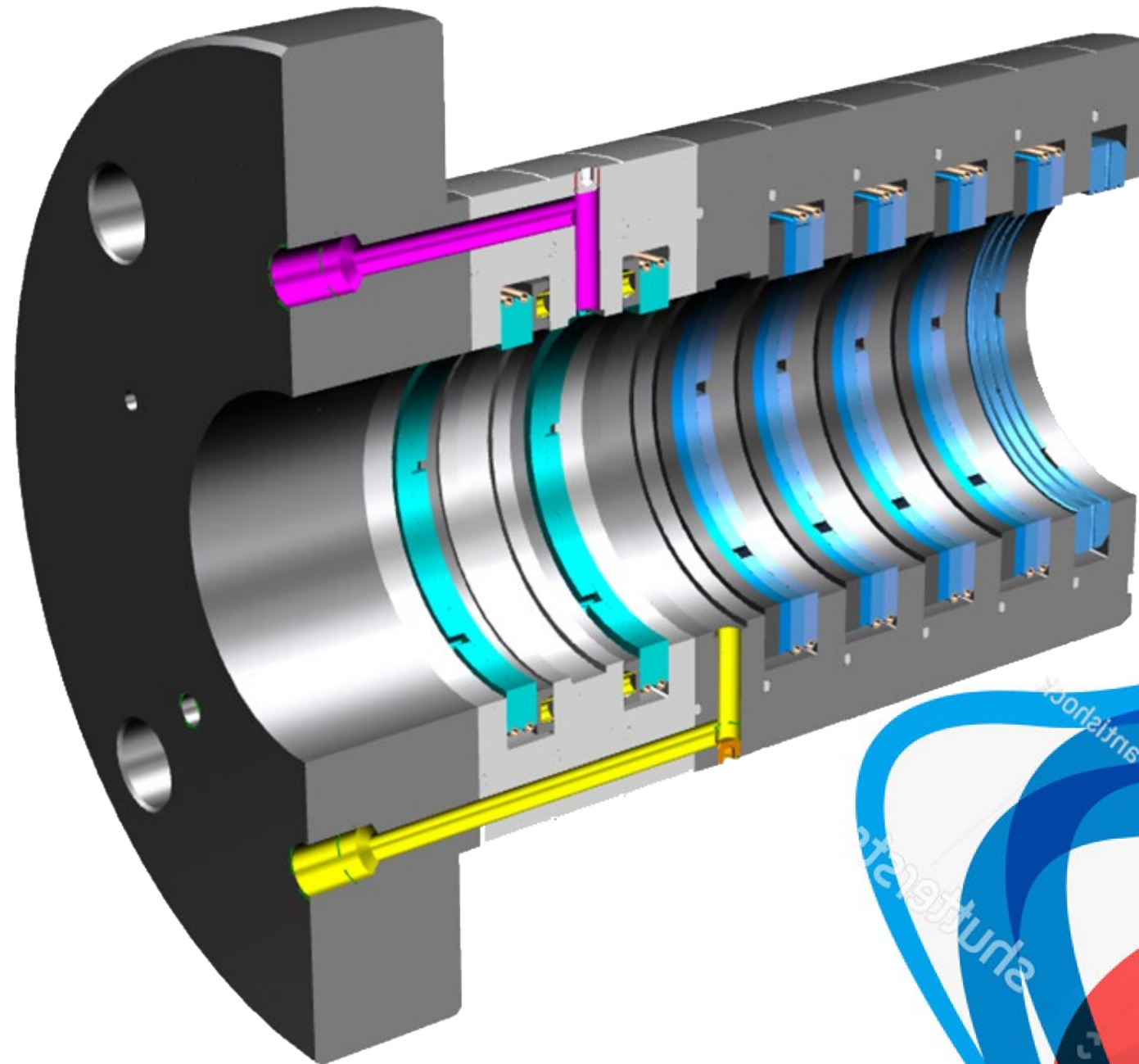
Purge systems sweep any process gas that makes it past the sealing elements and positively sweeps that gas into the collection leak line

The **Panel** allows precision Control & Monitoring of each cylinder's **Buffer** and **Purge** lines.



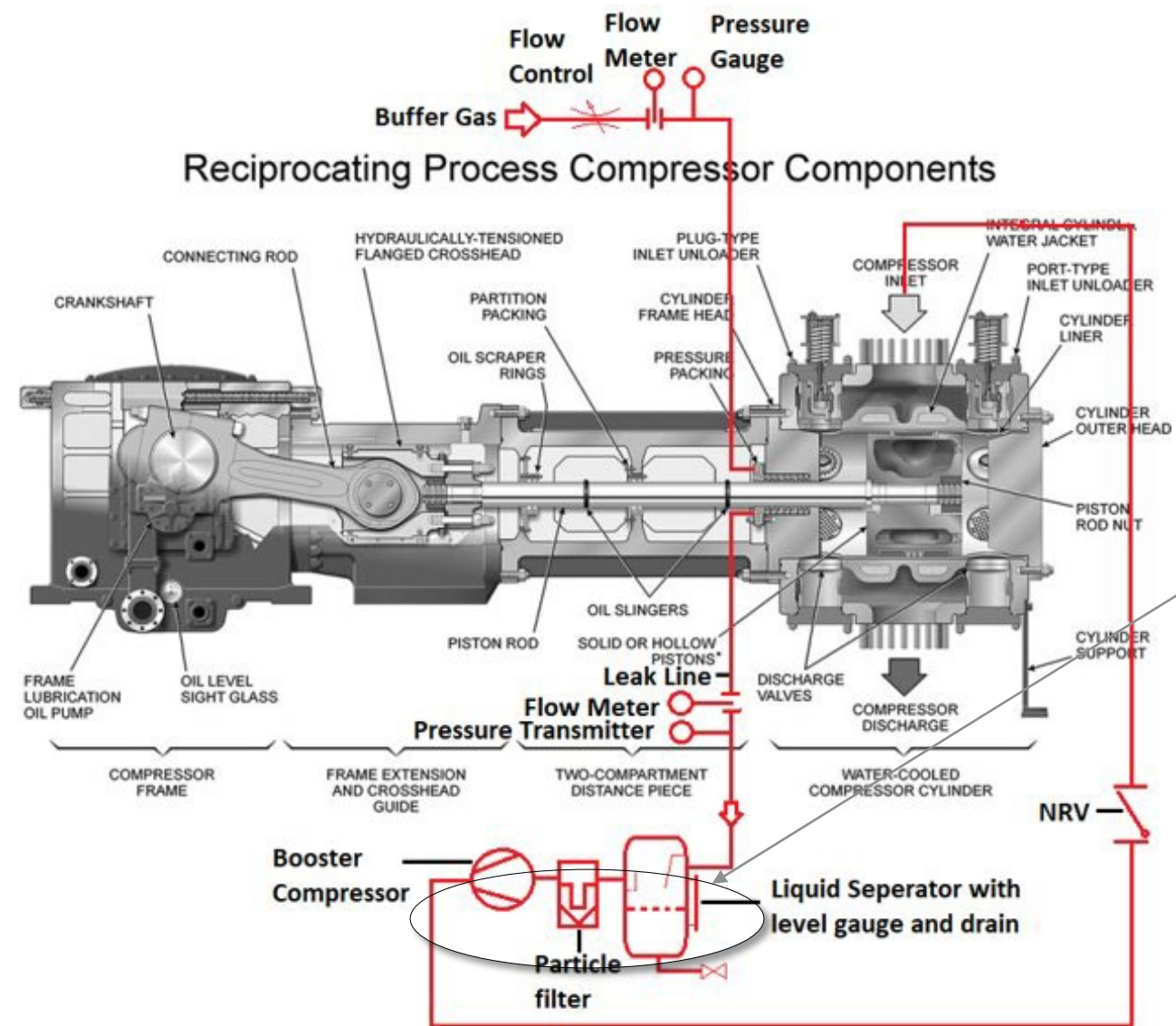
Option 3 (2 of 2): New packing with purge and buffer

- Completely new packing with the optional **Purge** and **Buffer**
- **Buffer** connection to avoid process gas entering the distance piece
- Combination of newest ring designs and material technology
- Vent connection to transport minimal leak gas to a safe location, a collection system or to the flare (if the connection pipes are already existing)



Leak Gas Recovery Concept

After upgrading the packing and Purge panel, a small auxiliary compressor would be added to the system to recover leak gas and boost the pressure to reinject the gas back into the suction line



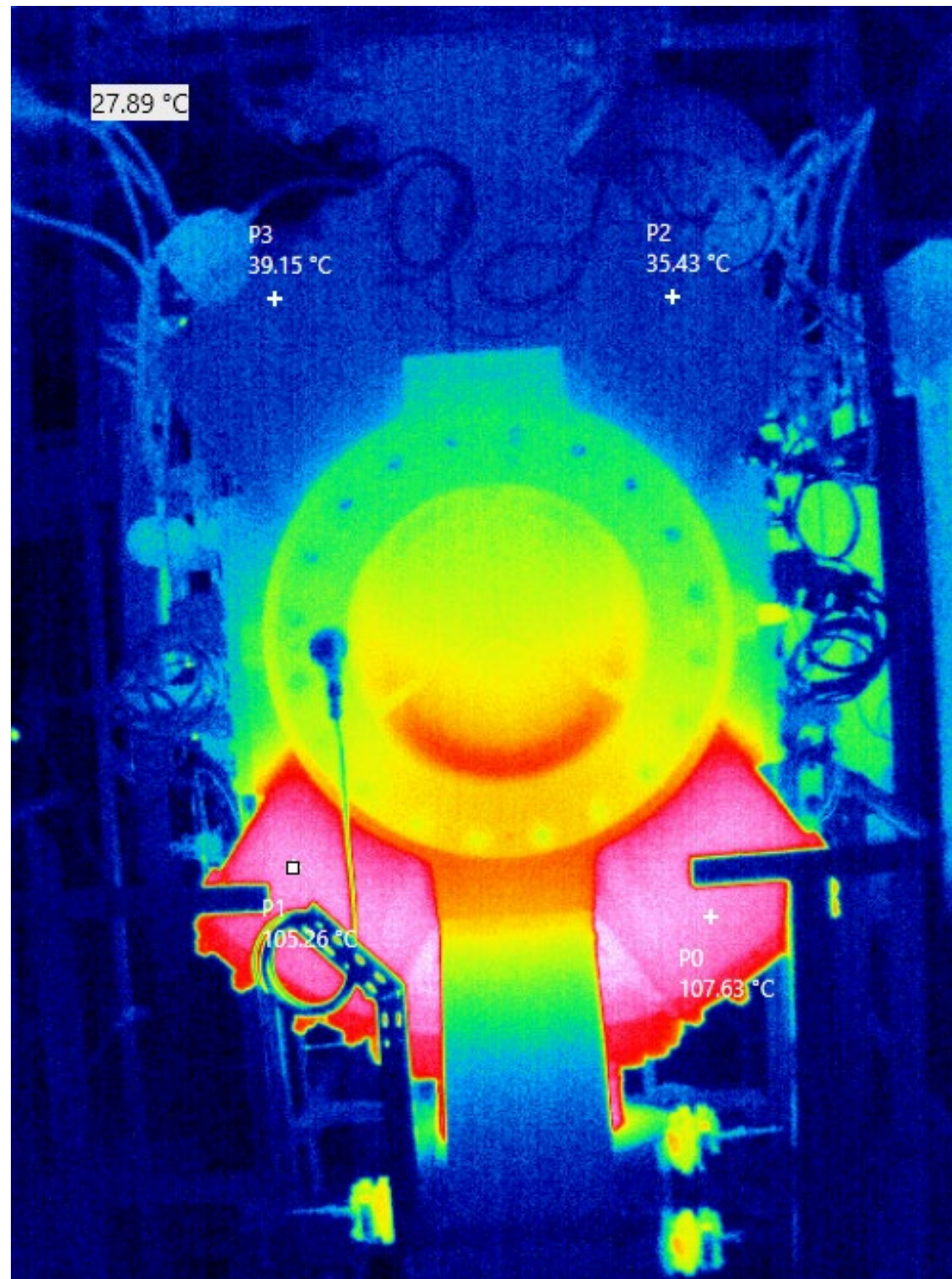
Experience sustainable solutions

- **Emission management expertise:**
Leverage global engineering knowledge to tackle Greenhouse Gas (GHG) and fugitive emissions with targeted emission management solutions beyond the packing.
- **Tailored sustainability:** No challenge is too great. Engage skilled engineers customize solutions to meet your specific sustainability goals.
- **Consistent excellence:** Across Service Centers, look for uniform procedures ensure top-tier quality in solution implementation, guaranteeing results that meet the highest standards.
- **Proprietary advancements:** Benefit from enhanced compressor sustainability and reliability through exclusive materials and solutions, which simultaneously reduce costs and health risks.



Take the next step on your sustainability journey with an in-depth analysis to determine the most effective upgrades for your compressors

Expert assessment for optimized compressor operation



Analysis programs are available for a comprehensive compressor assessment program designed to optimize the performance of compressors.

By utilizing a combination of various measurement and analysis techniques along with industry expertise, you can enhance the reliability and sustainability of compressor operations.

These programs are suitable for compressors of any type, age, and duty, whether they are individual machines or part of a larger fleet. Look to identify areas for improvement and implement strategies to maximize compressor efficiency.



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