BADOTHERM®

Case Study:
Improving Safety and Reliability of High-Pressure Measurements in Snamprogetti UREA plants

Overcoming high pressure challenges in the UREA synthesis process

Introduction

Profertil, a leading UREA producer, was facing continuous and recurring issues with pressure measurements in the high pressure urea synthesis section of their Bahia Blanca plant in Argentina. Despite attempts to resolve the issues, measurement failures continued to occur, putting their operations at risk and preventing them from achieving their objective of increasing production output and reducing energy consumption. To address this challenge, they turned to Badotherm in 2017, a specialist in the field of diaphragm seal technology. Through close collaboration and an unstoppable drive to engineer ultimate solutions, Badotherm was able to build a diaphragm seal system that solved Profertil's problems and delivered unrivalled performance.

Company	Profertil (JV Nutrien / YPF)
Location	Bahia Blanca
Country	Argentina
Website	www.profertil.com.ar
Technology	Saipem
Present capacity	1320 ktpa
Final Product	tkFT Granulation
Start-up date	2001

Recurring issues

Profertil had been experiencing frequent failures of pressure measurements in the high-pressure urea synthesis section of their plant from the start, with in total 38 failures of 6 critical pressure measurements over a period of 15 years of which 18 seal failures, with loss of asset function. The pressure diaphragm seals installed in Profertil's plant were based on Snamprogetti (Saipem) technology/design and originally supplied with non-Badotherm seals.

The issues with the diaphragm seal pressure measurements did not seem to be uncommon given the fact that in the Profertil design first double, and in a later stage, triple redundancy was applied. The original (non-Badotherm) design had 2 different materials, being a body material of AISI 316UG (UNS S31603) combined with a diaphragm of 25Cr-22Ni-2Mo Alloy (UNS S31050).

Pictures of installation of the diaphragm seal systems that experienced frequent failures at Profertil's Bahia Blanca site.

“We added extra measurements because we need these pressure measurements for a safe and reliable operation at the optimum process conditions”

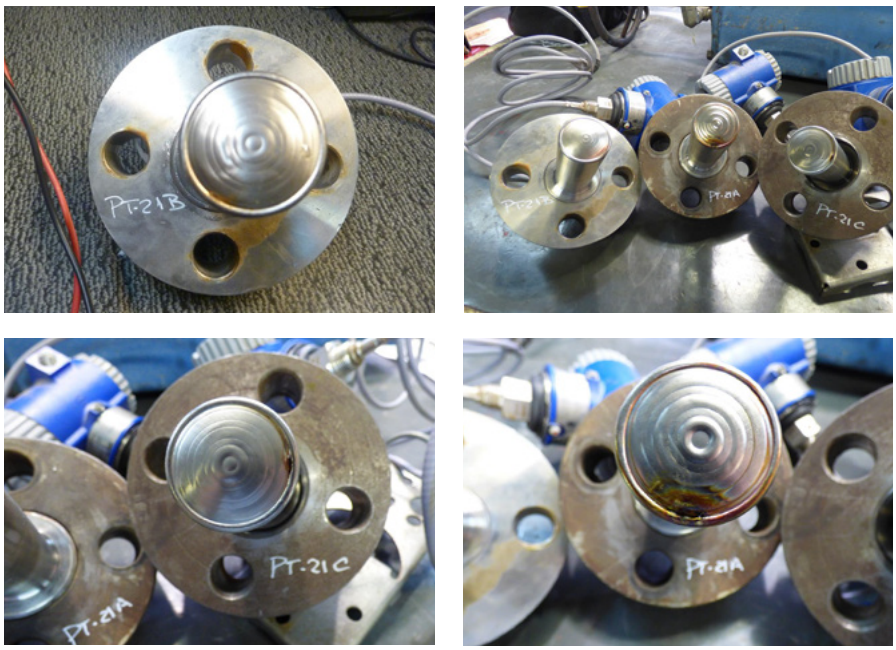
Pablo Laschiaza, Supervisor Instrumentation and Control Systems Profertil

In 2004 the original vendor changed its design with a different shaped diaphragm. In 2007, the body material was upgraded from AISI 316UG (UNS S31603) to 25Cr-22Ni-2Mo Alloy (UNS S31050), but the issues and failures remained. In 2009, triple redundancy was added.

Despite the redundancies, often, maintenance personnel would arrive to a planned shutdown with one or even two unavailable pressure measurement instruments. The pressure measurements showed large errors. During the several turnarounds, the reasons became clear. While conducting the analysis, it was observed that several of the diaphragms no longer had a convolution pattern and several other diaphragms were bulged. Bulging diaphragms in most cases mean that gas formation took place within the closed diaphragm seal system, either by filling fluids exceeding their maximum temperature or exceeding its vapor pressure curve.

Several other diaphragm seal systems had no filling fluid behind the diaphragms anymore, indicating the presence of leaks at the capillary connections or the diaphragm welds. The failures did not appear to be directly related to corrosion, but were related to temperature and/or vacuum effects, the selected filling fluid type, the construction and the filling methodology. This caused the diaphragms to bulge due to gas formation behind the diaphragm, pushing out the convolution shape. Typically, this happened frequently within a period of 6 months after installation, but randomly and without any clear cause.

Although the cost of renewing individual pressure measurements may have been relatively low, the frequency of replacements made the overall cost significant. Furthermore, the costs of replacement each time and the exposure to the risk of losing control of the process gave the maintenance team headaches. They required a partner with expertise in diaphragm seal design and high-pressure applications for the urea industry.



During 2014 to 2016 turnarounds diaphragms showed loss of convolution pattern and bulging seals, suggesting gas formation and potential leaks in the diaphragm systems.

> **“We really needed a better and more reliable solution.”**
>
> Pablo Laschiaza, Supervisor Instrumentation and Control Systems Profertil

Badotherm to the rescue

Profertil turned to Badotherm to help them find a solution. Badotherm had solved several measurement challenges in the urea industry, specifically with special materials such as zirconium and working closely together with industry experts like Mr. Mark Brouwer of ureaknowhow.

In their analysis, together with Profertil, Badotherm step by step solved the puzzle, reviewing the process conditions and checking all mechanical requirements. From a material perspective, whilst the Profertil metallurgist confirmed the suitability of the current material used 25Cr-22Ni-2Mo Alloy (UNS S31050) for this process medium, it was decided to upgrade using full zirconium extended seals. These are designed to perform well in high pressure applications urea synthesis area, especially for possible corrosion risk and long life time. The current materials used simply didn’t stay in long enough to be exposed to any corrosion risk. The Zirconium 702 (UNS R60702) diaphragm seals are meant to last. Badotherm manufactured the diaphragm seals in strict according to the Snamprogetti (Saipem) technical standard.

From a mechanical integrity perspective, Badotherm upgraded the complete diaphragm seal system to a fully welded system without screwed connections. Taking the process condition into account and the possibility of vacuum, using Badotherm BaSeCal methodology, the filling fluid was determined for BSO-18, a high temperature filling fluid with suitable characteristics for this typical application with high temperature and possibility of vacuum. Last, Badotherm performed extensive NDE testing on the application, including a cyclic pressure test of 240 cycles at 170 Kg/cm2.

The first 4 diaphragm seal systems supplied in 2018 performed well, but some feedback from the field led Badotherm to further improve their design by creating a capillary connection specifically designed for high pressure applications. As a result, Profertil ordered another 3 additional instruments for their stock in 2019.

Expert welders showcase their precision and skill at Badotherm’s manufacturing facility in Dordrecht, The Netherlands.

Robust performance and reliable pressure measurements

“Since the installation of the Badotherm full zirconium extended diaphragm seal system in 2018, we have not experienced any further failures of high pressure measurements”, Pablo stated and continues: “The new Badotherm diaphragm seal systems have delivered robust performance, improving the reliability and safety of our operations. And that is not all, the systems enable us to operate the high-pressure urea synthesis section at its optimum conditions, increasing production output and reducing energy consumption.”

In addition, the collaboration between Profertil and Badotherm has resulted in a deeper understanding of diaphragm seal design and high pressure applications, providing valuable knowledge for future projects. Profertil inspected all the instruments and performed calibration testing as well as dye penetrant testing to check for any potential crevices of material corrosion.

But after three years of operation the diaphragm seals look impeccable and in perfect shape. Both body and diaphragm seal have no signs of wear and tear. Ready to go in for another run of minimum three years of operations!

Picture of Badotherm’s zirconium diaphragm seal system taken during 2021 turnaround. Diaphragm seal body and diaphragm are slightly discolored, but without any sign of mechanical damage or active corrosion. Still in perfect shape after 3 years in operation

“The new Badotherm diaphragm seal systems have delivered robust performance, improving the reliability and safety of our operations.”

Pablo Laschiaza, Supervisor Instrumentation and Control Systems Profertil

Conclusion

This case study highlights the need for a good understanding of the process conditions and to engineer and manufacture a robust diaphragm seal design, including the importance of selecting an appropriate filling fluid in demanding UREA applications. By collaborating with Badotherm and leveraging their expertise in diaphragm seal technology, Profertil was able to solve a complex challenge, improving the reliability and safety of their operations, and achieve their objective of increasing production output and reducing energy consumption. The full zirconium extended diaphragm seals with capillary connection developed by Badotherm delivered unrivalled performance, providing a reliable solution for other UREA producers facing similar challenges.

Want more detail about this project and the specific diaphragm seals that were installed to resolve the issues?

Feel free to reach out to our specialists!

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