Case Study
ISSN (Online): 2350-0530
ISSN (Print): 2394-3629

International Journal of Research - GRANTHAALAYAH
May 2023 11(5), 57–61

GASKET SOLUTIONS FOR ELECTROLYZERS – AN OVERVIEW

Thorsten Hickmann [1], Martin Engelke [1], Eric Klemp [1], Prasad Venkatesan [1]

[1] Eisenhuth GmbH and Co. KG, Friedrich-Ebert-Str. 203, Osterode, Germany

Received 16 April 2023
Accepted 18 May 2023
Published 02 June 2023

Corresponding Author
Thorsten Hickmann,
t.hickmann@eisenhuth.de

DOI
10.29121/granthaalayah.v11.i5.2023.5183

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

Electrolysis seals play an important role in the chemical industry and are used to seal liquids and gases in electrolysis cells. A good seal is critical to the performance and reliability of the electrolysis process, ensuring that no unwanted substances enter the system and that the correct amount of liquid and gas flows through the cell.
This article explains the most important aspects of seal geometries, materials for electrolytic seals and required equipment.

Keywords: Gaskets, Sealing, Electrolyzer, PEM Electrolyzer, Alkaline Electrolyzer

1. INTRODUCTION

Electrolysis seals play an important role in the chemical industry. They are used to reliably seal liquids and gases in electrolysis cells Pitschak et al. (2017). A good seal is of great importance for the performance of the electrolysis process. It ensures that no unwanted substances enter the system and that the right amount of liquid and gas flows through the cell. Loadman (2012)

This article focuses on the key aspects of injection moulding tools, sealing geometries and materials used in electrolysis seals. The correct selection of these components is crucial to achieve an effective seal and ensure optimal functionality of the electrolysis system.

A through consideration of these aspects enables manufacturers and engineers to develop and apply the best solutions for electrolysis seals.

2. SUCCESS FACTORS FOR AN ELECTROLYSIS SEAL

The main task of an electrolytic seal is to seal the contact surfaces of the assembly. For this, it is important that there is no relative movement between the components.

To achieve this goal, it is important to look at the process as a whole.

Figure 1

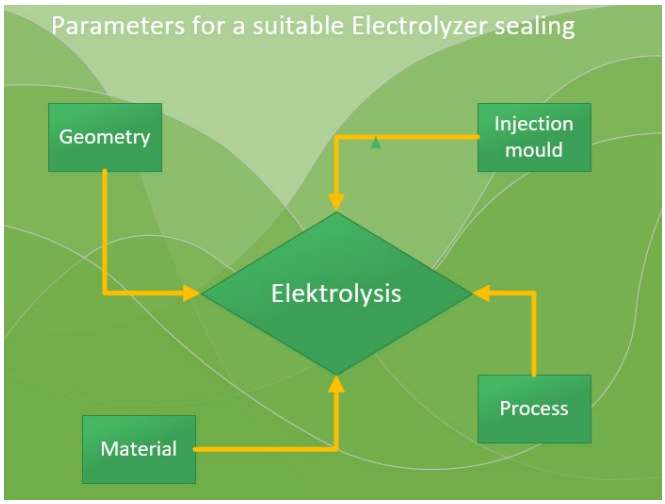

Figure 1 Success Factors for a Suitable Electrolysis Seal.

Figure 1 shows that the success factors of an optimally functioning electrolytic seal are an interplay of the factor's geometry, material, injection mould, and the production process.

2.1. MATERIAL

When sealing gases and liquids in electrolysis, we face a number of challenges. An effective electrolysis seal must be able to provide gas tightness and pressure resistance. It is important to avoid leaks and prevent gas leakage to ensure efficient and safe electrolysis.

One way to overcome these challenges is to choose the right sealing material. EPDM (ethylene propylene diene (monomer) rubber) is a proven material used in many electrolysis applications. EPDM offers excellent chemical resistance to a wide range of substances and is relatively stable at elevated temperatures Loadman (2012) This material is well suited for general sealing requirements in electrolysis.

For more demanding applications, for example in environments with acids, a fluororubber (FKM) compound can be used as a sealing material. FKM is a high-tech material known for its outstanding chemical resistance. It can withstand even aggressive chemicals and offers very high temperature and pressure resistance. The use of FKM seals can be an effective solution when dealing with extreme conditions and demanding environments in electrolysis. Loadman (2012)

In order to minimise gas bubble formation and leaks, not only the right material but also the right shape of the seal is crucial. The gasket geometry should be designed to allow optimal matching and pressure distribution between the

components to be joined. Careful design and shaping can achieve an effective seal. Loadman (2012)

Furthermore, regular inspection and maintenance of the electrolysis seals is of great importance. Wear or damage can occur over time and lead to leaks. Timely detection and maintenance of leaks or damaged seals is therefore crucial to ensure smooth operation of the electrolysis system.

Overall, the selection of the right sealing material and careful design of the sealing geometry is crucial to overcome the challenges of gas sealing and pressure resistance in electrolysis. By using materials such as EPDM or FKM and paying attention to the correct shaping, we can achieve a reliable and efficient seal that meets the requirements of electrolysis.

2.2. CHOICE OF THE APPROPRIATE GEOMETRY

O-ring and flat gaskets are often used as static seals that provide a reliable seal. Gronitzky (2017) However, additional sealing lips can provide a better seal at low forces and thus higher gas tightness and pressure resistance.

O-ring geometries are suitable when only a few plates are stacked on top of each other, because the force required for compression is very high Li (2023) (Figure 2)

Figure 2

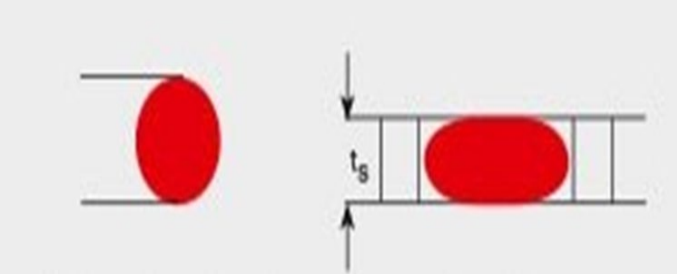

Figure 2 O-ring Geometry in the Original (left) and Pressed (right). Li (2023)

In an electrolyzer, sometimes 100 or more plates are stacked on top of each other, all of which must be sealed together. In this task, O-ring seals are conceivable as a geometry for a sealing task, but are rather unsuitable, as a lot of pressure is required. NOK Foundation Coorperation (2015)

A sensible alternative is to profile the seal, accordingly, as can be seen in Figure 3.

Figure 3

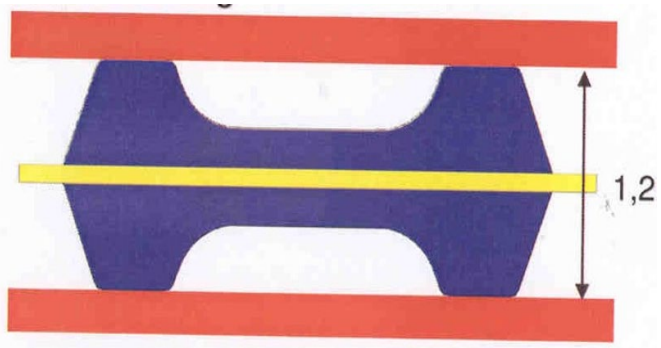

Figure 3 Sealing Profile for an Electrolysis Stack Consisting of a Large Number of Cells. NOK Foundation Coorperation (2015)

Figure 3 shows that the contact surface area increases significantly with compression. In this respect, the required forces increase accordingly when not only two plates, but perhaps 100 plates are pressed together. Nielson (2022) A corresponding approach to solving this problem is profiling to increase the contact surface pressing force, as shown here in Figure 3.

2.3. INJECTION MOULD AND SUITABLE PROCESS

Choosing the right injection moulding tools for electrolysis seals is crucial to producing a reliable seal. A key factor in tool selection is the tool steel as well as the surface finish of the tool, as these factors influence the shaping of the electrolysis seal and thus its performance.

When manufacturing electrolysis gaskets, it is important to select suitable gating points as they have a critical influence on the moulding. Du et al. (2023) The placement of the gating points allows for optimal distribution of the material during the injection moulding process.

Careful selection of gating points can improve the quality of the electrolysis seals by minimizing unwanted defects such as air pockets or material distortion.

In addition, factors such as the cooling of the mould should also be considered when selecting the injection moulding tool.

Figure 4

Figure 4 Injection Mould with Corresponding Gating Distribution for the Production of an Electrolysis Gasket.

Combination of material and mould is a guarantee for function. Effective tempering is important to reduce cycle times and ensure uniform vulcanization of the electrolysis seal. In contrast, insufficient tempering can lead to uneven shrinkage and deformation of the seal, which can sometimes severely impair its performance.

3. SUMMARY AND OUTLOOK

In summary, the careful selection of the material, geometry, process sizing and injection moulding tool is of great importance for the production of reliable electrolysis seals. For the gasket, the appropriate material is necessary accordingly. A suitable geometry is also important. For the tooling, the right tool steel, the surface finish of the tool and the placement of the gating points are the critical factors to ensure optimal shaping and performance of the seals.

Only if the above-mentioned success factors are equally taken into account, then it can be guaranteed that the electrolysis seal will permanently fulfil its task.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

The work was realized with the help of public funding. The funding was donated from the Federal Ministry for Economic Affairs and Climate (Germany) in cooperation with the project treasury institution Projektraeger Juelich in the project "Ticob". In addition, the authors like to thank the N-Bank Niedersachsen for the funding in the project "AEM Stack".

REFERENCES

Du, Q., Wang, R., Xie, L., Liu, G., & Lian, Zengyan. (2023). A Novel Design of Rim Sealing Flow for Improving Sealing Effectiveness. In Journal of Engineering for Gas Turbines and Power, 145(7), 1-31. https://doi.org/10.1115/1.4056645.

Gronitzky, M. (2017). Untersuchungen zur Funktion und Auslegung von Rechteckdichtringen für Drehdurchführungen [Diss.]. Hannover, Germany.

Li, Z. (2023). Study on the Sealing Performance of O-ring under High-Pressure Environment. In Journal of Physics : Conference Series, 2419(1). https://doi.org/10.1088/1742-6596/2419/1/012005.

Loadman, M. J. R. (Ed.). (2012). Analysis of Rubber and Rubber-Like Polymers. Springer Verlag. https://doi.org/10.1007/978-94.

NOK Foundation Coorperation (Ed.) (2015, January 06) : Sealing Structure Fuel Cell, U.S. Patent US8927.174.

Nielson, T. K. J. (2022). Dynamic Seal Test Rig : O-ring Leakage and Sliding Friction Measurements. In. Conference Paper, ASME Turbo Expo 2022 : Turbomachinery Technical Conference and Exposition.

Pitschak, B., Mergel, J., & Müller, M. (2017). Electrolysis Applications. In J. Töpler & J. Lehmann (Eds.), Wasserstoff und Brennstoffzelle, Technologien und Marktperspektiven. Berlin, 207–229.