CataLite® DeOxo

Complete deoxygenation of hydrogen
or inert gas streams

Catator

Catalytic DeOxo, short for deoxygenation, is the process of removing trace amounts of oxygen from hydrogen or inert gas streams through the reaction $O_2 + 2H_2 \rightarrow 2H_2O$. The process relies on highly active catalysts that promote fast and complete oxygen removal, typically down to ppm or sub-ppm levels. DeOxo is widely used in hydrogen purification, fuel cell systems, protective atmospheres for semiconductor and metal processing, and other applications where even small amounts of oxygen pose safety or quality risks.

In such systems, oxygen contamination can lead to corrosion, catalyst degradation, unwanted oxidation of products, and changes in reaction pathways. It may also create safety hazards: hydrogen–oxygen mixtures can fall within flammable limits, and oxygen ingress can cause localized ignition points or hot spots in equipment. Removing oxygen ensures safe operation, protects sensitive materials, and maintains consistent product quality in industries such as chemical synthesis, electronics manufacturing, gas purification, and metallurgical processing.

The most common DeOxo catalysts are based on noble metals, with platinum being the industry standard. These catalysts offer high activity, low light-off temperatures, and long lifetime, and are typically supported on high surface area alumina, silica, or similar oxides.

Pellet catalysts are the traditional substrate choice, providing high catalyst loading, good heat-transfer capacity, and mechanical robustness. However, packed beds create relatively high pressure drop and may suffer from uneven flow, which can lead to temperature hot spots. Honeycomb or monolithic substrates offer very low pressure drop and uniform flow distribution through straight channels, with fast thermal response due to their low thermal mass. Their limitation is lower catalyst loading per unit volume and reduced capacity to absorb heat from the exothermic reaction.

Mesh-type substrates bridge the gap between these designs. Their open, three-dimensional metallic structure combines low pressure drop with excellent heat transfer and relatively high surface area. Because gas flows both across and through the mesh, temperature distribution is more uniform and the risk of hot spots is reduced, making mesh substrates well suited for compact reactors or systems with variable oxygen loads.

The CataLite® Coating Technology

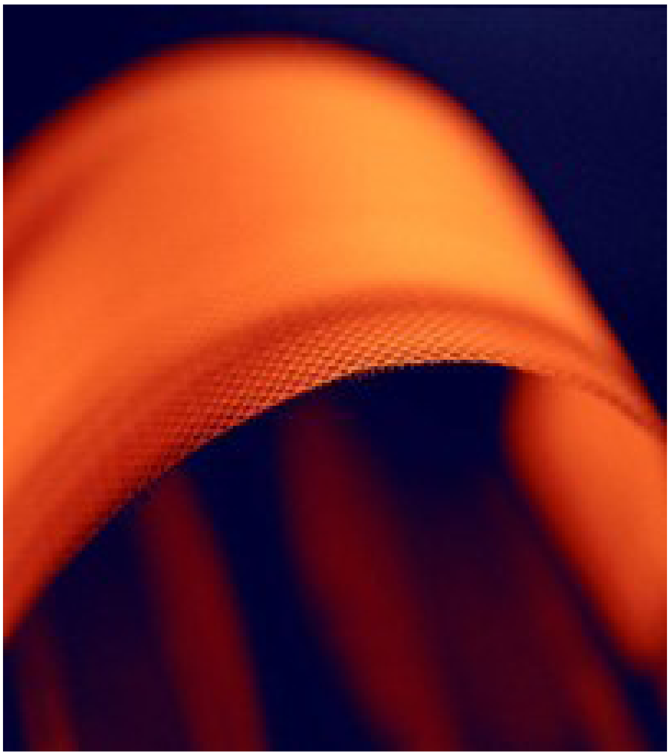
The CataLite® concept is Catator's proprietary catalyst-coating technology, developed to enable catalysis on virtually any surface, including metallic, ceramic, and polymer-based substrates. The coating is highly porous, strongly adhesive, and can be loaded with significant amounts of catalytic material through wet impregnation, calcination, and reduction. Coating thickness can be tailored from approximately 20 to over 100 µm, allowing a high density of active phase to be incorporated onto the substrate.

Mesh-type catalysts coated with Catator's CataLite® technology offer a uniquely powerful solution for DeOxo systems, where safe, reliable, and efficient removal of trace oxygen is critical. Unlike conventional pellet beds or ceramic monoliths, CataLite®-coated mesh structures combine exceptionally high catalyst loading with superior heat and mass transfer. The open, three-dimensional wire-mesh geometry generates controlled micro-turbulence, ensuring rapid mixing of hydrogen and oxygen while minimizing the risk of channeling, axial dispersion, or local hot spots. This results in fast and complete oxygen conversion across a wide range of operating conditions.

The metallic mesh substrates also deliver outstanding thermal conductivity and tolerance to thermal shocks, which is an important advantage for DeOxo, where exothermic reactions and transient oxygen spikes can create steep temperature gradients. As demonstrated test descriptions 1-3, CataLite® coatings adhere strongly even under extreme thermal cycling and vibration, offering long operational lifetimes with minimal degradation or delamination.

Coating Stability

Test 1: Thermal Cycling of CataLite® Mesh



Catalyst specification

Mesh material: High temperature ferritic stainless steel EN 1.4767
Wire diameter: 0.5 mm
Mesh opening: 1.3 mm
Catalyst comp.: Stabilized Platina on y-Al_2O_3

Test method

Continuous temperature cycling between 150 and 900 °C
Conditions: 100.000 cycles of 10 s each

Conclusion

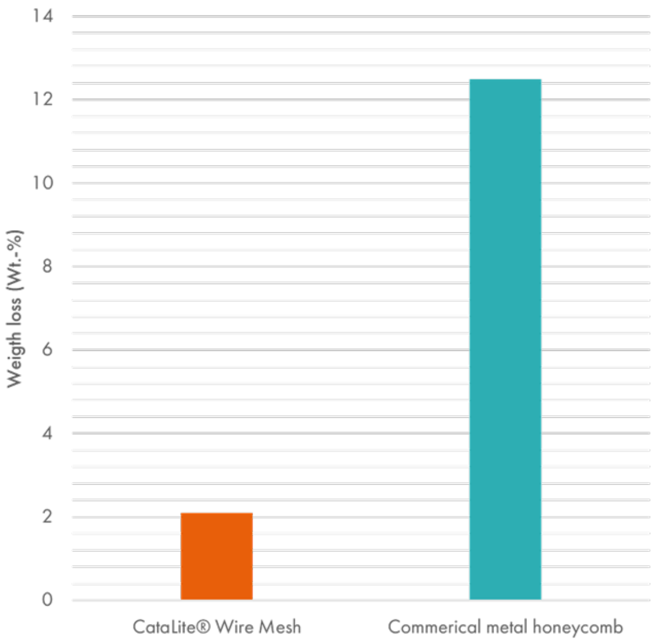
Catalyst coating highly stable, weight loss of catalyst < 1 wt%

Reference

Internal customer report

Coating Stability

Test 2: Wire mesh vs metal monolith substrate



Catalyst specification

Mesh material: High temperature ferritic stainless steel EN 1.4767
Wire diameter: 0.5 mm
Mesh opening: 1.3 mm
Catalyst comp.: Stabilized Platina on y-Al_2O_3

Test method

Catalyst heated in oven at 1000 °C for 24 h followed by ultrasonic treatment of catalyst in room temperature.

Conclusion

Commercial automotive metal monolith catalyst shows approx. 6 times higher weight loss than the wire mesh CataLite® catalyst

Reference

Internal customer report

Coating Stability

Test 3: Thermal Cycling CataLite® Plates

Catalyst specification

Plate material: AISI 310

Catalyst comp.: Stabilized Platina on y-Al_2O_3

Test method

Continuous temperature cycling between 150 and 550 °C

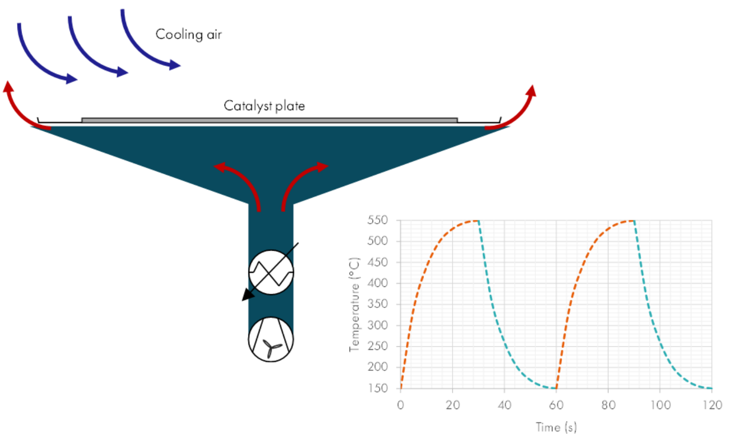
Conditions: 1020 cycles of 60 s each

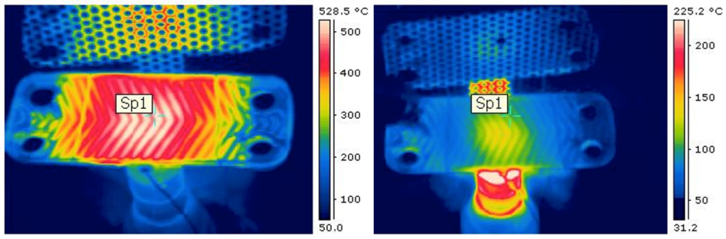
Conclusion

Catalyst coating highly stable, weight loss of catalyst < 1 wt%

Reference

Internal customer report





Because meshes can be formed into virtually any geometry-axial beds, radial beds, compact cartridges, or integrated modules, they enable highly space-efficient and low-pressure-drop reactor designs. This flexibility opens the door to process intensification, allowing DeOxo units to become smaller, safer, and more energy-efficient while maintaining excellent catalytic performance.

In this paper, the performance of a series of mesh-type CataLite® catalysts is demonstrated at demanding DeOxo conditions.

CataLite® DeOxo

The performance of mesh-type CataLite® catalysts in DeOxo service, CataLite® Deoxo, was evaluated using a series of samples exposed to varying pressures, temperatures, and moisture levels. Two experimental conditions were selected to represent dry, ambient operation and a more industrially relevant high-pressure, humid environment:

Test 1: 5000 ppm O_2 in H_2, anhydrous gas, 25 °C, atmospheric pressure

Test 2: 5000 ppm O_2 in H_2, 5 % H_2O, 90 ℃, 16 bar(g)

Oxygen concentration was measured upstream and downstream of the reactor using a Southland Sensing OMD-507 analyzer. Figure 1 shows the oxygen conversion as a function of Gas Hourly Space Velocity (GHSV) between 50,000 and 250,000 h^{-1} for Pt/SiO_2 and Pt/Al_2O_3 CataLite® coatings applied to 20-mesh EN 1.4767 substrates. The conversion target was defined as 99.96 %, corresponding to 2 ppm O_2.

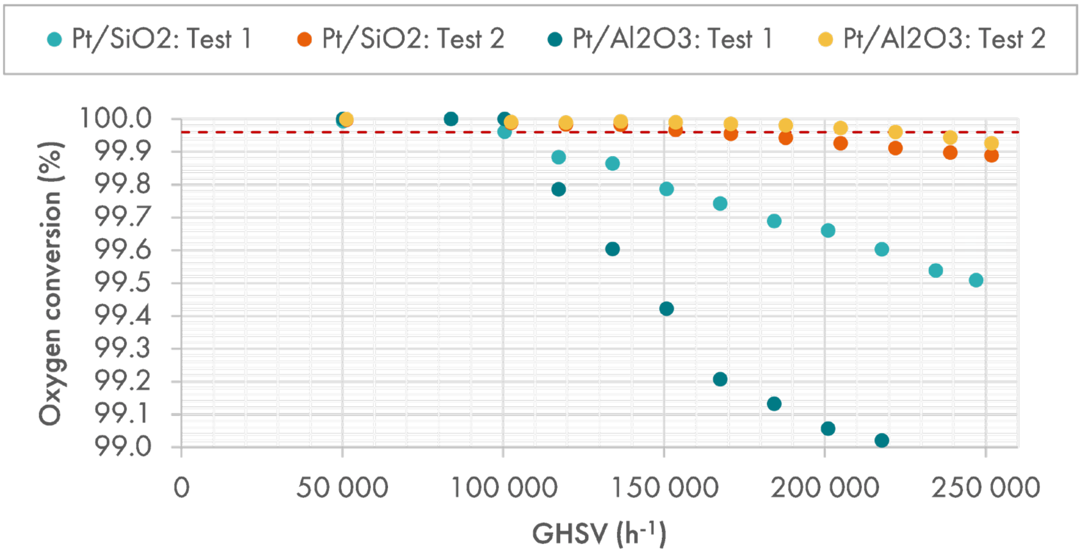


Figure 1. Conversion of oxygen as function of GHSV according to Test 1 and Test 2 for a Pt/SiO2 and Pt/Al2O3 CataLite® mesh-type of catalyst.

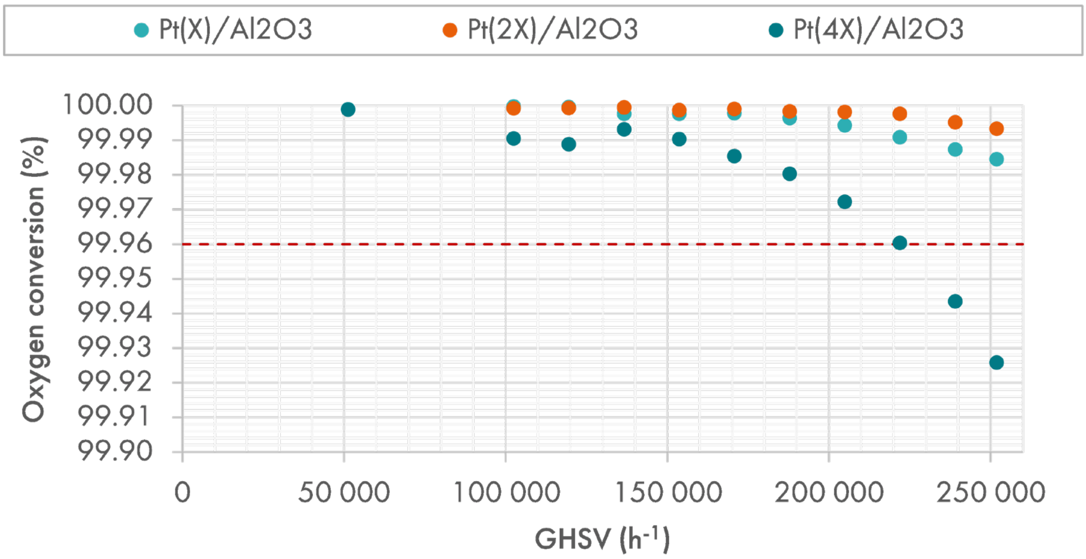


Figure 2. Conversion of 5000 ppm oxygen in a hydrogen stream over a series of Pt/Al2O3 CataLite® catalysts. Reaction temperature = 90°C, Operating pressure = 16 bar(g), steam content = 5 vol-%.

Both catalyst formulations reached the target conversion at high space velocities: approximately 100,000 h^{-1} for Test 1 and 150,000 h^{-1} for Test 2. The increase in temperature from 25 °C to 90 °C clearly offset the inhibition associated with water vapor and elevated pressure. A notable observation is the shift in optimal support: the silica-based coating performed best under dry, ambient conditions, while the alumina-based catalyst outperformed it at higher temperature, pressure, and humidity.

Because industrial DeOxo units often operate under moist, pressurized conditions, further testing focused on the alumina-supported system under the Test 2 conditions. Figure 2 shows the effect of varying platinum loading by a factor of four. A moderate increase in Pt concentration improved performance, but further doubling led to diminished activity, falling below the conversion target at lower GHSV values. This suggests an optimal loading regime beyond which additional Pt does not translate into higher catalytic efficiency.

Conclusion

The results demonstrate that CataLite® mesh-type catalysts are well suited for high-performance DeOxo applications. Both Pt/SiO_2 and Pt/Al_2O_3 coatings achieved >99.96 % oxygen conversion at exceptionally high GHSV values of 100,000-150,000 h^{-1}, even at O_2 concentrations as high as 5000 ppm. These values significantly exceed typical literature-reported GHSVs for DeOxo systems, which often fall in the range of 1,000–20,000 h^{-1} for ppm-level O2 removal at temperatures below 100 °C. The ability to maintain near-complete conversion at GHSV values an order of magnitude higher highlights both the intrinsic activity of the CataLite® coating and the excellent mass- and heat-transfer properties of the mesh substrate.

The tests also reveal clear structure-activity relationships. Silica supported catalysts excel in dry, ambient environments, whereas alumina-supported catalysts outperform under elevated pressure, temperature, and humidity conditions representative of industrial hydrogen purification. Furthermore, platinum loading showed an optimal range: moderate increases improved activity, while excessive loading led to reduced effectiveness, likely due to diffusion limitations or changes in dispersion.

Overall, the combination of high catalytic activity, strong thermal and mechanical stability, and extremely high permissible GHSV demonstrates the suitability of CataLite® mesh catalysts for compact, low-pressure-drop, and high-throughput DeOxo reactors. These attributes enable smaller and more efficient system designs while maintaining stringent oxygen purity requirements.

Let us know how we can help you!
Please reach out for further information to
info@catator.com

Based in Lund, Sweden, Catator is a world-leading technology develoment and integration partner for the commercialization of hydrogen and fuel cell technologies. Our mission is to accelerate the transition to a green hydrogen economy by creating the world's most compact, efficient and versatile solutions for hydrogen production, conversion and utilization.

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