



Minimizing the total cost of ownership
of catalytic DeNOx units



Managing a DeNOx installation strategically could save you up to \$100,000 per year

Dear colleague operator

You don't need us to tell you that new catalytic DeNOx installations are expensive to buy, operate and maintain. However, experience shows that with the appropriate global approach the total cost of ownership of a DeNOx installation can be reduced significantly.

Our goal is to help our customers to benefit from this **real savings potential**. Whether they are new or older installations, our approach can be adapted to a multitude of specific situations. Probably yours too. Although the scope of application is broad, the objective remains the same: to **minimize the total cost of ownership**, the most important criterion for operators.

This brochure gives a practical overview of our approach and we hope you will find the presentation interesting. But don't stop there: feel free to **contact us** for an in-depth consultation. Our experts **can explore with you** all the possibilities for improvement. They will assess their feasibility and provide all the necessary elements to calculate the gains that can be made.

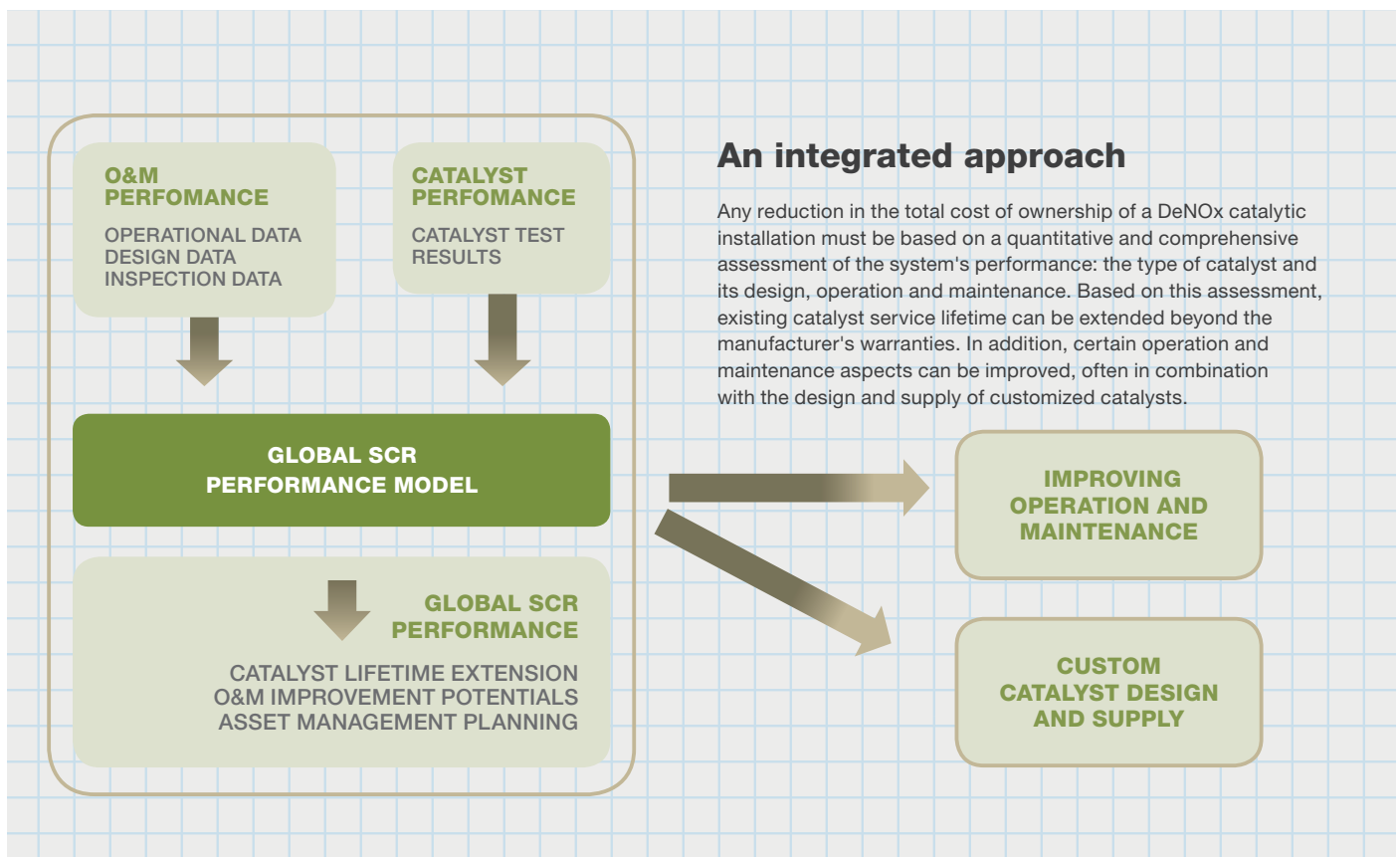
We wish you a pleasant read and hope that you will give us the opportunity to turn our words into action in the near future.



Xavier Henry
International VP,
Head of the SCR & Chemistry
businesses at ENGIE Laborelec

THE ESSENTIALS

- Postponing catalyst replacement is entirely possible, provided that its condition is independently assessed.
- By addressing a range of aspects of the operation and maintenance of a DeNOx unit, it is often possible to increase its overall performance. In other words, it is not only the catalyst that counts.
- There are cost-effective alternatives to simply replacing the catalyst, e.g. regeneration or washing.
- Where catalyst replacement cannot be avoided, less expensive solutions that don't require using the original equipment manufacturer (OEM) are available.



Why choose ENGIE Laborelec?

A complete portfolio of services and products for operators, by an operator

ENGIE Laborelec has the necessary knowledge, the experience, the experts and the tools to assist customers at every stage of the DeNOx system's life cycle. ENGIE Laborelec offers comprehensive support, reliable advice and solutions that are independent of equipment manufacturers: feasibility studies, installation design, commissioning and above all the operation and maintenance optimization.



25 years of experience

For many years, we have been involved in optimizing the design, operational performance and maintenance of more than 100 DeNOx catalytic installations around the world.

Our experts are part of a vast international network of specialists that includes technology suppliers, manufacturers, user groups, universities and research institutes.

Multidisciplinary expertise

In addition to its long-standing expertise in flue gas treatment, ENGIE Laborelec has specialists in related fields, such as combustion, boilers, thermal processes and materials technology. All these people work together to draw up a complete analysis of an installation's performance and its impact on upstream and downstream equipment, applying an operator's logic.

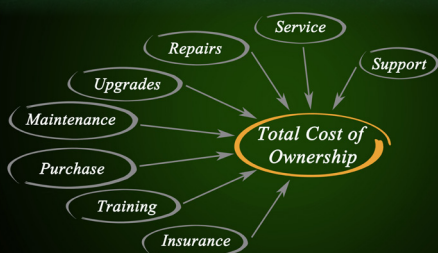
Because it is part of the ENGIE group, ENGIE Laborelec has practical knowledge of operating and maintenance practices and is completely manufacturer-independent—advantages which none of its competitors can offer.



The ultimate goal: minimizing the total cost of ownership

The various strategies we propose to put in place all have the same ultimate objective: reducing the total cost of ownership of your DeNOx facility, a key objective for any operator.

We provide advice on extending the catalyst lifetime initially set by its original guarantee. At the same time, our experts focus on improving operating and maintenance conditions, since these aspects can also make a significant contribution to extending your installation's service life, efficiency and overall performance. We also provide custom solutions for operational improvement as well as catalyst sizing.



01 How is your DeNOx installation doing? Evaluate to better replace

Is it possible to extend catalyst life? To answer this question, certain data are needed. That is why we carry out on-site inspections and laboratory testing to accurately assess the current status of your installation. On the basis of these data, we carry out an initial analysis of the remaining lifetime of the catalyst and formulate practical recommendations to improve its operating and maintenance conditions.

OPERATION AND MAINTENANCE PERFORMANCE



CATALYST PERFORMANCE



OVERALL INSTALLATION PERFORMANCE



Evaluation of operational and maintenance aspects

Our experts gather information on site:

- thorough visual inspection of the catalyst layers and the overall DeNOx system.
- collection of design and operation data.
- sampling of the various elements of the catalyst.



Determining the catalyst's performance

Samples from the catalyst are tested in the laboratory to assess:

- catalyst activity
- the SO₂/SO₃ conversion
- pressure drop
- chemical and physical composition.

Testing is carried out in line with the international standard VGB-S-302-00-201-2014-04-DE, which guarantees that the results obtained are representative.



Evaluation of overall performance

Based on the on-site inspection, the catalyst measurement results and design and operation data, our experts determine the overall DeNOx performance.

Our models, proven over 25 years, allow us to evaluate the installation's overall performance, possible operational improvements, and catalysts' remaining lifetime.

Advantages

Using ENGIE Laborelec to assess the **overall performance** of your DeNOx installation to:

- **increase your staff's expertise:** staff gain access to our knowledge-base as an operator and receive clear advice and explanations on the impact of the various operating and maintenance parameters, as well as on the catalyst's performance.
- **plan the risk-free management of your assets:** the quantitative assessment of the catalyst's remaining lifetime helps you with your budget planning. The proposed replacements or actions take into account practical considerations such as the actual operation and the timetable of scheduled shutdowns.
- **achieve substantial savings:** you receive a quantitative assessment of the catalyst's remaining lifetime extending beyond OEM guarantees.
- **identify and mitigate the risks of reduced performance:** the risk of unscheduled downtime decreases, some additional costs are avoided, particularly those resulting from a lack of knowledge of the progression/change in your installation's performance.

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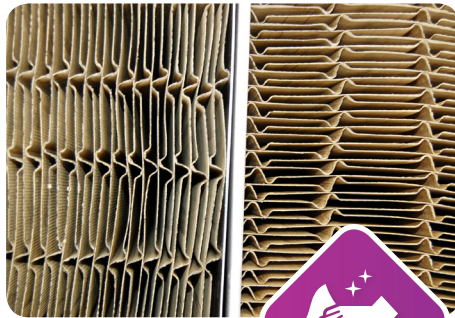
From expert advice to integrated solutions Improving operation and maintenance

Improving operating conditions and maintenance practices can help solve and prevent problems, extend service life and reduce the total cost of ownership of a DeNOx facility. Based on the data collected and laboratory testing, ENGIE Laborelec makes clear recommendations on how to optimize operation and maintenance. And it works with the staff on the ground to provide solutions tailored to each installation.



Ammonia injection adjustment

ENGIE Laborelec has the experience and is fully equipped to adjust the reagent injection to improve the NH_3/NO_x ratio. This improves the overall performance of the DeNOx unit and extends catalysts' remaining lifetime.



Catalyst cleaning systems

Our experts provide support both for new systems and to improve existing systems. We provide custom solutions for each installation. Our various cleaning approaches have already been implemented in over 100 reactors worldwide.



Other examples of custom solutions

Depending on customer needs, we design and supply specific DeNOx installation components, such as emission analyzers, on-site laboratory equipment for NH_3 measurement, NH_3 injection control loop optimization, etc. We also offer on-site staff training.

Advantages

Using ENGIE Laborelec to **improve the operation and maintenance** of your DeNOx installation to:

- **reduce the risks of decreased performance:** with the proposed measures for improvements, certain risks are reduced, such as the risk of unscheduled stoppages or increased operating costs.
- **increase the catalyst's lifetime:** experience shows that some operating or maintenance practices are harmful to the catalyst. Stopping these practices therefore has a positive impact on the catalyst's lifetime.
- **build up your staff's expertise:** operational and maintenance improvements are introduced working closely with your staff; this increases their understanding of the technology and ensures that measures are sustainable.

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Focus on total cost of ownership

Custom catalyst design and supply

Sooner or later, replacing the catalyst becomes inevitable. ENGIE Laborelec can size and supply a very wide range of products, developed to suit each installation meeting its own specific criteria. Catalyst replacements are also sometimes combined with structural improvements to solve operational problems, significantly reducing the total cost of ownership of your facility. This is all covered by our operating guarantees based on our long experience.



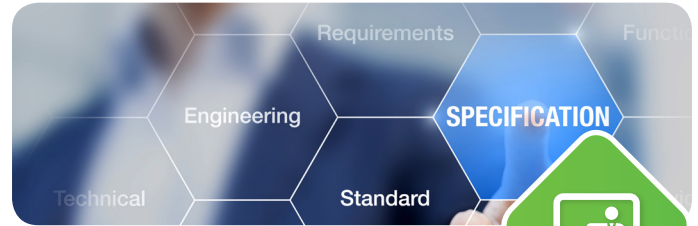
Supply of new or regenerated catalysts

Original equipment manufacturers are generally inclined to offer expensive standard proposals.

For catalysts, ENGIE Laborelec is able to offer a wide range of alternative solutions:

- New catalyst specially designed by ENGIE Laborelec to meet the individual constraints of each installation;
- Catalyst regenerated in line with our operator quality criteria, to reduce the risks associated with this approach; guaranteed overall DeNOx system, including catalysts from different manufacturers and based on actual operating conditions.

These solutions, precisely because they are adapted to the specific needs of your installation, result in a lower total cost of ownership compared to OEM solutions, and this is guaranteed by ENGIE Laborelec.



Supply of catalyst in tandem with structural improvements addressing operational problems

Depending on the quality of the original DeNOx system sizing, and operational experience, an efficient catalyst is not always sufficient to ensure optimal overall performance.

It is often necessary to make improvements to operating and maintenance practices and/or equipment at existing installations.

In its approach, ENGIE Laborelec, as an expert operator, is able to combine the custom design of catalysts with operational improvement solutions, such as adjusting cleaning systems, temperature management, ammonia injection optimization, etc.

Combining catalyst replacement with the structural improvement of DeNOx units allows us to guarantee longer service lifetimes than standard OEMs, with a positive effect on the total cost of ownership.

Advantages

Using ENGIE Laborelec for the sizing and **supply of catalyst solutions** for your DeNOx installation to:

- **have independent access to a comparison of alternative scenarios:** as an independent operator, we have no preference for particular products, but are willing to advise operators in a transparent manner, with their best interests in mind.
- **reduce the total cost of ownership:** among the various alternatives proposed by ENGIE Laborelec, there is always an offer that, compared to that of an OEM, guarantees a significant reduction in the total cost of ownership.
- **procure custom catalysts:** we can size new catalysts or regenerate them ourselves. This work is tailored to the specific characteristics and needs of each installation, and at a competitive price.
- **guarantee impeccable quality control:** we have a proven methodology for quality control during the manufacturing process.

Getting around the OEM monopoly

The DeNOx catalyst system market is generally dominated by the know-how of OEMs and catalyst manufacturers, who set maintenance and replacement programmes based on their own guarantees. Because equipment manufacturers do not provide access to their know-how, most operators are obliged to follow their recommendations as they lack the knowledge or ability to carry out independent tests.

ENGIE Laborelec, as an expert operator, is able to counterbalance this monopoly of know-how. We are totally independent. Our goal is to reduce the total cost to operators of DeNOx system ownership, whereas OEMs and manufacturers rely on frequent repairs and replacements to increase their revenues.

What distinguishes us from standard manufacturers

ENGIE Laborelec	Standard manufacturers
<p>✓ The frequency of catalyst testing is based on the actual condition of the catalyst.</p>	<p>✗ Catalyst testing frequency is fixed, generally high, and independent of the actual condition of the catalyst.</p>
<p>✓ Catalyst tests are carried out in independent and highly reputable laboratories, in line with international standards such as VGB-S-302-00-201-2014-04-DE. This ensures that the results obtained are representative.</p>	<p>✗ Tests are carried out in the OEM's laboratories and according to its own procedures, in a non-transparent, non-representative manner and unrelated to the VGB-S-302-00-2014-04-DE standard.</p>
<p>✓ The results of laboratory analyses can be complex. ENGIE Laborelec translates them so as to arrive at an overall evaluation of the performance of your DeNOx system and to respond to issues of most concern to you.</p>	<p>✗ Laboratory measurement results are often transmitted in a complex raw format, which does not answer operators' questions.</p>
<p>✓ Possibilities to extend catalyst lifetime are clearly assessed and objectively quantified.</p>	<p>✗ Only the lifetime initially provided for in the manufacturer's guarantee is taken into account, or the remaining lifetime is assessed in a vague and non-quantitative manner.</p>
<p>✓ The total cost of ownership is kept as low as possible. ENGIE Laborelec's independence from equipment manufacturers reduces total cost of ownership for the following reasons:</p> <ol style="list-style-type: none">1. the replacement of catalysts is assessed in a transparent manner, with the objective of maximizing lifetime;2. operating performance analysis and the proposed solutions are adapted to each unit;3. custom sizing of several alternatives is carried out, and these alternatives are compared transparently with criteria relevant to operators.	<p>✗ The total cost of ownership is high for the following reasons:</p> <ol style="list-style-type: none">1. catalyst replacement is imposed by equipment manufacturers;2. the potential for improvements in operation and maintenance is ignored;3. OEMs only offer their own products, irrespective of operator needs.



Five reasons to choose ENGIE Laborelec

- It has a wide range of technical skills in the fields of energy production, transmission, distribution and use.
 - It can increase the profitability and sustainability of your energy processes and assets
 - It offers the unique combination of contract research and operational assistance
 - It provides independent advice based on certified laboratory and field analyses worldwide.
 - It has over 50 years' experience in the field.
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**FOR MORE INFORMATION
PLEASE CONTACT US:**

- Online at denox.laborelec.com
- Email us at denox.laborelec@engie.com