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GETTING TO ZERO

TECHNICAL SOLUTIONS THAT HELP REDUCE
GREENHOUSE GAS EMISSIONS NOW

+



**RETROFITTING
DIESEL EQUIPMENT
AND VEHICLES
FOR A GREENER
FUTURE**

T.F. HUDGINS,
AN ALLIED RELIABILITY
BRAND, AND HJS
EMISSION TECHNOLOGY

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EXECUTIVE SUMMARY

Clean transportation is a political and economic imperative.

Driven by new efforts to reduce greenhouse gas (emissions and air pollution), the development of emerging technologies will play an increasing role in the future of transportation and possibly other sectors of the economy. Some of these technologies may replace internal combustion engines in some applications, but the availability and cost framework has not been adequately clarified.

As we wait for sustainable, energy-saving alternatives to mature and adequately scale, immediate action can be taken to reduce emissions by retrofitting existing diesel-powered engines and other equipment to protect human health and the environment today.

One example of an action that can be taken immediately is the remote monitoring of equipment to ensure compliance with EPS emissions requirements. Read on to learn how you can efficiently and cost-effectively work towards zero emissions in the short term, by taking advantage of the various retrofit technologies currently available.



DID YOU KNOW?

The estimated economic benefits of improved air quality far exceed the costs of implementing the measures.¹ Currently updated WHO Air Quality Guidelines of 2021 emphasize the importance of reducing air pollution concentrations at all levels.²

¹ Amann et al. 2017

² <https://www.ersnet.org> - WHO/AQGs - WHO/Air Quality Guidelines 2021

BENEFITS OF RETROFITTING

Modernizing existing industrial equipment and vehicles gets us closer to Zero.

For our purposes, modernization means retrofitting with state-of-the-art parts and systems. It's the addition of components or accessories that were not installed during the original production, or which do not comply with the latest standard, for a given piece of equipment or vehicle.

Retrofit technology includes filters, catalytic converters, and ammonia exhaust aftertreatment that target various pollutants expelled into the atmosphere, including carbon monoxide (CO), hydrocarbons (HC), particulate matter (PM), and nitrogen oxides (NOx), bringing in-service units to a comparable level of technology as new vehicles.

Retrofitting medium-duty vehicles, heavy trucks, buses, and in off-road, mining and marine applications of various types holds great potential for rapid and cost-effective reduction of pollutant loads. Depending on their nature, type, and age, the cost-benefit ratio is good to very good.

The replacement of older equipment and vehicles to meet or exceed the highest emission standards takes on average more than 10 years. Ten years is too long. We need a stopgap.

Retrofit technologies offer many benefits to help reduce harmful emissions:

- Available, highly effective, and cost-efficient
- Fast improvement of air quality values with little effort
- More economical investment choice than purchasing new equipment
- Increased energy efficiency
- Allows for current equipment to operate to end of life
- Opportunity for expanded use of low-carbon, renewable biofuels
- Can be used for all diesel-powered vehicles and equipment

Although other zero-emission solutions may soon enter the market, diesel technology is expected to be the preferred propulsion technology for the next ten to fifteen years, especially for heavy-duty vehicles, marine, locomotive engines, and other off-road vehicles.

"DIESEL RETROFIT TECHNOLOGIES ARE AVAILABLE, EFFICIENT, FIELD-TESTED, VERT APPROVED, ECONOMICAL, AND READY FOR USE."



DID YOU KNOW?

E-fuels are synthetic, produced regeneratively from water and carbon dioxide (CO₂). This fuel type influences the emission behavior of engines. By using biogenic fuels or natural gas, pollutant and CO₂ emissions can be significantly reduced – all the way to CO₂ neutrality.

INNOVATIVE GREEN SOLUTIONS

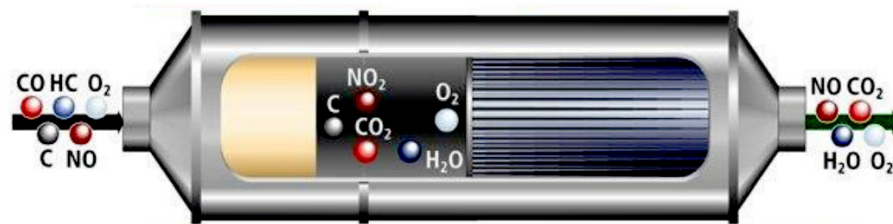
T.F. Hudgins, an Allied Reliability brand, and HJS Emission Technology provide techno-economic solutions to go-green, or greener.

The immediate future may very well be powered by what we're calling "next generation" advanced diesel technology. Equipped with diesel emission control systems that run the performance under real driving cycles, it is the ideal bridging solution until true Zero emission technology is commercially viable.³

Here are just a few of the [innovative solutions](#) offered by T.F. Hudgins and HJS Technology...

DIESEL PARTICULATE FILTER CONTROL

The HJS particulate filter system, trademarked SMF,[®] is designed to effectively capture soot particles, including fine-grain dust, and even cleans itself of deposited soot continuously and autonomously. It uses proven HJS-SMF technology with passive regeneration to reduce the gathered soot and combines with a high-efficiency diesel oxidation catalyzer (DOC) that connects upstream of the SMF for optimal results. The particle filter can be supplied with a catalytic coating for further support of regeneration (i.e. cleaning).



Shows oxidation catalyzer (left) and SMF filter module (right).

How it works

Once an exhaust gas temperature exceeds 200° C, the cleaning of the filter starts. The nitrogen dioxide, formed with the aid of an oxidation catalyst (NO₂), impinges on the deposited soot on the filter bags. The soot particles are oxidized and reduced, and the NO₂ previously formed is reduced again to nitric oxide (NO).

The continual repetition of this chemical process enables the HJS partial-flow, sintered-metal filter to be cleaned with no human intervention and typically no additional regeneration aids required.

APPLICATIONS

This system is mainly suited for off-highway applications, commercial vehicles and buses, as well as in combination with an SCR system for nitrogen oxide reduction. The technology is used for stationary engines, construction machinery, rail, and marine.

³ <https://epa.gov/cleandiesel/verification/verif-list.htm> and www.arb.ca.gov/diesel/verdev/vt/cvt.htm

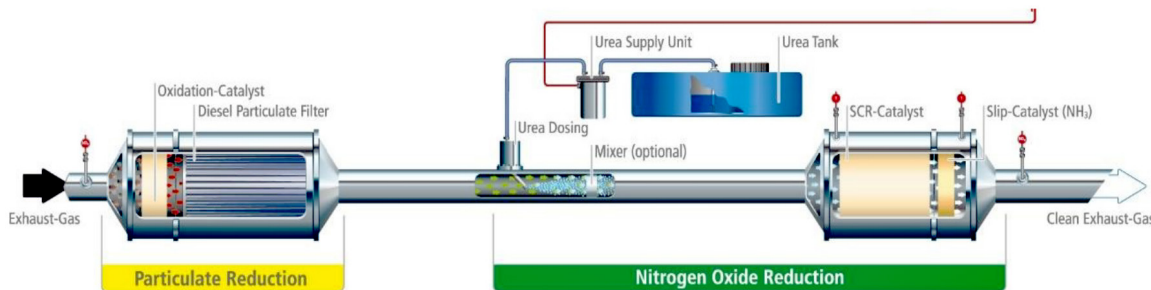
INNOVATIVE GREEN SOLUTIONS (CONTD.)

SELECTIVE CATALYTIC REDUCTION (SCR) TECHNOLOGY

HJS has developed a selective catalytic reduction technology system, trademarked SCRT,[®] consisting of diesel oxidation catalysts (DOCs), a [diesel particulate filter](#) (DPF), and NOx reduction devices. SCR is one of the most cost-effective and fuel-efficient technologies available to help reduce diesel engine NOx emissions.

The reductant source is automotive-grade urea, otherwise recognized as diesel exhaust fluid (DEF). The DEF can be rapidly broken down to produce oxidizing ammonia in the exhaust stream. It initiates a chemical reaction that converts nitrogen oxides into nitrogen, water, and tiny amounts of carbon dioxide (CO₂), natural components of the air we breathe, which are then expelled through the vehicle tailpipe.

“THE SCR TECHNOLOGY CAN BE INTEGRATED INTO EXISTING INFRASTRUCTURE AND CAN REDUCE NO_x UP TO 97 PERCENT IN MANY CASES.”



Shows SCRT technology flowchart.

INTEGRATION WITH OTHER SYSTEMS

Greater results can be realized when SCR is combined, for example, with:

- CRT (Continuous Regenerating Trap)

How it works

The system injects a liquid reductant agent through a special catalyst into the exhaust stream of the diesel engine.

Note that many of the same advances can be applied to existing fleets to reduce targeted pollutant emissions from older diesel engines—enabling you to retrofit, or upgrade, to the newest exhaust gas emission standards. Upgraded vehicles operating in critical low-temperature cycles often achieve significantly lower NOx-emission values than comparable “standard” OEM solutions.

INSTALLATION, REPAIR, & MAINTENANCE

All services are focused on safety, quality, and schedule.

Installation of DPF systems require care and attention, and the quality of the work is essential to providing long-term performance. TF Hudgins provides the complete installation through trained local installers under the direction of TFH engineers. The installation may be performed at the customer's maintenance shop or offsite, as required. We even provide union labor, where required. For every system that is commissioned and operated, we establish baseline data for performance over the life of our filters. Installation supervision ensures safe and trouble-free operation and maximum usability.

Installation of DPF systems and components includes:

- Review of contract documents and overall works
- Solve organizational issues of installation
- Provide technical preparation of the project
- Project implementation:
 - Supervise/train installers and technicians
 - Supply all equipment and additional spare parts, as required
 - Delivery of a fully working installation
 - Carry out commissioning, output equipment to the declared capacity
 - Complete the installation by drawing up an act of the work done and acceptance of the installation by the customer

Maintenance & repair services include:

- Trained representatives conduct routine system audits and verify performance of the filters.
- TFH can also perform repair and maintenance of installed systems under contract using our supervision in conjunction with the local workforce.
- TFH will maintain a local inventory of spare parts.
- TFH provides Service and Troubleshooting Manuals and maintains a 24-hour Help line.
- All repair history and system alarms are logged and stored in the cloud for analytics and historical purposes.
- The active regeneration and SCR systems have on-board software, diagnostics, and historic data storage that enables technicians and users to track and record the operational history of each installed system. The information can be downloaded onto a portable storage device or to the cloud and then analyzed and reported. Each system will have its history stored for reference and assessment

OUR PROMISE

- We operate and conduct operations with high safety standards for all aspects of our work.
- We use proven procedures and training to ensure installations are of exceptional quality and performance.
- We provide on-time out-comes for each installation.

REMOTE MONITORING

Many companies rely on remote monitoring of diesel equipment to ensure particulate reduction.

Remote monitoring of diesel equipment provides real-time insight into equipment performance and operational efficiency of diesel particulate reduction strategies. This and integration of the HJS Aftertreatment Control Unit (ACU) and the Telematics System deliver a best-in-class level of reliability.

The ACU supplies the integrated Telematics System with all relevant system data required for transmission via the Telematics Unit. T.F. Hudgins provides a cloud-based interface for data storage and presentation. In further support of remote monitoring, TFH provides customizable, flexible configuration options for data collection, data analysis and visualization, and expert support.

We also can perform emission tests in accordance with accepted industry standards on a weekly or as-needed basis.

The ability to react quickly to performance degradations or malfunctions will give you the reassurance you need that equipment is meeting emissions requirements in a consistent manner.

EMISSIONS DATA COLLECTED

- Exhaust temperature
- Particulate matter count
- NO_x values
- CO₂ values (raw, from engine output with no after treatment)
- Hydrocarbons installation.

We're certified around the world.

HJS International Retrofit Certifications

Switzerland: SN 277206 (VERT)

Germany: Annex 26 / 27

Italy: Decret No. 39

The Netherlands: RDW / TNO

Malta: Informal application

Denmark: Teknologisk Institut (202-5061-42)

United Kingdom: LEZ (CV) LEC (CVRAS)

Sweden: VVFS 2003:29

France: Regulation of 15.05.2013

United States: MSHA



CASE STUDY – TRANSPORTATION

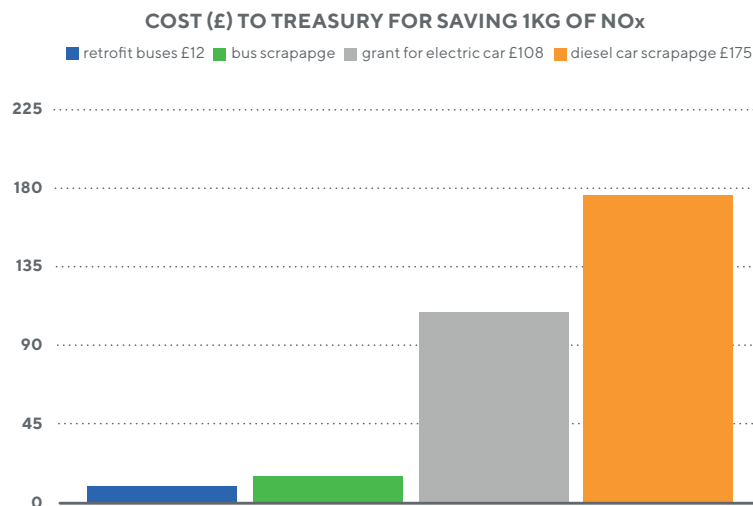
Investing in London’s “clean” buses delivered the best value for money.

OVERVIEW

Few retrofits exist for cars; furthermore, they are unproven in the real world and are very difficult to monitor in service. And if a scrappage scheme is justified for diesel cars, the case is even more compelling for diesel buses. The ambitious goal to retrofit the fleet of London’s buses is a prime example of lifetime extension and economic efficiency. It proved to deliver Euro VI emission performance and to maintain reliability with the use of direct monitoring already in place.

SOLUTION

The city of London opted for the bus retrofit and scrappage allowance, as it offered better value for their money than implementing a diesel car scrappage scheme or obtaining grants for electric cars. Real-world testing of Euro V1 diesel buses demonstrated a 95% reduction in NOx emissions compared with Euro 2 vehicles.



RESULT

Currently, a journey by diesel car, even a Euro 6, emits ten times the per passenger (9383 mg NO_x/km) of a comparable journey by a Euro V1 bus (40 mg NO_x/km). The NO_x emissions from a Euro V1 bus are even lower than a Euro 4 petrol passenger car (43 mg NO_x/km).

SUMMARY

This city-wide project demonstrated that cost, in terms of NO_x saved, is 15 times more expensive for diesel car scrappage than retrofitting buses. And it is 11 times more expensive than a bus scrappage scheme. To date, HJS has successfully upgraded up to 20,000 city buses in several major cities of Europe: Madrid, Berlin, London, Birmingham, and Manchester.

CONCLUSION

Retrofit towards Zero emission pays off.

Air pollution is one of the greatest environmental threats to human health, along with climate change. Improving air quality can also benefit climate change mitigation. Reducing emissions, in turn, will improve air quality.

There are several upgrade options for use in both vehicles and equipment that meet even the most stringent international emission standards. Retrofitting of machines is the most effective and economical solution for rapidly moving towards zero emission.

The upgrade technology discussed herein has been tested and approved, and it is available for fast installation, without waiting for the equipment to be replaced at the end of its life cycle, which could take years.

T.F. Hudgins and HJS Technology have excellent technical know-how, high-quality standards, reliability, and local service readiness, along with a significant value-added presence in the USA and globally.

Zero emission strategies need both speed and freedom to manage this transition. Clean air in our cities, environmental cleanup, and climate protection are mutually dependent issues. They are more topical than ever, and our joint contribution is urgently required!

CONTACT US

For more information about our products and services, contact us as follows:

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United States of America

[Engineered Products from T.F. Hudgins | Allied Reliability](#)

Since our founding in 1947, T.F. Hudgins, an Allied Reliability brand, has delivered engineered product and service solutions for compressors, engines, pumps, motors, and other machinery with a focus on increasing reliability, longevity, performance, safety, and environmental compliance.

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Federal Republic of Germany
www.hjs.com

Founded in 1976, HJS Emission Technology has been providing turnkey solutions and innovative components for emission control with a focus on exhaust gas technology, guided by the principles of environment and health protection. Thinking about tomorrow.



ASK ABOUT OUR ENGINEERED PRODUCTS AND SOLUTIONS TODAY, FOR A GREENER TOMORROW.

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Understanding how critical asset failures impact the environment, production, financials, and safety enables us to deliver the right monitoring, analytics, decision making and maintenance plans.

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