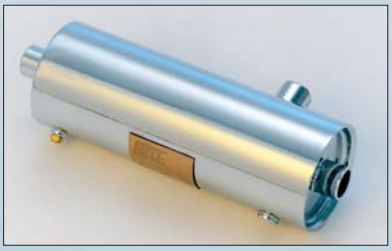
Catalytic Mufflers



... the emission control authority.

NTT® Technologies Inc.

Catalytic Mufflers

comply with **OSHA** *air quality standards ...*

improve the working conditions and productivity ...

protect products from detrimental exhaust emissions ...

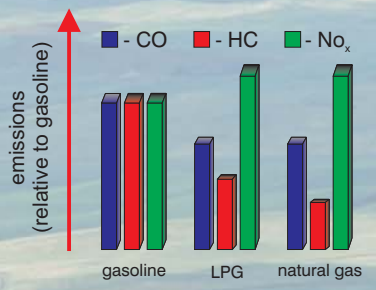
NETT® Catalytic mufflers present a simple, practical, and cost-effective solution to the problem of exhaust emissions from internal combustion engines in the workplace. Several advantages of NETT® mufflers make them the superior choice for most LPG-powered, natural gas and gasoline engines used in material handling and construction applications:

- *High reduction of toxic gases.* Carbon monoxide emissions are typically reduced by over 90%. Hydrocarbons are reduced by 70 to 90%. The characteristic smell of propane exhaust is virtually eliminated. Over 90% reduction of nitrogen oxides may be achieved if the NETT® 3-way catalyst system is used.
- *Excellent noise attenuation.* NETT® catalytic mufflers match or surpass the noise attenuation performance of the original silencer.
- *Long life and high durability.* Mufflers are built entirely from corrosion resistant materials: aluminized and/or stainless steel.
- *Direct-fit design.* All models are a direct-fit replacement for the original muffler. Installation time and cost are reduced to a minimum.

Controlling LPG Emissions

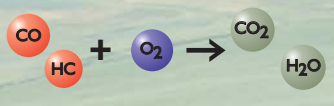
Liquified Petroleum Gas (LPG) is a mixture of petroleum and natural gases of high propane content. It is the most common fuel used for material handling vehicles (forklift trucks) in North America. LPG was introduced many years ago as a "clean burning" fuel. It is somewhat cleaner fuel than gasoline, especially due to its intrinsically low hydrocarbons emissions and the total absence of the heaviest and most toxic hydrocarbon species. However, as most LPG-engine users realize today, other toxic pollutants are abundant in LPG emissions. Safe indoor operation of LPG engines requires an excellent engine maintenance program and special emission control measures.

The major harmful emissions from LPG engines are similar to those from other internal combustion engines, powered by either gasoline or natural gas.

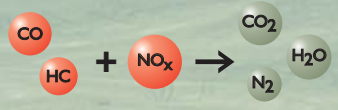


Exhaust Emissions From Different Types of Engines

- **Carbon Monoxide** (CO) is a very toxic, colorless and odorless gas. It causes headaches, dizziness, lethargy, and death. Typically, it constitutes 1-2% of LPG exhaust gas but poorly engineered engine conversions or a rich fuel mixture will result in much higher CO concentrations.
- **Hydrocarbons** (HC) and their derivatives are responsible for the characteristic odor of propane exhaust gases.
- **Nitrogen Oxides** (NO_x) constitute up to 0.25% of LPG exhaust. Because of high combustion temperatures, NO_x emissions from LPG engines are usually higher than those from gasoline engines. They are very reactive gases, extremely toxic to humans and detrimental to many industrial products (e.g. paper stock). A lean fuel mixture, which is sometimes used as a measure to control CO, will increase the NO_x emissions.



Reactions in an oxidation catalyst



Reactions in a 3-way catalyst

The most effective technology to control exhaust emissions is the emission control catalyst. Catalysts are used today on virtually every car sold in North America and they are installed on a growing number of LPG forklift trucks and other off-road equipment.

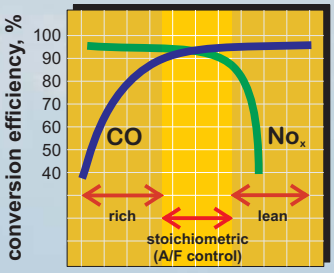
In the *oxidation catalyst,* two of the pollutants - CO and HC - are oxidized by oxygen to form harmless products. A newer catalyst technology is called the *3-way catalyst*. Reactions of CO and HC with NO_x result in the simultaneous removal of all three major exhaust pollutants in this type of catalyst.

3-Way Catalyst Systems

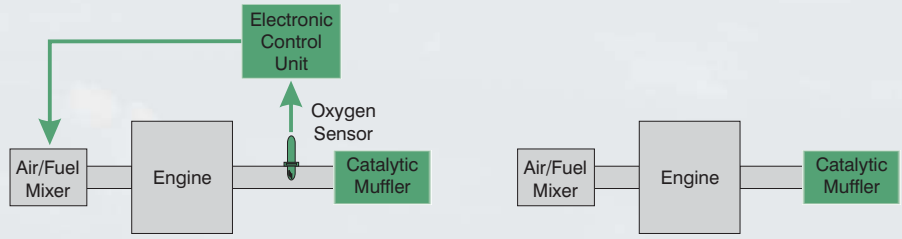
3-way catalytic mufflers for the simultaneous control of CO, HC, and NO_x are available in two configurations:

- **Closed-Loop Control System.** The complete system includes a catalytic muffler with built-in 3-way catalyst, a zirconium oxygen sensor, and an electronic control unit (ECU). The ECU receives a feedback signal from the O_2 sensor and maintains the engine air/fuel ratio at the stoichiometric point, which yields optimal catalyst performance.

This system provides the best conversion of both carbon monoxide and nitrogen oxides and can improve the fuel economy of the truck. Whenever NO_x control is important, use of the closed-loop system is strongly recommended. The air to fuel ratio controller supplied by NETT® Technologies, is a stoichiometric controller. Efficient NO_x control is not possible with lean-biased controllers. On the contrary, the use of a lean-biased controller, or simply a lean-biased tune-up of the engine, will increase the NO_x emissions.



Performance of the 3-Way Catalyst System



3-Way Catalyst - Closed Loop Control System

3-Way Catalyst - Open Loop Control

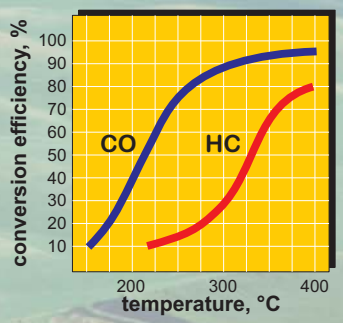
- **Open-Loop Control System.** The catalytic muffler with a built-in 3-way catalyst is installed directly into the existing exhaust system. The performance of the catalyst will vary depending on the engine A/F ratio (see performance chart).

Operating the truck at a lean mixture will result in good CO abatement. Operating the engine at a rich mixture will reduce the CO control function of the catalyst but will improve its NO_x conversion. The overall effect greatly depends on the engine maintenance program.

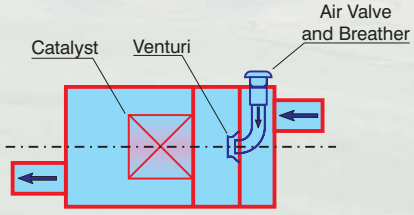
Oxidation Catalyst Systems

Oxidation catalyst systems are designed to control emissions of CO and HC. These systems represent an older emission control catalyst technology but are still popular in retrofit forklift truck applications. Because they need oxygen to achieve high efficiencies, they are also sensitive to the engine A/F ratio. They tend to work more effectively at leaner mixtures, when exhaust gases contain plenty of oxygen.

NETT® oxidation catalytic mufflers include a unique built-in secondary air delivery system to improve performance at stoichiometric and rich engine conditions. The NETT® system combines two devices used to deliver secondary air to the catalyst: a venturi and a check valve. The venturi-created vacuum draws ambient air into the catalyst at high engine speed, when the exhaust gas flow is high. The check valve lets air in as a result of exhaust pressure pulsations. It works effectively at low engine speeds, when the frequency of pressure pulsations is low.



Catalyst Performance At Different Temperatures



NETT® Oxidation Catalyst Muffler

(Noise attenuation components not shown)

Both the oxidation and the 3-way catalyst systems require a certain minimum exhaust gas temperature to work. A typical catalytic conversion of CO and HC as a function of temperature is shown on the left.

All graphs are only illustrative. Catalyst performance varies with engine, its fuel system, and duty cycle.

Other NETT Catalytic Products

NETT Technologies supplies a wide selection of emission control products for the following markets:

- Material Handling
- Construction
- Underground Mining
- Industrial Engines
- Small Utility Engines
- City Buses
- Municipal Trucks

These products include systems for diesel, LPG, natural gas, and gasoline engines. Our standard products and custom designed systems will fit any exhaust system configuration and will meet your emission control requirements.

NETT® Diesel Catalytic Muffler for Clark Model C500-S60

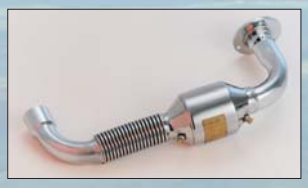
Catalytic Mufflers for Diesel Engines

Similar to the catalytic mufflers for LPG engines, except a special type of catalyst is used. The diesel oxidation catalyst performs without any special engine controls or extra oxygen supply. It effectively controls carbon monoxide, hydrocarbons, and diesel odor. Diesel particulates may be reduced by up to 50%, depending on the engine and type of diesel fuel.

Standard Diesel Catalytic Purifier Model NETT 160

Standard Catalytic Converters

A standard line of catalytic converters for construction, mining, and material handling vehicles, covering all common engine sizes, from very small to very large. They utilize a very robust catalyst design suitable for the most harsh environments.



NETT® Direct-Fit Diesel Catalytic Purifier for Bobcat Model 943

Direct-Fit Catalytic Converters

Direct-fit units for every make and model of equipment. They utilize a similar catalyst design as the standard units but the inlet and outlet configuration is designed to be a direct fit for your equipment, usually replacing a piece of standard exhaust pipe.

NETT® standard products are shipped from stock. Pre-designed models of direct-fit mufflers and catalytic converters are available for hundreds of makes and models of popular construction and material handling equipment. They are shipped either from stock or within a few business days. Custom built units can be designed, fabricated, and shipped in less than one week.

NETT® Technologies Inc.
P.O. Box 27143
Toronto, Ontario
Canada M9W 6L0
Tel.: 905.672.5453
Fax: 905.672.5949
E-mail: sales@nett.ca
Web: http://www.nett.ca

Distributed by