Mission scrubbed!

Foley's engine scrubbers in demand for construction, transportation, mining and other industries

Foley Industrial Engines has been manufacturing and selling diesel and gas engine scrubbers for more than two decades. The demand for the devices has grown considerably in recent years as OSHA and MSHA have strengthened regulations on engine exhaust, particularly in the mining, construction and transportation industries.

The firm's newest line of scrubbers is branded as CleanAirExhaust365 exhaust scrubbers, and Foley has become a major supplier of the devices in the United States. The emission control devices install at the end of an engine's tail pipe and make the exhaust emissions legal and safe to breathe by converting harmful exhaust to water and carbon dioxide. Inside the canister is a honeycomb substrate coated with a small amount of precious metals where the catalytic reaction occurs. Foley scrubbers are used on construction sites, as well as in tight spaces, such as mines and tunnels, throughout the country. Foley scrubbers were used in the construction of Boston's Big Dig.

With a diesel exhaust scrubber a contractor can work safely and legally in a confined space without harming its employees. Foley has supplied scrubbers for both gas and diesel engines to forklift users, concrete saw operators, generator owners and others who need to run an engine in an enclosed space.

While the company maintains an extensive inventory of parts and engines in stock, the scrubbers are a made-to-order item. They can be custom built for almost any engine, according to Jessica Manos of Foley, who said that the company ships out between 500 and 1,000 catalytic scrubbers and mufflers a year.

"All of our scrubbers are made to order so we can guarantee a perfect fit," said Manos. She said contractors just need know the size of the tailpipe and the engine horsepower. Manos also noted the turnaround times for orders is usually within three to five days, but can be reduced to 24 to 48 hours with an added rush option. Orders are shipped from Foley's Worcester facility via UPS.

FOLEY ENGINES

A custom scrubber made at Foley's Worcester, Massachusetts, plant.

Foley was founded more than a century ago, and has long been known as a supplier for Perkins and Deutz engines and engine parts, Ford industrial engines, Twin Disc / Rockford power takeoffs and Zenith carburetors, as well as remanufactured exchange parts. ■

FMI: To learn more visit www.foleyengines.com or call 800-233-6539.

Foley Environmental

Thank you for inquiring about our Foley Exhaust Purifiers and Scrubbers for propane or gasoline fueled engines.

Foley Environmental is a division of Foley Industrial Engines. We are the oldest engine distributor in North America. With almost 100 years in the engine business we have extensive knowledge of exhaust scrubbers and purifiers. This makes us the ideal supplier for your company's needs. Foley Environmental serves both the public and private sectors. Our customer base includes Boston's Big Dig, California public works projects, Brown University, Bucknell University, Hyster Forklift Co., Narragansett Electric Co, IBM, and many more public works projects and companies. Many OEMs, such as Yale and Hyster Forklift Co, now include our Foley Environmental purifiers as standard equipment on new machines. These companies are a testimony to our effective solutions to exhaust emission problems. As the only U.S. based exhaust purifier specialist, we pride ourselves on shipping within 24 to 48 hours of the receipt of an order.

TWO STYLES OF PURIFIERS / SCRUBBERS

Our exhaust scrubbers allow you to work indoors with a propane or gas engine without any health risk. These air purifiers install easily and come in different styles, depending on the application. Here in the East, purifiers really came into their own on Boston's Big Dig. This was the largest public works project since the Tennessee Valley Authority. Foley Engines supplied

most of the purifiers used on this project. Because of the experience gained during the Big Dig, Foley Engines is now an OEM supplier to Hyster and Yale for their forklift purifiers.

Clip-On Style. The easiest to install is simply a clip-on style purifier that installs at the end of the tail pipe. We supply the purifier with the appropriate sized muffler clamp and it installs easily. Depending on the horsepower of the engine, the scrubber is typically the size of a coffee can. Scrubbers are physically larger for a high horsepower engine such as a 1000 HP engine in a generator. When the purifier is no longer needed, such as in a rental application, it can be removed and stored.

Combination Muffler/Purifier. The other style purifier or scrubber is a direct fit combination exhaust purifier/muffler. This style is most appropriate where there is no room at the end of the tail pipe for a clip-on purifier. These applications include skid steer loaders, and zero tail swing mini-excavators. These combination muffler purifiers are exactly the same shape and spatial dimensions as the OEM muffler and the installation time is similar to changing out a muffler. Typically, once installed these are not removed. These muffler/purifiers usually cost up to twice as much because they are both a muffler as well as a purifier.

To keep you up and running, we stock here in the US over 400 scrubbers, both the clip-on style and the combination muffler/scrubber version. Since we are the only U.S. based exhaust purifier specialist, we are able to ship these units quickly, often the same day as the order is placed, and without any customs delays.

We have scrubbers for gas-fueled engines, such as Honda and Wisconsin. The scrubbers for the Honda's are combination muffler/purifiers that are identical to the OEM Honda muffler in size and shape. For Wisconsin engines, we supply a clip-on purifier. But because Wisconsin engines are inherently "dirty," we recommend that you change the carburetor jet size and install new spark plugs and premium spark plug wires such as Accel. See Tech Tip 28, "Spark Plug 101," at Foleyengines.com for more info on Wisconsin spark plugs. The Tech Tip 13, "Foley Engines Clean Air Tip," has more info on exhaust scrubbers for gasoline fueled engines.

What They Do & How They Do It

Simply put, our exhaust purifiers allow you to work indoors close to a gas or propane fueled engine without any health risks. They do this by using catalytic exhaust technology to make the exhaust emissions safe to breathe. Each purifier houses a catalytic core, which eliminates harmful emissions by collecting gas particles and burning off dangerous pollutants. These include particles such as Carbon Monoxide (CO) and Hydrocarbons (HC). The harmful emissions of gas or propane engines are converted into water (H_2O) and Carbon Dioxide (CO_2), which makes it safe to work in close proximity with your machine.

Attached you will find engine exhaust emissions test data for Honda, Kohler, Clark, and Wisconsin (single and multi-cylinder) spark ignition gasoline/propane fueled engines. These engines are typically horizontal shaft and vertical shaft engines such as the Honda GX160 (5.5 hp), Honda GX200 (6.5 hp), Honda GX270 (9.0 hp), Kohler command 11 (11 hp) and the Wisconsin W4-1770 (35 hp). In a typical exhaust gas purifier application (where the engine carburetion jetting is correctly adjusted) the following average exhaust gas emission reductions can be expected.

Carbon Monoxide (CO)	=	70% - 82%+
Hydrocarbons (HC)	=	55% - 88%+
Oxides of Nitrogen (NOX)	=	80% - 85%+

These average exhaust gas emissions reductions are dependent upon using a well maintained, relatively new engine operating with moderate to heavy load which is consuming a regular unleaded on-highway gasoline or liquid propane fuel. In addition the engine carburetor main jet or propane needle jet(s) has been changed (slightly leaned) to provide additional oxygen for increased catalyst activity. The lean jetting change will optimize catalyst performance and minimize CO, NOX and HC emissions. The exhaust gas purifier is a combination purifier/muffler replacement mounted directly to the engine exhaust manifold or an inline exhaust gas purifier.

The attached test data related to a Honda GX270 engine and indicates that 82% by using a model 2SXT-GX240/270 catalytic purifier and a #85 carburetor main jet could reduce the Carbon Monoxide (CO) levels. In

addition Hydrocarbons (HC) was reduced by 88% by using a 2SXT-GX240/270 we saw a reduction in NOX by 80%+.

The attached test data (pages 6-8) lists exhaust gas emissions test results for Honda GX160, GX200, GX270 and a Kohler Command 11 gasoline engine. The engine carburetion for each engine was optimized to minimize emissions without reducing engine power or producing significant increase in cylinder head temperatures. As noted on average the Carbon Monoxide (CO) emissions were reduced by 82% to 92%. The Hydrocarbons (HC) was reduced by 70% to 90% on average.

The attached test data (pages 8 & 9) lists exhaust gas emissions test results for Wisconsin model W4-1770 (35 hp) engine. The engine carburetion for each engine was optimized to minimize emissions without reducing the engine power or producing significant increases in cylinder head temperature. As noted the Carbon Monoxide (CO) emissions were reduced by 50%, Hydrocarbons (HC) emissions were reduced by 51% and Oxide of Nitrogen (NOX) emissions were reduced by 64% on average. Please review and advise.

Pages 9-11 list exhaust gas emission test results for a Clark forklift truck with a dual fuel gas/propane engine and a Broderson carry deck crane with a Continental propane fueled engine. In both cases the engines were operated on propane fuel and carburetion was adjusted slightly leaner to optimize catalyst performance. As noted the Carbon Monoxide (CO) emissions were reduced by 82% to 84%, Hydrocarbons (HC) were reduced by 71% to 73% and Oxide of Nitrogen (NOX) emissions were reduced by 55% to 80% depending on load/speed condition.

We have detailed directions on how to install both styles of gas exhaust purifiers in our Forms Section and on pages 12-15. See Exhaust Purifier Installation Procedures on our website FoleyEngines.com. For the clip-on style, simply call us toll free at 1-800-233-6539.

If you have any questions, please call us toll free at 1-800-233-6539, or simply email your inquiry to info@foleyengines.com.

Foley Environmental is different: we're a three-generation, 97 year old family firm that wants to help!

Sincerely,

The Foley Engines Team

P.S. After you've got the exhaust fumes taken care of, you should think of the noise. Most engine noise is from the air intake. We supply a combination air filter/noise reducer. This innovative device is called a Walker Airsep and it is ideal for noisy generators and other equipment.

Please call us toll free at 800-233-6539 with any questions. We can fax you detailed information. Or, email Dr. Diesel directly at DrDiesel@FoleyEngines.com.

P.P.S. In a rush? We have an optional special rush service, which guarantees shipment within 24 hours.

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Website: www.FoleyEngines.com

Test Data for Foley 3SXT Catalytic Purifiers for Gasoline/Propane Engines:

Test Dates: Various test conducted from 1994-1997

Test Equipment: Horbia Mexa 534GE 4 Gas analyzer, exhaust gas measured = CO, CO2, HC, O2

Test Engines: Honda GX160, Honda GX200, Honda GX240, Honda GX270, Kohler Command 11

Test Fuel: Regular Unleaded

Test Load/Speed: Full engine load and governed speed

Purifier Models: Foley model 3SXT-GX160/200, 3SXT-GX240/270, 3SXT-Kohler Command 11 purifier muffler

Test Data Results

Test Engines	Before Purifier Raw CO Raw HC	After Purifier 3SXT CO 3SXT HC
Honda GX160 -Stock main Jet = 72 -Lean Jet = 70	6.5% 100PPM	1.2% 30PPM
Honda GX200 -Stock main Jet = 74 -Lean Jet = 70-72	5.5% 80PPM	1.0% 30PPM
Honda GX270 -Stock main Jet = 88 -Lean Jet = 82-85	7.0% 100PPM	0.9% 10PPM
Kohler Command 11 -1 ½ turns out in main stock -1 to 1 ¼ turns out in mains lean	6.2% 60PPM	0.5% 10PPM

Test Data for Foley SXT Catalytic Purifiers for Gasoline/Propane Engines:

Test Date: March 17, 1994

Test Equipment: Horbia Mexa 534GE 4 Gas analyzer (CO, CO2, HC, O2)

Test Engine: Honda GX240/270, 9 brake horsepower, spark ignition naturally aspirated engine, powering a concrete trowel machine

Test Fuel: Gasoline, regular unleaded

Please note that all of the tests were conducted at full engine load and speed. The test results are as follows:

A) Raw Emissions With Leaner Main Jet Changes:

Main Jet Size	Carbon Monoxide (%)	Hydrocarbons (PPM)	Engine Operation
#88 (stock)	7.0% CO	100 PPM HC	Good
#85	5.2% CO	80 PPM HC	Good
#80	1.8% CO	20 PPM HC	Slight Misfire
#75	-	-	Misfire

B) Raw Emissions With Main Jet Changes and 3SXV Purifier:

Main Jet Size & Purifier	Carbon Monoxide (%)	Hydrocarbons (PPM)	Engine Operation
#88 + 3SXT Purifier	2.5% CO	30 PPM HC	Good
#85 + 3SXT Purifier	0.9% CO	10 PPM HC	Good

By using leaner carburetion jetting the raw CO and HC emissions will drop as noted. However, if the carburetion jetting is too lean a misfire may result, engine power levels will drop and cylinder head temperature will increase (with leaner jetting). We currently believe that the #85 main jet may be the

ideal carburetion jet (for Honda GX240/270) and will reduce raw CO and HC emissions, maintain engine power levels (with minimal increases in engine cylinder head temperature) and provide adequate oxygen for the catalytic purifier. As noted the Carbon Monoxide (CO) levels dropped from 5.2% to 0.9% (an 88% reduction) by using the #85 main jet and the 3SXV catalytic purifier.

We believe that a #82 main jet should also be considered and will test this jet to determine if we can reduce CO/HC further without hindering engine power.

Test Data for Foley 5SXT

Exhaust Emission Results:

Equipment Type:	Concrete Saw
Model Number:	Correct Cut CC3500 (manufactured by Diamond Products)
Serial Number:	
Engine Type:	Wisconsin SI Gas 35 HP 4 cylinder (model W4-1770)
Fuel Type:	Gasoline
Equipment Owner:	Stephenson's
Ambient Conditions:	Outdoor – 65°F / Sunny – June 19, 2003 – 1:30-2:30pm EST
Test Equipment:	SPX/Horbia S54371 5 Gas Analyzer (Bar 97)
Measurement Ranges:	CO – 0 to 10.0% Volume HC – 0 to 5000 PPM HC (N-Hexane Equivalent)\ CO2 – 0 to 20.0% Volume O2 – 0 to 20.0% Volume NOX – 0 to 2000 PPM NOX
Repeatability:	2% of reading
Duration:	Approximately 60 seconds of sampling time at test point

Test With Stock Jetting and No Purifier

Test Results	Test 1 Idle	Test 2 High Idle No Load	Test 3 Full Load

CO	10.66%	11.53%	11.68%
HC	771 PPM	598 PPM	430 PPM
NOX	55 PPM	68 PPM	83 PPM

Test With Lean Jetting and Purifier

Test Results	Test 1 Idle	Test 2 High Idle No Load	Test 3 Full Load
CO	4.32%	5.57%	5.80%
HC	303 PPM	268 PPM	209 PPM
NOX	6 PPM	14 PPM	30 PPM

Exhaust Emission Test Result

Equipment Type: Fork Lift Truck
Model Number: Clark C500-70
Serial Number: 685-0123-7419K OF
Engine Type: SI Gas/LP engine-duel fuel
Fuel Type: Propane
Equipment Owner: Ryco
Ambient Conditions: Indoor – 45°F/Sunny – February 26, 1997 – 48% Humidity

Test Equipment: Horbia Mexa 534GE 4 Gas Analyzer
Measurement Ranges: CO – 0 to 10.0% Volume
HC – 0 to 5000 PPM HC (N-Hexane Equivalent)
CO2 – 0 to 20.0% Volume
O2 – 0 to 20.0% Volume
Repeatability: 2% of reading
Duration: Approximately 120 seconds of sampling time at test point

Baseline Test – Stock Clark SI Engine

Test Results	Test 1 Idle	Test 2 High Idle No Load
CO	3.61%	3.02%
HC	150 PPM	127 PPM

After Addition of Purifier Test – Stock Clark SI Engine + Purifier

Test Results	Test 1 Idle	Test 2 High Idle No Load
CO	0.65%	0.97%
HC	40 PPM	40 PPM

Exhaust Emission Test Results:

Equipment Type: Crane
Model Number: Broderson Crane IC-80-3 E-SP
Serial Number: #285187
Engine Type: Continental TM27 (52 hp)
Fuel Type: Propane
Equipment Owner: High Reach Inc.
Ambient Conditions: Sunny/Partly Cloudy – 76°F

Test Equipment: Ferret Instruments Model 14-5 gas Emissions Analyzer
Measurement Ranges: CO – 0 to 10.0% Volume
HC – 0 to 10,000 PPM HC (N-Hexane Equivalent)
CO2 – 0 to 20.0% Volume
O2 – 0 to 21.0% Volume
NOX – 0 to 5000 PPM NOX
Repeatability: 2% of reading
Duration: Approximately 60 seconds of sampling time at test point

Baseline Test – Stock Continental LP Engine

Test results	Test 1 Idle	Test 2 High Idle No Load
CO	2.20%	2.42%
HC	76 PPM	81 PPM
NOX	104 PPM	1371 PPM

After Addition of Purifier Test + Stock Continental LP Engine

Test Results	Test 1 Idle	Test 2 High Idle No

		Load
CO	0.35%	0.41%
HC	22 PPM	20 PPM
NOX	46 PPM	267 PPM

Foley SXT Exhaust Gas Purifier and Purifier Muffler Installation Instructions:

1) The Foley SXT Purifier is supplied in a kit form with the following items:

   A) SXT Catalytic Purifier
   B) Oxygen Sensor Port with Plug
   C) Exhaust Clamps
   D) Heat Installation Wrap

2) The gasoline/propane exhaust should be in a very good state of condition with respect to tuning, repair and maintenance. All engine components and component tolerances should be will within the engine manufacturer specifications. The engine should not be consuming an unusual amount of lube oil. The ignition and carburetion systems should be operating properly and should be set to the engine manufacturer specifications. A complete tune up prior to installation of the gas purifier is recommended to minimize harmful exhaust emissions. It also provides good purifier operation and life. Ensure that the engine spark plug(s) are new and that the air cleaner element(s) is new and/or clean. See Tech Tip #28 Spark Plug 101 at www.FoleyEngines.com for more information.

3) If you are installing a purifier/muffler simply remove the stock OEM muffler. Using a new exhaust gasket, exhaust clamps, bolts and nuts (if applicable) install the purifier/muffler in the

same manner as the stock OEM muffler. Torque all fasteners to manufacturer specifications.

If you are installing a "plain style" purifier (SXT-P), avoid installing the purifier to close proximity to electrical components, fuel lines, fuel tanks, hydraulic oil lines, hydraulic oil tanks, plastic components or any other combustible items. These purifiers are designed to slip over the outlet pipe of the stock OEM muffler. Or they are designed to be installed inline in the exhaust system tubing before the muffler. Use new exhaust clamps for a "plain style" purifier. The purifier should be securely mounted. Avoid installing the purifier on badly rusted muffler, weak exhaust piped or muffler with weak tailpipes.

If you are installing a "plain style" purifier before the muffler on a gasoline or propane engine, locate the exhaust gas purifier as close to the exhaust gas manifold outlet as possible. Cut out a 7.5" to 12.5" (depending on the exhaust gas purifier model as required) long section of the stock exhaust pipe. Install the exhaust gas purifier into the exhaust pipe. Use the supplied muffler clamps or weld the exhaust gas purifier directly to the exhaust pipe. If you are welding the exhaust gas purifier to the exhaust pipe use a #309 filler rod as filler material. Is using muffler clamps torque the nuts and bolts of the exhaust clamps to the correct specified torque. Ensure that there are no exhaust leaks.

4) Drill an 11/16" diameter hole into the exhaust pipe as close to the engine exhaust manifold as possible (within 12" is ideal). The 11/16" diameter hole must be drilled before the catalytic purifier. Fully weld the supplied steel oxygen sensor port (18mm X 1.5mm port) on top of the 11/16" diameter hole. The oxygen sensor port and plug are supplied with the exhaust gas purifier. Purchase one wire or 3-wire oxygen sensor from your local automotive parts store. Apply a high heat anti-seize compound to the threads of the oxygen sensor port. Start the engine and allow the engine to fully warm up for at least 15 minutes. Attach the voltage meter set to millivolts (mV). Measure the millivolt signal from the oxygen sensor while the engine operates at a steady idle speed and at a constant load.

Use this table to interpret the oxygen senor voltages:

Millivolt Voltage (mV)	Interpretation
Less than 250 mV	Too Lean
250 mV to 410 mV	Lean
410 mV to 580 mV	Ideal for Purifier Operation
580 mV to 800 mV	Rich
Over 800 mV	Too Rich

Adjust the engine carburetion (richer or leaner as required). In most cases engine will have to have the carburetion slightly leaned to produce and oxygen sensor voltage of 410 mV to 580 mV. This range will produce the best carburetion setting for proper purifier operation and will result in the lowest Carbon Monoxide (CO), Hydrocarbons (HC) and Oxides of Nitrogen (NOX) pollutant levels. Alternately you can use and automotive exhaust analyzer (4 gas or 5 gas model) to measure the CO, HC, and NOX after the exhaust purifier. Adjust the engine carburetion (richer or leaner, usually slightly leaner than the stock jetting) to obtain the lowest CO, HC, and NOX emissions. Take extra care when adjusting the idle fuel air mixture or high-speed main jet size. Engine failure can result if the engine carburetion setting is adjusted to a lean setting. If a sudden miss-fire occurs the air fuel ratio is probably too lean or too rich. Use a cylinder head temperature gauge (for air cooled engines) to determine if the engine is running at the correct operating temperature. If the engine is running too hot a richer air fuel ratio will be required to keep the engine cool. In general (based on tests conducted on the 2002 model year Honda single and tin cylinder engines) we have found that reducing the carburetion main jet size by one or two jet sizes leaner produced the lowest CO, HC, and NOX emissions. Minor jetting changes (1 or 2 jet sizes) to leaner or possibly richer carburetion main jets will not affect engine performance and cooling. On propane fueled engines simply adjust the mixture screw to adjust the air fuel ratio. Remember to take extra care when adjusting the air fuel ratio so as to prevent the engine from overheating and misfiring.

On newer EPA or California specification engines the engine carburetion may have adjusted to a leaner (or possibly) richer calibration at the factory. If this is the case carburetion re-jetting and adjustment may not be required. Alternately only minor jet leaning (typically only 1 jet size smaller) may be required. Test the Carbon Monoxide (CO) emissions to determine the stock CO emissions before the catalytic purifier is installed.

5) When the carburetion is properly adjusted the model SXT catalytic purifier is ready for service. In order to ensure long purifier life, avoid using the choke when the engine is warmed up and operating under load. In addition we recommend that the use of any engine shutdown mechanisms (for example a water tank level kill switch on a concrete saw) be disconnected. If the engine ignition system is shutdown while the engine is under load, raw fuel will collect on the catalytic purifier core. The raw fuel will burn rapidly and will melt the catalytic core and automatically void the warranty. In addition keep the engine well tuned and equipped with new air cleaner elemental at all times.

6) The purifier has very high surface temperature (1300 F degrees +) and may produce a red/orange glow or small flames from the outlet cone. Insulate the purifier with the supplied heat insulation warp after the purifier has been installed. Secure the heat insulation wrap after the purifier with hose clamps or wire. Cover the heat insulation wrap from oil or fuel contamination, if the purifier produces excessive flames from the tailpipe; double-check the engine carburetion to determine if the air fuel ratio is too rich. Leaning of the engine carburetion may be required. If the engine carburetion is correct, set the correct air/fuel ration, consider adding a section of tailpipe to the purifier outlet. This section of tailpipe should reduce the flames at the purifier outlet cone.

7) During engine operation avoid all personal contact with the purifier and or purifier/muffler. After engine shutdown avoid all personal contact and do not allow the purifier to come in contact with any combustible objects. When re-fueling, adding lubrication oil, adding coolant, adding hydraulic oil or during any periodic maintenance, ensure that the engine is shutdown and that the surface temperatures of the purifier and/or purifier muffler have cooled to ambient temperatures. Avoid re-fueling and avoid any contact of any form when the catalytic purifier or purifier muffler is hot. If you have any questions, please call 508.753.2979 for additional information.

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North American Toll Free: 800.233.6539

Dear Sir,

With Respect to your exhaust purifier gas inquiry attached your will find engine exhaust emissions test data for Honda, Kohler, Clark, and Wisconsin (single and multi-cylinder) spark ignition gasoline/propane fueled engines. These engines are typically horizontal shaft and vertical shaft engines such as the Honda GX160 (5.5 hp), Honda GX200 (6.5 hp), Honda GX270 (9.0 hp), Kohler command 11 (11 hp) and the Wisconsin W4-1770 (35 hp). In a typical exhaust gas purifier application (where the engine carburetion jetting is correctly adjusted) the following average exhaust gas emission reductions can be expected.

Carbon Monoxide (CO)	=	70% - 82%+
Hydrocarbons (HC)	=	55% - 88%+
Oxides Of Nitrogen (NOX)	=	80% - 85%+

These average exhaust gas emissions reductions are dependant upon using a well maintained, relatively new engine operating with moderate to heavy load which is consuming a regular unleaded on-highway gasoline fuel or liquid propane fuel. In addition the engine carburetor main jet or propane needle jet(s) has been changed (slightly leaned) to provide additional oxygen for increased catalyst activity. The lean jetting change will optimize catalyst performance and minimize Co, NOX and HC emissions. The exhaust gas purifier is a combination purifier/muffler replacement mounted directly to the engine exhaust manifold or an inline exhaust gas purifier.

The attached test data related to a Honda GX270 engine and indicates that the Carbon Monoxide (CO) levels could be reduced by 82% by using a model 2SXT-GX240/270 catalytic purifier and a #85 carburetor main jet. In addition Hydrocarbons (HC) was reduced by 88% by using a 2SXT-GX240/270 catalytic purifier muffler and a #85 main jet. By using the 2SXT-GX240/270 we saw a reduction in NOX by 80%+.

The attached test data (page 3) lists exhaust gas emissions test results for Honda GX160, GX200, GX270 and a Kohler Command 11 gasoline engine. The engine carburetion for teach engine was optimized to minimize emissions without reducing engine power or producing significant increase in cylinder head temperatures. As noted the Carbon Monoxide (CO) emissions were reduced by 82% to 92% on average. The hydrocarbons (HC) emissions were reduced by 70% to 90% on average.

The attached test data list exhaust gas emissions test results for Wisconsin model W4-1770 (35 hp) engine. The engine carburetion for each engine was optimized to minimize emissions without reducing engine power or producing significant increases in cylinder head temperature. As noted the Carbon Monoxide (CO) emissions were reduced by 50%,

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Hydrocarbons (HC) emissions were reduced by 51% and Oxide Of Nitrogen (NOX) emissions were reduced by 64% on average.

Pages list exhaust gas emissions test results for a Clark forklift truck with a dual fuel gas/propane engine and a broderson carry deck crane with a continental propane fueled engine. In both cases the engine were operated on propane fuel and carburetion was adjusted slightly leaner to optimize catalyst performance. As noted the Carbon Monoxide (CO) emissions were reduced by 82% to 84%, Hydrocarbons (HC) emissions were reduced by 71% to 73% and Oxide Of Nitrogen emissions were reduced by 55% to 80% depending on load/speed condition. If you have any questions please call the sales office at 1-(800) 233-6539.

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Test Data for Gaspro 3SXT Catalytic Purifiers for Gasoline/Propane Engines:

Test Dates:	Various test conducted from 1994-1997
Test Equipment:	Horbia Mexa 534GE 4 Gas analyzer, exhaust Gas measured = CO, CO2, HC, O2
Test Engines:	Honda GX160, Honda GX200, Honda GX240, Honda GX270, Kohler Command 11
Test Fuel:	Regular unleaded
Test Load/Speed:	Full engine load and governed speed.
Purifier Models:	Gaspro model 3SXT-GX160/200, 3SXT-GX240/270, 3SXT-Kohler Command 11 purifier muffler

Test Data Results

Test Engines	Before Purifier		After Purifier	
	Raw CO	Raw HC	3SXT CO	3SXT HC
Honda GX160 -Stock main Jet = 72 -Lean Jet = 70	6.5%	100 PPM	1.2%	30 PPM
Honda GX200 -Stock Main Jet = 74 - Lean Jet = 70-72	5.5%	80 PPM	1.0 %	30 PPM
Honda GX270 -Stock Main Jet = 88 -Lean Jet = 82-85	7.0%	100PPM	0.9 %	10 PPM
Kohler Command 11 Engine -1 ½ turns out on main stock -1 to 1 ¼ turns out on mains lean.	6.2%	60 PPM	0.5%	10 PPM

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Test Data for Gaspro SXT Catalytic purifiers for gasoline/propane engines:

Test Date: March 17, 1994

Test Equipment: Horbia Mexa 534GE 4 Gas analyzer (CO, CO_2, HC, O_2)

Test Engine: Honda GX240/270, 9 brake horsepower, spark ignition naturally aspirated engine, powering a concrete trowel machine

Test Fuel: Gasoline, regular unleaded

Please note that all of the tests were conducted at full engine load and speed. The test results are as follows:

A) **Raw Emissions With Leaner Main Jet Changes:**

Main Jet Size	Carbon Monoxide (%)	Hydrocarbons (PPM)	Engine Operation
# 88 (stock)	7.0% CO	100 PPM HC	Good
# 85	5.2% CO	80 PPM HC	Good
# 80	1.8% CO	20 PPM HC	Slight Misfire
# 75	-	-	Misfire

B) **Raw Emissions With Main Jet Changes and 3SXV Catalytic Purifier:**

Main Jet Size and Purifier	Carbon Monoxide	Hydrocarbons	Engine Operation
#88 + 3SXT Purifier	2.5 % CO	30 PPM HC	Good
#85 + 3SXT Purifier	0.9 % CO	10 PPM HC	Good

By using leaner carburetion jetting the raw CO and HC emissions will drop as noted. However if the carburetion jetting is too lean a misfire may result, engine power levels will drop and cylinder head temperature will increase (with leaner jetting). We currently believe that the #85 main jet may be the ideal carburetion jet (for Honda GX240/270) and will reduce raw CO and HC emissions, maintain engine power levels (with minimal increases in engine cylinder head temperature) and provide adequate oxygen for the catalytic purifier. As noted the Carbon Monoxide (CO) levels dropped from 5.2% to 0.9% (an 82% reduction) and Hydrocarbons levels (HC) from 80 PPM to 10 PPM (an 88% reduction) by using the #85 main jet and the 3SXV catalytic purifier.

We believe that a #82 main jet should also be considered and will test this jet to determine if we can reduce CO/HC further without hindering engine power.

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Test Data for Wisconsin Gaspro 5SXT-W41770

Exhaust Emission Results

Equipment Type:	Concrete Saw
Model Number:	Correct Cut CC3500 (Manufactured by Diamond Products)
Serial Number:	
Engine Type:	Wisconsin SI Gas 35 HP 4 cylinder (Model W4-1770
Fuel Type:	Gasoline
Equipment Owner:	Stephenson's
Ambient Conditions:	Outdoor - 22C / Sunny – June 19, 2003 – 1:30-2:30pm EST
Test Equipment:	SPX/Horbia S54371 5 Gas Analyzer (Bar 97)
Measurement Ranges:	CO – 0 to 10.0% Volume
	HC – 0 to 5000 PPM HC (N-Hexane Equivalent)
	CO_2 – 0 to 20.0% Volume
	O_2 – 0 to 20.0% Volume
	NOX –0 to 2000
Repeatability:	2% of reading
Duration:	Approximately 60 seconds of sampling time at test point

A) Test With Stock Jetting And No Purifier:

Test Results	Test 1 Idle	Test 2 High Idle No Load	Test 3 Full Load
CO	10.66 %	11.53 %	11.68 %
HC	771 PPM	598 PPM	430 PPM
NOX	55 PPM	68 PPM	83 PPM

B) Test With Lean Jetting And Purifier:

Test Results	Test 1 Idle	Test 2 High Idle No Load	Test 3 Full Load
CO	4.32 %	5.57 %	5.80 %
HC	303 PPM	268 PPM	209 PPM
NOX	6 PPM	14 PPM	30 PPM

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Exhaust Emission Test Results

Equipment Type:	Fork Lift Truck
Model Number:	Clark C500-70
Serial Number:	685-0123-7419KOF
Engine Type:	SI Gas/LP engine-duel fuel
Fuel Type:	Propane
Equipment Owner:	Ryco
Ambient Conditions:	Indoor – 9C/Sunny – Feb.26, 1997 – 48% Humidity
Test Equipment:	Horbia Mexa 534GE 4 Gas Analyzer
Measurement Ranges:	CO – 0 to 10.0% Volume
	HC – 0 to 5000 PPM HC (N-Hexane Equivalent)
	CO_2 – 0 to 20.0% Volume
	O_2 – 0 to 20.0% Volume
Repeatability:	2% of reading
Duration:	Approximately 120 seconds of sampling time at test point.

A) Baseline Test – Stock Clark SI Engine

Test Results	Test 1 Idle	Test 2 High Idle No load
CO	3.61%	3.02%
HC	150 PPM	127 PPM

B) After Addition Of Purifier Test – Stock Clark SI Engine + Purifier

Test Results	Test 1 Idle	Test 2 High Idle No load
CO	0.65 %	0.97 %
HC	40 PPM	40 PPM

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Exhaust Emission Test Results

Equipment Type:	Crane
Model Number:	Broderson Crane IC-80-3E-SP
Serial Number:	#285187
Engine Type:	Continental TM27 (52 hp)
Fuel Type:	Propane
Equipment Owner:	High Reach Inc.
Ambient Conditions:	Sunny/ Partly Cloudy – 25C
Test Equipment:	Ferret Instruments Model 14- 5 gas Emissions Analyzer
Measurement Ranges:	CO – 0 to 10.0% Volume
	HC – 0 to 10,000 PPM HC (N-Hexane Equivalent)
	CO_2 – 0 to 20.0% Volume - Calculated
	O_2 – 0 to 21.0% Volume
	NOX –0 to 5000
Repeatability:	2% of reading
Duration:	Approximately 60 seconds of sampling time at test point

A) Baseline Test –Stock Continental LP Engine

Test Results	Test 1 Idle	Test 2 High Idle No Load
CO	2.20%	2.42%
HC	76 PPM	81 PPM
NOX	104 PPM	1371 PPM

B) After Addition Of Purifier Test + Stock Continental LP Engine

Test Results	Test 1 Idle	Test 2 High Idle No Load
CO	0.35%	0.41%
HC	22 PPM	20 PPM
NOX	46 PPM	267 PPM

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Gaspro SXT Exhaust Gas Purifier And Purifier Muffler Installation Instructions:

1) The Model SXT Catalytic purifier is supplied in a kit form with the following items:

A) SXT Catalytic purifier (1 Unit Supplied)
B) Oxygen Sensor Port With Plug
C) Exhaust Clamps
D) Heat Installation Wrap

2) The gasoline/propane exhaust should be in a very good state of condition with respect to tuning, repair and maintenance. All engine components and component tolerances should be will within the engine manufacturer specifications. The engine should not be consuming an unusual amount of lube oil. The ignition and carburetion systems should be operating properly and should be set to engine manufacturer specifications. A complete tune up prior to installation of the exhaust gas purifier is recommended to minimize harmful exhaust emissions and provides good purifier operation and life. Ensure that the engine spark plug(s) are new and that the air cleaner element(s) is new and/or clean.

3) If you are installing a purifier/muffler simply remove the stock OEM muffler. Using a new exhaust gasket, exhaust clamps, bolts and nuts (if applicable) install the purifier/muffler in the same manner as the stock OEM muffler. Torque all fasteners to manufacturer specs.

If your are installing a “plain style” purifier (SXT-P) purifier, avoid installing the purifier to close proximity to electrical components, fuel lines, fuel tanks, hydraulic oil lines, hydraulic oil tanks, plastic components or any other combustible items. These purifiers are designed to slip over the outlet pipe(s) of the stock OEM muffler or are designed to be installed inline in the exhaust system tubing before the muffler. Use new Guillotine style exhaust clamps or accuseal exhaust clamps for “plain style” purifier. If the “plain style” purifier is equipped with support tabs, use the support tabs to firmly secure the purifier to the muffler, engine or equipment chassis. Fabricate struts from round 16 gauge steel tubing (1.5” diameter or greater), flatten the tube ends and drill bolt holes in the tube ends. Attach the struts from the support tabs, use the inlet/outlet muffler clamp nuts to secure mounting struts. Check the engine mounts to determine if the engine is rubber mounted or solid mounted to the equipment chassis. If the engine is rubber mounted secure the support struts only to the engine. If the engine is solid mounted, the support struts can be mounted to the engine chassis. Use grade 5 bolts, nuts (mechanical locknuts) and lock washers to securely attach the struts to the purifier and to the muffler, engine or chassis. The purifier should be securely mounted. Avoid installing the purifier on badly rusted muffler, weak exhaust piped or muffler with weak tailpipes.

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If you are installing a “plain style” purifier before the muffler on a gasoline or propane engine, locate the exhaust gas purifier as close to the exhaust gas manifold outlet as possible. Cut out a 7.5” to 12.5” (depending on the exhaust gas purifier model as required) long section of the stock exhaust pipe. Install the exhaust gas purifier into the exhaust pipe. Use the supplied muffler clamps or supplied accuseal clamps or weld the exhaust gas purifier directly to the exhaust pipe. If you are welding the exhaust gas purifier to the exhaust pipe use a #309 filler rod as a filler material. If using muffler clamps or accuseal clamps torque the nuts and bolts of the exhaust clamps to the correct specified torque. Ensure that there are no exhaust leaks.

4) Drill an 11/16” diameter hole into the exhaust pipe as close to the engine exhaust manifold as possible (within 12” is ideal). The 11/16” diameter hole must be drilled before the catalytic purifier. Fully weld the supplied steel oxygen sensor port (18mm X 1.5mm port) on top of the 11/16” diameter hole. The oxygen sensor port and plug are supplied with the exhaust gas purifier. Purchase a wire or 3 wire oxygen sensor from your local automotive parts store. Apply a high heat anti-seize compound to the threads of the oxygen sensor port. Start the engine and allow the engine to fully warm up for at least 15 minutes. Attach the voltage meter set to millivolts (mV). Measure the millivolt signal from the oxygen sensor while the engine operates at a steady idle speed and at a constant load. Use this table to interpret the oxygen sensor voltages:

Millivolt Voltage (mV)	**Interpretation**
Less than 250 mV	Too Lean
250 mV to 410 MV	Lean
410mV to 580 mV	Ideal for purifier operation
580 mV to 800 mV	Rich
Over 800 mV	Too Rich

Adjust the engine carburetion (richer or leaner as required). In most cases engine will have to have the carburetion slightly leaned to produce an oxygen sensor voltage of 410 mV to 580mV. This range will produce the best carburetion setting for proper purifier operation and will result in the lowest carbon monoxide (CO), Hydrocarbons (HC) and Oxides Of Nitrogen (NOX) pollutant levels. Alternately you can use an automotive exhaust gas analyzer (4 gas or 5 gas model) to measure the CO, HC and NOX after the exhaust purifier. Adjust the engine carburetion (richer or leaner, usually slightly leaner then the stock jetting) to obtain the lowest CO, HC, and NOX emissions. Take extra care when adjusting the idle fuel air mixture or high speed main jet size. Engine failure can result if the engine carburetion setting is adjusted to a lean setting. If a sudden mis-fire occurs the air-fuel ratio is probably too lean or too rich. Use a cylinder head temperature gauge (for air cooled engines) to determine if the engine is running at the correct operating temperature. If the engine is running to hot a richer air fuel ratio will be

required to keep the engine cool. In general (based on test conducted on 2002 model year Honda single and tin cylinder engines) we have found that reducing the carburetion main jet size by one or two jet sizes leaner produced the lowest CO, HC and NOX emissions. Minor jetting changes (1 or 2 jet sizes) to leaner or possibly richer carburetion main jets will not affect engine performance and cooling. On propane fueled engines simply adjust the mixture screw to adjust the air fuel ratio. Remember to take extra care when adjusting the air fuel ratio so as to prevent the engine from overheating or misfiring.

On newer engines, EPA or California specification engines the engine carburetion may have adjusted to a leaner (pr possibly) richer calibration at the factory. If this is the case carburetion re-jetting and adjustment may not be required. Alternately only minor jet leaning (typically only 1 jet size smaller) may be required. Test the Carbon Monoxide (CO) emissions to determine the stock CO emissions before the catalytic purifier is installed.

5) When the carburetion is properly adjusted the model SXT catalytic purifier is ready for service. In order to ensure long purifier life, avoid using the choke when the engine is warmed up and operating under load. In addition we recommend that the use of any engine shutdown mechanisms (for example a water tank level kill switch on a concrete saw) be disconnected. If the engine ignition system is shutdown while the engine is under load, raw fuel will connect on the catalytic purifier core. The raw fuel will burn rapidly and will melt the catalytic purifier core and automatically void the warranty. In addition keep the engine well tuned and equipped with new air cleaner element at all times.

6) The purifier has very high surface temperature (1300 F degrees+) and may produce a red/orange glow or small flames from the outlet cone. Insulate the purifier with the supplied heat insulation wrap after the purifier has been installed. Secure the heat insulation wrap after the purifier with hose clamps or wire. Cover the heat insulation wrap from oil or fuel contamination, if the purifier produces excessive flames from the tailpipe; double-check the engine carburetion to determine if the air fuel ratio is too rich. Leaning of the engine carburetion may be required. If the engine carburetion is correct set the correct air/fuel ratio, consider adding a section of tailpipe to the purifier outlet. This section of tailpipe should reduce the flames at the purifier outlet cone.

7) During engine operation avoid all personal contact with the purifier and or purifier/muffler. After engine shutdown avoid all personal contact and do not allow the purifier and/or purifier muffler to come in contact with any combustible objects. When re-fueling, adding lubrication oil, adding coolant, adding hydraulic oil or during any periodic maintenance ensure that the engine is shutdown and that the surface temperatures of the purifier and or purifier/muffler have cooled to ambient temperatures. Avoid re-fueling and avoid any contact of any form when the catalytic purifier or purifier

muffler is hot. You have any questions please call 1-(800) 233-6539 for additional information.

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Honda 2SXT-GX120/140/160/200/240/270 and 3SXT-GX340/390 and 4SXT-GX610/620/670 Horizontal Shaft Purifier Mufflers

Installation, Testing and Carburetion Tuning Instructions:

1) The Honda gasoline/propane fueled engine should be in a very good state of tune/repair. The Honda engine should be periodically maintained in strict accordance with engine manufacturer specifications and maintenance requirements. The engine should not be consuming an unusual amount of lube oil and oil consumption levels should be well within engine manufacturer specifications. The ignition and carburetion systems should be operating properly and should be set to the engine manufacturer specifications. A complete tune-up prior to installation of the catalytic purifier muffler is required. To minimize harmful exhaust gas emissions and provide good purifier operation and life. Ensure that the engine spark plug(s) is new and that the air cleaner element is new and clean prior to catalytic purifier muffler installation.

2) On the GX620 undo the clamps on the inlet and outlet pipes of the muffler where applicable. Undo the four+ 8mm bolts which retain the muffler. On the GX240 to GX390 series Honda engines undo the three 8mm nuts which retain the stock Honda muffler to the cast iron exhaust manifold pipe. On the GX120 to GX160 undo the two 8mm nuts which retain the muffler to the engine cylinder head. Remove the stock Honda exhaust muffler. Using the same 8mm nuts and a new exhaust gasket, install the 2SXT/3SXT/4SXT purifier muffler. Torque the 8mm nuts and exhaust clamps (where applicable) to the correct specified torque. Orient the exhaust outlet flow diverter to the required orientation. Check the equipment/engine to make sure no engine/chassis components are in contact with the body of the catalytic purifier muffler or the exhaust outlet flow of the purifier muffler. Start the engine and check for exhaust leaks.

3) Start the engine and allow the engine to fully warm-up for 5 to 10 minutes. Using a carbon monoxide (CO) exhaust analyzer or 4 gas/5 gas analyzer (0% to 10% CO range) measure the level of carbon monoxide at the outlet of the catalytic purifier muffler. The engine should be running at governed engine speed and constant full load if possible. The usual carbon monoxide level without the catalytic purifier muffler should be in the range of 5.0 to 7.0% CO. Remove the carburetion float bowl and the carburetor main jet using a small flat screwdriver. Using a magnifier carefully check and make a note of the number stamped on the main jet body slightly above the threads of the main jet. Install one main jet size leaner (for example a #85 main jet is leaner than an #88 main jet) then the stock main jet. Honda carburetor main jets are readily available from your local Honda dealer (industrial, construction and motorcycle dealers). The main jet part number

for a #85 main jet will be 99101-1240850. The main jet part number for a #88 main jet will be #99101-1240880. The Honda main jet part number is usually 99101-1240XXO. Only the digits denoted by XX change. Start the engine and operate the engine at governed engine speed and constant full load. Measure and make note of the level of carbon monoxide with the leaner letting. The carbon monoxide level should drop to about 2.0% to 3.0% CO or less. If lower carbon monoxide levels are required try a smaller jet size (for example#83 jet instead of the #85). The carbon monoxide level should drop to about 1.0% to 1.5% CO or less. Remember to operate the engine at the same speed/load and ensure that speed/load is constant. Take extra care to correctly install the carburetor float bowl to the carburetor. Check for fuel leaks from the carburetor float bowl or carburetor body. Ensure that the float bowl is free of dirt or other contaminants. On recent model Honda engine (US EPA PHI small non-road engine emissions approved and 1995 California emissions regulations for ulge engines approval and other related approvals) the carburetor has been calibrated to a relatively lean jet setting of about 14.2:1 to 14.7:1 air/fuel ratio at full load and speed. Therefore only one engine carburetion main jet change may be required for proper catalytic purifier muffler operation.

4) Take extra care when adjusting the carburetor main jet size. Engine failure, engine damage or lean engine misfire can result if the engine carburetion is set to lean. In general terms reducing the carburetor main jet size by one or two jet sizes leaner will not affect engine performance and reliability. Carbon Monoxide (CO), Oxides of Nitrogen (NOX) and hydrocarbon (HC) emissions will be reduced dramatically when used with the catalytic purifier muffler. Leaning of the main jet size by more than 2 jet sizes may be too lean and should be avoided. The engine could overheat and damage can occur. If the main jet size is to be leaned more than 2 jet sizes we recommend that the engine cylinder head temperature be constantly monitored when the engine is operating. In addition leaning of the main jet by more than 2 jet sizes may dramatically increase levels of Oxides Of Nitrogen (NOX).

5) When the carburetion jetting is properly adjusted the catalytic purifier muffler is ready for service. Double-check the catalytic purifier muffler installation for exhaust gas leaks, etc… In order to ensure long catalytic purifier muffler life, avoid using the choke or any electrical shutdown devices when the engine is warmed up and operating under load or at no load conditions. This will melt the catalytic purifier muffler core and void the warranty immediately. Reduce engine speed and load and allow the engine to idle for 1 minute before shutting the engine down. Keep the engine properly tuned, properly maintained and equipped with a clean air cleaner element at all times. If you have any questions call **1-(800)-551-5525** for additional information and assistance.

Honda Carburetor Main Jet Part Number Examples

Honda Main Jet Part Number For #72 Main Jet	=	#99101-1240720
Honda Main Jet Part Number For #78 Main Jet	=	#99101-1240780
Honda Main Jet Part Number For #95 Main Jet	=	#99101-1240950