Data Center Generator Maintenance
FEASIBILITY AND BENEFITS OF NO-LOAD EXERCISING

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INTRODUCTION

Diesel generator operators are all too familiar with the problem of engine slobber or "wet stacking," a buildup of unburned fuel in the exhaust system that can lead to decreased engine performance and premature failure.

Wet stacking typically occurs when generators frequently run with little or no load because the generator is improperly sized for the power required or because adequate load is not available during the exercising period. Data center providers frequently have insufficient load and incur the added costs and time to connect an external load bank with resultant higher emissions and extra fuel costs.

EXPLANATION OF WET STACKING

GENERATORS RUN AT LESS THAN 30% OF LOAD

When generators run at less than 30% of capacity for extended periods of time, their engines are unable to sustain the optimal operating temperatures needed to burn fuel completely.

Pressure inside the combustion chamber falls below crankcase pressure, and piston rings can't expand enough to seal the space between the pistons and cylinder walls.

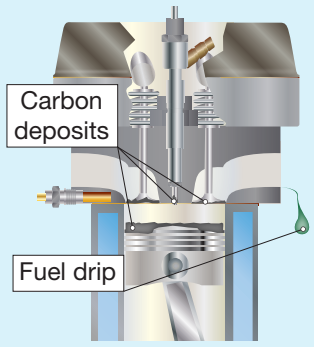
WHAT WET STACKING CAN LEAD TO

Wet stacking fouls fuel injectors; causes excessive valve guide wear; and can lead to damaged pistons, piston liners, and rings; among other problems, as depicted in *Figure 1*.

EMISSION CONSIDERATIONS

In addition to shortened engine life and higher maintenance costs, operators may also run afoul of emissions regulations, which have grown tighter in recent years.

Figure 1



WET STACKING: A CRITICAL ISSUE

IMPACT OF NEW EMISSIONS TECHNOLOGY

Wet stacking has become a more critical issue in recent years as diesel generator makers have incorporated new emissions control technologies into their products. These include diesel oxidation catalysts (DOC), selective catalytic reduction (SCR) components, and diesel particulate filters (DPF). See *Figure 2*.

Such aftertreatment technologies are all negatively affected by low-load operation, which can cause emissions targets to be missed. SCR and DPF components, in particular, must operate within a specific exhaust temperature range.

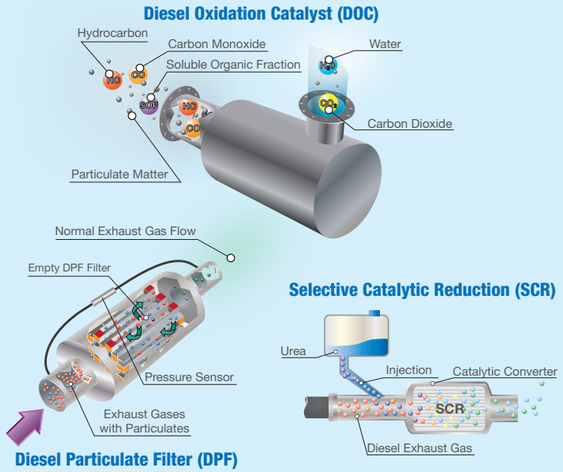
SOLUTION TO ADDRESS WET STACKING

The solution for wet stacking for years has been to exercise the generators at 30% of the rated capacity once a month to burn off unused fuel or prevent buildup. However, technology advances are making the need for this costly procedure less demanding. This paper asserts that some of today's diesel generators can be safely run at 30% of the rated capacity or higher as little as once per year to maintain optimal performance and stay within emissions guidelines.

WHY IT'S NECESSARY TO ADDRESS WET STACKING

Wet stacking doesn't damage the engine in the short term, but over time it can lead to poor performance and reduced engine life. In extreme cases the exhaust stream can combust under rapid application of the high exhaust temperatures.

Figure 2



THE HISTORIC OVERSIZING PROBLEM

CONCERNING DATA CENTER APPLICATIONS

Historically, the wet stacking problem has occurred in data centers because generators were greatly oversized for the usual loading.

Confusion over compatibility between generators and static UPS devices often caused data center operators to over-provision diesel generator capacity.

These conditions led to lightly loaded generators operating for many hours, leading to eventual wet stacking issues. However, equipment manufacturers and data center specifying engineers have largely resolved those issues as application knowledge and generator sizing tools have improved. Therefore, currently, wet stacking is a concern for data center operators during monthly exercising.

LOAD-BANK TESTING

LOADING TO MINIMUM LOAD

The simplest way to avoid wet stacking during monthly exercise is to run the generator at the manufacturer's recommended minimum loading. Because data center operators do not wish to transition to building load, the monthly exercise requires use of a load bank, which can be used to supplement or perform loaded maintenance activities.

This load-bank testing artificially boosts the load placed on the generator to burn the accumulated buildup. Most generator operators recommend that load-bank testing be done monthly for a minimum of 30 minutes runtime.

In addition to runtime, data centers also need to consider the time it takes to setup the load bank. For a typical data center facility using between five and ten generators, that can add up to a significant time commitment by operations personnel, not to mention fuel consumption.

REVISITING LOAD-BANK TESTING PROCEDURES

Many facilities conduct load-banking according to maintenance procedures that were drawn up years ago and have never been revisited.

Technology improvements can now simplify this monthly procedure. In an industry that has historically moved rather slowly, the news has probably not reached many operators.

LOADING MODERN DIESEL ENGINES

TAKING ACCOUNT OF LATEST DIESEL TECHNOLOGY

Modern diesel engine designs now incorporate several technologies that enhance operating efficiency and reduce the gaps between pistons and rings that allow unburnt fuel to escape. Other advances include:

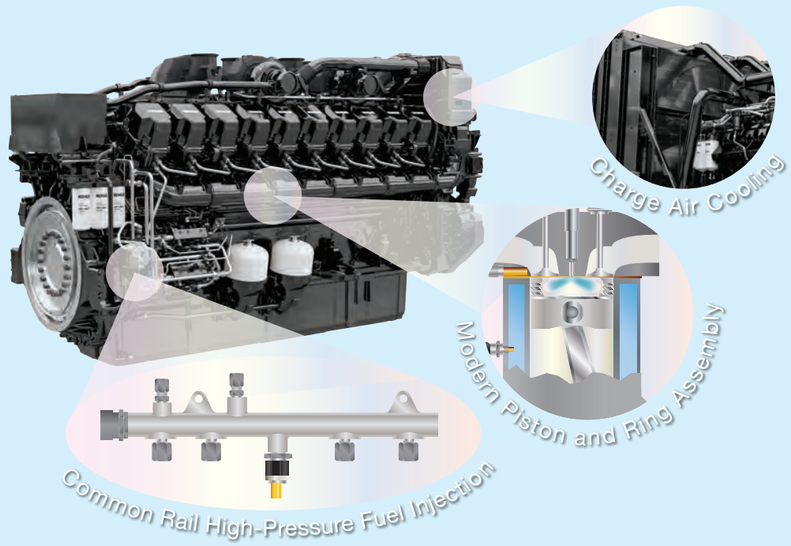
- Common rail systems allow better atomization of fuel into the cylinder and the ability to have multiple injections per cycle. This allows the combustion process to be better tailored to the requirements of emissions and/or cylinder temperatures, a process called “fuel mapping.”
- Charge air cooling allows more air to be delivered to the cylinder at a lower temperature, which permits fuel to be combusted more completely.
- Modern piston and ring assemblies are engineered to a much finer degree of tolerance than those of older engines. This significantly reduces the blow-by that allows fuel to escape the combustion chamber. The result is that the engine burns more efficiently and the conditions that lead to wet stacking are significantly mitigated.

This combination of common rail systems and improved ring designs enable lower-exercise loading by containing combustion gases and enabling a shaped charge to be created. See *Figure 3*.

Increasing cylinder pressures also increases cylinder temperatures at lower loads.

Figure 3

KOHLER® KD SERIES™ DIESEL



REVISITING OLD MAINTENANCE ASSUMPTIONS

KOHLER® KD SERIES™ FIELD EXPERIENCE

These and other efficiency improvements should enable generator operators to revisit old assumptions about maintenance schedules and significantly reduce the once-monthly load-banking requirements.

In fact, test and field experience with generators such as the KOHLER KD Series suggests that unloaded monthly exercise is allowable, as long as the generator is load bank-tested annually, which is standard practice for most data center operators.

SWITCHING TO ANNUAL LOAD TESTING

The savings from switching from monthly to annual loaded testing are compelling. For example, a 3250-kilowatt running a load-banking cycle for 30 minutes each month burns about 660 gallons of diesel fuel and emits 186 pounds of pollutants per year.

In contrast, performing the same monthly exercise unloaded consumes less than 300 gallons per year and total pollutant emissions are reduced by 82% on a pounds per year basis. See *Figures 4 & 5*. There are also collateral onsite savings.

Switching the annual load testing method does not violate NFPA110 requirements. The regulation states that exercising of the unit is required to be performed monthly for 30 minutes at either 30% of rated load or at loads to maintain the minimum exhaust gas temperatures set by the manufacturer.

Figure 4

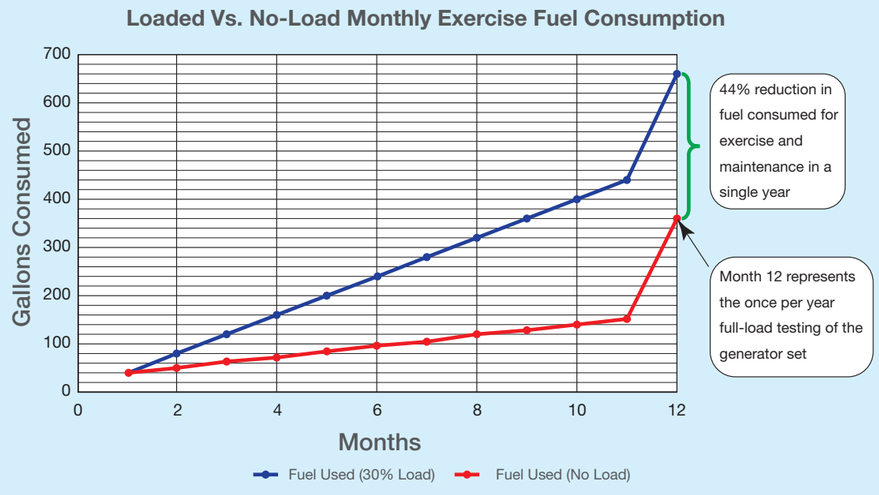
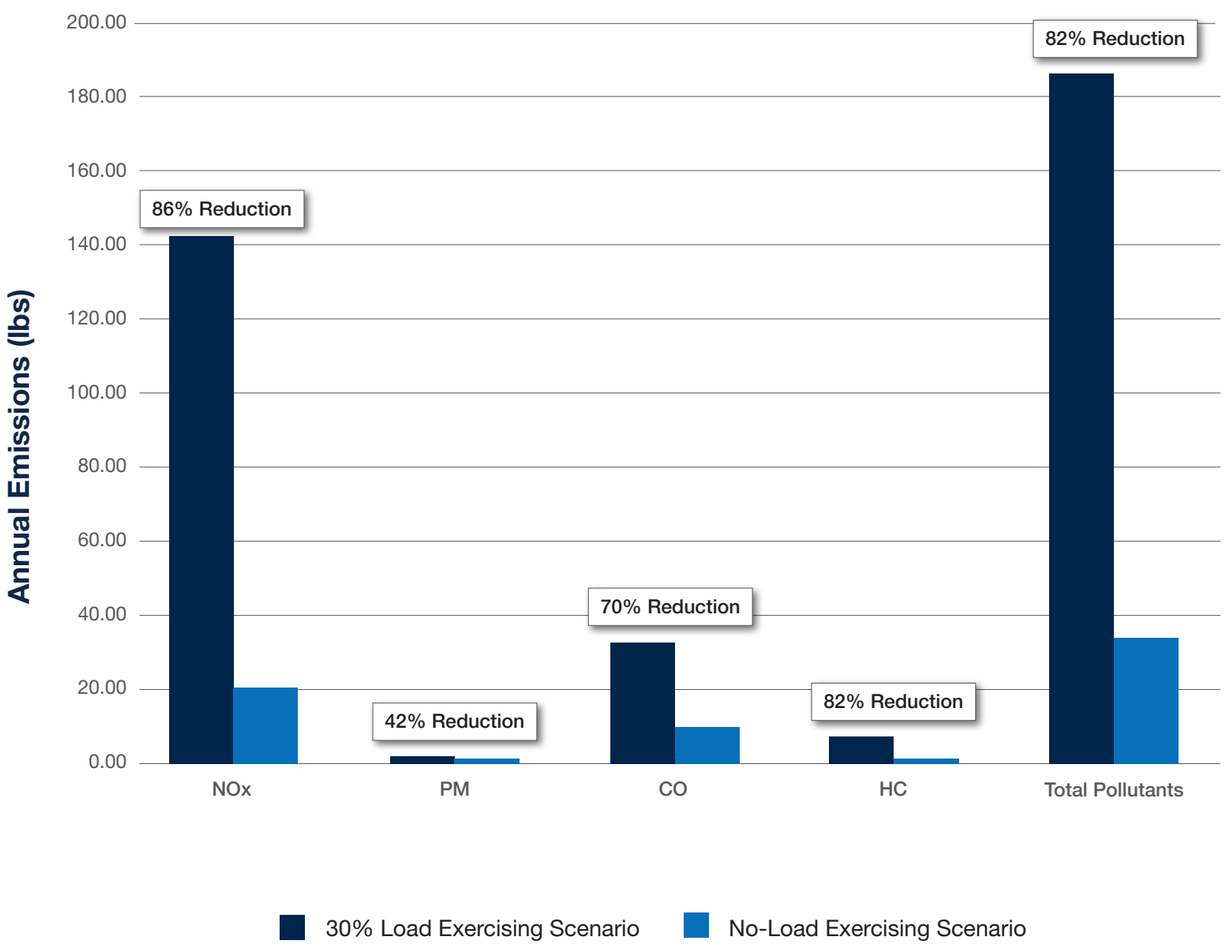


Figure 5

Loaded Vs. No-Load Monthly Exercise Pollutant Creation



REVISING MAINTENANCE SCHEDULES

KOHLER SERVICE PROVIDERS WILL ADVISE

Before revising maintenance schedules, consult with your dealer, service provider, or the manufacturer.

Depending upon the types of aftertreatments you use, service schedules and capacities may differ.

For example, low-temperature operations in the presence of a combined DOC/SCR/DPF emissions control system may run the risk of oxidizing stored hydrocarbons and damaging the SCR catalyst when exhaust temperatures are later raised through higher loading or could plug the DPF.

Regional/local air emissions may also dictate the exercising requirements when using aftertreatment devices.

Be sure to consider this during submissions for permitting of the facility.

Manufacturers and their channel partners can help you choose the right aftertreatment technologies and match testing loads to permitted levels.

ABOUT THE AUTHOR

Brad Meissner currently works as a product manager with responsibility for >700 kW diesel generators at Kohler Co.

Degreed in both mechanical engineering and engineering management, he has spent more than seven years in the power-generation industry. His career started in engineering developing alternators, diesel fuel tanks, enclosures, and generator sets. For the last three years, he has worked as part of the product management team at Kohler Co. His specialties include codes and standards, diesel emissions, generator set packaging, and mechanical systems.

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Printed in U.S.A. G26-41 KPS 130 6/21