Servicing Diesel Particulate Filters on Diesel Generator Systems

Information Sheet # 62

Your Reliable Guide for Generator Maintenance

1.0 INTRODUCTION

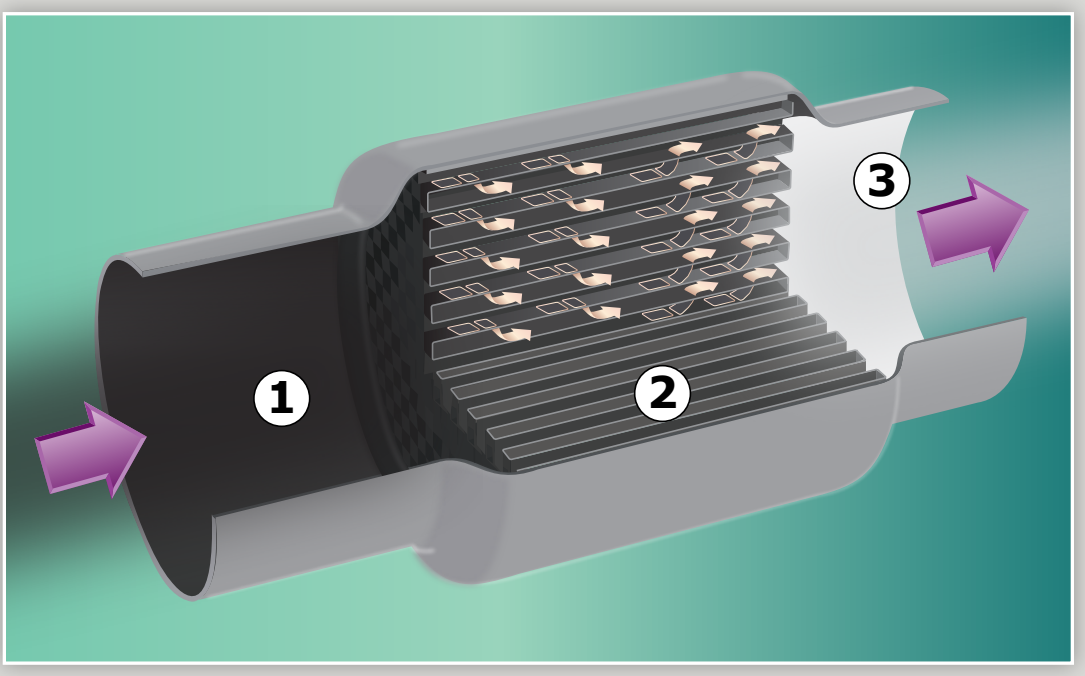
We detail the function, construction and service recommendations for diesel particulate filters used in the exhaust after-treatment of diesel generators.

This Information Sheet discusses servicing issues regarding Diesel Particulate Filters (DPF's) used on Stationary and Mobile Diesel Generator systems.

2.0 PURPOSE OF DIESEL PARTICULATE FILTER (DPF)

The DPF is used to trap soot and ash from the diesel engine exhaust in order that the particulate matter release is greatly limited in accordance with Environmental Protection Agency (EPA) regulations. DPF systems can reduce particulate matter (PM) emissions by more up to 98%. Exhaust gas is channeled through the porous, ceramic filter cells (see diagram one) and PM is deposited on the walls. Most ceramic DPF's are catalyzed with precious metals to reduce the temperature required for regeneration; this will also reduce the carbon monoxide (CO) and hydrocarbons (HC) from the exhaust.

DIAGRAM ONE - DPF "DIESEL PARTICULATE FILTER"



1 - Exhaust inlet carrying particulates

2 - Filter extracts particulates

3 - Outlet exhaust with particulates within EPA requirements

To fulfill our commitment to be the leading supplier in the power generation industry, the Loftin Equipment team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our **Information Sheets** are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.

3.0 EPA REGULATIONS

Off-road diesel engines were considered major environmental polluters and the first federal exhaust emission standards were adopted by EPA in 1994 in order to limit the pollutants. These standards were phased in over time with Tier 1 through 3 regulations. Most manufacturers were able to achieve compliance by the use of improved engine design and combustion technologies. However, Tier 4 rules set in 2004, called for additional reductions of oxides of nitrogen (NOx) and PM – in the order of 90% additional reduction over those of Tier 3. This required diesel engine manufacturers to incorporate control technologies for advanced exhaust gas treatment, with few exemptions such as marine engines covered by separate EPA regulations, and underground mining engines regulated by the Mine, Safety and Health Administration (MSHA).

4.0 CARB REGULATIONS

The California Air Resources Board (CARB) introduced restrictions on PM emissions from diesel generator sets operating for example, near schools. Emission control devices were required by CARB to have their performance levels verified by them. There are three levels applicable to DPF's – 1 through 3. In practice only level 3 is used. It requires a minimum 85% PM reduction.

5.0 COMMON PRACTICE

Because DPF's require exhaust heat for regeneration (burning off trapped soot) they are always placed as close as possible to the exhaust manifold or turbocharger. Some smaller displacement engines can achieve the Tier 4 Final emission regulations

by the use of such technology as diesel oxidation catalysts (DOC's).

6.0 DIESEL EXHAUST

Because a particulate is smaller than the pores of a human lung, there is concern that even ultra-fine and nano sized particles, overall particulate numbers and black soot can cause health problems. The use of PDF's can further reduce the Particulate Number (PN), which may offer a more robust unit for measuring compliance with very low PM mass levels. In addition to soot, filters can also collect such inorganic-based exhaust constituents derived for other sources including combustion of engine lubricating oil, products of normal wear and corrosion.

7.0 TYPES OF DPF'S

There are variants of DPF's available which include: Cordierite Wall Flow, Silicon Carbide Wall Flow, Ceramic Fiber and Metal Fiber Flow-through Filters.

8.0 FILTER PM CLEANING METHOD

The DPF can be regenerated (or cleansed) by burning or oxidization of the collected matter by one of two technologies.

- **Passive Regeneration -** Where the engine exhaust temperatures are sufficiently high enough to continuously oxidize the trapped PM in the filter, under normal operating load conditions. DPF installations should always include the addition of a pressure differential switch to provide a warning when regeneration is required. This may be accomplished with a load bank or operating the generator at a load that will cause the exhaust to rise above the regeneration temperature, typically 450 - 700°F.
- **Active Regeneration -** if conditions, such as light load, low speed, etc. for passive regeneration cannot be achieved, increased back pressure sensors indicate that accumulated soot has built up in the filter. This is removed using additional heat from an

outside energy source - such as electricity, which induces chemical reactions with the soot during such periods. This will elevate the exhaust temperatures sufficiently to clean the filter. Some active DPF's use a wire mesh as the filter medium and pass an electrical current through it for regeneration.

9.0 DPF MAINTENANCE

While the regeneration cycle will combust much of the accumulated particulate matter, noncombustible materials trapped in the filter can be left behind. This residue will create a back pressure that will eventually require the filter to be removed and put through a special and proper cleaning process. If left untreated, reduced fuel economy, filter damage or ultimately engine damage can occur. Such special cleaning will prolong the filter life, maintain engine performance and lower overall maintenance costs. To improve the operating time between maintenance, engines with after-treatment devices should use low-ash lubricating oil that meets API specification CJ4.

10.0 DPF SERVICE RECOMMENDATIONS

We strongly recommend that the DPF is removed periodically and taken to the engine dealer or expert service outlet station for special cleaning procedures. These can include pneumatic (or pulse) cleaning, testing and thermal regeneration with inspection and air flow testing to identify any restrictions. The pneumatic cleaning will remove any burnt ash residue from the filter. If an air flow restriction is found, the DPF is placed in an automated thermal regeneration, where the baking process allowing for a slow temperature increase and subsequent cooling period, is carried out typically up to 12 hours (3 hours for silicon carbide and cordierite filters). If after this initial process is carried out but abnormal back pressure is found, pneumatic cleaning (vacuum) should be done along with a visual check after the baking process to ensure that the DPF is restored to its optimum state before being fitted back on the engine. Any seals should be replaced to ensure there is no blow-by of untreated exhaust. The frequency of such DPF cleaning will depend largely on, the particular engine model emissions, application and duty. Great care must be taken to ensure that the filter body and/or filter element are not damaged during this process. As these residuals are toxic, proper disposal precautions must be employed.

11.0 FURTHER READING ON DPF TECHNOLOGY

All major engine manufacturers have studied and developed DPF technology as a key component of exhaust emission after-treatment to achieve existing and future emission standard.

World-wide Emission Standards: **www.dieselnet.com/standards/**

Manufacturers of Emission Controls Association (MECA): **www.meca.org/**

EGSA On-Site Power Generation: Guide to On-Site Power Reference Book, Chapter 41; **www.egsa.org**