December 2009

RECOMMENDATION
concerning
DIESEL FUME - / DISCHARGING TEST
of
AIR FILTERS

Electrostatic effects allow filters to achieve higher efficiency with lower resistance to air flow. Exposure to some types of aerosol, such as combustion and fine particles may inhibit such charges with the result that the filter's efficiency drops off.

This diesel fume procedure is used to determine whether the filter efficiency is dependent on the electrostatic removal mechanism and to provide quantitative information about its relevance.

E U R O V E N T
EUROPEAN COMMITTEE OF AIR HANDLING, AIR CONDITIONING AND REFRIGERATION EQUIPMENT INDUSTRIES

Diesel fume test - Discharging test procedure

General

Electrostatic effects allow filters to achieve higher efficiency with lower resistance to air flow. Exposure to some types of aerosol, such as combustion and fine particles may inhibit such charges with the result that the filter's efficiency drops off. It is important for filter users to be aware of the possibility of performance degradation arising from inhibition of media electrostatic charge during operational life.

The following procedure is intended to be used solely to determine whether the filter efficiency is dependent on the electrostatic removal mechanism and to provide quantitative information about its relevance. This is accomplished by measuring the efficiency of the filter as it is and by repeating such measurement after removing the effect of the electrostatic mechanism, so that only the mechanical efficiency is left. To verify that most part of the charge have been inhibited, efficiency test at 50% and 100% of nominal airflow shall be conducted during the end of the procedure. A difference in the efficiency of small particles indicates that the electrostatic effect is still effective.

1.1 Test method for discharging of filter

The test is based on the inhibition of the electrostatic efficiency mechanism. The filter treatment is based on a mixture of air and fumes (passing through the filter to be tested) containing combustion particles produced by a modern diesel engine commercially available on the market for power generation. It is important to run the test in such a manner that the exhaust fumes and the smell from the filter do not cause problems to people or the indoor and outdoor environment.

1.1.1 Equipment

1.1.1.1 Test rig

The test may be performed in the standard main body duct system as long as the air is not re-circulated through the laboratory (see Figure 1).

Key

1 Diesel engine
2 Exhaust pipe
3 Fan
4 Filter housing
5 Exhaust air
6 Ambient air

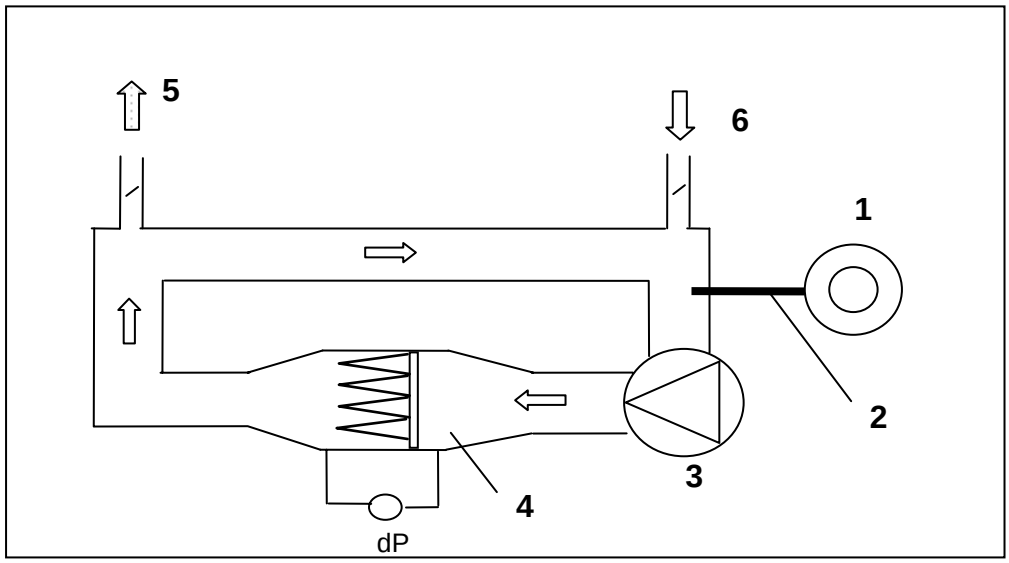

Figure 1 — Auxiliary test rig for preconditioning of filters

An auxiliary system is recommended to be used. In the latter case, the filter is preconditioned in the auxiliary system and taken out for measurement of efficiency and pressure drop in the standard test duct. The principle of an auxiliary test set-up is shown in Figure 1.

The system contains a fan, a diesel engine and filter housings including valves. By introducing diesel exhaust fume in the airflow upstream the filter, the fine exhaust particles will inhibit the electrostatic

charges on the fibres of the filtering medium. It is recommended to use a re-circulating system with at least 10% air exchange with the ambient atmosphere to cool down the air in the duct. If test air is not cooled, the temperature may rise to a point (higher than 65°C) where the test object might be damaged.

The air mixture containing the particles produces by the diesel engine shall be fed to the filter at the rated (nominal) ± 50% airflow of the test object in order to simulate real airflow conditions. The airflow may be set by using the pressure drop reading over the filter, or by implementing an airflow measurement device (flange or similar) in the test duct.

1.1.1.2 Diesel engine

The diesel engine must be of a modern type, producing enough fine particles to shorten the preconditioning time as much as possible. The engine should be operated in such a way that a maximum concentration of fine particulates be produced. This will contribute to a fast discharge of the test object, but not increase significantly the airflow resistance of the filter during the test. No or very low amount of visible smoke should exit the exhaust pipe of the engine.

The diesel engine must be connected to an external source. The easiest way is to use a diesel powered electric generator. The load can be, for instance, the fan in the auxiliary rig. It may be noticed that there is a high power demand when the fan is started and the diesel will easily create soot for a short time. It is preferable to have the diesel fume injection tube designed so that it can be removed from the preconditioning rig when the fan is turned on. This also facilitates checking of the visual cleanliness of the diesel fume (soot or not soot).

The particle distribution of the diesel aerosol will change due to aging and shall be introduced into the filter as close as possible upstream the filter. Typical distributions of “fresh” and “aged” diesel fumes are shown in Figure 2. The fresh diesel fume is measured immediately after the engine, while the aged aerosol is measured about 20 seconds later.

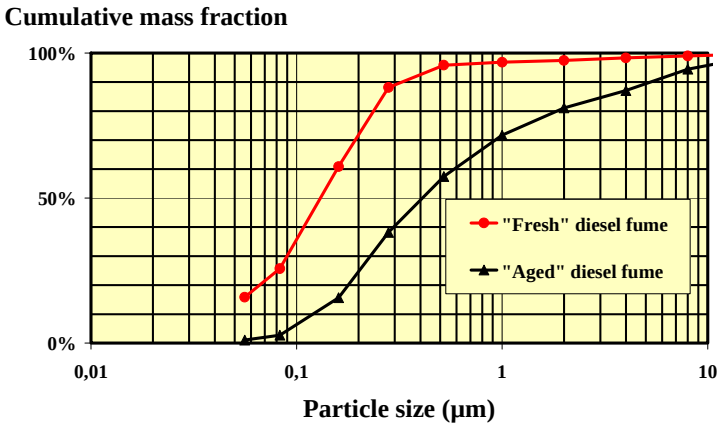

Figure 2 — Example of particle distribution from fresh and aged diesel fume (Lehtimäki 2006).

The diesel engine must be serviced as described in the service manual in order to prevent the diesel from generating soot particles. The fuel used should be of "green-type", like the one normally used in modern diesel automotive vehicles.

Once a year, the diesel fume equipment shall be qualified by comparing its discharging ability with the isopropanol inhibiting process on known highly charged filter media or samples. (Efficiency and pressure drop of filter media are measured after the media has been immersed in isopropanol and dried for 24 hours according to EN 779:2002).

1.1.2 Initial efficiency and pressure drop

The filter to be tested shall be visually inspected to ensure that no cuts or other damage had occurred. The test is started by measuring the initial fractional efficiency and pressure drop according to the main body of this standard. The filter shall be recorded as it is supplied by who request the test.

The efficiency corresponding to 0.4 µm particle size shall be used for determining the trend of efficiency before and after the preconditioning step. It is recommended to weigh the filter before the test.

1.1.3 Discharging test

After the initial efficiency and pressure drop have been recorded the filter shall be placed in the auxiliary test rig with the diesel fume generator. The airflow shall be set to nominal ± 50% and the diesel engine shall be started.

The diesel conditioning procedure will be completed in steps, where in between preconditioning periods the efficiency and the pressure drop shall be recorded at nominal airflow (100%). When efficiency starts to flatten out after some preconditioning steps the difference in efficiency for 0.4 µm particles between 50 and 100% nominal airflow shall be evaluated.

If the difference of efficiency between 50% and 100% airflow is less or equal to 5% (absolute value) the test can be stopped and the lowest efficiency obtained at 100% shall be reported as the preconditioned efficiency. If the difference is higher, the test shall continue with additional challenge periods until this difference has reached the discharged criteria.

The amount of fine particles collected in the filter during a full test varies with efficiency, electrostatic effect and media. The typical amount is 10 to 30 grams, which takes between 6 to18 hours to complete depending on diesel generation. It is recommended to weigh the filter after each measurement to notice unusual changes of diesel fume generation

This low loading will normally not increase the pressure drop or blacken the media. If the pressure drop increases more than 50 Pa at nominal airflow during the test, the test shall be stopped and an evaluation of the system shall be done. An increase in pressure drop may indicate (not always) that a wrong setting of the diesel engine has been used and possibly too large particles/soot have impaired the test. If there is any doubt, the qualification test with isopropanol can be used.

1.2 Expression of results

The initial and preconditioned efficiencies as well as pressure drops of the filter shall be reported both in a graph and in a table. For information, the weight increase can also be reported.

1.3 References

1) EN 779:2002 Annex A
2) Eurovent 2004 round robin test on the basis of EN 779 Annex A and long time tests in real life. Final report NTV 2005/007
3) ISO/TC 142 WG03 N012. ROUND ROBIN TEST – Preconditioning. 2006-06-15
4) Investigation of Mechanisms and Operating Environments that impact the Filtration Efficiency of Charged Air Filtration Media. ASHRAE research report 1189 Phase I Report. 2002
5) Investigation of Mechanisms and Operating Environments that impact the Filtration Efficiency of Charged Air Filtration Media. ASHRAE research report 1189 Phase II Report. 2005
6) ISO/TC142 wg3 report; Efficiency of Air Filters; Round Robin Test within ISO/TC 142. WG3 N012 RRT Preconditioning – Summary: 2006-06-14

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