AN INTEGRATED APPROACH to EMISSIONS REDUCTION & SILENCING

Emissions and Silencing for On-site Power – Exhaust System Integration Continues

The EPA's RICE NESHAP initiative has accelerated the integration of the emissions system and the silencer for on-site power applications. As emission standards continue to tighten it is likely that we will see continued exhaust system integration. A "single cube" exhaust system makes it easier for engine manufacturers, dealers and packagers to meet the regulatory requirements for any air shed in North America and beyond. To be effective, the single cube approach needs to accommodate any required combination of emissions control and silencing while ensuring that engine back pressure specifications are met. The single cube approach allows the system designer to meet the liabilities associated with engine exhaust requirements by dealing with a single supplier.

Overview of Emissions Requirements

For diesel engines, in addition to the silencer, all or some of the following emissions devices may be required:

(1) Diesel Oxidation Catalyst (DOC) to reduce unburned Hydrocarbons and Carbon Monoxide (CO)
(2) Diesel Particulate Filter (DPF) to reduce Particulate Matter (PM)
(3) Selective Catalytic Reduction (SCR) to reduce Nitrogen Oxides (NOx).

The required combination of these emission devices can vary from application to application. Some projects may require DOC + DPF + SCR to meet Tier 4 or Euro VI requirements. A "Tier 4 Final" (T4F) certified engine will come equipped with all of these capabilities "built in" by the engine manufacturer. However not all applications require a certified T4F engine. Many T4F engines with SCR systems turn off the engine when low urea (aka Diesel Exhaust Fluid) levels occur – an unacceptable situation for some applications. There are many cases where it may be more appropriate to use a Tier 2 or Tier 3 engine coupled with a third party exhaust after-treatment and silencing system. For example in some cases, especially for large engines, the space requirements may not allow placement of the engine manufacturer's T4F solution, yet there may be a regulatory requirement to achieve certain CO, PM or NOx targets. Another example is international projects where there may be a desire to eliminate visible smoke and reduce NOx, but cost requirements may make it more attractive to use a Tier 2 or Tier 3 engine with a third party exhaust system. Another example is emergency standby engine/generators. Typically an engine used for emergency standby does not need to be Tier 4 certified. Often for these applications Tier 3 or Tier 2 engines are used. In some instances, especially for emergency standby engines in heavily populated areas there may be a requirement for NOx reduction in addition to silencing. In these cases the engine will require an exhaust system that has both an SCR and silencing.

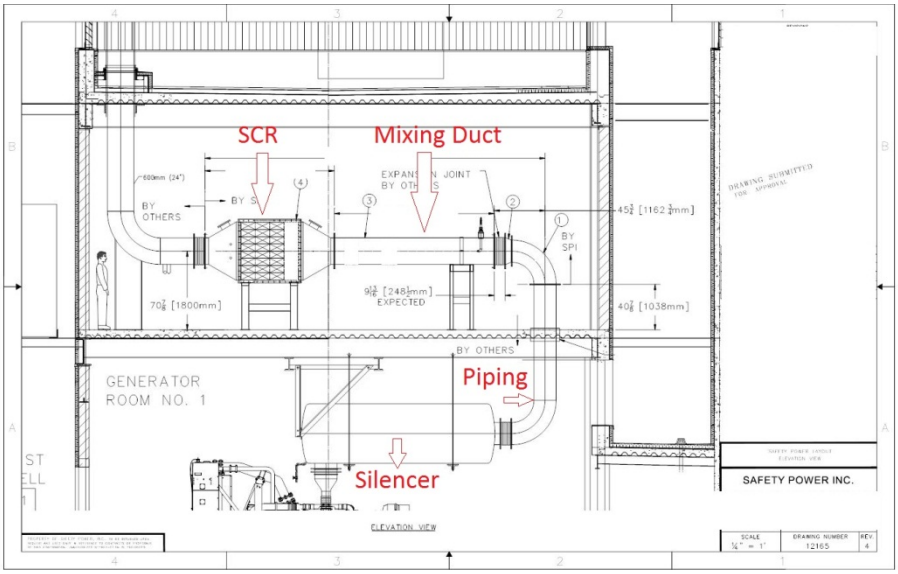
For natural gas engines used in on-site power, the situation may be somewhat different. Many natural gas engines operate in prime power mode. Often they are used as part of a Combined Heat and Power (CHP) system. Many of these engines require a combination of Oxidation Catalyst (similar to a DOC) to reduce CO and an SCR to reduce NOx. CHP applications typically also have heat recovery devices in the exhaust. These devices reduce the available back pressure - leaving less available back pressure for the emissions and silencing system.

Of course both natural gas and diesel engines require silencing. The silencing requirements can vary depending on the site and its local regulatory requirements. Silencing requirements typically vary from a reduction of 20dBA to a high of 40dBA across a predefined set of octave bands

As a result, there are many different combinations of silencing and emissions control that can make it difficult to select the right solution. For example an engineer must consider the engine out emissions and the local regulatory requirements before selecting a silencer and associated emissions solution. In addition if multiple components are required, such as a separate SCR, silencer, DOC and DPF the engineer has to allow enough space for the components and must ensure that the allowable pressure drop for the engine is met. This can create a challenge. For example Figure 1 shows a drawing for an SCR and a silencer for a 2MW engine. As can be seen in Figure 1 there are many expansion joints and a significant amount of piping that interconnects the devices. In addition a lot of space is required for both the silencer and the SCR.

Figure 1

Example of Multiple Exhaust Devices



A further complication for the engineer is how to package the emissions system with the engine. For example, is the emissions system going to be installed on top of an enclosure for outdoor application or will it be hung indoors from a ceiling above the engine? Is there enough space to mount the emission system horizontally or must it be mounted vertically? Will the exhaust enter the emissions system at a side wall or from the bottom? Dealing with these packaging constraints is a challenge which is especially important when there are tight space constraints.

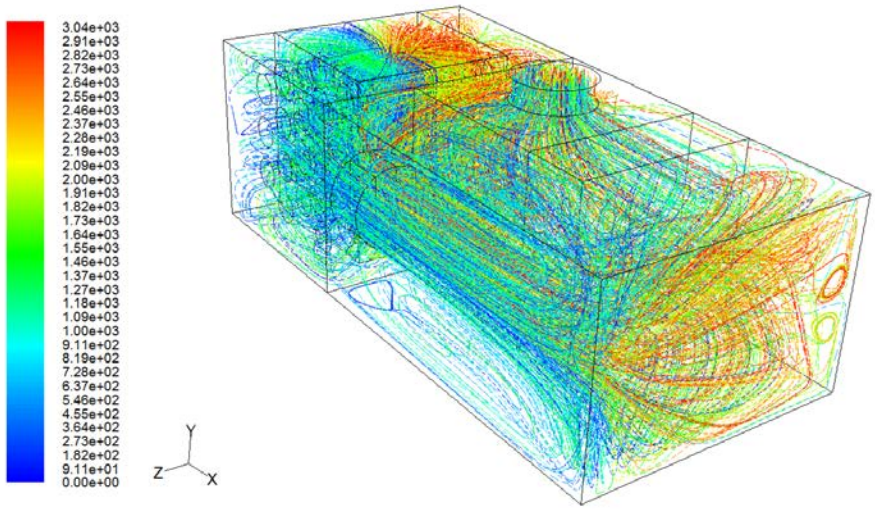
An Integrated Approach to Emissions and Silencing

An ideal solution for engine manufacturers, dealers and packagers is the single cube approach discussed earlier. In this approach, a single device handles any combination of silencing, DOC, DPF and SCR. The ideal single cube solution would allow the engine exhaust to meet most regulatory requirements for noise and emissions anywhere in the world. In addition the ideal cube approach would allow highly flexible packaging of the device if there are space constraints.

In order to create a single cube solution, a product family is required to deal with the various emissions, silencing and allowable pressure drop required for the many available engines that could be used in on-site power applications. To ensure that the cube is as small as possible the entire product family should be pre-engineered with Computational Fluid Dynamics (CFD) software to ensure optimal flow with minimal pressure drop. An example of a typical CFD streamline plot for a single cube is shown in Figure 2.

Figure 2

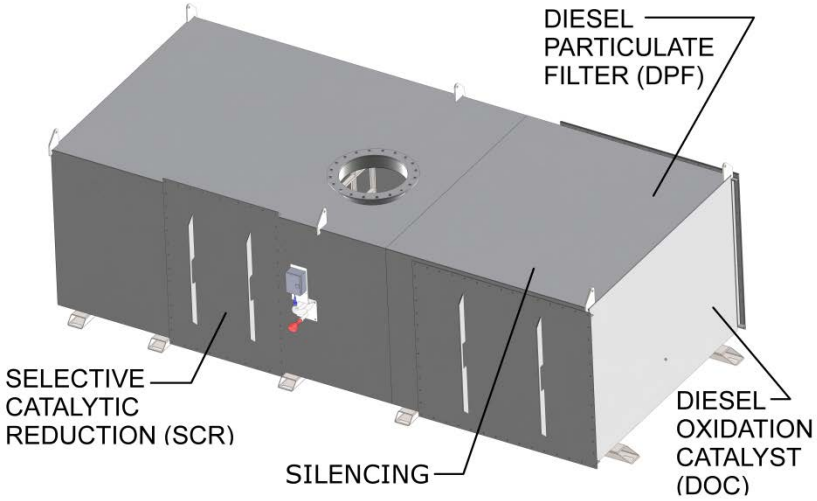
Example of CFD for A Single Cube Solution



By incorporating the mixing tube required for an SCR inside the cube, the overall size of the SCR portion is reduced. The cube approach also allows integration of any combination of silencing, DOC, DPF with the SCR. For example, with the cube approach, it is relatively easy to configure an SCR plus Oxidation Catalyst and silencer for a natural gas engine or to configure a full Tier 4 solution for a diesel. If the cube is pre-engineered then the pressure drop for the combined system is automatically determined when the system is configured. Several different silencer inserts are available to meet different acoustics requirements. Figure 3 shows the packaging of modules in a single cube equipped with all of the available modules.

Figure 3

Example of a Single Cube Solution



In addition to having a single cube solution to emissions and silencing, a significant number of interconnecting pipes and expansion joints can be avoided thereby reducing installation time and cost. The cube can be easily mounted on a genset enclosure or can be ceiling hung in a building application. Often it takes up not much more space than a conventional standalone silencer. The cube is suitable for indoor or outdoor mounting.

Future Directions for Emissions and Silencing

The integration of technology to deal with the reduction of engine emissions and silencing will continue to become an important aspect of exhaust systems for on-site power. In the future there will be continued enhancements of the overall exhaust system leading to smaller, less costly and more efficient solutions to the ever increasing demand to further reduce emissions from engines used for on-site power applications.

In Conclusion

Regulatory requirements and overall system cost will continue to drive exhaust systems that have tight integration between emissions control and silencing. Some engine manufacturers and system integrators will find a single cube solution to be a cost effective approach to meeting their customers' requirements.

About the Author

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