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From a few kilowatts (kW) to several Megawatts (MW), engine-driven generator systems usually employ an engine-mounted radiator for engine cooling. However, for some applications, particularly generators above 500 kW, where the generator is installed in a building or other enclosed space, there is insufficient space to adequately vent the radiator hot air from the generator room. When the warm air output of the generator, either through fans or radiated heat, cannot be adequately ventilated, the ambient room temperature can result in shutdown due to high engine temperature. If no other space is available, the solution is to move the cooling device to a remote area where the hot air can be dissipated freely, such as outside the building. This solution is called Remote Cooling. Building on the information sheet covering "Remote Radiators," this information sheet further expands on systems that can be employed when the generator location does not permit adequate ventilation, and discusses the merits of alternative remote cooling systems, such as heat exchangers.

1.0 TRADITIONAL METHOD FOR COOLING AN ENGINE-DRIVEN GENERATOR SYSTEM

Most manufacturers' base model generators have the radiator mounted on the base frame; see Figure 1. The heat from the radiator is ducted through the generator room via a cowling to ensure heat from the engine's cooling system is not vented back into the room. However, when a system designer evaluates an area proposed for generator installation, they have to take into account the total heat emission from the system, which includes the following:

1.1 ENGINE COOLING:

The most significant amount of heat energy emitted from a generator system is that of the engine when running, particularly at full output power. Water from the engine is piped to an engine-mounted radiator, and a fan driven by the engine blows cool air through the radiator to ensure return water piped back to the engine is within the required limit.

Examples of Cooling Solutions for Engine Driven Generator Sets

Figure 1 Generator Set Engine Mounted Radiator

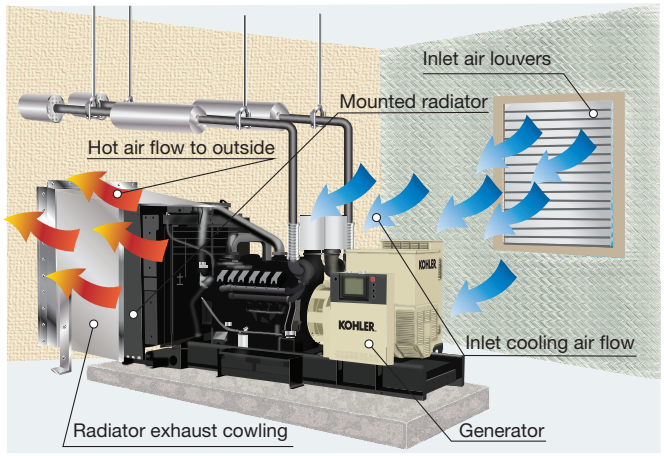


Figure 2 Remote Radiator System

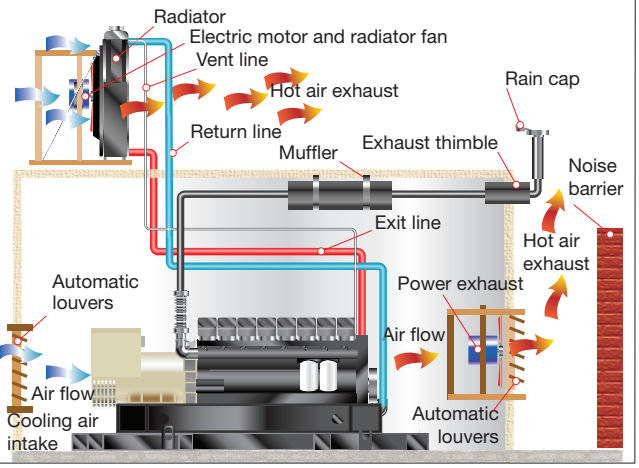
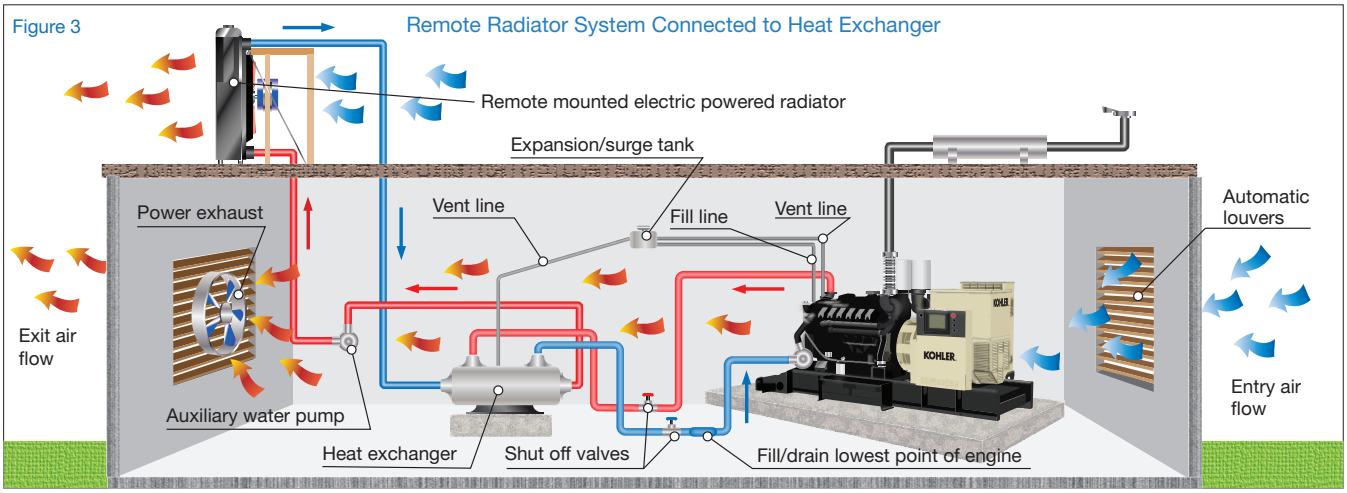


Figure 3 Remote Radiator System Connected to Heat Exchanger



1.0 TRADITIONAL METHOD FOR COOLING AN ENGINE-DRIVEN GENERATOR SYSTEM (CONTINUED)

1.2 TURBOCHARGER COOLING/CHARGE AIR COOLING:

Larger engines, those over 500 hp, have an additional level of heat emission. Many larger engines employ turbochargers to meet emission and power requirements. Turbochargers are driven by the exhaust gas to force more air into the engine combustion chamber, and more air can combust more fuel with an increase in power from the same cylinder size. However, the exhaust gas elevates the temperature of the air being compressed; for better combustion and greater power, this compressed air is cooled by an additional air-cooled radiator also mounted to the engine.

1.3 GENERATOR END COOLING:

The electrical generator also emits heat in the electro-mechanical process to produce electricity. All generators have a fan on their shaft to blow cooler air over the generator windings.

2.0 DETERMINING IF A GENERATOR LOCATION PROVIDES ADEQUATE VENTILATION:

The first calculation is to determine if an engine-mounted radiator system can be ducted via a cowling to the outside. Manufacturers will provide figures for heat generated and engine and generator airflow requirements. The following determinations will provide the system design with the required cooling solution:

2.1 RADIATOR MOUNTED ON ENGINE OPTION:

This is the most frequently used option for an open (non-enclosed) generator for inside installations. ***See Figure 1.***

For this engine-mounted radiator option the following criteria will have to be met:

- Radiator cooling air can be ducted directly outside with no recirculation of the radiator into the generator room.
- Sufficient space in the generator room to contain radiator mounted arrangement.
- Easy access to an exterior wall. This can be a problem in a basement application.
- Larger generators employing exhaust aftertreatment will require more space when the equipment is mounted to the generator. While exhaust will be piped out, the radiated heat of the exhaust system has to be taken into account, with many manufacturers lagging the engine exhaust equipment with thermal blankets.
- There are no areas obstructing airflow. There is sufficient inflow of outside air to dissipate radiated component heat, especially engine surfaces and heat from the generator end. Generator systems are rated to provide kW output at a set altitude, ambient temperature, and humidity. If the ambient air rises above the assumed rating, around 70 degrees Fahrenheit, rated power will not be available.
- The correct outflow of generator room air to avoid increased internal ambient heat. If there is insufficient natural airflow to the outside, a motorized fan air outlet should be employed to increase airflow through the room.

2.2 REMOTE MOUNTED RADIATOR OPTION:

Sometimes, the conditions for an engine-mounted radiator cannot be met. For instance, the distance to an outside wall might be too far for ducting to be an option, and there could be insufficient space to dissipate radiated heat. If this is the case the next available option is to mount the radiator remotely. Please refer to Figure 2 for a visual representation. ***See Figure 2***.

For a remote radiator option to be considered, there are other criteria to be taken into account:

- Engine distance from the remote radiator's location. Excessive distance from the engine can result in two dynamics.
    1. **Static Head**: When the radiator is much higher than the engine, water pressure can exceed the engine's limits, resulting in gasket failure. This can occur even without coolant flow.
    2. **Dynamic Head:** When coolant is piped over a certain distance, the resistance of a too-narrow pipe diameter can restrict the flow of coolant. To avoid a pressure drop across the radiator, the system designer will have to calculate the required pipe dimensions. Sometimes, increased piping is cost and logistically prohibitive. Sometimes increased piping is cost and logistically prohibitive.
- If only the dynamic head is considered, one solution is to install a booster pump for the coolant flow.

2.3 REMOTE MOUNTED RADIATOR COUPLED TO A HEAT EXCHANGER OPTION:

When all the criteria for an engine-mounted radiator cannot be met, and the remote radiator solution will result in problems with both the Static and Dynamic heads, the heat exchange option is another consideration. ***See Figure 3***.

When there is insufficient access to an outside wall, such as a basement, and the generator room is too far away from the remote radiator, adopting a heat exchanger allows the system designer to eliminate the issues of space and the static and dynamic head, in the following way:

- The cooling system of the engine is fed through a heat exchanger located in the generator room, at a level water head, so it does not strain engine seals and has a distance that does not require larger dimensional piping. Per ***Figure 3*** coolant is pumped from the engine to the heat exchanger.
- An auxiliary coolant pumps hot coolant from the exchange to an outside remote radiator. The hot coolant is the result of the heat exchanger removing heat from the coolant received from the engine. The heat exchanger returns the cooler coolant/fluid to the engine.
- The remote radiator cools the coolant/fluid pumps to it from the heat exchanger. As per other remote radiators, cooling is by an electric-driven fan that removes the heat by blowing through the radiator vanes. Cooler coolant/fluid is then returned to the heat exchanger.
- The piping between the heat exchange and the remote radiator will be sized as required, with no issues with the static head.

To fulfill our commitment to be the leading supplier in the power generation industry, the Buckeye Power Sales 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.

Buckeye Power Sales
Reliable Power Professionals Since 1947

CANAL WINCHESTER, OH
8155 Howe Industrial Parkway
Canal Winchester, OH 43110
(614) 751-4515
(866) 889-2628

CINCINNATI, OH
4992 Rialto Road
West Chester, OH 45069
(513) 755-2323
(800) 368-7422

CLEVELAND, OH
8465 Tower Drive
Twinsburg, OH 44087-0394
(330) 425-9165
(800) 966-2825

TOLEDO, OH
27100 Oakmead Dr.
Perrysburg, OH 43551
(855) 638-2728

CHICAGO, IL
1308 Marquette Drive
Romeoville, IL 60446
(630) 914-3000

INDIANAPOLIS, IN
1707 S. Franklin Road
Indianapolis, IN 46239
(317) 271-9661
(800) 632-0339

FORT WAYNE, IN
7525 Maplecrest Road #221
Fort Wayne, IN 46835
(855) 638-2721

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