KOHLER®

Remote Cooling

Design Factors for Standby Generators

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INTRODUCTION

A remote cooling system may be an option for many different generator applications, but due to the increased complexity and higher overall cost, they are typically only used when necessary. Some types of installations where a remote cooling system may be necessary include:

- Basement or interior generator rooms (no access to an exterior wall)
- Low headroom or access constraints
- Areas with obstructions to airflow

There are a few options for remote cooling systems such as cooling towers, city or pond water cooling, and remote radiators. Cooling towers and cooling ponds are costly and use up a lot of space, so these are unlikely to be used in many cooling applications unless already existing on-site. In addition, local codes may prevent or restrict emergency standby generators from using city or pond water cooling systems.

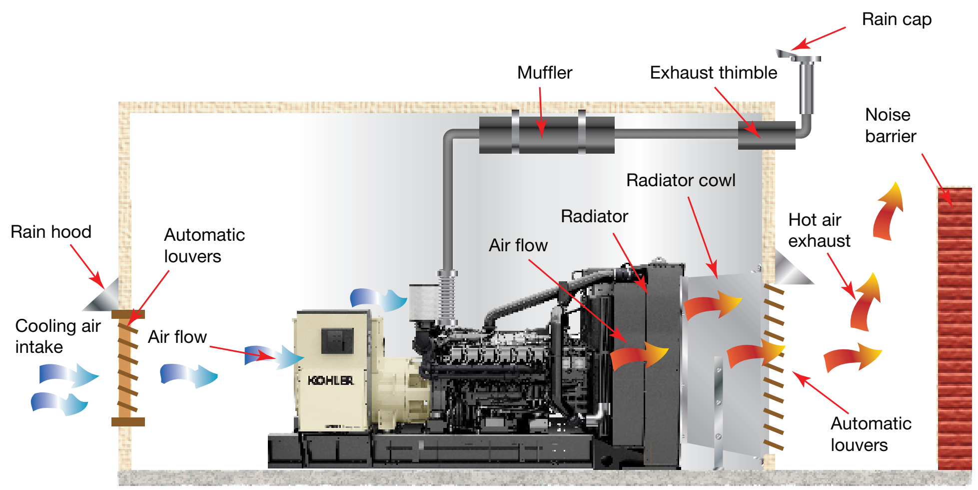
Radiator and heat exchanger cooling systems are the most common remote cooling methods we will be discussing in this paper.

ROOM DESIGN CONSIDERATIONS

Unit-mounted radiator systems are the most common application for indoor applications where the generator is placed in a room. When designing a generator room, there are several things to consider, but regarding generator cooling, airflow is one of the most important design considerations. See Figure 1.

Figure 1

Generator-Mounted Radiator System



ROOM DESIGN CONSIDERATIONS (CONTINUED)

REMOTE COOLING SYSTEM

With a remote cooling system, less airflow is required, but there will still need to be adequate airflow to remove radiant engine/exhaust heat, alternator heat, and provide enough combustion air for the engine. The generator manufacturer can provide these airflow requirements for their gensets. Any portion of the exhaust piping and silencer that is in the room should be wrapped to reduce the amount of radiant exhaust heat in the room.

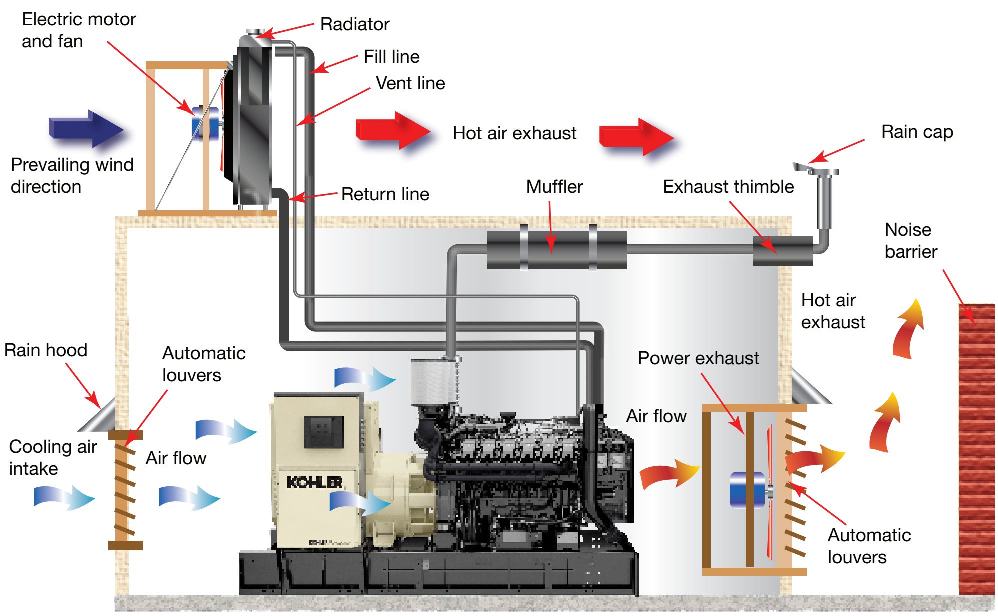
LOCATION OF ROOM AIR INLET/DISCHARGE

In addition to the air volume required, it is important to consider the location of room air inlet/discharge in relation to the genset to avoid any hot spots or localized overheating. One important reason for this is that if the combustion air intake temperatures get too high, the generator engine will derate and the generator will not be able to output rated power.

As shown in Figure 2, cool air must come from the alternator end and flow over the entire generator before leaving the room on the engine end of the generator. Since the room ventilation needs to provide adequate airflow to cool genset at highest possible ambient temp and generator load, it is best to have movable dampers to control airflow at lower temperatures and load.

Figure 2

Remote Radiator System



RADIATOR PLACEMENT

For proper cooling, the radiator itself would ideally be placed as shown in Figure 2, away from external heat sources or structures that may block airflow and upstream of the generator exhaust and room air discharge to prevent recirculation of hot air. However, this must be balanced with the requirements of the generator cooling system, which will function best the closer it is to the radiator. To determine how far away the radiator can be from the generator, two things must be considered: static head and dynamic head. These limits can be found on manufacturer spec sheets; consult your local distributor for more information.

STATIC HEAD

Static head (pressure when there is no coolant flow) is determined solely by how much higher the radiator is than the engine. If the static head exceeds the limits for the engine, it can cause premature gasket and seal failure by exposing them to pressures greater than they were designed for.

DYNAMIC HEAD

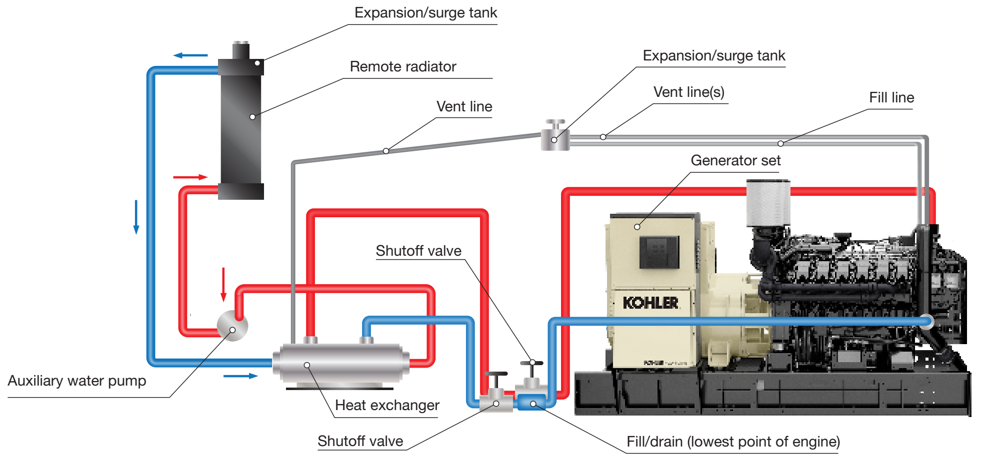
Dynamic head is a more complicated calculation of the total resistance of the cooling system while coolant is flowing. This is affected by several factors, including coolant flow rate, pipe size, and pressure drop across the radiator. To some extent, dynamic head can be reduced by increasing piping size, but this can become cost prohibitive and has diminishing returns.

HEAT EXCHANGER SETUP

If static and/or dynamic head of an installation would exceed the generator limits, alternative designs may be needed. If only dynamic head exceeds limits, a booster pump can be used to overcome the additional restriction in the system, but if static head limits are exceeded, the radiator and generator will need to be isolated from one another. This is typically accomplished using a heat exchanger setup like that shown in Figure 3.

Figure 3

Static Head Heat Exchanger and Dynamic Head Auxiliary Pump Solutions



RADIATOR CIRCUIT DESIGN

Most large generators will have two distinct cooling circuits that need to be accommodated by the remote cooling system: the engine jacket water cooling and the charge air cooling. The jacket water circuit cools the engine block itself, while the charge air circuit cools the air leaving the turbochargers. The charge air cooler (CAC) is necessary due to the turbochargers compressing the intake air, raising its temperature. CAC design is important as EPA emission certifications for an engine are dependent on a specific temperature rise of the intake air over ambient temperature (typically 20°C, but it varies by engine), so any remote cooling system must maintain this CAC performance.

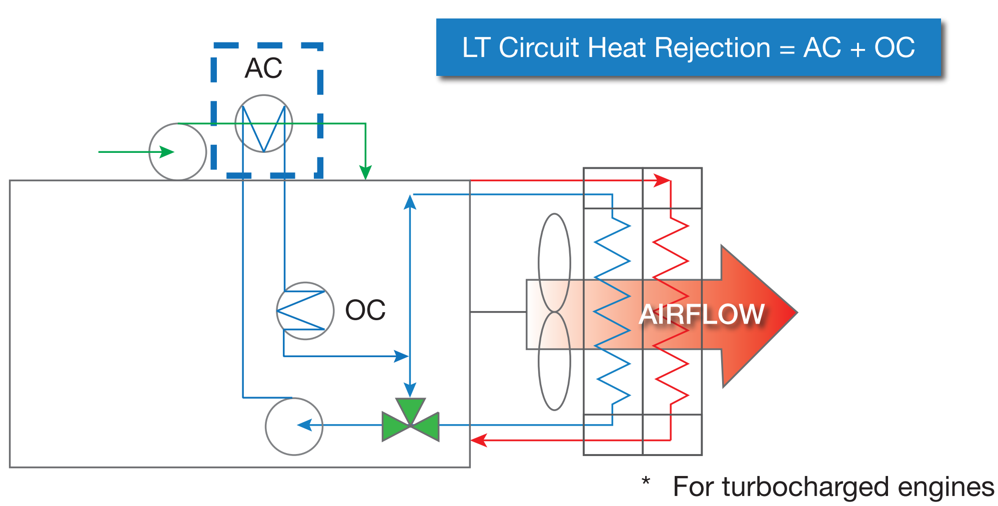
The detailed requirements of these circuits that will be necessary for radiator sizing, such as coolant flow rates and heat rejection for each circuit, can be found on the generator spec sheets provided by the manufacturer.

AIR-TO-AIR OR WATER-TO-AIR COOLED

One additional consideration for remote cooling of the CAC circuit is whether the engine is air-to-air or water-to-air cooled. Water-to-air CACs utilize an integrated heat exchanger to cool the charge air using a liquid coolant circuit (typically separate from the jacket water) like Figure 4.

Figure 4

Combined Circuit – Separate Circuit Charged Air Cooler (SCAC)

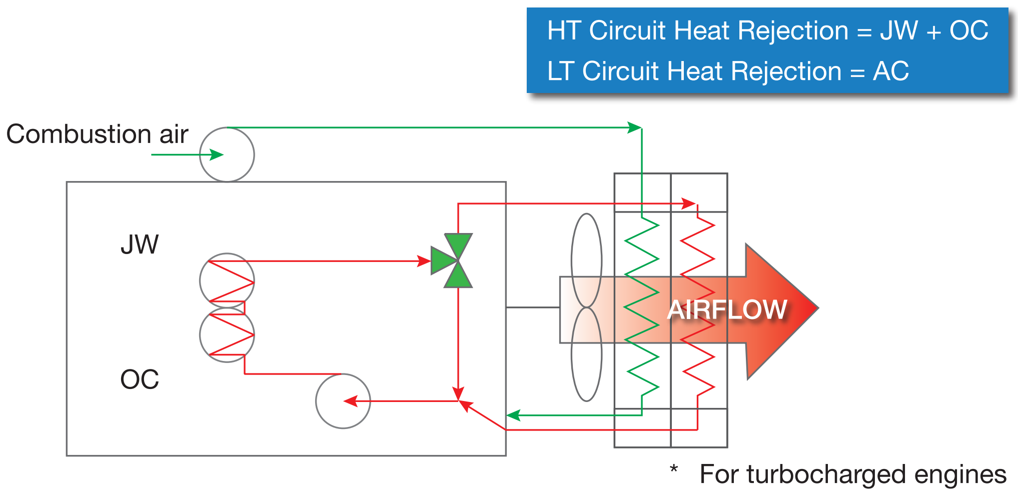


AIR-TO-AIR CAC

Air to air CACs run the intake air directly through the radiator as shown in Figure 5. Air-to-air systems are more difficult to cool with remote systems and likely need a heat exchanger setup unless very closely located. This is because excess piping causes greater pressure drops in the charge air circuit (lower boost at engine) and increases turbo lag, which can reduce transient response and generator performance.

Figure 5

Combined Circuit and Charged Air Cooler (CAC)



GENERATOR-RATED OUTPUT

By removing the mechanical cooling fan, the engine load is decreased, which may allow for an increased generator rating if there is excess alternator capacity (some engine/alternator combinations will have closely matched engine and alternator ratings, in those cases the genset rating cannot be increased).

However, local or national codes (such as NFPA 110) will require that cooling system fans are powered by the emergency power source (generator), so this excess capacity is not always usable power, as it is still necessary for cooling.

KOHLER® ADVANTAGES

If a project requiring a remote cooling system is determined, be sure to reach out to a KOHLER distributor for assistance in designing the cooling system to meet the site's needs. Distributors close to the site will have in-depth knowledge about suppliers and code requirements. In addition, when designing the room to incorporate the generator, consider using the room sizing tool within Power Solutions Center Sizing and Specification software found at:

https://powersystems.kohlerenergy.com/en/sizing-program

SUMMARY

Designing remote radiator cooled generator systems has many factors to consider including room design, the standard unit-mounted radiator type, the location of the radiator, and genset ratings. Consult with a local KOHLER distributor for assistance in designing remote radiator systems for your project to assure proper performance and reliability.

ABOUT THE AUTHOR

Alex Hischke is a Sr. Project Engineer at Kohler Co. He is a graduate of Michigan Tech who joined Kohler in 2017 and is a part of the Industrial Solutions engineering team, where he is responsible for the design of engineered special custom generators and enclosures.

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