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on-peak performance

ON-SITE POWER GENERATION FOR A COMPETITIVE FUTURE

Specifying fuel: Fueling standby power options

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A supplement to *Consulting-Specifying Engineer*, with information from EGSA.

CONSULTING - SPECIFYING engineer

EGSA Electrical Generating Systems Association

Preheating for savings

Using forced-circulation preheaters instead of thermosiphon preheaters can reduce electrical consumption 25% to 36%. This provides another energy-saving strategy when specifying heaters for new gensets or upgrading heaters on existing installations.

Greg Walters,
Kim Hotstart Mfg.,
Spokane, Wash.

Every little bit counts" has become a mantra in the effort to maximize energy efficiency and reduce facility operating costs. Today, reducing electricity consumption is a priority with nearly everyone, from homeowners to Certified Energy Managers of large organizations. For operators of standby generators, a simple change to engine-preheating methods can add just such incremental savings to a facility's overall electrical usage.

Preheater basics

Engine-coolant preheaters are a standard accessory on most emergency power supply systems (EPSS) that use diesel, propane, or natural-gas fueled engines. These devices, also called jacket water heaters, are designed to keep engine temperature at an optimum level for startup and load acceptance. Typically, this means maintaining the coolant at a minimum of 90 F.

Kim Hotstart mdl CSM forced circulation preheater is shown installed on a 1,500 kW genset.
Photo: Kim Hotstart

>> Preheaters are critical components wherever NFPA 110 applies.

Preheaters are a critical component wherever NFPA 110 – Standard for Emergency and Standby Power Systems applies. This standard details specific requirements for an EPSS, generally requiring generator sets to be capable of starting and powering attached loads within 10 seconds after normal power is lost. Engine coolant preheaters help ensure the generator set can meet this requirement. They are powered by a facility's available electrical service and, with exception of weekly exercising and loss of normal power, operate continuously.

Conventional engine preheaters are of an external tank-type design using thermosiphon method of circulation. These units feature a heating chamber with a thermostatically controlled element, and supply and return lines to the engine water jacket. Heated coolant circulates as the result of a thermosiphon effect—as heated liquid rises out of the chamber, it is simultaneously replaced by colder liquid from the engine. Thermosiphon heaters require strict adherence to installation guidelines to operate effectively. Proper hose routing and size, in addition to the heater's mounting location, are critical. And outlet temperatures need to be high—sometimes exceeding 200 F—to ensure proper circulation.

Forced circulation alternative

An alternate design can end up both saving energy and improving reliability, as shown in testing conducted by Kim Hotstart Mfg. Co., Spokane Valley, Wash., in cooperation with Avista Utilities, Spokane, Wash. Called "forced circulation," this method cycles the heating element on and off, based on the control thermostat setting, using a pump to push fluid throughout the system.

With forced circulation, the heater control thermostat is exposed to temperatures closely coupled to engine temperature. This results in lower electricity use, reduced outlet temperature, and more uniform engine heating. With lower outlet temperatures, heater hoses, heating elements, and engine seals all may last longer. Thermal images of heater operation illustrate the performance differences of thermosiphon preheaters compared to forced circulation preheaters featuring electric pumps.

Energy-saving results

Testing found that the benefits of forced circulation can be realized on any generator set, regardless of engine size. Comparative reviews of thermosiphon and forced-circulation preheaters was completed on 50-kW, 750-kW, and 1,500-kW generator sets with respective engine sizes of 4.4-L, 27-L, and 50-L displacement. Results were consistent in all three situations.

Engine preheater specifications for a 50-kW set with a 4.4-L diesel engine call for a 1,500-W thermosiphon preheater. Side-by-side testing was done using two identical gensets. Data collection showed energy consumption of 0.71 kWh and maximum heater outlet temperature of 190 F for the original thermosiphon installation. Temperature gradient across the engine was 75 F. The heater outlet hose of the thermosiphon heater was routed close to the engine thermostat. Due to the high outlet temperature, the engine thermostat opened and resulted in lost heat to the engine radiator.

Testing with a forced circulation preheater featuring an integral 5-gpm pump produced a reduction of 0.21 kWh in electrical consumption

Table 1 Generator set heater test results
Electrical consumption per hour of operation

Genset size	Thermosiphon	Forced circulation	Savings
50 kW	0.71 kWh	0.50 kWh	0.21 kWh
750 kW	2.8 kWh	1.8 kWh	1.0 kWh
1,500 kW	2.97 kWh	2.33 kWh	0.74 kWh

To estimate annual dollar savings, the kWh savings can be multiplied by the number of hours of preheater operation in a year (8,760 hours/year less time of genset operation due to loss of normal power and exercising), with the resulting figure then multiplied by the cost of electricity. The cost of a forced circulation installation will depend on the genset size and if it is a new or existing installation. Local generator set distributors or service companies can help with heater specifications and cost estimates. In addition, the local utility can be contacted to determine if incentive programs are available for engine heater replacement.

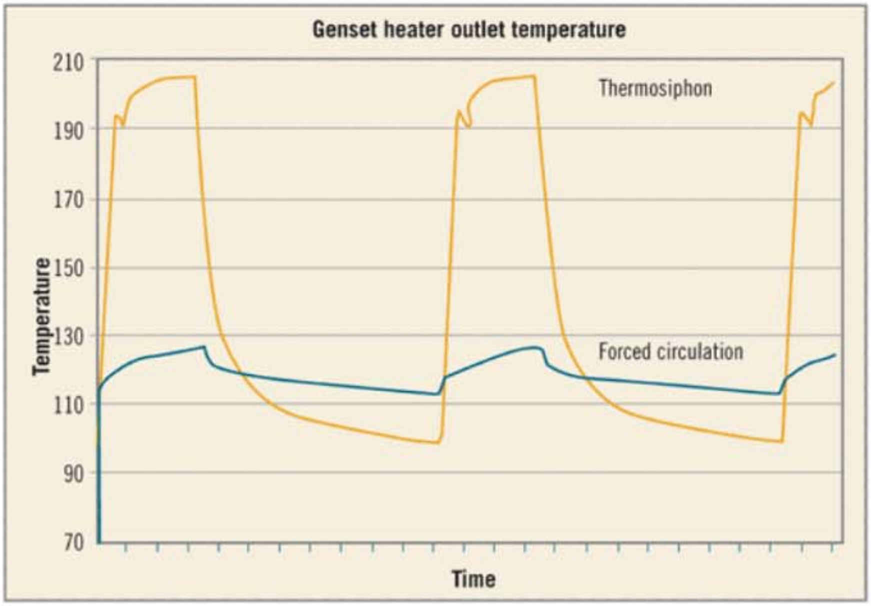

Figure 1 This shows the heater outlet temperature comparison. It reflects the Kim Hotstart test results of 50 L, V-16 engine.
Source: Kim Hotstart

This shows one of two original equipment thermosiphon preheaters on a 1,500 kW genset.
Photo: Kim Hotstart

and maximum outlet temperature of 117 F. This eliminated opening of the engine thermostat. The temperature gradient across the engine was just 10 F. Total energy consumption was reduced 29%.

Comparative testing of preheaters also was performed on two identical 750-kW generator set installations with 27-L, V-12 diesel engines. A 6,000-W thermosiphon preheater was compared with a 6,000-W forced circulation system with integral 10-gpm pump. Test results using the forced circulation heater produced a 1.0-kWh reduction in electrical consumption and 100-F lower outlet temperature. The temperature gradient across the engine was reduced by 90 F. Electrical use in this application was reduced 36% compared with the thermosiphon heater.

On larger generator sets, dual thermosiphon preheaters are common. To evaluate these installations, testing was conducted using a 1,500-kW genset with a 50-L V-16 diesel engine. The original preheater installation included dual 4,990-W thermosiphon heaters, one for each side of the engine, totaling 9,980 W. For comparison, one 9,000-W forced circulation preheater featuring a 10-gpm pump was used on the same genset. Testing revealed that heater outlet temperatures dropped from 205 F to 127 F and energy consumption was reduced 25% (see Figure 1).

Consider your options

Replacing an existing thermosiphon preheater with a new forced-circulation model will have a first cost that will need to be worked into any facility's calculations. Such a move might not be the right one for every genset installation. However, as this testing shows, forced-circulation preheaters offer an option for managers seeking to lower ongoing energy costs through incremental operational improvements.

Walters is market manager with Kim Hotstart Mfg. and works directly with genset manufactures and engine OEMs to develop engine heating solutions.