White Paper

Load Banks for Regenerative Braking Applications

ASCO Power Technologies®

Load Banks for Regenerative Braking Applications

To slow and stop equipment that moves, elevators, cranes, and hoists powered by engine-generators often employ regenerative braking technologies. These technologies oppose inertial load by converting kinetic energy to electricity. This document explains how resistive load banks can supplement the regenerative function of generator engines and provide superior regenerative braking capabilities.

BACKGROUND INFORMATION

In most braking applications, objects are slowed and stopped using friction devices. These systems dissipate kinetic energy to the surrounding environment as heat. Common examples include braking systems on conventional (non-hybrid) vehicles as well as friction brakes used on elevators, cranes, and other equipment that must control the movement of load-carrying devices.

Regenerative braking technologies also convert kinetic energy to slow and stop equipment. These systems differ by applying load to a generator to create a force opposing the motion of moving equipment, and thus provide braking force by using kinetic energy to generate electricity. For elevators, cranes, and hoists powered by engine-generators, their gen-sets are sometimes used to provide regenerative braking to slow and stop devices.

USING RESISTIVE LOAD BANKS FOR REGENERATIVE BRAKING

For systems without a resistive load bank, it is important to understand that regenerative loads place mechanical stresses on both a generator and its engine. However, engines typically have a limited capacity for opposing moving loads, and their regenerative power ratings are usually a small fraction of total rated engine power, as shown in figure 1. Consequently, the available regenerative power could be insufficient for the application. Applying excess braking force could result in over-speed conditions that can damage engines. These outcomes can each be avoided by directing regenerated electricity to resistive load banks sized to provide the necessary amount of load to regenerative equipment.

Specifications - Engine	
Aspiration	Turbocharged
Cylinder configuration	In-line 4
Displacement - L (cu in)	4.4 (269)
Compression ratio	19.3:1
Max power at rated rpm - kW (hp)	
Standby	117.5 (157.5)
Prime	106.9 (143.2)
BMEP - kPa (psi)	
Standby	1778 (258)
Prime	1616 (234)
Regenerative Power - kW (hp)	13.8 (18.5)

Specifications - Engine	
Base Engine	Turbocharged and Aftercooled, diesel-fuel
Displacement in^3 (L)	610.0 (10.0)
Overspeed Limit, rpm	2100 ±50
Regenerative Power, kW	26.00
Cylinder Block Configuration	Cast iron with replaceable wet cylinder liners, In-line 6 cylinder
Battery Capacity	550 amp minimum at ambient temperature of 32°F (0°C)
Battery Charging Alternator	55 amps
Starting Voltage	24-volt, negative ground
Lube Oil Filter Type	Single spin-off, full flow/bypass
Standard Cooling System	122°F (50°C) ambient radiator

Figure 1: The nameplate for the 4.4-liter engine at left specifies 117.5 kilowatts (kW) of motive power, but only 13.8 kW of regenerative power. The 10-liter engine at right develops only 26 kW of opposing force.

Directing regenerated current to resistive load bank offer the following advantages. First, the load bank can be used to provide regenerative braking loads beyond the capability of the engine, reducing the supplemental braking force that must be provided by mechanical equipment. Second, a regenerative load bank can be used to dissipate all regenerative loads from an engine-generator, thus avoiding placement of any braking stresses on the engine.

CONFIGURING RESISTIVE LOAD BANKS FOR REGENERATIVE BRAKING

Resistive load banks used in regenerative applications can typically dissipate 200 to 400 kW of load. Within these ranges, these units offer load steps as low as 50 kW. For elevators, crane, and hoist systems operating in dedicated locations, pad-mounted load banks offer application flexibility, including the ability to dissipate heat far from the point of equipment use. This capability can be particularly useful when the heat generated by indoor equipment must be dissipated outdoors. Mounting resistive load banks on engine radiators can offer a compact space-saving arrangement, and would be required to supply regenerative braking for equipment such as mobile cranes. Pad-mounted and radiator-mounted load banks are shown in figures 2 and 3, respectively.

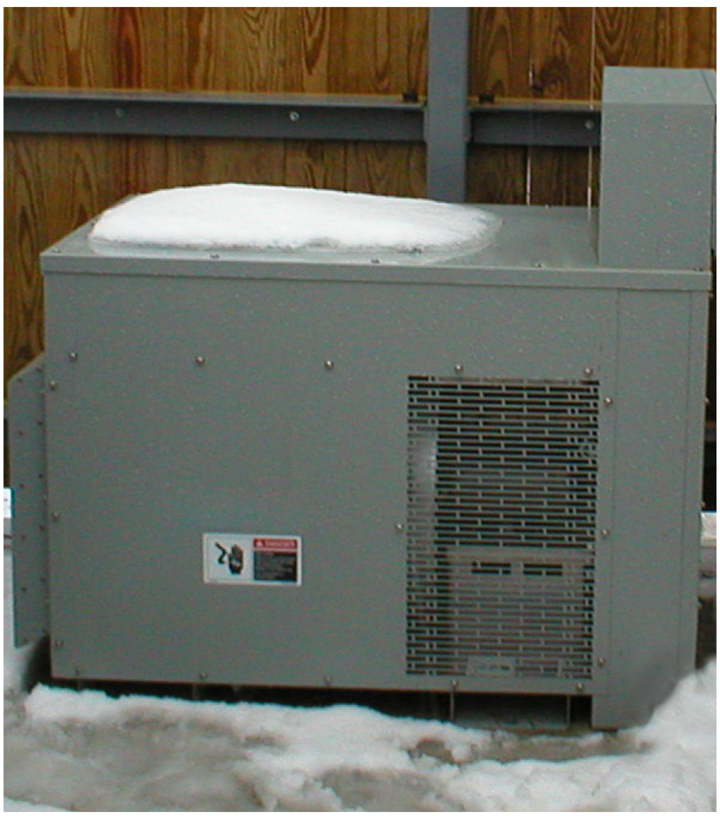

Figure 2: A 150 kW resistive, pad-mounted load bank.

Figure 3: A 200 kW resistive load bank mounted on the radiator of a generator set.

When configuring load banks for regenerative braking applications several options are available for providing effective control and operations. These include:

Timer Circuits

Regenerative load banks use an integral Generator Voltage sensing circuit that delays initial and sequential step-loading until the generator reaches its rated voltage. This circuit also operates a cool-down timer that keeps load bank cooling fans running following load removal.

Reverse Power Relay

A reverse power relay monitors the power from the generator. If it detects a reverse power condition, the relay will signal the load bank controls to add additional load.

Automatic Load Control

An external current transformer monitors generator output. When generator loading decreases, the automatic load controller automatically adds step-loads until the total generator output exceeds the minimum required amount. The controller sheds load when the generator output exceeds a maximum set point.

Digital Load Controllers

Digital load bank controllers often provide for control of regenerative loading features. These controllers enable operators to engage and disengage regenerative loading and set values for the amount of regeneration loading that should be applied (see figure 4).

Figure 4: Example of a digital load controller.

OPERATING DESCRIPTION

In automatic mode, load bank controls will continually monitor the current from the generator through the external current transformer. The automatic controller will add or subtract load to maintain a minimum load on the generator. If the reverse power relay senses regenerative current, it will instantaneously apply additional load, typically in 50 kW increments. The reverse power relay will continue to add load until a set point is reached. When the relay no longer senses reverse power, it will shed load in discreet steps.

The regenerative load bank can be designed to pick up load stages based on either the load bank resolution (typically 50 kW), or bulk load. If designed for bulk load, then full capacity of the load bank will be automatically added in a single action when reverse power is sensed. The correct addition of load is critical in reverse power applications to prevent a generator over speed condition. Therefore, generator capacity and motor loads are important design criteria for regenerative load banks.

SUMMARY

For applications involving motor deceleration, a resistive load bank offer a practical means for applying load to dissipate current for regenerative braking operations. Properly specified load banks will be equipped with automatic load control features, as well as reverse power relays and generator sensing circuitry. To specify a load bank for regenerative applications, generator voltage, kW capacity, regen kW capacity, and motor load data are needed for proper design.

ASCO Power Technologies | Avtron
6255 Halle Drive
Cleveland, OH 44125
Tel: 216.573.7600
LBsales@ascopower.com

ASCO Power Technologies | NJ Froment & Co. Ltd
Easton-on-the-Hill
Stamford, PE9 3NP
United Kingdom
Tel: +44 1780 480033
froment.sales@ascopower.com

loadbanks.ascopower.com

whitepapers.ascopower.com
customercare@ascopower.com

ASCO. Innovative Solutions.