COR COOLING

Creating Optimum Reliability

TIER 3 & 4 MOTORS OVERHEATING IN HARSH AUSTRALIAN ENVIRONMENTS: A COOLING SYSTEM SOLUTION

FREE WHITEPAPER

A subsidiary company of

austinengineering LTD

www.corcooling.com.au

INTRODUCTION

Off-road diesel engines, such as dozers, graders, forklifts and tractors, have long working lives and are significant sources of fine-particle matter (PM) and nitrogen oxide (NOx) pollution into our fragile environment.

While on-road diesel engines sold in Australia, such as highway registered trucks and buses, are regulated to meet strict emission limits, there are no regulations or standards in place (as of yet) to control emissions from non-road diesel engines.[1]

However, in the USA, where many of the original equipment manufacturers (OEMs) are based, federal standards to restrict emissions have been in place since 1998, when Tier 1 standards for off-road diesel engines were implemented. The increasingly stringent Tier 2 and Tier 3 standards were introduced from 2000, with Tier 3 standards for NOx + HC (Hydro Carbon) being similar in stringency to the 2004 standards for highway engines. The Tier 1-3 standards are met through advanced engine design, with no or only limited use of exhaust gas after treatment (oxidation catalysts).

In 2004 Tier 4 emission standards, which are being phased-in over the period of 2008-2015 were introduced. The Tier 4 standards require that emissions of PM and NOx be further reduced by about 90%. Such emission reductions can be achieved through the use of control technologies—including advanced exhaust gas after treatment. [2]

Off-road equipment incorporating these Tier 3 and 4 designed engines are increasingly being put into service in the harsh Australian environment.

THE PROBLEM

Meeting these standards has meant that the cooling systems for these engines have to deal with more heat load than ever before.

The Tier 3 and 4 designed systems require high use of exhaust gases being fed back through the motors to meet application requirements. High levels of EGR (Exhaust Gas Reticulation) means more heat development during operation, which means more heat to get rid of from the system to prevent engine overheating. All types of engines designed to meet Tier 3 and 4 emission requirements create more heat than standard diesel motors.

The current trend is to design off-road equipment with smaller “front ends” or bonnet scapes, to make them more compact, increase visibility around them or to make them more aerodynamic in design. This results in a system requirement for smaller cooling packs, but which offer more cooling capacity. The result of these design trends is that earth moving and other off-road machinery is not as serviceable from a trash collection point of view (in high debris environments). In an attempt to resolve this issue, the trend is to go for a higher efficiency radiator - which means tighter tube and/or fin spacing.

The result of installing radiators with tighter tube spacing is that some of the off-road equipment, operating in harsh Australian environments, is experiencing clogging of the cooling system in a very short period of operating time. This is due to debris reducing air flow through the cooling system, leading to overheating.

An example of this is a recent case of an OEM front end loader with a Tier 4 motor which could operate for only 10 minutes before the cooling system would overheat. This meant operation had to stop for the cooler pack to be cleaned before work could resume.

Another example is a forklift company who had taken their standard 5 tonne forklift and added a very large attachment to it in order to be able to move bulky products. This attachment added a lot of heat to the system, mainly via the hydraulics, putting the system at risk of overheating.

Overheating a system risks damaging the motor; motors are designed to run at their optimal temperature and anything above their designed temperature will cause damage to the motor.

THE SOLUTION

In order to combat the inherent high temperatures of a Tier 3 or 4 system, together with the need to allow these machines to operate in harsh conditions, the OEM cooling packs are able to be replaced by a cooling system that is more suitable to the requirements of operating in harsh Australian environments.

In the case of the overheating front end loader (Tier 4 motor) operating in an extremely harsh environment (mentioned above) - an open flow through system was developed for the radiator, charge air cooler and oil cooler. The result being that the loader can now operate for 45 minutes with no temperature rise at all, and then depending on the amount of work it does, it is some time after that before a cooling system clean is necessary. The new cooling system more than quadrupled the front end loader's operation time, before cleaning is required.

In the case of the forklift with heavy attachment (Tier 4 motor), after working closely with the forklift OEM, a complete assembly cooler pack additional to the OEM system was supplied as a bolt on pack to dispense the extra heat.

Cooling system solutions can be tailored to OEM equipment specifications resulting in drop in replacements. This results in limited equipment downtime whilst alterations are made, and limited costs as no other motor alterations need to be made.

A custom designed cooling system will reduce the likelihood of damage to the motor due to overheating, and reduces the need for cooling system cleaning – reducing equipment repair and maintenance costs.

The above solutions were developed by COR Cooling, the only national service provider and manufacturer of industrial cooling and heat transfer equipment. For more information, or to seek assistance with your machinery cooling systems, please visit www.corcooling.com.au.

Sources

1. http://www.epa.nsw.gov.au/air/nonroaddiesel.htm
2. http://www.dieselnet.com/standards/us/nonroad.php
3. http://www.resources.nsw.gov.au/__data/assets/pdf_file/0010/461278/Bill-Furniss-and-George-Lin,-Caterpillar-CAT-Engine-Overview-Coal-Applications-2013.pdf