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Creating Optimum Reliability

MINING MACHINE COOLING SYSTEMS FAILING BEFORE ENGINE LIFE: A SOLUTION

FREE WHITEPAPER

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INTRODUCTION

Modern diesel engines in off-road mining equipment are increasingly being designed and manufactured to produce higher efficiency outputs with lower emissions.

Lower emissions standards are becoming increasingly stringent, resulting in the need for additional increases in charge air density for diesel engines[1].

To achieve increased efficiency, such as improvement in fuel economy, the modern engine is designed with a higher boost pressure on the manifold inlet side of the engine. This higher boost pressure results in hotter charge air temperature.

It is important to ensure the temperature of the charge does not become excessive. In modern boosted engines, this is a real possibility. Excessive temperatures can lead to reduced charge density and higher combustion temperatures which can affect torque, power and emissions[2].

The need for more effective cooling has resulted in a move away from water to air aftercoolers, an older technology, towards air cooled charge air coolers (CAC) as a means to reduce the possibility of overheating.

This high efficiency, low emission design of diesel engine is now evident in nearly every new machine which enters the market, compared to only a few models five years ago.

THE PROBLEM

The Air to Air CAC units used on these high efficiency engines are manufactured with alloy or copper brass cores and commonly fail before engine life. This early failure is due to the extreme duty cycles of expansion and contraction the CAC is subject to.

Even small charge air leakage has a significant degradation in the effectiveness of a CAC to increase inlet air density on turbocharged diesel engines. This problem increases exponentially related to the operating boost pressure of the engine.

The leakage also causes the turbo to increase speed to maintain the boost pressure and raises the temperature of the charge air entering the CAC, further reducing efficiency. In addition, leakage causes increased load which can lead to the failure of the turbo charger owing to turbo over-speeding whilst compensating for the leak.

As a result of the above effects, the engine provides lower horsepower and higher hydrocarbon levels than the rated values and has a significant impact on fuel economy[3].

Of importance specifically to mining operations is the aforementioned impact of CAC leakage on fuel economy. CAC leakage increases fuel usage and therefore operational costs. Independent fuel trials have showed savings of up to six percent by replacing a leaking CAC, which was still within manufacturer specifications for leakage, with a non-leaking unit.

It is therefore important to monitor the health of the charge air cooler so corrective action can be taken during the condition-based maintenance schedule[4].

To date, the mining industry's maintenance programs, in general, have yet to catch up with this newer Air to Air CAC technology and therefore testing of the cooling system on these engines is not common. This results in machine efficiency issues, and the related increase in fuel consumption costs (already one of the highest cost inputs to a mining operation), going unnoticed and unresolved.

THE SOLUTION

A CAC test kit is available, for use by mine maintenance staff, or by outsourcing maintenance services to your cooling system maintenance partner.

The CAC pressure testing process is straightforward and involves removing the turbo hoses and clamps, installing test plug assemblies into the inlet and outlet and connecting a gauge assembly. Air is then introduced into the system and pressurised to OEM specifications.

The gauge assembly is monitored to see if the letdown rate is less than OEM specifications. If this is the case, it means the CAC needs to be replaced.

Please note that use of an inferior test kit does not address the issue of a pressurised bung blowing out of the CAC and can introduce a serious safety risk.

CAC failures can also be reduced, or have their life extended, by installing an updated CAC product which utilises the optimum cores for each application. These CACs will still require testing as part of maintenance programs.

Integrating a CAC test into maintenance schedules will result in early detection of CAC leakage, and the associated lack of efficiencies such as fuel economy. This is an area of potential high savings for mine sites. It will also reduce turbo failures owing to over-speeding.

This solution is provided by COR Cooling, the leading provider of reliable application specific heat transfer solutions to the mining, transport, marine and industrial industries Australia wide. For more information visit www.corcooling.com.au.

Sources

1. 2. Charge Air Cooling. H. Jääskeläinen, M. K. Khair. 2012.

3. 4. Assessment of charge-air cooler health in diesel engines using nonlinear time series analysis of intake manifold temperature. A.A. Joshi, S. James, P. Meckl, G. King, K, Jennings. 2012.