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Engine misfire often to blame for vibration

Engineer's Angle
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Vibration is easily attributed to misalignment, a bent shaft or a deficiency with a propeller. Often, though, the true source of the problem is engine misfire.

The combustion process is one of the most important functions of a diesel engine. It is comprised of physical and chemical reactions, and has four stages:

- Ignition Delay Phase. This is the period from the beginning of the injection to the point of the ignition of the fuel. The fuel that's injected must be completely vaporized, air-to-fuel ratio must be precise, and temperature must be high for ignition to commence.
- Pre-Mixed Burning Phase. As ignition begins, heat spreads rapidly throughout the engine, causing combustion to begin.
- Diffusion-Controlled Burning Phase. Lower heat is diffused to control the burning of the fuel.
- Combustion Tail Phase. The falling temperature and pressure initiates cooling, resulting in slower heat release.

An engine misfire occurs when one or more of the cylinders inside the engine doesn't fire correctly, especially when there is an interruption of the air-to-fuel ratio inside the combustion chamber.

It's important to note that misfire doesn't always occur at all RPMs. It could actually occur at idle. Other scenarios that can make a misfire more likely to occur include:

1. A lack of air to the engine makes it difficult for the chemical reactions necessary for combustion to happen.
2. Faulty electronics can hamper the flow to the engine, hampering the reactions necessary for combustion.
3. Fouled injectors can lead to poor atomization.
4. Poor timing.
5. Contaminated or poor quality fuel.

Misfires are one of the most difficult problems to diagnose because many situations can cause it. When an engine misfires, performance suffers. When performance of a mechanical component suffers, so does fuel economy and power output. This also increases emissions by reducing the efficiency of combustion.

The cylinder cutout test is often used to diagnose a weak or failed injector. The test disables each injector and measures the difference in the fuel volume with the injector disabled compared to enabled.

Load on the remaining cylinders is higher and the delivered fuel volume increases to compensate. If a failed injector is cut out, delivered fuel volume on remaining cylinders will not change.

Another tool is vibration analysis. In a general vibration survey, engine misfire vibration is picked up as a half-order harmonic of the engine RPM. This vibration is usually absorbed through the engine's isolators, but excessive misfire may be transferred through the isolators or exhaust system and into the hull.

A traditional vibration analyzer will not pick up the exact cylinder misfiring nor identify the nature of the misfire. To precisely diagnose the misfire, use a diesel engine analyzer that uses ultrasonic measurements to detect degradation to internal engine components.

By identifying specific issues, they can be fixed before they become expensive repairs. Left untreated, engine misfire can cause overloads to the crankshaft journals and connecting rods, which can be detrimental to an engine's life.

Today's diesel engines are large machines that have thousands of parts and multiple systems. When any one component fails, it can lead to a host of negative or catastrophic events.

Most engineers follow the prescribed maintenance and routine inspections, but even with that, a significant amount of maintenance expense goes into unexpected failures.

Condition monitoring programs can help identify problems before they cause failures.

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