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ATLANTA
May 21-25, 2017

Dirt – a lethal Diesel Fuel Contaminant

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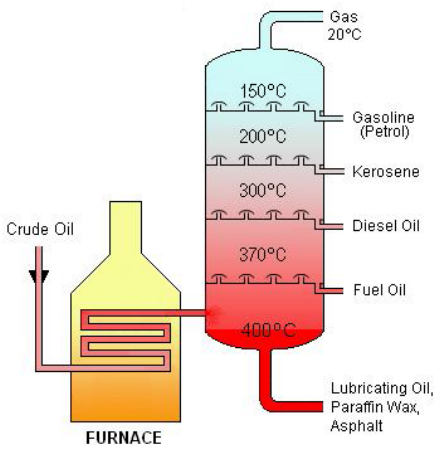
Benefits Statement

This case-study shares how a Power Plant, successfully overcame the challenge of ***Dirt Contamination*** and saved > **K$100** by simply installing Filtration System (fitted with Depth Elements) as part of their Diesel Fuel Receiving Procedure from Vendors.

Situation



1. Diesel Fuel exits the Refinery having met quality specifications.

2. Typically, fuel is pumped through refinery pipelines, into ship tanks and possibly moved across oceans, received into storage tanks in Fuel Terminals, from there piped to Supply Depots, filled into Delivery Trucks before final discharge into the end-user's Fuel Main Storage Tank.

3. Continues its journey into the Fuel Service Tank, piped to the in-built Fuel Tank of running diesel engines to serve the intended purpose – *deliver much needed power.*

4. Not surprising therefore that this very lengthy journey of piping, transfers, changing storage, trucking etc, sometimes taking days, weeks or even months; subject the fuel to varying handling practices.

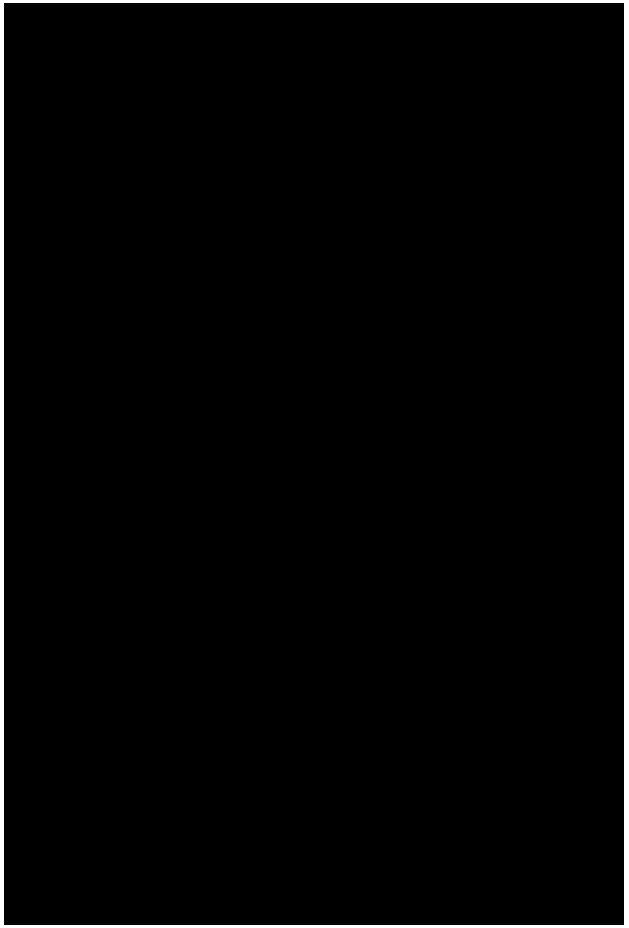
5. Diesel fuel becomes severely exposed to dirt ingress, often compromising its expected ISO Cleanliness quality.

Problem

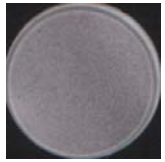
In the Case Study under review, Petrosave Laboratory researched recurrent problems of

a. shortened Fuel Filters life
b. restrictions to Fuel flow leading to sudden stoppage of running engines as well as
c. wear pattern observed in failed fuel pumps.

From a study by Petrosave Laboratory; typical ISO Cleanliness of unfiltered fuels delivered for use in the Lagos, Nigeria averaged ISO 23/22/18 as against fuel cleanliness specification by major OEMs - CUMMINS & CATERPILLAR engines require ISO 18/16/13.



Representative sample of newly supplied Diesel Fuel; ISO Cleanliness 23/23/22



ISO Cleanliness Basics

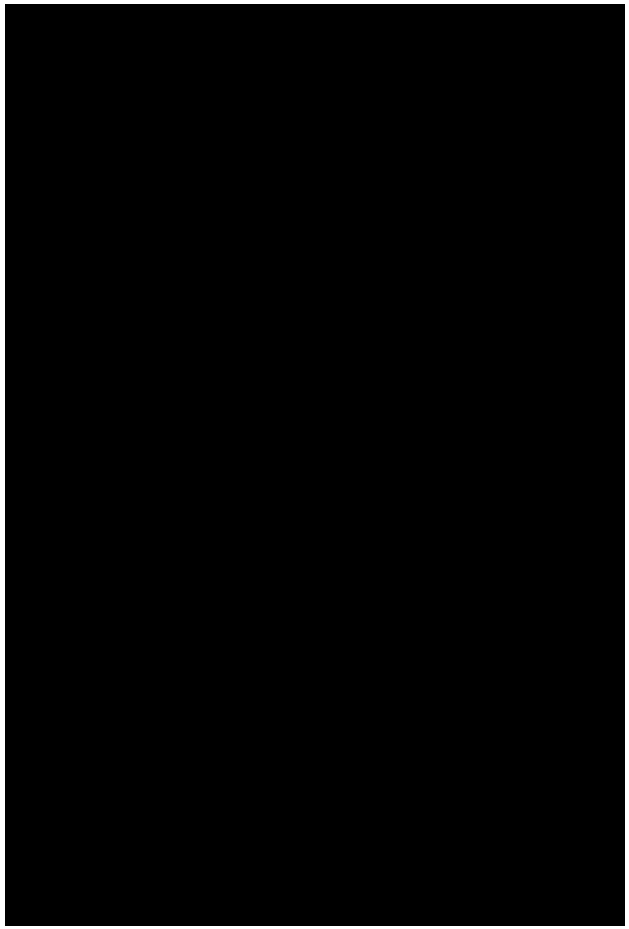
1. Determining Diesel Fuel cleanliness requires determining both size and number of particles in the representative fuel sample i.e. the particle size distribution.

2. The International Standard Organization (ISO) developed a method for expressing oil contamination by coding the size distribution called ISO 4406.

3. Equipment manufacturers have found that particle sizes approaching the 4 and 6 microns ISO checkpoints are particularly critical to the durability of modern, high performance fuel system; tight clearances

4. Industry ISO Cleanliness Specification by CAT & CUMMINS for diesel engines application is 18/16/13
    - 18 – 1,300 to 2,500 particles of 4µm per ml
    - 16 – 320 to 640 particles of 6µm per ml
    - 13 - 40 to 80 particles of 14µm per ml

5. The human eye can see down to 40µm; the human hair is 75 – 80 µm thick



Implications

Some of the consequences of running such modern high performance generating sets on unfiltered fuel are severe;

1. ranges from frequent replacements of expensive injectors, fuel filters, and pumps to
2. incurring avoidable repair costs plus
3. huge losses in production downtime and
4. factory rejects.

Worn out injector
Typical Injector component clearances is 2 – 5 microns

Discussion Notes

Fuel Cleanliness

1. Modern fuel systems have been developed to reduce emissions and fuel consumption as well as improve engine performance. These high pressure fuel system operate at pressures approaching 2100 bar [30,500 psi] and with component match injectors typically 2 – 5 microns for Injectors. At these pressures, very small hard particles are potential sources of fuel system malfunction.
   a. With Mechanical Injectors 10 – 15 years ago, diesel fuel cleanliness was not such an issue. In fact fuel filters specification was typically 15 micron size. However, the situation is different with today's prevalent use of Electronic Injectors (EI).
   b. EI is key to high performance diesel engines. It is designed with very tight clearances and having High Pressure ends discharging 30,000 psi or more, in order to achieve desired spray effect (better fuel atomization) as well as economize fuel consumption. Therefore, clean diesel fuel has become a mandatory requirement for engines fitted with EIs.

2. Excessive contamination of diesel fuel can cause premature clogging of diesel fuel filters and premature wear of diesel fuel injection system parts. Depending on the size and nature of the particles, this can lead to:
   a. Reduced component life
   b. Component malfunction
   c. Fuel system and/or engine failure.

Source: Cummins Manual - Diesel Fuel Specification

Discussion Notes

Fuel Cleanliness cont'd

3. Determining Fuel Cleanliness requires determining both size and number of particles in the representative fuel sample i.e. the particle size distribution.

4. The International Standard Organization (ISO) developed a method for expressing the fuel contamination by coding the size distribution called ISO 4406.

5. Engine builders and fuel injector equipment manufacturers have found that particle sizes approaching the 4 and 6 microns ISO checkpoints are particularly critical to the durability of the fuel injection system.

6. Cummins and CAT recommends that if the diesel fuel does not meet the ISO Cleanliness Code of 18/16/13 when supplied to the engine, additional filtration should be applied before the fuel is delivered to the engine's fuel tank.
    - 18 – 1,300 to 2,500 particles of 4µm per ml
    - 16 – 320 to 640 particles of 6µm per ml
    - 13 – 40 to 80 particles of 14µm per ml

Source: Cummins Manual - Diesel Fuel Specification

Fuel Cleanliness - Search for Solution

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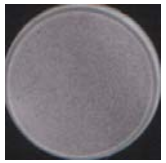

Improvement

Newly installed 30 GPM Diesel Fuel Filtration System mounted on skid plate:

1. 1200 Housings x 3 arranged in parallel flow; 1 Pressure Gauge fitted to each Housing
2. Depth Elements Filters x 3 per Housing; capable of removing down to < 1µm particle sizes
3. Configured to allow 8,500 Gals Delivery Truck discharge under 2 Hours; while filtering
4. Fitted with sampling valves at Inlet and Outlet pipes to monitor filtration efficiency.

Needs Pay-Off

Diesel Fuel filtration, since becoming part of Company's Fuel Receiving Procedure, proved to be a proactive tool.

1. Successfully managed ingress of particulate contaminants associated with local diesel fuel deliveries; achieved Improved ISO Cleanliness as specified by OEM

2. By operating within the ISO 18/16/13 Cleanliness Limit, saved sensitive Fuel System components from premature failure caused by dirt induced abrasive wear
   - Extended service life of Filters, Pump, Injectors etc ; direct impact on the Bottom-line

3. Increased Uptime; minimized sudden Generators shutdowns associated Process Downtime.
   - Improved operational efficiency arising from more Uptime and helped manage profit-margin erosion in the competitive local market .

4. Eliminated write-offs arising from emergency process shutdowns.
   - Lower unit cost rate & directly reduced business Carbon Footprint

Business projects to achieve **> K$100** as costs-avoidance savings in 1 year.

Thank You