



Image courtesy of APR Energy PLC

*CLEAN*Diesel® Solutions for Power Generation

Ensuring Power Continuity and Reliability

aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding



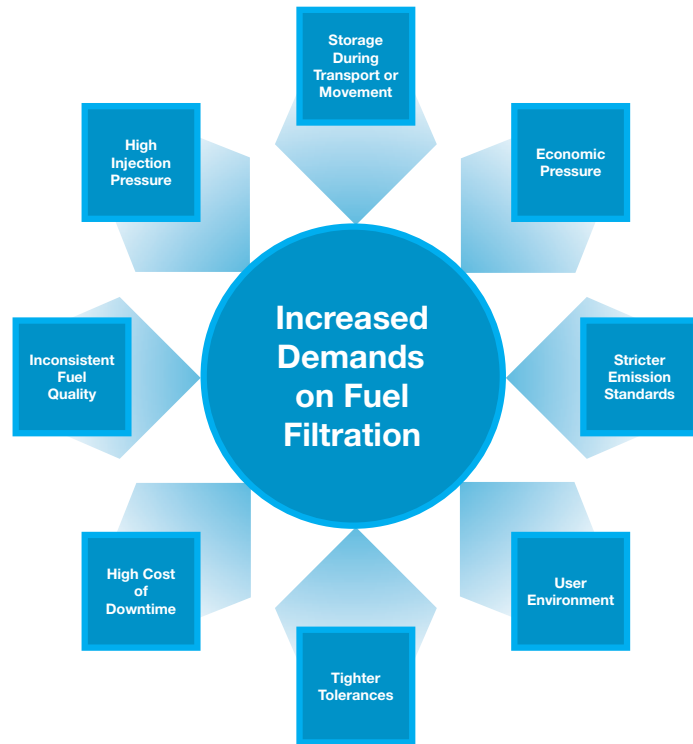
ENGINEERING YOUR SUCCESS.

Ensuring Continuity and Reliability in Diesel Power Generation

Today's diesel powered generators are more efficient, have tighter tolerance between internal components and are required to meet even cleaner emission standards. In order to ensure high efficiency operation and to minimize unplanned downtime, fuel cleanliness should be of the utmost concern.

Parker Hannifin understands that fuel cleanliness begins at the source, the refinery, and ends when the fuel is combust. Fuel may leave the refineries clean, but as they are stored and transferred, solid and water contaminants are introduced to the fuel causing quality to fall below OEM required specifications.

Parker **CLEANDiesel**® solutions includes a complete range of products and technologies to help you achieve your fuel cleanliness needs. Our fuel conditioning solutions will help you see the contaminants which can cause premature injection failures.

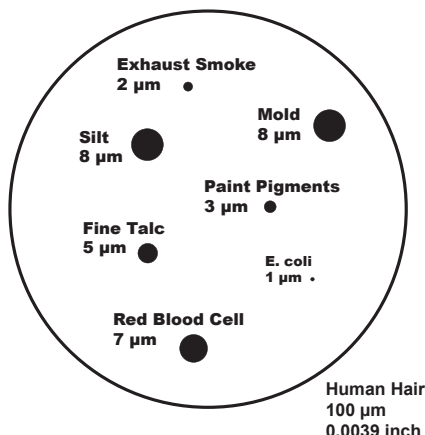


How Big are Contaminants?

It is common for diesel equipment users to inquire as to what fuel quality needs to be attained for their application or equipment. First, this question should be posed to the equipment or engine

OEM. Many OEM's have published required fuel cleanliness levels and OEM's could deny warranty claims if these standards are not met. Although, most equipment will have on-board filters to achieve the required cleanliness level, in order for the on-board filters to extend the life of equipment, the fuel delivered to the vehicle must meet certain initial cleanliness level. Poor to fair fuel quality may have a sufficient level of contamination

to overwhelm the on-board filters, increasing equipment wear, causing either short or long term issues. Further, some OEM's require a given level of fuel quality to be delivered to the vehicle to maintain the engine warranty. A single fuel related unplanned equipment upset can easily surpass the same cost of several years of a well-run fuel maintenance program which includes the bulk fuel filtration costs.



| Bulk Diesel ISO4406 Quality Ranges* | | |
|-------------------------------------|------------|----------|
| Poor | > 22/20/18 | |
| Fair | 22/20/18 | 19/17/15 |
| Good | 18/16/13 | 16/14/12 |
| Excellent | < 15/13/11 | |

*ISO 4406:1999 Cleanliness Standards

Sources of Contaminants

Contaminants are commonly introduced during transfer and storage. When fuel is loaded into transport storage or bulk storage terminals, existing contaminants will mix with the new fuel. Real world maintenance practices may also accentuate the problems, where transfer nozzles may be contaminated as no dust caps are fitted, schedules are missed and replacement of expired or damaged equipment is not

performed. Types of contaminants which can cause equipment failures include:

- Simple rust, airborne dirt and water.
- Temperature variation (precipitation of dissolved water).
- Additive impact and compatibility issues (note most low sulphur diesel will

contain a lubricity improver which may stabilize water haze) as well as possible low temperature and combustion improver (cetane) additives.

- Biodiesel compatibility, aging and purity issues.
- Microbiological spoilage.

Contaminants as small as 4 microns in diameter can cause extensive injector damages in today's modern diesel engines.

Effects of Contaminants

Abrasive Contaminants Accelerates Injector Wear

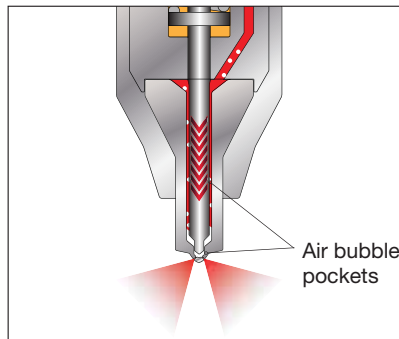
Increased injection pressure action on the same level of abrasive contaminants in fuel will result in accelerated injector abrasive wear. Abrasive wear can only be reduced by removing abrasives from the fuel. On-board filtration is effective up to certain initial fuel cleanliness levels. Additional pre-filtration may be needed to transform cleanliness level of the fuel supply to meet operating requirements of on-board filters.

Water in Fuel is a Key Cause in Injector Failure

An excessive amount of latent water in the fuel is a key cause of injector failure. Water has inadequate film strength to minimize metal-to-metal contact between the plunger

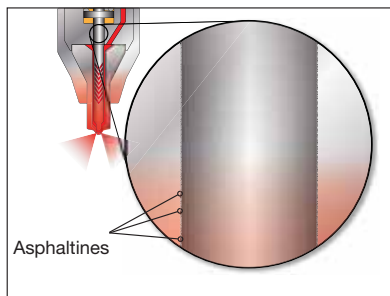


Injector plunger scuffing and seizure is nearly always caused by excessive amounts of water in the fuel.



Air bubbles in the tip of injector provides no damping allowing the check to impact the tip with much greater force.

and the barrel, resulting in plunger scuffing or seizure. Water can be effectively removed by the use and regular maintenance of a water separator or bulk fuel filter/water coalescer. Removal of excess latent water is essential to prevent scuffing with the upcoming injection pressure increases and subsequent hydraulic loading of internal injector parts.



Asphaltines formed by very hot fuel contain highly abrasive particles.

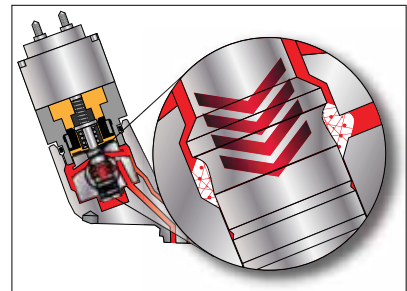
Excessive Fuel Temperature

Increasing fuel temperature reduces fuel viscosity and fuel film strength. Injector plunger and barrel scuffing are highly probably because of the reduced fuel film strength. Limiting the maximum fuel temperature will become even more critical with the increased use of very low sulfur fuel which has lower film strength, and common rail fuel systems which run elevated fuel temperatures.

Supply Pressure Is Crucial to Proper Filling and Proper Operation of the Injector

When fuel filters are plugged and restrict the flow of fuel entering the injector this causes vacuum bubbles which implodes resulting in incomplete filling.

Incomplete filling of the injector can cause erratic fuel delivery and may eventually lead to internal cavitation damage to the injector.



Low fuel supply pressure from plugged fuel filters can cause cavitation damage of injector poppet valve during injector fill.

CLEANDiesel® Solutions

Proven solutions to ensure your fuel quality is up to specification when you need it.

Distribution/Transport

Fuel may meet diesel engine cleanliness requirements when they leave refineries, but what happens during transport and storage? Contaminants like silica, dust, pipe scale, algae, and water are common contaminants introduced during transport and storage of bulk diesel fuel. The more transfer points you have the greater the opportunity for fuel contamination. To ensure fuel does not become off specification at delivery, filtration systems should be incorporated at every transfer point in the supply chain.

- Bulk filtration and water removal solutions at reception and loading
- Condition monitoring to ensure accountability along the supply chain
- Control of contaminants and prevent continuation of existing fuel supplies



On-Site Fuel Storage

How reliable is your fuel when you need it? CLEANDiesel filtration solutions protect your vital assets from harmful contaminants. Even contaminants at microscopic sizes can cause catastrophic damage or unnecessary downtime. To ensure continuity and reliability of power, on-site filtration is a must in addition to establishing a filtration regime. Our solutions can be implemented at:

- Data Centers
- Municipal Power
- Hospital Emergency Power
- Underground Storage

Containerized Power

Increase demand for greener energy and quick power establishment in countries without the proper infrastructure have created a demand for a supplemental energy source such as diesel in order to ensure power is consistent, reliable, and allows for reduction of loads on existing power grids. Wind and solar energy is not consistent so additional diesel power in containers are used to ensure steady flow of electricity.

For remote locations where electric infrastructures are non-existent, containerized power modules provide fast and reliable temporary power to a small city while the infrastructure is being established.

Applications for Containerized Power includes:

- Fuel quality accountability at reception
- Filtration Prior to Storage
- Maintenance Fuel Forwarding
- Filtration at Dispense



Image courtesy of APR Energy PLC

Additional Fuel, Oil, Air Filtration Products



Racor's Engine Filtration Solutions will significantly increase your Power Generation equipment uptime through our superior performing full line filtration systems.

Parker Racor offers:

- Application expertise
- Environmentally friendly products
- Innovative product offerings
- Global solutions

Our Fuel, Air, Crankcase, and Oil Filter Solutions will:

- Lower your cost of ownership
- Provide ease of service
- Increase asset availability
- Provide superior performance
- Give you a one-stop shop

Fuel Filtration

The heart of these advances is in Racor's proprietary engineered filter media families. Our selection of Aquabloc® medias is known worldwide for its combination of high efficiency, long life and unsurpassed water-removal performance, meeting and exceeding the challenges of today's diesel engine requirements in all markets and environments.:

- Maximum fuel system protection in minimum space.
- Expert integration of engine components for cost savings and ease of assembly.



Turbine Series Fuel Filtration System



ABS Oil Filtration System

Oil Filtration

Racor Absolute Bypass Oil Series removes dirt, varnish, ash, tar, soot and other contaminants that full-flow filters cannot remove from your engine's oil and hydraulic systems. Racor takes pride in providing oil filtration solutions that save our customer maintenance cost and downtime.

- Eliminates resins and oxidation products.
- Extends the miles/hours between oil changes.

Air and Closed Crankcase Ventilation (CCV) Filtration

Racor engineers collaborate with customers to design Air and CCV filtration solutions that provide installation flexibility, superior performance, ease of service and unmatched customer satisfaction.

- Easy to install and service
- Long service life



CCV Series and AFM Series Filtration Systems

CLEANDiesel® Products & Services

Meeting your complete power generation filtration need

Cartridges



- Filters particulate contaminants
- Removes water
- Final fuel polishing
- High flow fuel filtration

Small Housings



- For flow rates under 100 gpm
- Ideal at dispensing
- Small compact design
- Use in underground fuel storage

Condition Monitoring & Control



- Fuel Accountability
- Real-time
- Stop low specification fuel from entering storage

Bulk Filtration Housings



- Complete filtration systems for particulate and water removal
- Quick installation at remote sites
- Flow rates range from 100 to 1040 GPM

Laboratory Services



- Full flow diesel testing
- Contaminant composition analysis
- Liquid chemical composition analysis
- Root cause analysis

Skids/Systems



- Complete filtration systems for particulate and water removal
- Quick installation at remote sites
- Flow rates range from 135 to 1040 GPM

SizeRight™



- Determines optimum filtration system
- Sizing for low operating cost
- Sizing for maximum flow rate

Global Distribution/Integrators



- Knowledgeable about diesel products and applications
 - Global access to products
 - Custom solutions to meet your needs

Additional Fuel, Oil, Air Filtration Products

Turbine Duplex



- Efficient and reliable engine protection
- Removes damaging particles
- Auabloc® Media

GreenMAX™ Fuel Filter Water Separator



- Three heater options, for all weather conditions
- Heavy-duty, high capacity
- Two-stage Aquabloc Media

SNAPP™ Fuel Filter Water Separator



- Quick-service, no tools required
- Clear bowl for at-a-glance inspection
- Self-venting drain

Fuel Polisher



- Removes contamination at the source, the fuel tank
- Eliminates costly downtime
- Durable construction

ECO-TL Engine Air Cleaner



- Improves performance and reduces maintenance
- Compact design
- Easy twist-lock service

Super Impactor



- Eliminates environmental pollution from crankcase emissions
- Integrated patented pressure regulator

ABS Oil Cleaner



- Improves oil cleanliness for service savings
- Removes up to 99% of all solid contaminants
- Extends oil change intervals

Accessories



- Enhance and upgrade fuel system performance
- Easy service
- Gauges, in-bowl heaters, filter funnels

Visit us on-line at
www.wecleandiesel.com

© 2015 Parker Hannifin Corporation. Product names are trademarks or registered trademarks of their respective companies.

VEL2224R1 0415



Parker Hannifin Corporation
Velcon Filtration Division
1210 Garden of the Gods Road
Colorado Springs, CO 80907 USA
tel +1 719 531 5855
www.velcon.com

Parker Hannifin Corporation
Racor Division - North America
P.O. Box 3208
Modesto, CA 95354 USA
tel +1 800 344 3286
www.parker.com/racor