



Pall Corporation



Diesel Fuel Filtration

Particulate and water removal
solutions for diesel fuel applications

Filtration. Separation. Solution.SM

Diesel Fuel Filtration

Introduction

With increasing operating costs (e.g., fuel usage cost, equipment downtime cost) and strict environmental legislation (e.g., GHG emissions), the mining industry faces difficult challenges when running fleets of large diesel powered engines. To ensure optimum engine performance and reliability, particulate and water contamination in diesel fuel must be controlled to acceptable (specification) limits. Standard on-board fuel filters are not designed to handle high levels of contamination. Therefore, to prevent premature plugging and frequent change-outs of on-board filters, fuel cleanliness should be controlled throughout the entire fuel supply chain.

The Impact of Particulate Contamination on Diesel Powered Engines

There are three types of engine fuel injection system failures that can be attributed to the presence of hard, particulate contamination:

- **Mechanical failures** from component wear and blocking component movement
- **Electrical failures** (typically as injector solenoid burnout) from silting around the poppet valve stem, restricting movement
- **Performance failures** from blocking of injector nozzles and altering injector spray patterns

Diesel Engine Fuel Injector Systems

As engine fuel injection technology has progressed, so has its sensitivity to contamination.

Electronically Controlled Unit Injectors (EUIs)

The injector nozzle openings of EUIs are 6-7 μm in diameter. These openings can become blocked or suffer erosion from particulate contamination as diesel fuel is passed through them at high pressures. Nozzle shape can be changed or spray patterns altered, adversely impacting engine performance in the form of reduced power output and poor fuel economy.

High Pressure Common Rail System (HPCR)

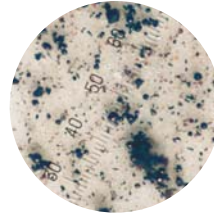
HPCR system technology offers improved power and fuel efficiency and lower exhaust emissions. To achieve these results, HPCR systems operate at pressures in excess of 2000 bar and have injector nozzle openings in the 2-3 μm diameter range. This requires diesel fuel 30 times cleaner than what is acceptable for standard EUIs and over 100 times cleaner than what is typically dispensed at the pump. This level of cleanliness cannot be attained with on-board filtration alone; supplementary bulk and point of filling filtration is required.



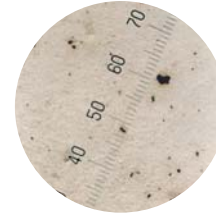
Defining Acceptable Fuel Cleanliness Levels

While Diesel fuel cleanliness can vary significantly along the fuel supply chain, one engine manufacturer defines typical incoming fuel cleanliness at a cleanliness level of 22/20/17 per ISO 4406.

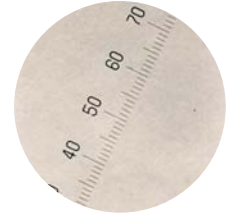
For EUI fuel injection systems, equipment OEMs typically require a fuel cleanliness level of 18/16/13 per ISO 4406. New HPCR engines require diesel fuel cleanliness levels as low as 12/9/6 per ISO 4406.



ISO 22/20/17



ISO 18/16/13



ISO 12/9/6

How Dirty is it Really?

To put this into a more practical perspective, the table below shows the equivalent contaminant mass and water volume that would be pumped in one year for a large mine site using 137,000 liters of diesel fuel/day, for various fuel contamination levels.

ISO 4406 Cleanliness Code	22/20/17	20/18/15	18/16/13	12/9/6
Kilograms of particulate contaminant pumped per year	800	200	50	0.4
Water Content (ppm)	5000	1000	500	100
Liters of water equivalent pumped per year	250,000	50,000	25,000	5,000

Thus, if 0.5 % (5000 ppm) of the fuel was water, the mine would pump approximately 250,000 liters of water, equivalent to \$200K* worth of fuel.

*based on 80 cents per liter

Diesel Cleanliness – a Site-Wide Investment

Diesel fuel cleanliness control must be a site-wide investment and managed with advanced particulate and water filtration technologies, from the point of delivery, through storage, right up to the dispensing nozzle.

Supplying equipment with diesel fuel at required cleanliness levels will result in a number of significant benefits, including:

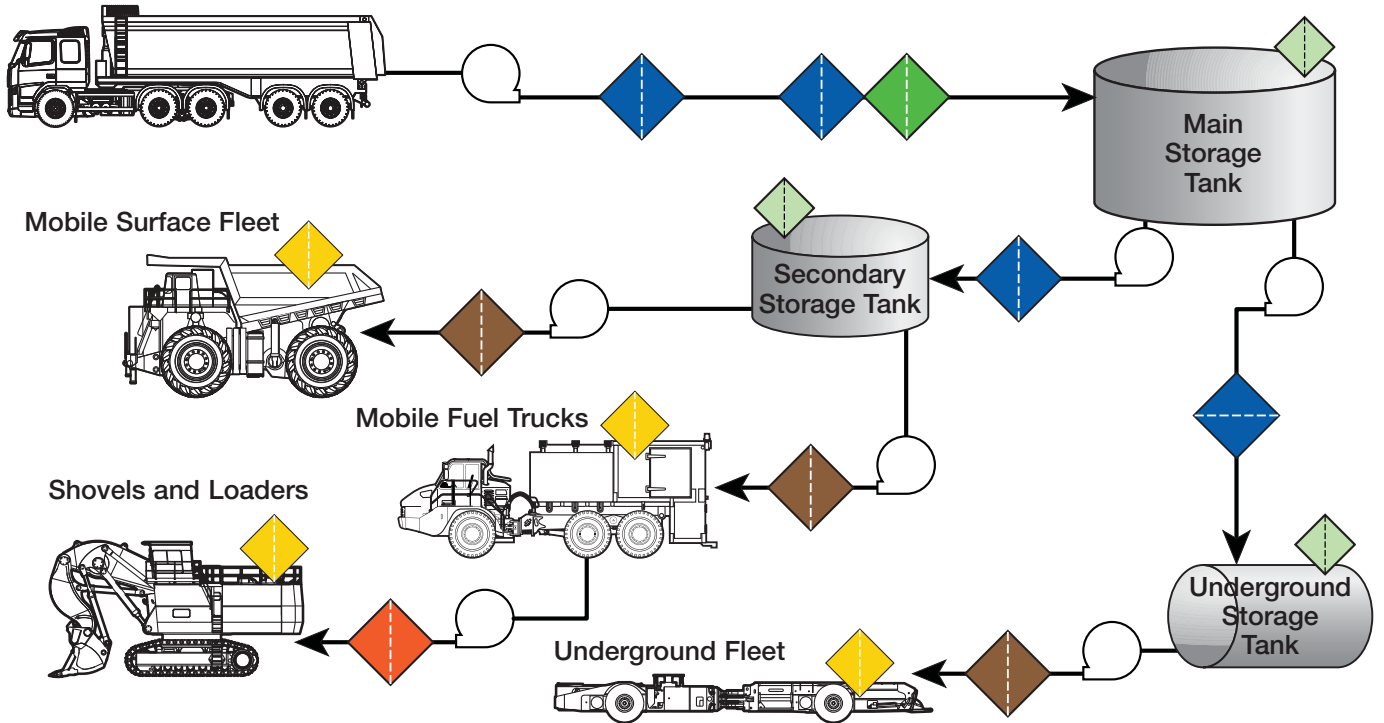
- Improved diesel engine performance and reliability
- Improved diesel engine operating costs
- Reduced diesel engine maintenance costs
- Reduced vehicle downtime
- Reduced fuel consumption
- Reduced air pollution

Diesel fuel cleanliness control - from delivery, to storage, to pump, to injector...

Diesel Fuel Filtration

Filtration Applications and Product Positioning

Fuel Delivery

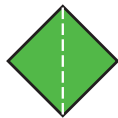


Contamination Control Recommendations



Bulk Fuel Treatment

Particulate Filtration
 Basket strainer
 or coarse metal mesh strainer
 pre-filtration
 Ultipleat® Diesel Fuel filters
 • JN or JS grade filter medium



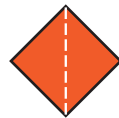
Liquid/Liquid Coalescer

Free Water Removal
 PhaseSep® Liquid/Liquid coalescer
 • JS grade or finer pre-filtration required



Point of Use Fuel Treatment

Particulate Filtration
 Ultipleat Diesel Fuel Filters
 >300 L/min (>80 USgpm)
 • JZ grade filter medium
 Ultipleat SRT filters
 <300 L/min (<80 USgpm)¹
 • AP grade filter medium



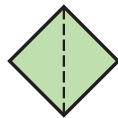
Mobile Support Fuel Treatment

Particulate Filtration
 Ultipleat SRT filters
 • AP grade filter medium



On-Board Fuel Treatment

Particulate Filtration
 Nylon Depth Media Fuel Filters
 • Heavy duty or severe duty grade filter medium



Air Breather Filter

Particulate Filtration/Water Ingression
 • Filter rating: 1-3 µm in Air
 • Desiccant available in PFD series

Filter Medium Performance

Filter Medium Grade	Target Downstream ISO Cleanliness Level ²
JS	17/14/11
JN	15/13/08
JZ	14/12/09
AP	14/12/10



¹Based on typical fluid cleanliness levels; if fuel is adequately pre-filtered, max flow can be increased up to 835 L/min (220 USgpm)

²Dependent on upstream bulk/point of use/mobile support fuel cleanliness levels

Pall Diesel Fuel Filtration Products



Ultraleat Diesel Fuel Filters

Housing Features

- Designed to ASME Section VIII Div. 1 requirements, with code stamping as an available option
- 10 barg (150 psi) pressure rated vessels
- Carbon Steel and 316 Stainless Steel options
- Horizontal and vertical configurations

Element Features

- 6" diameter Ultraleat (wave-shaped pleat) filter medium pack
- In-to-out filter element flow path
- Coreless element configuration for environmentally friendly disposal



Nylon Depth Media Fuel Filters

Features

- Proprietary polymeric media with optimized removal efficiency and dirt capacity for 'heavy duty' and 'severe duty' applications
- Compatible with biodiesel fuels
- For fuel flow rates up to 650 litres per hour (170 gallons per hour)
- Can be configured for particulate and water control in a single stage
- Available accessories:
 - Priming pump (manual or electrical)
 - Diesel fuel heater
 - Water in fuel sensor
 - Pressure sensor/switch
 - Temperature sensor



Ultraleat SRT Filters

Housing Features

- Auto-pull element removal mechanism for easy and fast element removal
- Cap or head service configurations

Element Features

- 3" and 6" diameter Ultraleat (wave-shaped pleat) filter medium pack
- Stress Resistant Technology (SRT) media for enhanced performance under cyclic flow and dirt loading conditions
- Anti-static filtration medium
- In-to-out filter element flow path
- Coreless element configuration for environmentally friendly disposal



PhaseSep Liquid/Liquid Coalescers

Features

- Unique stacked element design - separator and coalescer in one unit
- Large diameter fluoreopolymer media; performance not impaired by the presence of surfactants or fuel additives
- In-to-out flow direction
- Wide fluid compatibility



Air Breather Filters

Features

- Optimum protection against airborne contamination ingress into vented fluid systems
- Suitable for flow rates up to 1500 L/min (400 USgpm)



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Further documentation is available at pall.com/mining

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Because of technological developments related to the products, systems, and/or services described herein, the data and procedures are subject to change without notice. Please consult your Pall representative or visit www.pall.com to verify that this information remains valid. Products in this document may be covered by one or more of the following patent numbers: EP 0 930 926; US 5,480,547; US 6,332,987; EP 0 667 800; EP 0 982 061; EP 1 380 331; US 5,543,047; US 5,690,765; US 5,725,784; US 6,113,784; US 7,083,564; US 7,318,800; EP 0 667 800; EP 0 982 061; EP 1 380 331; US 5,543,047; US 5,690,765; US 5,725,784; US 6,113,784; US 7,083,564; US 7,318,800; EP 1 656 193.

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