



What is the Diesel Bug ?

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The diesel bug is formed by a build up of Microbial contamination!

What is Microbial Contamination?

Microbes are bacteria, fungus, algae and yeast. The primary function of microbes is to decompose and recycle organic material back to the environment.

Microbes are responsible for the creation of crude oil, by the decomposition of forests and animals over millions of years. There are 27 separate species of bacteria, yeast and fungus that reside naturally in crude oil.

When crude oil is refined, these resident microbes are killed. Yet, microbes easily re-enter petroleum products through contact with air and water. Then given the right conditions, within 24 hours a single cell weighing one millionth of a gram can grow to a slimy biomass weighing 10 kilograms (22 pounds).

What are the effects of Microbial Contamination?

Microbes eat the energy from the fuel, which they use to multiply and create protective layers to protect against threatening environmental changes. Effectively they are decomposing the petroleum product.

As a colony numbering millions, depending on the species present, microbes either form matting, slime, sludge, organic acids and sulphides.

The matting, slime and sludge enter the fuel lines to block filters, injectors and in sever cases, the fuel lines themselves. The slime, visible on tank walls and fuel system components, is a protective layer that effectively shields the microbes against the additives in the oil.

The organic acids degrade protective coatings such as paints, rubber, some plastics and metal oxide films as well as destroy or inactivate chemical corrosion inhibitors and cause hydrogen embrittlement of metals. Black deposits on copper or copper containing alloys in pipe work and bearings as well as pitting are evidence of microbial induced corrosion.

Engines rely on high quality fuel that has been properly filtered and separated (from water), with no flow restrictions, to achieve proper atomisation, combustion, engine performance and fuel efficiency. Fuel that is infected with bacteria is not reliable and there are many and varied consequences of using contaminated fuel.



These include:

1. encouraging growth of further contamination
2. fuel filter clogging and blockage
3. coalesce malfunctions
4. engine wear due to variations in fuel flow
5. corrosion of the fuel system
6. corrosion of engine fuel injectors
7. damage to in-line instruments

Engine fuel injection equipment and fuel pumps are most susceptible to the effects of microbial contamination resulting in corrosive damage.

Ultimately, performance suffers and fuel consumption and maintenance costs increase, but perhaps the most critical concern is the real potential for blockages in the fuel system which cause engine failure while underway - with potentially devastating consequences.

Where do the microbial bugs come from?

Microbes are prolific in earth's atmosphere and are carried as spores in air and water. They can enter diesel at any point in the supply chain through vents and filling ports. No one knows when the fuel becomes contaminated, but once acquired, diesel bugs can be extremely difficult to get rid of. Twenty-seven (27) individual species of bugs can occur in diesel fuel.

Each species has its' own characteristics:

- **BACTERIA** utilise hydrocarbons and reproduce 'asexually' by binary fission; swelling in size as they feed, they then separate into two cells. In this way microbes double their numbers every 20 minutes, one spore becomes 262,144 in 6 hours. typical bacteria known to utilise hydrocarbons are *Pseudomonas aeruginosa*, other *Pseudomonas* species, *Flavobacterium* spp., *Acinetobacter* spp., *Alcaligenes* spp., *Micrococcus* spp., *Arthobacter* spp., *Corynebacterium* spp., *Brevibacterium* spp., *Klebsiella* spp.
- **YEAST** bud onto the parent cell, then eventually separate. Reproduction takes several hours and yeast prefer acidic environments. Typical yeasts growing on hydrocarbons are *Candida* spp., *Saccharomyces* spp., *Torula* spp., *Torulopsis* spp., *Hansenula* spp.
- **FUNGUS** grow in the form of branched hyphae, a few microns in diameter, forming thick, tough, intertwined mycelial mats at fuel/water interfaces. Typical moulds which degrade hydrocarbons are *Penicillium* spp., *Aspergillus* spp., *Fusarium* spp., *Monilia* spp., *Botrytis* spp., *Cunninghamella* spp., *Scopulariopsis* spp., *Cladisporium resinae*, *Hormoniconus resinae*.
- **SULPHATE REDUCING BACTERIA (SRB)** are a specific group of bacteria utilising simple carbon, not hydrocarbons, and require the activity of other microbes in a consortium. SRB produce hydrogen sulphide. SRB are also directly involved with many microbial corrosion reactions and can cause sulphide souring of stored distillate products.

Bugs feed on diesel, kerosene, oils: crude oil products with the outcome of decomposing it. That is why diesel bugs are often used to clean up Oil spills.



It is quite normal to have a small resident bug population in diesel tanks. They feed on the energy of the fuel, produce some waste and cover themselves in a protective bio-film, known generally as slime!

Slime allows bugs to survive dramatic changes in their environment, including the toxic effects of biocides. These resident bug populations are small and have no measurable effect on the quality of the fuel. But with the right temperature range and any free moisture present, the bug population begins reproducing rapidly causing an exponential growth in population.

Doubling their number every 20 minutes, bugs form microbial mats or long strings of seaweed like structures. These bug colonies can develop into a biomass several centimetres thick across the fuel/water interface and weigh up to 10Kg. Producing slime and acid as 'waste products' that are carried throughout the fuel system causing many maintenance problems.

- Restricted fuel flow, uneven atomisation and incomplete combustion caused by slime build up in the fuel lines, filters and injector needles.
- Cylinders develop cool spots causing uneven wear to the rings and cylinder bores. Acids and gums can eventually leach into the lubricating oil, causing corrosion of the crank components.
- Some species create acids that remove ions from the atomic structure of metals: this is the main cause of corrosion in fuel tanks, lines, pumps and injectors.

The presence of bugs in fuel has a definite effect on the quality of diesel and are responsible for increasing operating costs.

Biocides have been widely used to kill bugs in diesel. Biocides may kill much of the bug population, however, the dead population drops to the bottom of the tanks and forms sludge.

Small groups of bugs can survive under the protection of the slime they produce. Then given the right triggers, the bug population quickly regenerates, requiring more biocides. This repetitive process increases sludge in the tanks, which has to be removed to ensure safe operation of the engine.

What are the effects of using Biocides?

Biocides are frequently used to treat severe contamination, however many of them are hazardous chemicals and require careful handling. Although some are marketed as being "environmentally friendly", many are harmful to the environment and waste disposal contractors may need to be called in if waste containing dead microbes and biocide are to be removed.

Adding biocides to the fuel system can actually cause more problems. The fallout of dead cells collecting on the bottom of the tank forms a sludge material that can still find its way into the fuel system, clogging fuel lines and filters, potentially leading to performance problems and possibly engine damage. This can be especially true in rough weather when the contents of the tank are effectively shaken into suspension.

Furthermore, over time biocides lose their effectiveness as microbes develop immunity to the chemicals. Occasional dosing can actually accelerate this action and some owners have reported bio-mass growth in systems despite regular treatments with biocides.



What is the solution ?

The most effective way off removing and controlling the microbes is by incorporating a fuel separator and cellulose fine filter. The growth of the microbes is possible only by the combination of nutrients, moisture and a temperature of between 10 & 30°C. By removing one element of this triangle the microbes can no-longer multiply.

By removing the moisture in the oil to a very low level (below 300PPM) the microbes are unable to reproduce rapidly. This alone can control the growth of the microbes but if there is already a high level of microbes present then they have to be removed.

By using a fine filter with a cellulose element the sludge formations will be attracted to the cellulose and bind to the filter surface as the fuel passes through the element.

The benefit of using CJC™ fuel separator is that not only does it incorporate a separator and a cellulose based fine filter (3 microns) it also has massif dirt holding! - while your engine filter would have been blocked many times the CJC™ unit is still running and keeping your inline filters clean.

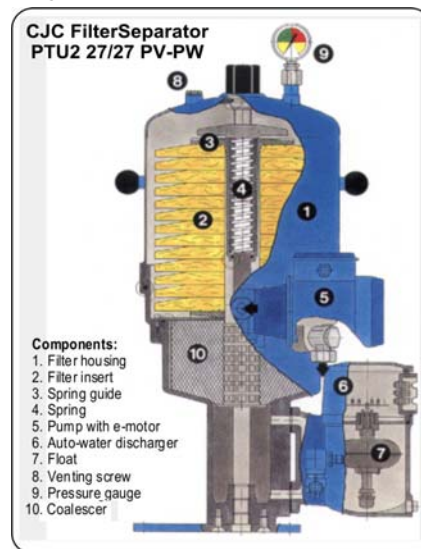


Fig. 4: Principle sketch of CJC Filter Separator

What type of instillation is involved?

CJC™ filter separators are designed as off-line filters. This means they are not connected directly to the engine!

We recommend that the unit is installed between the main tank and the day tank, with an overflow back to the main tank. The flow rate is set so that the unit put a greater flow to the day tank than is need by the engine as max power.

By using the constant overflow, and the fact that the unit is preferred to be filtering 24hours a day even when docked, the fuel in the day tank will be filtered and separated many times before reaching the engine. (See Diagram)

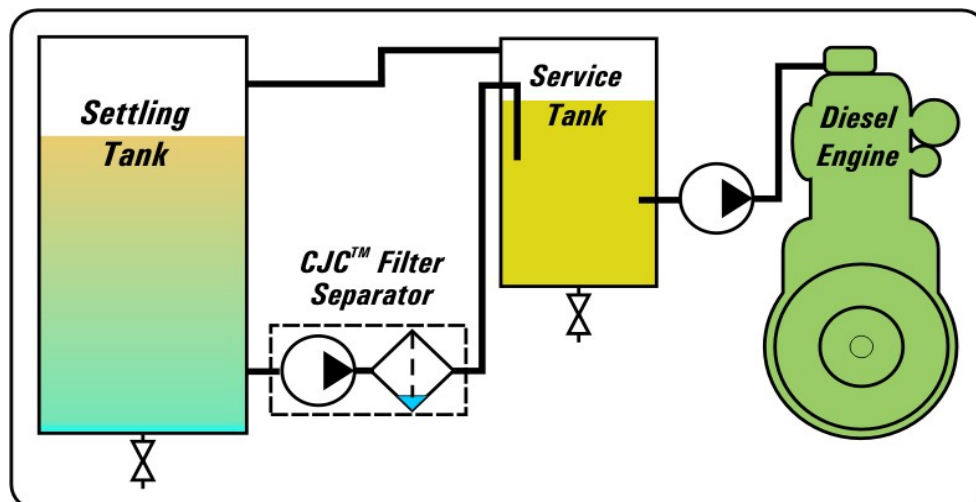


Fig. 3: Installation principle for CJC FilterSeparator in marine diesel fuel system.



For vessels that don't have separate fuel tanks the unit can be installed to circulate the main tank constantly. The suction line from the filter separator is installed as low as possible in the tank (ideally on the drain), with the return line as close as possible to the suction line going to the engine!

What does the CJC™ Filter Separator look like?

For engines sizes up to 1100 HP



For engines of 1100HP to 2200HP





What maintenance is required?

The CJC™ filter separators are virtually maintenance free. The only moving part is the pump which is designed to run 24 hours a day. The unit shall require you to discharge the water every few days on the manual option, while the automatic water discharge unit can discharge the water directly to the bilge!

Like all machinery we recommend that you view the unit everyday for safety and environmental considerations!

What does the CJC™ Filter Separator cost?

<u>Engine size</u>	<u>Cost</u>	<u>Type</u>	<u>Elements</u>
Up to 1100HP	€3985	Manual water discharge	1
Up to 1100HP	€5150	Automatic water discharge	1
1100HP to 2200HP	€4790	Manual water discharge	2
1100HP to 2200HP	€6285	Automatic water discharge	2
2200HP to 3200HP	€5100	Manual water discharge	3
2200HP to 3200HP	€6700	Automatic water discharge	3
3200HP to 4200HP	€5670	Manual water discharge	4
3200HP to 4200HP	€7450	Automatic water discharge	4

Prices valid until September 2003

Price includes Delivery, Freight case, VAT does not apply & first element

Running costs Normal conditions would require about 3 changes of elements every year.
Each element costs €80.

Number of elements listed above!