innospec

TECHNICAL BULLETIN

Customer Technical Service

Purifier blockages when using VLSFO

Innospec has over 70 years' experience analysing and treating fuels for the best possible performance outcomes. This technical bulletin has been prepared to discuss the spike in separation failures experienced by the shipping community due to excessive sludge dropping out during purification. We will guide you through the reasons why this is happening and the steps you can take to mitigate the risks when using Very Low Sulphur Fuel Oil (VLSFO).

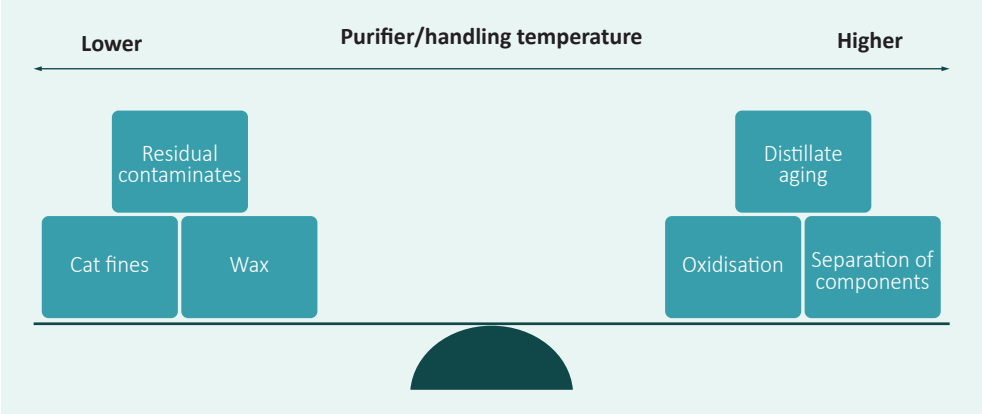
Understanding VLSFO

Residual streams are by far the cheapest and they are not going away, so a good blender will maximise residual content in the VLSFO blend while maintaining sulphur levels below 0.5%. So where do these streams come from?

These streams might include: Fluid Catalytic Cracking (FCC) slurry oil; hydro processing (de-sulphurisation plants); bio fuels; straight run distillates; petrochemical waste streams; and straight run Vacuum Gas Oil (VGO), all of which are potential sources for low sulphur blend components with vastly different properties.

This provides blenders with immense flexibility when producing low sulphur fuels; however, each one provides different challenges for handling on-board. It also gives us an idea why viscosity, density and appearance can vary so much with VLSFO.

What causes the sludge?



The processes that remove sulphur also remove the natural components within oil that keep fuel stable. These refined distillate streams are also incompatible with residual streams which cause a natural separation over time. This leaves VLSFO (which is generally a blend of the two) particularly vulnerable to instability.

For this reason, a fuel's resistance to aging will vary depending on what processes were involved during its manufacturing and these processes will determine how it ages and/or how quickly.

We are seeing many VLSFOs with viscosities below 100 cSt that have a much higher distillate component than expected, but we are also seeing more handling issues with these fuels which we can trace back to their production origin.

Types of purifier sludge

Distillate
Distillate aging, polymerisation and fuel instability

Wax
n-paraffin wax crystals separating in fuel due to lower temperatures

Residual
Residual aging, asphaltene dropout and fuel instability

Purifier blockages when using VLSFO

How to prevent purifier sludge?

Distillate Sludge

We are seeing a large spike in distillate aging cases onboard. These processes are accelerated by the addition of heat which is why they are most common in the purifier (Figure 1) and at the engine.

Distillate aging occurs most commonly through oxidation and depending on the chemistry. Oxidised distillates form grit-like sediments or glue-like gums that block purifiers, filters, fuel pumps, and injectors. This causes major disruption to ships' operations and untold damage to machinery. As discussed earlier, a lower viscosity (below 100 cSt) indicates a higher proportion of distillate components thus leaving them more susceptible to distillate aging.

Other processes include polymerisation – if high concentrations of olefins (alkenes) are present in the fuel then this type of reaction can occur. Olefins form in refinery cracking processes and if these refinery streams are utilised in the fuel blending then polymerisation can occur. These can initiate a chain reaction that continuously form polymers that are insoluble in the fuel and form large amounts of gums and sediments. These gums and sediments can block fuel filters and form deposits on fuel injectors that ultimately cause operability issues.

Figure 1. Aged distillates blocking up sludge lines and purifiers; if not removed, this sticky substance can become impregnated with other impurities such as cat fines or sediments, effectively creating a grinding paste inside fuel lines.

Octamar™ HF-10 PLUS will chemically prevent these reactions from taking place, while ensuring purifier temperatures can be maintained, by capturing these problem elements in VLSFO and stopping distillate aging long before it starts.

Waxes

Wax formation in VLSFO is a phenomenon caused by n-paraffins from distillate blend components. At lower temperatures they grow into crystal structures large enough to see (often named the Wax Appearance Temperature – WAT) and block fuel systems. The larger the n-paraffin, the greater the temperature required to prevent wax forming e.g. C-10 (Decane): melting point-30°C, C-40 (Tetracotane): melting point of 82°C, both are common in VLSFO.

N-paraffins in VLSFO can be extremely long, leading to cases where wax appearance temperatures exceed 60°C, which is well above the recommended purification temperature for low viscosity fuels (Figure 2). This is leading to excessive sludging during separation where even a small amount of wax formation in fuels can concentrate in the purifiers and filters, and block fuel systems.

Viscosity @ 50˚C	Storage Temp	Separation Temp
Up to 20 cST	30˚C	40˚C
20 to 30 cST	30˚C	50˚C*
30 to 40 cST	15˚C above PP	60˚C*
40 to 50 cST	15˚C above PP	70˚C*
50 to 70 cST	15˚C above PP	80˚C*
80 to 180 cST	15˚C above PP	98˚C

*Figure 2. *Separation temperatures can be set up to 98°C. The higher the temperature the better the result will be. Consider the viscosity in the booster and adjust the temperature accordingly, Alfa Laval service letter SB 32343.*

By maintaining VLSFO above its wax appearance temperature, the problem can be prevented or even reversed. Unfortunately, we know that elevated temperatures during storage, handling and purification will dramatically accelerate the oxidation and polymerisation reactions that lead to distillate aging. It is also true that WAT may not always be available to us.

Chemically restoring VLSFO stability will allow vessels to keep temperatures above the WAT while removing the risk of distillate aging and simultaneously increasing purifier efficiency. The most effective way to prevent these problems is by pre-treating VLSFO with Octamar™ HF-10 PLUS.

Purifier blockages when using VLSFO

Residual Sludge

Residual sludge is a familiar sight for every seafarer who has handled High Sulphur Fuel Oil (HSFO) in the past. It contains asphaltenes and other impurities (cat fines) that must be purified at temperatures approaching 98°C to ensure effective separation, and failure to purify effectively risks considerable damage to the engine.

The residual content of VLSFO is much less than HSFO (3.5% S) and yet we are seeing far more residual sludge crashing out at the purifier. Why is this occurring? It comes down to the blend stability. Distillate and residual fuels are structurally dissimilar, which means mixing a larger proportion of distillate into a blend greatly increases the chances of sludging, but reduces the time and temperature required for sludge drop out, leading to far more sludge per tonne of fuel.

Octamar™ HF-10 PLUS has proven to be the most effective dispersant stabiliser on the market. It keeps residual components in solution and prevents VLSFO separation- reducing sludge drop out at the purifier by up to 70%.

How do we purify VLSFO effectively?

Efficient purification can only take place at elevated temperatures (Figure 3). If the temperatures are too low then cat fine and particulate removal is ineffective, waxes drop out of solution and water separation is poor. If the temperatures are too high then distillate aging, polymerisation and fuel instability is accelerated.

We can confirm that fuels with a viscosity below 100 cSt are most at risk of distillate aging due to their increased distillate fraction and the likelihood that they come from highly refined streams at the refinery.

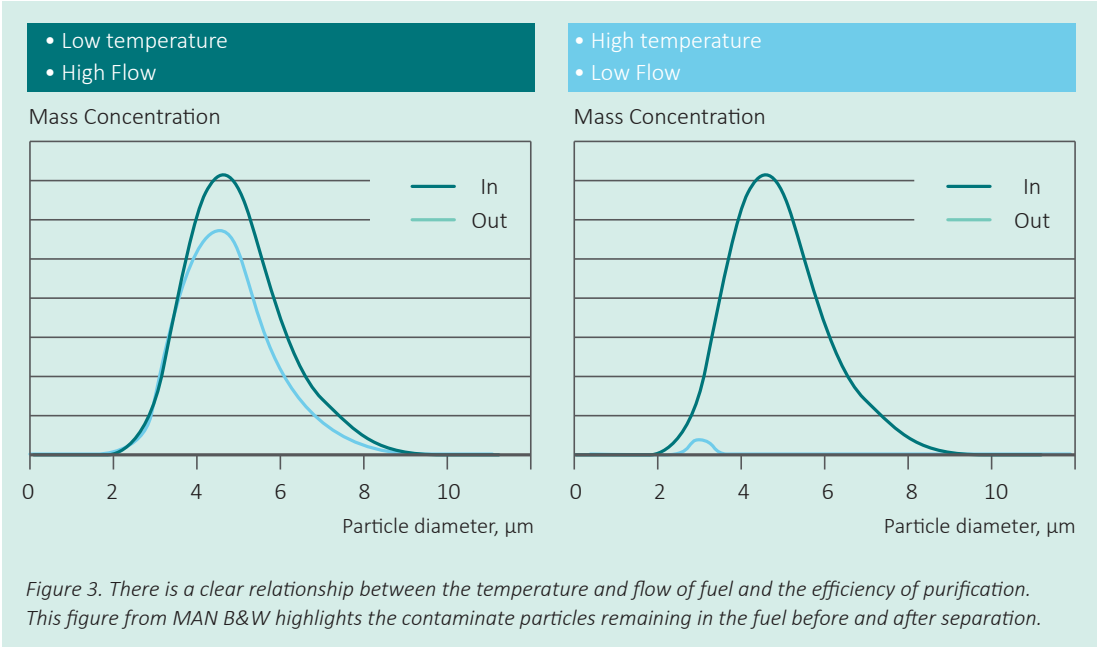


Figure 3. There is a clear relationship between the temperature and flow of fuel and the efficiency of purification. This figure from MAN B&W highlights the contaminate particles remaining in the fuel before and after separation.

By chemically restoring the stability of the fuel with our unique technology, you will be able to target the problem elements in the fuel and prevent distillate aging caused by oxidisation and polymerisation. Maintaining efficient separation temperatures, reducing sludge and removing the risk of wax entirely will keep your vessels and crew working safely and effectively.

Octamar™ HF-10 PLUS has already delivered unparalleled fuel performance improvements for fleets globally. Vessels have seen fuel handling on-board dramatically improved, separation efficiency returned and the compound benefits on fuel savings through less fuel crashing out as sludge and better combustion efficiency.

Purifier blockages when using VLSFO

The safest, cheapest and most effective way to treat your problems

Octamar™ HF-10 PLUS

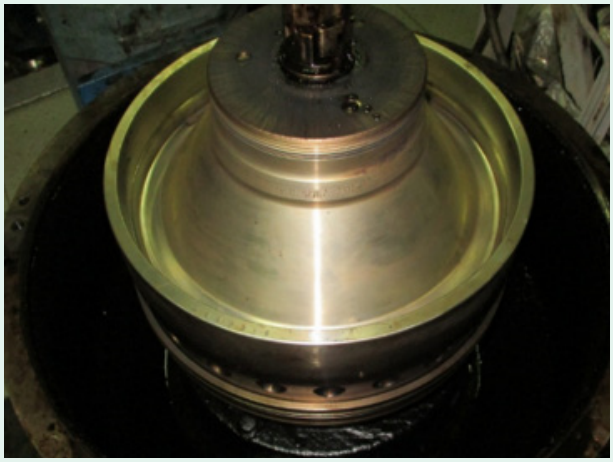
Innospec are fuel specialists like no other, so work with us to improve your fleet's performance and ensure the safety of your crew, ship and the environment.

Use **Octamar™ HF-10 PLUS** to maximise fleet performance, stabilise VLSFO blends and reduce sludge formation.

- Prevent purifier blockages
- Maintain handling temperatures to prevent wax without aging VLSFO
- Improve compatibility and stability of VLSFO which ultimately increases operability
- Significantly reduce sludge, crew maintenance hours and component costs
- Achieve longer periods between unplanned maintenance intervals
- Boost Engine performance by cleaning fuel pumps and injectors in service

Untreated VLSFO

VLSFO treated with Octamar™ HF-10 PLUS



*The purifier on the left experiencing severe sludging issues (required cleaning every few hours) at the recommended purification temperature, while the purifier on the right is the same purifier using the same VLSFO just twenty-four (24) hours after applying **Octamar™ HF-10 PLUS**.*

Innospec

Innospec is at the forefront of developing fuel additive technology for a changing world. Our focus is on supporting the fuel industry as it adapts to major environmental challenges, new legislation and the more demanding performance targets set by OEMs. While we operate at the novel and cutting edge of technology, our goal as market leader is always to create reliable and highly functional products. We build global supply chain solutions by understanding the important differences within regional and national markets. Our worldwide network spans 23 countries.
We can work with you to create the next generation of fuels, today.

Please contact your local sales representative for more information.

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