HEATBASE Ltd FACTSHEET 50
Ongoing problems with kerosene and Oil burning appliances

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Last year the UK Domestic kerosene market rapidly started suffering several problems and continues to do so. The problems are adversely affecting the operation and service duration of AGA type cookers that use traditional natural draught vapourising burners, some "coking" up and requiring another service within 2 - 4 months, but 1 – 6 weeks in several cases. There are many reports of boilers that use pressure jet burners smoking or breaking down soon after fuel deliveries and in some cases within 24 hours of the delivery. Contamination is being found in fuel pumps and burner nozzles after failure, but the external filters in the fuel supply lines are clean. There are also reports of strange brown sludge blocking oil lines and filters or water in the fuel supply lines, with no evidence of water or contamination in fuel samples taken from the tank bottom. Problems after routine replacement of flexible oil hoses are also being reported, customers are complaining of oil leaks or continuing oil smells, when no oil leak is visible. This is also occurring on Biofuel compatible hoses, even when biofuel is not used. None of these issues are related to one specific Oil Company and the problem appears to be affecting all Oil Companies all over the country; not that any of them accept or admit that there is a problem. These issues seem to be occurring on a more regular basis now and technicians dealing with the problems are expecting them to become more widespread, and worry that they might cause potential environmental and safety risks, which might in turn leave the Service technician liable to prosecution for negligence in the event of a serious incident.

Strangely, farmers all over the country were experiencing very similar problems last year with tractors breaking down due to fuel problems and blocked filters and in many cases 2 micron filters in their engines blocking within 50 hours of operation, this was taken seriously and fuel testing was carried out on many fuel samples.

Regardless of whether problems occur in a domestic kerosene or agricultural diesel or DERV tank, the end users dirty oil tank is commonly blamed for the problem, as any existing sediment, dirt or water in an oil tank can be drawn into the fuel as Agricultural diesel and DERV now contains 7 % Biofuel, which has a strong cleaning effect. However, kerosene should not contain any Biofuel at all but some after market additives for kerosene can also have a similar cleaning effect on the Oil tank, which can lead to problems.

Apart from "Biofuel" content, the most commonly blamed problem with diesel is the "Diesel Bug" (which can also be present in kerosene), which is the general term for various types of microbes which live in the layer between the fuel and any free water in the tank base; Bacteria: single cells typically between 1 – 10 micron in size, Mould: a type of fungi which grows into long multicellular filaments, Biofilms: complex structures of microbes which can stick to the walls of the Oil tank, but there are other contaminates not related to microbial contamination which also affect diesel and kerosene: Asphaltenes: hard, brittle particles that are not soluble in fuel and are usually 2 micron or smaller in size. They can stick together and build into larger particles which can block filters. They tend to collect at the bottom of the tank and form an oily sludge that is often mistaken for microbial contamination. Gums and other resins: as fuel ages and oxidises, it breaks down into peroxide, organic acids and gummy sediment which usually falls to the bottom of the Oil tank and become disturbed during filling. Once disturbed they can be drawn into the fuel line and can stick to filters causing blockages. As Oil Storage depots treat their storage tanks with Biocides from time to time to kill or prevent growths of "Diesel Bug", logic would indicate that some of these deposits or contaminates will still be present in the fuel itself, which will then be passed downstream, especially as filtration from an Oil terminal, Oil depot storage tank or fuel delivery tanker is not nearly as sensitive as that of downstream oil storage tanks. As Biodiesel has aggressive solvent properties it can loosen deposits from Depot storage tanks and fuel delivery systems or other upstream storage facilities, and therefore, it may already be holding water and other contaminates when loaded into the delivery tanker, which will then enter the tankers manifold and metering system, which in turn will end up in the end users tank.

According to an article in Farmers Weekly regarding the ongoing tractor problems; out of 100 samples of fuel analysed, only 15% contained contaminates from poor storage, and even then, not in high enough concentrations to cause significant blockages. What was discovered was that the fuel itself had high total contamination levels; clean gas oil usually has a total contamination value of less than 6mg/kg but many samples were between 15 and 20mg/kg and some in the low 20s, but because the legal limit is 24mg/kg, the fuel is deemed to be within specification. But further testing proved these particles were causing the problems; that they could drop out of fuel in cold weather and accumulate during prolonged cold periods, but not melt back into the fuel when the temperature rose, again this indicates that the particles causing problems were delivered within the fuel. Although these particles are small enough to pass through the 10 micron fuel station filter, thus causing problems with the tractor filters downstream of storage, whilst in the storage tank they can start to bind together, becoming larger particles until they eventually become of sufficient size and quantity to block the

10 micron filter as well. As testing on kerosene hasn't been conducted, we can't be sure if these same high particle counts are occurring in kerosene at the point of delivery, but it is possible. If these tests were carried out and found to be of similar amounts found in Agricultural diesel, it would prove that the base fuel is contaminated and the problem was not because of Biofuel content as is also commonly blamed with diesel; but regardless, fuel "tank sludge" is becoming a growing issue with both diesel and kerosene. Tank sludge becomes stirred up during fuel deliveries, but then usually settles back to the tank base within a matter of hours. But visible particles are now being witnessed held in suspension for excessively long periods of up to several months after delivery, any particles smaller than 50 microns may not be "visible" to the human eye and will pass the "clear and bright" test used to initially check for contamination or off spec fuel. Farmers are now being advised to replace their 10 micron fuel station filters every third delivery, but this won't solve the problem of smaller particles passing through and blocking engine filters, and wouldn't be necessary if particles and contamination weren't being supplied with the fuel delivery itself or the fuel delivered was filtered to a better standard.

There is a possibility that Kerosene is becoming contaminated with Gas Oil in Fuel tanker hose reels and metering systems. Biodiesel is delivered from the same tanker as kerosene on a daily basis, through the same hose reel and meter as kerosene and there are Government best practice guidelines and procedures on how wet line tankers supplying different fuels should proceed when supplying a different fuel type after another to prevent cross contamination, but they also state that even if the procedures were properly adopted there would still be a possible co-mingling of oils due to manifold content and pump and meter turbulence. Industry estimates this could be between 5 and 25 litres when changing between fuel types, dependent on the metering system installed on the vehicle. This cross contamination may not be visible during the "clean and bright" test due to the low percentage of cross contamination, but it could have a cleaning effect on the kerosene storage tank as well as adding the already proven suspended particulate matter from the Gas Oil to the kerosene. However, this would still not explain oil leakages or smells from new biofuel compatible hoses.

Some after market additives for kerosene have a similar cleaning effect to "biofuels" and claim to "*reduce sludge formation within the oil storage tank; stop particles dropping to the bottom of the tank where they will build up as sludge, and ensures smaller deposits go through the nozzle to be burnt during combustion*". Another says it "*decreases settling behaviour of sediment, ensures clean lines, filters, preheaters and burners. Longer storage times, prevents build-up of tank bottom sludge*", some of this is achieved by slowing down the production of deposits formed as fuel ages, holding any new microscopic particles in suspension, but will also break down large particles of sediment in the tank bottom because of the cleaning and dispersant effect of the additive; any suspended particles in the fuel that are small enough will therefore pass through the kerosene industry standard 50 micron tank strainers, causing potential blockages in 10-15 micron filters downstream after they collect and bind together in the fuel supply line. If there is no 10-15 micron filter fitted or if particles are smaller than this they will pass through this finer filter, they will then pass through to the appliance to be burned during the combustion process; causing changes to the characteristics of flames and problems with combustion, or increased "coking" in vaporising burners, but as the particles stick and bind together, they could potentially contaminate and damage oil pumps, solenoid valves or burner nozzles in the process. While the use of additives and their effects are a good idea to keep a new or clean oil tank, with a new or clean oil supply line, with fuel that has low particulate counts clean, it is not such a good idea to use them in an existing dirty installation especially as they also state "*If your tank already has an element of sludge, the dispersants will gradually remove it. On average an inch of sludge can be removed over a 12 month period*". That is a massive amount of sludge to be breaking up and passing down a fuel supply line to any combustion appliance and could explain many of the problems that are occurring in our industry at the minute, as well as others that have been occurring on a regularly increasing basis over the last 10 years.

Manufacturers of after market additives don't always stipulate that a tank should be new or cleaned prior to use; they just assume it is free of dirt and water, but an additive that is approved by AGA does have a stipulation that an oil tank must be drained, cleaned and purged before using the additive. AGA have confirmed if this is not done, contaminated fuel can be passed to the AGA burner causing problems. Additives are being supplied from various sources with no checks or knowledge of the cleanliness of the oil tank, the appliance type(s) that the tank supplies, or the condition or material used in the oil supply line and ancillary equipment and offer no advice to inform anyone of the possible implications of their use in the wrong application. Some Oil companies are adding additives as standard, often without asking the customer if they want them or not and some Oil companies are also selling additives to people with AGAs when the additive company says it isn't suitable. Although one additive company states a specific dose rate of their product, double or treble dosing is common due to the size of the bottles and the quantity of fuel it treats or is delivered. According to its Technical datasheet, another additive supplied directly from the tanker has a variable dose rate of between 100 – 500 ppm, depending upon the desired effect; but they do not give any information on what problems it claims to fix, or what desired effect might be achieved in the differing dose rates; but supply it in a 500ppm dose rate as standard.

The following examples are some of the cases or problems that we have physically experienced in the last 14 months, although I have heard of many similar situations from Technicians in other parts of the country:

- We have evidence that a farmer that had purchased a brand new diesel "fuel station" and had only used "new" fuel supplied by an oil distributor, had particles smaller than 10 micron in size passing through the fuel station filters and causing blockages with the finer filtration provided to protect his modern tractor engines, but that the 10 micron filters fitted to the fuel station had also blocked after only a few deliveries of fuel had been purchased, and then again after even shorter intervals while the tractors continued to suffer problems. In this case particulates had to be delivered with or within the fuel.

- We have evidence that a brand new Oil tank, oil supply line and boiler installation that had the Industry standard 50 micron tank strainer and an additional 10 micron paper filter fitted prior to each of the burners, had evidence of "dirt" on the back of the nozzles on the first annual service; both 50 and 10 micron filters were clean. This would indicate that particles or contaminates smaller than 10 micron had been delivered with the fuel.

- We have evidence of brown sludge contaminating fuel supply lines, filters and nozzles, causing a boiler to smoke and breakdown. The Oil tank was a top outlet supply with a ridged (non -floating) style suction pipe. Although fuel taken from the tank bottom was clear and contained no water, the ridged feed pipe assembly was coated on its entire length in crud and deposits. The tank was less than 5 years old.

- A Customer that only uses their AGA during winter, so only has it serviced annually in August, had no water content in their tank in August 2016/17, 1mm in 2018 and 18mm in 2019. They ran out of Oil in March 2020 and they requested a visit to bleed the boiler and light the AGA. When dipping the Oil tank for water, there was none present, even though the customer confirmed they had not had it removed.

- During a Standard boiler service an Oil tank was routinely dipped for water, there was none present and hadn't been on any previous service visit. The 50 Micron strainer was removed and found to be clean. Upon re-firing the boiler, discoloured fuel was seen to come through the clear PVC flexible oil hose and then the burner locked out. Contamination had come through the line and blocked the new nozzle. The Oil supply line was blown though from the tank and purged, the oil pump was cleaned, and the nozzle replaced and re-fired again. Once the contents of the fuel line settled it separated into a layer of dyed green water, hazy kerosene, with an obvious scum and sediment layer between the 2 liquids. We carried out our own dip-slide incubation of the fuel for "Diesel Bug" but no positive results were obtained. Biocides often contain dyes and depending on the type, will absorb water. It is possible that this was phase separation of dyed green water had been delivered from an upstream storage facility suspended within the fuel, and that the water had eventually dropped out of suspension while lying in the oil supply line. This fuel was later passed on for independent analysis.

- Additives sold specifically for AGAs claim they reduce the "coking" effect. We have written conformation stating that any "particles" in the fuel which are burned during combustion of an AGA will <u>increase</u> the "coking" effect.

- We have information from AGA, that the additive they approve will cause contaminates to be sent to the AGA unless the Oil tank is drained, cleaned and purged prior to the use of the additive and they have confirmed this stipulation was from the additive manufacturer.

- We have evidence that Oil Companies are advertising and supplying the wrong additives as standard to customers with AGAs; e.g. one company promotes a fragranced additive to AGA customers to mask smells, but according to the additive manufacturer, is not suitable for AGAs and should only be used with pressure jet appliances.

- We have evidence that people may be getting additives without their knowledge and that paperwork does not always show there are additives in the delivered fuel; A customer that had AGA problems after a delivery of fuel on our recommendation questioned whether any additives were in the fuel, the Oil Company denied they had ever supplied an additive to this customer, there was nothing on any delivery ticket, or invoice that would indicate an additive and they even gave written confirmation that they had not supplied any. The fuel analysis report that was carried out showed an overdose of additive, that only that particular Oil company can sell.

- A customer whose boiler started smoking soon after a fuel delivery, even though the boiler had only been serviced 3 months prior, on our recommendation checked whether there was an additive in their fuel and if it was compatible. She received an email from the Oil company stating that the additive supplied might not be suitable for older boilers and they wouldn't recommend its use in older boilers and that any water in a tank would cause

problems, but they couldn't check for sediment. The customer in question did not know they had an additive in the fuel; they hadn't asked for it but after looking back through paperwork, had been receiving it for over a year. The Oil company had never checked about the age of the boiler or cleanliness of the fuel tank before they started supplying it, or even informed the customer that they were supplying it.

- There are lots of customers paying for additives without their knowledge. When enquiring as to whether customers use aftermarket additives and finding they do on invoices or delivery tickets, many claim they didn't know they had them and hadn't asked for them. Additives are not supplied free of charge from the generosity of the Oil supplier, the customer incurs additional costs when they didn't want or ask for them.

- A customer that had been supplied the "wrong" additive for their AGA for over a year without their knowledge, even though prior to their first delivery, they were asked, and they confirmed to the oil company that they had an AGA. The AGA started having problems after a fuel delivery, the service interval before the burner blocked with carbon dropped from its standard 6 month service, to 6 weeks and continued to do so. Fuel samples were taken and found to contain massive amounts of suspended sediment 3 months after the last fuel delivery, the Oil tank used an industry standard 50 micron strainer. Fuel Analysis showed there was no free water present and there was no live micro bacterial growth, but fuel sampled from the tank bottom outlet had a well within spec Char value of 9.1 mg/kg even though there was sediment present, but the same oil sampled from just prior to the oil control valve had an out of spec Char value of 20.1 mg/kg. Only after having the tank cleaned and its contents filtered down to 2 micron, and the oil supply lines cleared and flushed through did the AGA suddenly become free of trouble again, running on the same, but sediment free oil. This would confirm that any sediment held in suspension of fuel, will increase the "coking" effect of a vapourising burner affecting its performance and shortening the service interval, but would also confirm that either a massive amount of particulate matter had been delivered with the fuel, OR that the potential problems caused by using the wrong aftermarket additives in a dirty Oil storage tank might take a year or more to materialise. Although it was stated that nothing can increase the Char value of the fuel, because it has also been confirmed that burning any suspended particles will increase "coking" in a vapourising burner, it would also indicate that once any particles pass through a filter into an oil supply line, thy might stick, collect and build up over a period of time, but as any particles that are from dispersed old and aged fuel deposits there is a distinct possibility that they then contaminate any "good" or fresh fuel that comingles with these deposits on route to the appliance.

- As above we have proven in this example, that sediment that is passing through filters builds up in the fuel supply lines over time, eventually causing combustion difficulties and rapid coking in an vapourising burner; e.g. an AGA that hadn't been up to temperature for quite some time was serviced, the 10 micron filter was clean, but then a small amount of carbon blocked the burner within 24 hours, it was removed but the same thing happened 24 hours later. The oil control was removed and dismantled, but found to be clean, the supply from the oil control to the burner was blown clear. The AGA managed 7 days before blocking again. This time the whole fuel line was blown clear and the oil control was stripped down again and the supply to the burner was again blown through, the oil tank was not cleaned in this case, but a fuel sample taken from the oil tank outlet showed small floating particles, the 10 micron filter was still clear. This time the AGA managed to run nearly 4 months without problem, until the customer ran out of fuel. The AGA was relit without dismantling it and is running at temperature again. This would indicate that even where sediment is present in the tank and building in size and held in suspension, smaller particles had been passing through the 10 micron filter, and accumulating in the fuel supply line over a period of time which in turn caused additional combustion problems downstream.