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Generator Service - Fuel Polishing Equipment Choices

Do you offer a permanently installed automated fuel polishing system or onsite fuel polishing as scheduled maintenance or a demand service?

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EXECUTIVE SUMMARY

The fuel product quality is the same, but onsite fuel polishing as scheduled maintenance or a demand service is the most cost-effective solution for most customers with a few exceptions.

Fuel maintenance and the fuel polishing required thereof are here to stay. Either the end user ('customer') buys a permanently installed automated system or has a vendor perform the fuel polishing as scheduled maintenance or a demand service. Depending on the systems cost versus the annual polishing cost, the purchase and installation of the permanently installed system with a vendor replacing the filters and maintaining the system twice a year is approximately fourteen times more than a vendor performing the fuel polishing on an annual basis. The useful life of the permanent system is equal to that of the emergency system it supports, so it is a capital asset. As for the periodic filter servicing, it requires a trained person with knowledge of the equipment and some basic maintenance skills. If onsite maintenance personnel are not long-term or have a high turn-over, this may mean frequent and ongoing training or the use of a vendor to perform this work. Additionally, onsite maintenance personnel may not be present or available for some customers. Automated permanently installed polishing equipment can filter the fuel to a 1- or 3-micron level, which is easily four to ten times better than most engine mounted filters. It can isolate and trap water in the system and provide an alarm for the drainage of same. With an optional automatic chemical additive injection system, it can add biocides, water dispersants, sludge dispersant, cold flow inhibitors and fuel preservatives on a metered scheduled basis. The fuel quality from this system is very high and it may be the best solution for customers with skilled onsite maintenance personnel, equipment with limited access to the tank ports, an access limited or remote location, a customer with known fuel quality issues, large fuel storage tanks or mission critical applications.

By comparison, there are multiple advantages for the customer that uses a vendor for their scheduled or demand service fuel polishing versus a permanently installed automated systems. There is no capital expenditure. There is no ongoing expense to the customer for the maintenance or repair of the equipment. The customer has no liability for the entire process from polishing to the proper disposal of the hazardous waste products generated from the service. The mobile equipment used offers the same level of filtration and water removal as the permanently installed system. Regarding chemical additives, a vendor with a technician onsite can administer them in conjunction with the polishing. The long-term fuel quality from one system to the other is non-conclusive for this paper. The volume of fuel moving in the tank with a mobile polisher is approximately ten times that of the permanently installed system. This allows debris to be pushed or released from areas in the tank that otherwise would amass more of the same. Having a technician onsite for the polishing allows for a visual inspection of the fuel system, a visual sample of the fuel product before & after polishing and greater flexibility if large amounts of debris, water or biomatter are discovered.

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INTRODUCTION

As the generator service provider, do you sell and install a fully automated fuel polishing system that runs every other day without fail and requires only minor maintenance for the foreseeable future or do you provide mobile fuel polishing and perform the work inhouse in conjunction with scheduled maintenance on an annual, semiannual or demand basis?

PROBLEM STATEMENT

How does a permanently installed automated fuel polishing system compare with a mobile polishing system, equipment cost, operating expense to the customer, operation, service, service life, equipment maintenance, service interval and fuel quality?

ABSTRACT

The poor quality of the crude oil currently coming out of the ground and the inclusion of biodiesel in varying amounts in our diesel fuel formulations make fuel maintenance a growing trend in power generation. Polishing fuel is an integral part of it. Whereas diesel fuel maintenance for power generation was a simple function of ensuring the tank was full and maybe adding some kerosene for winter temperatures, it now encompasses a much higher level of testing, polishing and chemical additives. At present, the NFPA continues to address the testing and remediation of diesel fuel, but we still do not have clear marching orders or an authority having jurisdiction. Regardless, we need to take steps and measures to protect and maintain the diesel fuel that we use to make emergency power. Permanently installed automated fuel polishing equipment or routine scheduled polishing with mobile equipment is required for standby diesel generators moving forward.

In a nutshell, fuel polishing is the technical process of fluid filtration that removes contaminants from diesel fuel in successive filter stages involving multiple passes of increasingly finer filter elements. 2 microns filtration is an accepted final filter stage size for polishing equipment. Engine manufacturers are currently specifying 4 to 5-micron absolute engine mounted fuel filter elements on Tier 4 engines. For comparison, an average human hair is 50 microns in diameter and the human eye cannot see anything smaller than 40 microns. Fuel polishing is the microscopic filtration of our industries' lifeblood.

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The diesel fuel has two major contaminants, trash and water. Trash comes in two varieties, solid particles like rust, gums, wax and dirt (rocks, sand & clay) and organic matter like bacteria, yeast, mold and biofilms. To keep it simple, the first group is debris and the second is biomatter. Due to their large size on the micron level, both debris and biomatter are easily removed in the early bulk filtering stages of polishing. Water comes in the form of emulsified, dissolved and free water. Free water being the bulk water that accumulates in the bottom of the fuel tank. In a measurable amount, it is called the tank 'water bottom'. By design, the fuel supply pick-up tube in most tanks allows for the retention of water below the usable fuel level as a safeguard. Emulsified water in diesel fuel is a temporary condition. Polishing is the easiest way to remove it. Dissolved water is the worst. Ultra-Low-Sulfur Diesel ('ULSD') is highly hygroscopic. Hygroscopic means it attracts and readily absorbs water. The source of water can be as basic as the atmosphere or condensation caused by heated return fuel. At 50°F fluid temperature, the water saturation of ULSD is approximately 50 ppm. That's 2.5 gallons of water in a 500-gallon tank. As you increase the fuel temperature, its ability to absorb water increases. At maximum saturation, dissolved water in diesel fuel drops out to become free water at the bottom of the tank. The easiest way to remove emulsified water is polishing with water block or water coalescing filters. In the past, engine and injector manufacturers allowed 200 ppm (.02% by volume) of dissolved water in diesel fuel. Most, if not all modern engine manufacturers now have an extremely low to zero tolerance for dissolved water. Fuel polishing as a function of fuel maintenance is the best practice for removing harmful contaminants from stored fuel.

Very clean and equally high-quality diesel fuel is required for modern diesel engines. With each increase in diesel engine efficiency, there is a new demand for progressively higher fuel pressures and smaller injector openings. 15,000 to 30,000 PSI high pressure common rail diesel engine injection systems demand and require progressively cleaner fuel. In the past, most diesel engines would have one or more 10 micron spin-on fuel filter with a cellulose-blended (paper/wood) media element and one or more spin-on drainable fuel water separator filters that use a hydrophobic barrier media element and a water trap. A well-engineered system may even have an upstream water separator to capture and contain the water before the engine mounted fuel filters. Now, we have one or more 2 to 5 micron filters with expensive micro-fiberglass (inert inorganic bonded fixed pore fibers) media with absorbent technology, that captures and contains a small amount of water in the filter element, plus a fuel water separator filter with a hydrophilic depth coalescing media. What worked in the past, will not work moving forward.

The chemical energy in our stored diesel fuel and the super-efficient diesel engines that allow us to convert it to electricity require increased fuel maintenance now, more than ever. Each technological increase in diesel engine efficiency, requires increasingly cleaner fuel. The ever-present dissolved water, contaminating biomatter and inherent debris commonly found in our stored diesel fuel tanks requires periodic microscopic filtration as a best practice. There are two options, a permanently installed automated fuel polishing system or the routine scheduled polishing with mobile equipment. Both options will address the contamination issues and clean the fuel to the level required, but the power generation service provider has a choice of what to offer. Mission critical, remote location (island, isolated, basement, roof or mountain top), limited access (jail, prison, government facility or installation), limited equipment access (underground storage tank), very large fuel storage tanks and known fuel issue customers are an ideal application for a permanently installed automated fuel polishing system. All others are a good candidate for fuel polishing as a function of generator service, not unlike the accepted practice of annual load bank testing.

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EXAMPLE CUSTOMER SITE FOR COMPARISON

Typical Emergency System (per NEC 700) with a 500 to 1,200-gallon sub-base fuel tank. The customer has an outside contractor perform quarterly generator maintenance with an annual load bank test and a fuel sample with a laboratory analysis. No fuel maintenance (chemical additives or polishing) at present. Customer has maintenance personnel onsite to perform a visual inspection and monitor alarms, but they do not have the resources to perform fuel maintenance.

PERMANENTLY INSTALLED AUTOMATED FUEL POLISHING SYSTEM

COMPARISON INFORMATION

EXAMPLE EQUIPMENT

Automated (function, safety and alarms) NEMA 4 120 Vac 15 amp NEMA 5-15R Plug 1/3 HP gear pump rated at 2.5 gallons per minute (150 GPH) system with a 10 or 30 micron stainless steel primary filter (field serviceable & reusable) with either a disposable 1, 3, 10 or 25 micron spin-on fine filter and an integrated water collection sump.

A typical permanently installed automated polishing system will use a programmable logic controller (PLC) for sequencing and monitoring the system for operation and alarm status. For input, it will use vacuum, pressure, leak detection and water detection sensors. Additionally, it may have a pump overload protection relay. It may have traditional direct reading vacuum and pressure gauges for reference. It should have local circuit protection, a manual-off-auto and alarm reset switch and indicator lights for common functions (system power, pump running and alarms). It should have ball valves to isolate the entire system and isolated normally open relays for common alarm or leak detection.

Optional Feature – automatic chemical additive injection (not included)

CUSTOMER COST

1st Year – $12,250.00 Equipment & Semi-annual Maintenance

Annually thereafter - $1,000.00 Semi-annual Maintenance *(labor, filters & consumables)*

10 Years in Service - $21,250.00

Approximate Equipment & Installation Cost (one-time expense) – $11,250.00
($7,000 Polisher + $2,000 mechanical & electrical contractor) @ 20% Margin (25% Mark-up)

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EXPENSE

Annual Labor (estimated $150.00/Hr., burden TBD) – $600.00
Two hours onsite per filter service, semi-annual service. No travel time included.

Annual Filter Cost – $300.00
Two sets of $150.00 per set, semi-annual service. Average filter service $120.00 @ 20% Margin (25% Mark-up) = $150.00 x two services = $300.00

Example (cost) Two spin-on filters required ($115.00 to $125.00 + $120.00 Average)

1 micron spin-on filter - $80.00
3 micron spin-on filter - $45.00
10 micron spin-on filter - $35.00
25 micron spin-on filter - $35.00

Consumables $100.00
Estimated $50.00 expense for the consumables (absorption blankets, gloves, rags, paper towels, etc.) & filter disposal fee per service. Hazardous waste material disposal would be additional.

OPERATION

In automatic, the system will time, function and self-monitor without any outside assistance. Upon alarm, the system will shut down and indicate the fault. At that point, manual assistance is required to correct and reset the fault.

SERVICE

Cursory visual inspection of the system and note any issues. Typically, the stainless-steel mesh primary filter element and the secondary filter element(s) should be serviced at least every six months. Depending on the equipment, this process will very. Typically, it will require placing the system in the off position and closing the system isolation valves. Draining the water trap and removing the primary filter element for cleaning and replacing it. Remove the secondary filter(s) and replace them with marked dated filter(s) of the appropriate rating. Open the isolation valves, the water trap and system purge valve. Manually turn on the system to prime and close the water trap and purge valves. Inspect for leaks and return he system to service.

SERVICE INTERVAL

The service interval for the typical application of an automated fuel polisher is every other day or 16 times per month on average. The pump run cycle time in hours represents the required time to cycle the complete contents of the fuel tank based on the pump rating in gallons per hours. If wanted, it can be run continuously or daily. The service maintenance would increase accordingly.

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EQUIPMENT SERVICE LIFE

With proper maintenance, this equipment and its black iron piping and malleable fittings have a service life of approximately 20 years. It is field repairable and the expectation is that the component parts will be readily available for the foreseeable future. Additionally, there aren't any proprietary wear parts.

EQUIPMENT MAINTENANCE

This system should be visually inspected a minimum of every 6 months for a light duty cycle. Monthly inspections are recommended for systems that are being used more than an average of 8 hours a day and five days a week. Depending on the quality of the fuel being delivered and the ongoing consumption, the filters would be replaced semiannually or as needed based on the system indications. As a function of long-term maintenance, the pump motor with permanently lubricated bearings can be monitored periodically for its nominal operating temperature and current load.

FUEL QUALITY

The permanently installed automated fuel polishing system provides consistent fuel maintenance and can be programmed to run every day, every other day, weekly or as wanted. It continuously monitors and provides alerts for high pump vacuum or pressure, low fuel flow, pump overload, leak detection and high water in the separator bowl. Based on 150 gallons per hour, 500 gallons of fuel would turn every 3.33 hours and 1,200 gallons would turn in every 8 hours of operation. Based on routine polishing of the fuel and proper maintenance (water draining, cleaning the mesh element & changing the spin-on filter elements), the assumption is the fuel will be of very high quality with no debris or free water. With a sub-base tank (large shallow rectangle with structured baffles and limited access due to the skid base, generator, engine, accessories, etc.) and limited port selection and locations for the return and supply plumbing, the flow pattern through the tank will be the only limitation working against this system and the overall fuel quality. The fluid flow rate for the example equipment is 2.5 gallons per minute and the suction and return ports are fixed, so there will be a set flow pattern established in the tank. To address the possible poor flow patterns within some tanks with a permanently installed automated polishing system, a mobile system could be deployed every few years to ensure better sweeping of the tank. With the optional automatic fuel additive feature, biocide, sludge treatment, water dispersant or fuel stabilizer could be added in precise amounts periodically and refilled during the quarterly maintenance. This would further increase the fuel quality and help prevent fuel issues.

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CONCLUSION

The permanently installed automated fuel polishing system is a good option for any customer application, but it may be the only option for some. As a long-term capital expense, the customer has an automated system that will continuously safeguard their fuel with minimal maintenance and supervision for the life of their power generation equipment. Factor in the quantity of fuel that will pass thru the system in a year versus an annual polishing and the permanently installed automated polishing system wins by a landslide. The fuel quality derived from it is equal to annual or semi-annual onsite polishing with mobile equipment. The only shortcoming is the limited or low fluid flow pattern thru the fuel tank. To that end, the day may come where multiple additional access ports are placed in tanks for cleaning and the internal baffling and structural tank supports are design for the best possible flow pattern thru the tank.

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ONSITE FUEL POLISHING AS SCHEDULED MAINTENANCE OR A DEMAND SERVICE

COMPARISON INFORMATION

EXAMPLE EQUIPMENT

185 lb. two-wheel dolly mobile fuel polisher with quick release (cam & groove connectors, 25' clear suction & 25' discharge) hoses and a built-in drip tray containment base. Color-coded vacuum & pressure gauges, water level sight glass, inlet ball valve, outlet diverter ball valve and accessory selector valve 120 Vac 15 amp NEMA 5-15R Plug ¾ HP rotary vane pump rated at 26 gallons per minute (1,560 GPH) system with a pump strainer, a 1, 5, 10, 25, 75, 250 or 800 micron disposable filter bag with two inline disposable 1, 3, 10 or 25 micron spin-on fine filters.

For reference, the estimate cost for the described equipment is $13,000.00

COST CUSTOMER (SALE PRICE)

Per Polishing – $1.20 per gallon based on fuel tank capacity

Example (cost per gallon pricing)

500 Gallon sub-base tank @ $1.20 per gallon	$600.00 per polishing
1,200 Gallon sub-base tank @ $1.20 per gallon	$1,440.00 per polishing

10 Years in Service - $6,000 – 500 gallon tank & $14,400.00 – 1,200 gallon tank

EXPENSE

Annual Labor (labor burden TBD) – 500 Gallon Tank – 3 hours onsite & 1,200 Gallon Tank - 6 hours onsite with scheduled maintenance. No travel time included.

Annual Filter Cost - $162.50
One set of filters $130.00 per set, annual service. $130.00 @ 20% Margin (25% Mark-up) = $162.50

Example (cost) $130.00 Two bag & two spin-on filters required ($7.00 + $8.00 + $80.00 + $35.00)

5 micron filter bag - $7.00	1 micron spin-on filter - $80.00
10 micron filter bag - $7.00	3 micron spin-on filter - $45.00
25 micron filter bag - $7.00	10 micron spin-on filter - $35.00
75 micron filter bag – $7.00	25 micron spin-on filter - $35.00
250 micron filter bag – $8.00	
800 micron filter bag - $8.00	

Consumables Per Polishing – $50.00
Estimated $50.00 expense for the consumables (absorption blankets, gloves, rags, paper towels, etc.) & filter disposal fee. Hazardous waste material disposal would be additional.

OPERATION

No customer equipment to operate or service maintenance required.

A typical mobile polisher has sequential steps or phases to complete the polishing. For the proposed equipment, we will have three phases.

Phase One (bypass mode) – Bypass the filters and carefully (without mixing water into the emulsified state and stirring up the trash) vacuum any free water, sludge and debris from the bottom of the tank to a suitable waste container. During this process, monitor the clear suction hose for clean fuel, water level sight glass for the accumulation of water and the vacuum gauges (static head and pump) for a blockage in the pick-up tube. The collected fuel product is for disposal.

Phase Two (bulk filtering loop) – The discharge hose goes back in the tank and the primary high micron bag filter is selected. The successively finer spin-on filters are bypassed. During this process, monitor the clear suction hose for steady fuel flow, water level sight glass for the accumulation of water and the primary filter vacuum gauge for a filter change. Fuel samples can be taken from the primary element drain as a working reference. Once clean fuel is drawn, move to the final stage.

Phase Three (final product) – All three filter elements are in the loop. During this process, monitor the clear suction hose for steady fuel flow, water level sight glass for the accumulation of water and the primary filter vacuum gauge for a filter change and the fine filter pressure gauges for back pressure indicating a filter requires replacement. The pump pressure gauge is monitored to maintain a steady working pressure. During this stage, chemical additives can be added for good distribution.

Quality polishing equipment will have vacuum and pressure gauges with colored-coded scales representing the operational range for the equipment. Filter cleaning or replacement is indicated by color-coded gauges. In the absence of color-coded scales, the technician will use known working pressure or vacuum range values to monitor the process and polisher components for proper operation

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SERVICE

Per onsite fuel polishing service and based on our 500 to 1,200 gallon sub base fuel tank example, the technician will access the generator enclosure and perform a quick visual inspection of the fuel system citing any missing, broken or leaking; piping, hoses, labels or markings, mechanical level gauges, valves, fittings, spill fill bucket, sensor wiring, paint, corrosion or miscellaneous damage. Thereafter, check the fuel level using the tank sight gauge, generator control panel, tape measure or fuel tank stick with water finding paste and note the fuel level and presence or level of water found with the paste. After which open any tank ports (normal vent, emergency vent, mechanical fuel gauge, leak detection, fuel level sensors, filler, etc.) available with good access for the suction wand and return hose. Pull a bottom and middle sample of fuel with a Bacon Bomb or suitable tool and place the samples in clear sampling containers. From the samples, determine the water bottom content and look for debris and biomatter and note the findings. Position the fuel polisher adjacent to the fuel tank and place the return and suction hoses in the tank. Connect the polisher to a local outlet in the generator enclosure or nearby. Establish and verify the polisher has the appropriate micron level filters based on the quantity of debris or biomatter found in the visual fuel sample. If the water finding paste and bottom sample show a large quantity of free water, debris or biomatter on the bottom of the tank, place a suitable waste fuel container near the polisher and move the discharge / return hose to the container, switch the polisher valves to bypass the filters and pump out the water bottom, debris or biomatter. Continuously monitor the clear suction hose to verify when clean fuel is being picked up. At the point of clear clean fuel, shut off the pump and clear the hoses into the waste container. Manifest the waste fuel product for proper disposal offsite and place the return hose back in the tank. Switch the valve back to the bag filter (higher micron rating…25, 75, 250 or 800 micro) <u>only</u>, bypassing the two finer spin-on filters. Run the system in and out of as many ports available, varying the return and suction hose position and using the suction wand to stir-up or scour the tank until the clear suction hose runs clear or the bag filter requires replacement. After which drain the water trap and switch back to a filter loop that has the bag element followed by the two successively finer micron level filters series. Filter the fuel for long enough to turn the tank four to six times (500 gal. tank – approximately 40 to 120 minutes, 1,200 gal. – approximately 192 to 288 minutes) depending on the fuel condition. Replacing a filter or draining the water trap as indicated by the system back pressure or gauge indications. Chemical fuel additives can be manually administered in the tank during this process for good distribution throughout the fuel. Take another bottom and middle sample from the tank and perform a visual inspection and comparison with the pre cleaning samples. Note the findings, replace the fuel tank access ports and demobilize the equipment.

EQUIPMENT SERVICE LIFE

No customer equipment.

MAINTENANCE

No customer maintenance required.

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SERVICE INTERVAL

The service interval for mobile fuel polishing would be initially determined by the condition of the existing fuel and fuel tank. If the fuel is found to be free of debris, biomatter and excessive free water, annual to semi-annual polishing would be good starting point. If the tank has excessive water, debris, biomatter or sludge, a more frequent interval of polishing would be required and the possible application of chemical additives. Ultimately, the annual laboratory testing and analysis results will outline the required service interval. The technician and required equipment can be onsite for this specific service standalone or any internal in conjunction scheduled generator maintenance.

FUEL QUALITY

The fuel maintenance or the cleaning derived from an annual onsite polishing by a trained technician with the appropriate equipment can equal or exceed that of an automated permanently installed fuel polishing system. As a starting point, a technician onsite can take a visual fuel sample and use water finding paste to confirm the amount of water in the tank. If a fuel vendor has mistakenly delivered biofuel or B20 (20% biodiesel) blend, the technician may smell the bio component of the fuel. If water or excessive water is found in the tank, a technician can bypass the filters and pump off the water bottom for proper disposal, thereby eliminating the bulk of the water in a single step. Further, a technician may find a missing vent cap or other source of water intrusion, based on the quantity of water in the tank. If further biomatter or debris is found, the technician can use the larger bag element only (bypass the two fine filters) to vacuum up the trash without even using the higher quality more expensive filters. In both cases, by using a clear suction hose, the technician can see the water, debris or biomatter as it appears in the hose and distinguish when to change the filtration process. By virtue of moving approximately 26 gallons of fuel per minute, the manual process of polishing stirs up the fuel tank to a higher level than a permanently installed polisher, which moves fuel at 2 or even 5 gallons a minute. Large flat shallow baffled tanks tend to collect debris and the higher volume of fluid movement helps move trash toward the suction pick-up.

CONCLUSION

To the customer, mobile onsite fuel polishing represents a cost-effective method for having their fuel polished and their equipment inspected by a qualified technician on an annual or semi-annual basis. Short of the scheduling and the invoice, the end user is not involved or responsible for the process. By nature of its ability to effectively move a larger volume of fuel and scour the tank better than a permanent system, the fuel quality and tank cleaning obtained by the mobile fuel polishing equipment exceeds that of permanently installed fuel polishing equipment.