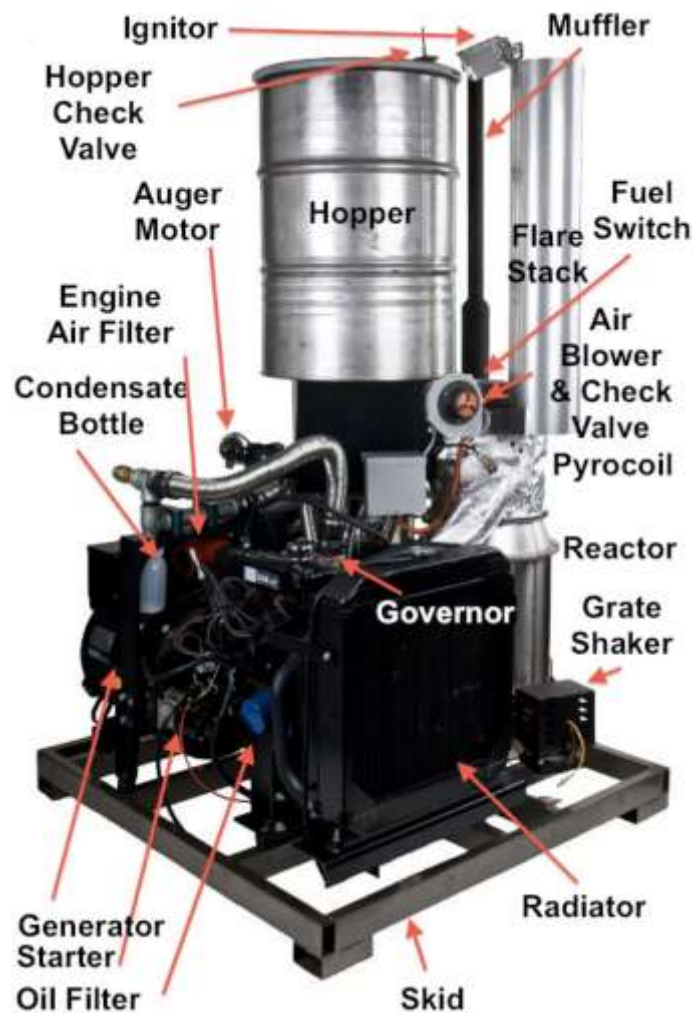




ALL POWER LABS
OPEN SOURCE ENERGY
1010 Murray Street · Berkeley CA, 94710
GEK Hotline: 510-845-1500 · Fax: 510-550-2837
www.allpowerlabs.org · www.gekgasifier.com

10&20kW PowerPallet *Maintenance Schedule*



Notes about Gasification/Engine systems: *The PowerPallet is a stand-alone, fully integrated power station including the GEK Gasifier, engine, and generator for power generation from biomass. The maintenance schedule for the PowerPallet system we recommend is on a conservative schedule. We highly recommend checking the following items frequently as suggested while using a new type of feed stock (moisture content, size, shape, species, plant component, etc.) for the first time.*

The composition of biomass feedstocks are naturally variable in their characteristics, and their solid state inherently leads to greater variability in the products of thermal decomposition reactions mostly due to the inability to achieve ideal mixing of solids with air. Because of this, biomass is inherently more difficult than the convenient and consistent fluid phase of fossil fuels to which the world has become so accustomed.

Biomass as a renewable fuel requires different system design (ie: wood stoves, boilers, gasifiers, etc.) and hands-on maintenance considerations (ie: ash/char purging, flue cleaning, condensate traps, cleaning of build-up, etc) than the extended neglect we expect to achieve with maintained liquid fossil fuel systems such as cars and gas/diesel generators.

All downdraft gasifiers (and most all gasifier designs for that matter) are sensitive to variations from 'ideal' feed stocks. Because we are unable to test all types of biomass feed stocks around the world, we encourage you to take an active and observant role into the maintenance tasks and schedule for the first of several run cycles. This will ensure the system as a whole runs in a safe manner at its highest efficiency, with the lowest possible emissions, and have a longer total life overall. We highly recommend keeping a maintenance and operation log of the feedstock characteristics used, time of start- up, notes on temperature and pressure, full run time, generator load, maintenance tasks done and notes (sample log included in this document). As you run the system over many cycles, you will discover the feedstock's degree of deviation from ideality and will be able to adjust the maintenance schedule from what is conservatively suggested below.

Do realize that this information from you in the field is very important to us as we make system developments and offer upgrades to current customers like yourself. We would greatly appreciate these notes from you as we are constantly improving our system design and documentation based on reports from people like you. Please take part in helping us create and improve low cost renewable energy solutions for changing world by contributing your run notes, suggestions, comments, and pictures.

Thank you,
Jay Hasty
R&D, Customer & Technical Support Team
support@allpowerlabs.org

Suggested Maintenance Schedule

Item	Daily	10-12 hours	50hrs/ 10cycles	300hr/ 50cy	1000hrs/ 100 cy
GEK					
Visual inspection, Reactor and Hopper Gaskets			X		
Purge Char from Reactor		X			
Check/Clean Cyclone			X		
Check/Empty Cyclone Condensate Jar			X		
Check/Change Gas Filter bulk media			X		
Check/Clean Gas Filter Foam Disks		X			
Check/Clean Gas Lines				X	
Check/Clean Dual Gas Blowers				X	
Check Reactor Air Lines					X
Check Reactor Reduction Bell					X
Check Reactor nozzles					X
Engine					
Check/Purge Air Filter	X				
Engine Condensate Jar	X				
Check Spark plugs					X
Engine oil	X				
Throttle valve	X		X		
Run with Valve cleaner/alt fuel*					X
Recalibrate O2 Sensor			X		

*See also, Engine Maintenance Schedule

Notes on Maintenance Schedule Items:

WARNING: When doing any maintenance or opening of the PowerPallet or GEK Gasifier systems, do this in a well-ventilated area using the CO meter provided. The closed system will contain CO from the previous run. It is highly suggested to turn the Gas Blowers on high for up to 1- 2 minutes with all valves open to purge the CO out of the flare stack before doing maintenance on the system.

- Reactor Gaskets:
 - Gaskets will wear over time depending on frequency of separation and attachment of neighboring flanges or components. To ensure a longer life, be careful not to damage, pinch, stretch, or over-tighten components. Make sure that the mate is free of wood chips and particulates before attaching.
 - Typically the most frequently worn is the Reactor Lid Port Cover silicone gasket. Make sure it is able to maintain a gas tight seal.

- Due to the frequency of use of the hopper lid this seal can become worn. Check to see that it is maintaining a gas tight seal. The gasket should wrap all the way around the lip of the hopper barrel edge.
- Purge Char from Reactor:
 - The Grate Shake mechanism purges the smaller char/ash particles to maintain proper gas flow throughout the reaction chamber.
 - Purge the ash/char from underneath the grate by opening the square side port of the GEK Reactor Vessel. This is easily done with a vacuum cleaner.
 - This high temp char is perfect as the final stage filter media for the Gas Filter. Be sure to sift out the fine dust, see *Filter Media*.
- Cyclone:
 - It is possible for soot and particulates to stick and build-up in the gas lines and cyclone over time. To maintain the efficiency of the cyclone, detach and purge any build-up that may have accumulated.
 - Detach the cyclone by disconnecting the top circular flange of the cyclone and the four bolt square flange at the Gas Cowling.
 - Scrape the build-up off of the inside of the Cyclone and the Gas Exit Port of the Reactor Vessel.
 - You will most likely need replacement gaskets. Depending on your version, we direct you to the gaskets you will need. These are found at most hardware or online stores.
- Cyclone Condensate Jar:
 - The two condensate jars on the system (Cyclone and Engine Condensate Jar) and the Gas Filter Barrel, are the lowest points in the system that are designed for trapping condensation in the gas. Check/Empty these before start-up.
- Gas Filter bulk media & condensate:
 - The saw dust or char media used for the bulk of the Gas Filter media traps any soot, tars, and condensate in the gas stream before entering the engine.
 - Check the condensate level of the Gas Filter by looking at the level viewing port at the bottom of the Gas Filter
 - Check the filter bulk media when the engine is running and observe the Reactor pressure and the Gas Filter pressure(P_{filter}). If the difference of the two pressures is greater than 3" H₂O, the bulk filter media will need to be changed.
 - Use a wire brush to scrape the grates clean of soot/particulate build-up.
 - The spent bulk filter media can be tried and mixed with the feedstock up to 15% by weight. Otherwise, dispose of properly.
- Gas Filter Foam Disks
 - The Filter Foam Disks will need to be cleaned as they will acquire build-up over time. Clean by washing with soap and warm water. Dispose of properly, wear gloves.

- The Filter Foam Disks work by trapping finer particles with an added oil layer. Thoroughly dry the Filter Foam Disks and dip them into clean motor oil. Squeeze out the excess.
- Make sure the Foam Filter Disks contact the outer wall of the Gas Filter when installed.
- Air Lines:
 - Take the Reactor Vessel out of the Gas Cowling and use a wire brush to remove any build up around the Gas Lines.
 - Check to make sure the Air Lines have not been cracked or have experienced other damages.
 - How to access the Air Lines:
 - Detach the Flare Stack from the top of the reactor and disconnect the Gas Line at the flex hose connection.
 - Unbolt the Reactor Lid and set aside without damaging the Fuel Switch.
 - Disconnect the thermocouple at the top of reduction (T_tred) and the bottom of reduction (T_bred).
 - Un-bolt the Reactor from the Gas Cowling.
 - Carefully lift the Reactor out of the Gas Cowling. Char will fall out from the bottom of the Reactor, make sure it doesn't get into the PowerPallet equipment.
 - Do not set the Reactor resting on the corrugated Air Lines. Place it upside down to have access to the Air Lines.
 - Remove (ie: vacuum) the charcoal and feed stock out of the Gas Cowling before re-assembly.
 - Replace all compromised gaskets. Contact ALL Power Labs at support@allpowerlabs.org for ordering and spec information. We will provide our supplier information.
 - Re-assemble the GEK Gasifier in the reverse order.
- Gas Lines
 - Open the Gas Line Clean Out Port near the Gas Line connection at the bottom of the Gas Filter. Use this port to empty any condensate and use a long brush to clean out any build-up inside the Gas Line.
- Dual Gas Blowers:
 - The Gas Blowers will need to be checked for the possibility of build-up on the fan blades. If build-up does occur, clean blades and housing with isopropyl alcohol. Do not submerge surrounding blower components with isopropyl alcohol. Wear gloves
- Reactor Reduction Bell:
 - Due to high thermal cycling over long run times at high temperatures in a harsh combustion and a reduction environment, over time the Reduction Bell will need to be checked for any accumulated damage that may have occurred.
 - Remove the Reactor Taper to inspect the Reduction Bell. Check to make sure that the Reduction Bell has not been compromised.

- Reactor Air Nozzles:
 - Because the highest temperatures are experienced at the tip of the air nozzles of any gasifier system, these will need to be checked for any thermal damage.
 - Check the tip of the Nozzles to make sure the opening has not enlarged due to melting or corrosion.
- Air Filter:
 - Before each run, briefly check to make sure the engine's Air Filter is not clogged.
 - If the Air Filter is dirty, blow it off with compressed air or similar method.
- Engine Condensate Jar:
 - Empty any condensate collected in the jar. There may be an oil layer in the condensate jar from any oils carried over from the foam filter disks. Do not pour this on the ground, please dispose of this in an environmentally responsible way.
- Spark Plugs:
 - As a precaution, check to make sure the spark plugs are free of any build up. If the spark plugs are replaced, you may need to adjust the spark gap to our specs. (See Engine Specs documentation).
- Throttle Valve:
 - Make sure the throttle valve is free of any build up that may have occurred over time. If build-up does occur, (ie: wood tar, or oxidation) clean with isopropyl alcohol.
- Run with Alternative Fuel:
 - As a precaution we suggest running the engine on its intended fuel (See Engine Specs documentation) with valve cleaner for one 6 hour cycle according to the maintenance schedule.
 - Consider running the engine with valve cleaner while running with alternative fuel.
 - Disconnect the Gas Line from the governor. ***how would the governor settings react to this?
 - Connect a fuel line with an in-line fuel filter to the engine if needed (See Engine Specs documentation).
 - Use an external gas can or use a regulator to connect a propane/natural gas canister. (This will depend on your engine type).

Engine Maintenance Schedule

- Kubota (10kWPP)

[DG972-E2]

Item	Service Interval						
	Daily	Every 50 hrs	Every 100 hrs	Every 200 hrs	Every 1 year	Every 1000 hrs	Every 2 years
Checking engine oil level	☆						
Checking and replenish coolant	☆						
Checking air cleaner element	☆						
Checking fuel line setting condition	☆						
Checking fuel connector	☆						
Cleaning air cleaner element		☆					
Checking fuel hose and clamp bands		☆					
Natural gas fuel check		☆					
Checking battery electrolyte level		☆					
Cleaning spark plug			☆				
Checking fuel filter			☆				
Check fan belt tension and damage			☆				
Changing engine oil		★		☆			
Replacing oil filter cartridge		★		☆			
Checking fuel line setting condition				☆			
Checking radiator hoses and clamp bands				☆			
* Replacing air cleaner element					☆		
Replacing fuel filter					☆		
Cleaning gas mixer					☆		
Cleaning water jacket and radiator interior					☆		
Replacing spark plug						☆	
Checking valve clearance						☆	
Cleaning cylinder head						☆	
Checking valve seats						☆	
Replacing intake air line							☆
Replacing fuel hose and clamp bands							☆
Replacing radiator hoses and clamp bands							☆
Replacing battery							☆
Changing radiator coolant (L.L.C.)							☆

★ Change engine oil and replace oil filter cartridge after the first 50 hours of operation.

* Replace the element after 6 times cleaning.