

“A generator is only half of it!”



Generator Buyers Guide
GBG-2001

US Carburetion Publication GBG-2001

FORWARD

This guide was produced to help those desiring to purchase a reliable back-up source of electricity and for any that may already own a generator and desire a better fuel source other than gasoline.

All the information presented is strictly the opinion of the author based on years of experience in the alternate fuels industry and in contact with the general public and their needs.

After considering this information you may feel that the author leans heavily toward propane as a key source of fuel. Even though it may be considered biased it is for a good reason,

PROPANE IS THE GREATEST FUEL ON EARTH FOR POWERING A FOUR CYCLE ENGINE AND FOR COOKING A TASTY STEAK.

Can't do that with gasoline (and please don't try)!

The author.

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Section 1- WHERE TO BEGIN?

The most common mistake made by those seeking to acquire a backup power supply for their home is that they choose a generator first without much thought to their actual power needs. Usually the generator is oversized for the needed load and this can be a costly mistake. A generator is most efficient at about 75% of its rated load. Running below half of the rated wattage is like delivering newspapers with an airplane. Yea, you can get the job done, but it's just unnecessary.

So lets briefly discuss where to start in the process of making the correct decision when buying a generator.

Step 1: Decide how much wattage you really need.

This is probably the easiest step but the most neglected. Take the time to sit down and think of what you will *really* need in case of long power outages. Make a priority list with the most important item at the top and working down to the least necessary. Below you will find a basic list in order of what seems to be most important to the average person.

- **Water Pump**
- **Furnace Blower**
- **Refrigerator/Freezer**
- **A Few Lights**
- **Microwave Oven**

Now that you have a list of the essentials, it's time

to figure out how much power you will require to have all these things. As you will see later, you may start deleting some from the bottom of the list as the price of power becomes apparent.

Generators are sold based on the wattage output. Often two numbers are given and they are Rated watts and Maximum Watts. Some manufacturers will list the model as a 5000 watt generator but that is actually the maximum momentary peak allowed . The actual rated continuous running wattage may be around 4500 watts. So this is important in comparing one unit to another. The basic formula is that it takes two conventional horsepower to generator 1000 watts of electricity. Some 5000 watt generators have a 9hp engine. One would assume that the engine actually can produce 10hp if necessary.

Watts are simply Volts times Amps. Some manufactures list their units by VA (voltage amps). When you go to purchase a new vacuum cleaner, you see that they are rated in amps. So a 12amp vacuum would be 1440 watts (120 V x 12 A). So how do you add up all your wattage needs?

The best method is to read the sticker on the item you want to power and get the actual rated wattage as given by the manufacturer. If the data is not available for some reason, you will find a basic rating sheet at the end of this section to help you.

Consider this actual manufacturers label. The rating is in amps only so we multiply voltage times amps. Since this refrigerator reads:

Eastembarn Manufacturing Company ®
Smithburg, TN
120 V 6A 60 CYCLES

Model BZ20635 UL Listed

Serial UR5878112

Simply multiply 120 volts times 6 amps and the total running watts for this refrigerator is 720 watts.

Well, you may say that doesn't use very much. However, the refrigerator has a compressor/motor. Motors are said to consume at least 3 times their rated wattage to initially start them, especially older less efficient motors and compressors. Some have been tested and found to consume up to 5 times their rated wattage. Let's use a generally accepted rule of 3 times. So that 720 watts running becomes 2160 watts of starting wattage also known as Max. This is a very close estimate but you can be very accurate by hiring an electrician to test each of your desired power loads with an AMP meter. Most people choose the data plate method described above. Finally, after deciding what your total needs are, add at least 25% extra for the sake of your generator and perhaps some item in the future you have yet to consider. Even though this is not mandatory, it is a good idea.

Here is a list of popular items and their average wattage

Wow, it adds up fast doesn't it. You didn't realize you needed a 20 KW generator did you? Relax, there is a way to eliminate many of these items and yet have the use of them when the power is out. Change out some of the items to gas. For

Item	Rated Watts	Max watts
Water Pump	700	2100
Furnace Blower	600	1800
Refrigerator/Freezer Combination	800	2400
Light Bulb	100	100
Microwave Oven	500	
Window Fan	200	600
Water Heater	5000	
Color Television	350	
Fax Machine	200	
Range Top Burner (each)	1500	
Electric Oven	10,000	
Radio	150	
Toaster 2 Slice	1100	
Computer	500	

instance, a 5000 watt electric water heater can be easily changed to a 30,000 Btu gas water heater. Not only will this free up a large amount of wattage, you will have a faster, more efficient source of hot water and save money year around. An unvented gas heater is 99.99% efficient and extremely safe. They are actually a natural humidifier when operating. A couple of these in strategic locations around the house can eliminate baseboard or even strip heat.

Also, when you ask the gas company to set you a large tank for just your generator you may have trouble finding a gas company that is willing to do it. They are mainly interested in selling propane not setting tanks. Their goal is to pump gas year around. They know that a generator may not be used for years so don't expect them to get excited because you want a big tank. But, if you tell them you are thinking of replacing an electrical appliance with a gas one, they may be real happy to work with you. It is not unusual for a gas company to give a free water heater or a full rebate when changing over. Check with all your local gas companies, especially the big ones. If you find a good salesperson that knows their stuff, they can help you to see many ways to eliminate the use of electricity and you may find that your electrical needs are not as high as you thought.

The following is some general information about using a generator to charge batteries. The batteries DC voltage is changed to AC for use in the home. We give this for reference because it is becoming very popular.

Different ways for remote powered home, cabin, battery charging, water pumping, sign illumination, Motor home or trailer.

First choice is a good quality electric start generator operating on propane. For manual operation when you need power simply turn the key and start it as you would your car. If you don't like to listen to the noise and pay for fuel to run 1 light bulb there is another alternative. Battery powered ac voltage. There are specially designed batteries built for this purposes. In use, your power demands are drawn off the batteries as needed as AC. When the batteries need to be charged, an alternate fueled generator can be set up so that it will start automatically, charge the batteries and shut off when they are full. The advantage is that the generator operates at full efficiency for only a short period of time. Now you have power 24 hours a day with lower cost and without continuous noise. If you want to run your generator even less, the installation of solar panels or a wind generator to supplement power to your batteries is the answer. Now your generator becomes what it is designed for, an emergency backup power supply.

This information supplied courtesy of

In Hot Water Heat and Power Company 1-888-745-2009

Please call or email them direct if you want further information at
rod@lightheat.com www.lightheat.com

So now you know what size power generator you need but what brand and what engine will best fit your needs? This is the topic of the next section.

Section 2- A GENERATOR IS ONLY HALF OF IT.

So now you know the wattage generator you need. You will soon find that a generator of the same wattage sold by different manufactures will vary in price by hundreds of dollars, and for good reason.

The generator is only half of it. The engine, often manufactured by another company, makes up the other half of the unit. And a good engine will cost more money.

The basic things to consider when choosing the engine that will drive your generator is:

- **How long do I plan on running the generator at any given time?**
- **How much life do I expect to get out of the generator I purchase?**
- **Do I want a disposable model, or one that will last for years?**

As an example, Generac® claims that their positive oil pressure engine will outlast a Briggs & Stratton® or Tecumseh ® conventional side-valve type engine by 3 to 5 times. That may be a good reason for having a positive pressure overhead valve (OHV) type engine. If positive oil pressure makes such a big difference, it stands to reason that having an oil filter to filter out any impurities will increase the life of the engine even more. These two features come with every automobile sold on the market today and for good reason; longer engine life.

Here are some other claims made about the superiority of the overhead valve engine:

Oil Pressure Lubrication: Oil, the life blood of the engine, gets to the engine parts quickly under pressure and consistently unlike regular engines that splash the oil around in a very haphazard way.

Cooler Running: The better lubricated an engine is the cooler it will operate due to a reduction in friction.

Oil Pressure Shutdown: OHV engines usually have an oil PRESSURE shut down device that is more reliable than an oil LEVEL shut down device.

Now that the reasons are clear as to why it is beneficial to have a top quality engine the question becomes; is spending double, triple, or more for one generator over another worth the extra life of the unit?

Only you and your pocket book can answer that question.

Since the generator and the engine come together as one unit, it is important to know a little about the actual generator end. Lets take a look.

Section 3-WHAT ACTUALLY IS A GENERATOR?

Technically a generator is a machine that converts mechanical energy (from the engine) into electrical energy. But you knew that. So what you want to know is what do you need to know when buying one?

When shopping for a generator, usually you will not get much information about the actual generator end of the unit. Most of the sales literature is geared toward the engine and for good reason. It does the hardest part of the electrical generating process.

So here are some basic, very basic, facts about what the generator is made of and how they produce power.

Pick any wall plug in your home. If you had quality test equipment you would see that any of these electrical plugs would produce a reading like this: 120 volts then 0 volts then 120 volts then 0 volts, alternating current, alternating between zero and 120 volts.

All generators have an armature that spins inside of a magnetic field. This spinning causes the electricity generated to flow one way and then the other, also known as alternating (AC) current. This off-on-off-on-off pattern is duplicated by the generators armature spinning in the magnetic field. The complete cycle from on to off, to on, to

off again happens 60 times per second and is called a cycle. It is basically a law of physics that the armature inside of a generator needs to spin at precisely 3600 rpm (there is a way to have an 1800 rpm generator but we will use the most common 3600 as an example) to generate the 120 on-off's per second. The engine, by means of a mechanical governor, will monitor its speed and will move the throttle open or closed based on load to keep the armature spinning at exactly 3600 RPM. For example, lets suppose that you have a 2500 watt load on a 5000 watt generator and suddenly you apply 2000 more watts of load. The energy required to force the armature to spin at 3600 rpm is increased and the engine will begin to slow up. As soon as this happens, the governor will detect a decrease in speed and open the throttle more to allow the engine to speed back up to 3600 rpm. Just the same when a decrease in load takes place the engine will begin to over speed and the governor will close up the throttle to the point where the engine is turning at 3600 rpm again.

This basic information is helpful when it's time to purchase a generator. Knowing the basic parts involved gives you a big advantage when comparing one generator to another.

For instance, the armature mentioned above has an iron core with wire wrapped around it. These wires are also known as windings. This is the first clue to knowing if one generator is of a higher quality than another is if the windings are made of

COPPER instead of the less expensive ALUMINUM type. The only advantage we can think of to the consumer for aluminum windings would be that the overall unit weight is lighter for lifting and moving. But heavier is better. So if two comparable generators have the same engine and produce the same wattage, then chances are that the heavier one has either more windings, copper instead of aluminum windings, or denser magnetic material all of which means a higher quality product. When it's time to purchase, this is usually the last thing the manufacturer tells you. They brag about the all the engine characteristics but mention very little about the actual power plant.

The second and the most advertised feature you will encounter is the term "brushless". This is in regard to how the armature gets the electricity from inside the generator to the power outlet. Brushes are mechanical and brush or rub against the end area of the armature. These will eventually wear down and are not very "clean" in the way that they transfer power. The brushless type is just that, no brushes. A non-mechanical method is used to transfer the electricity from the armature. Because there are no moving parts, less maintenance is required and the electrical HERTZ or CYCLES are very clean which is important for computers and other sensitive equipment.

Section 4-LET'S TALK POWER!

Engine power that is. The basic four cycle engine uses hydrocarbon based fuels to create time controlled explosions to move the piston that drives a crank shaft that makes the engine spin. They really don't care what fuel is used to make these explosions. If the fuel is lower in BTU content, the governor will compensate by opening the throttle a little more. That is why just about any four cycle engine can run on gasoline, propane or natural gas.

What fuel is best for you? Gasoline? Propane & Gasoline? Gasoline, Propane & Natural Gas?

The chart on the next page will give some of the features and advantages or disadvantages of these three fuel types to help you decide which is the best fuel for you.

You will notice that vaporization is listed as one characteristic of the fuels. All engines burn fuel in a vapor form. Even gasoline. When you filled your lawn mower with a gas can or your car at the gas pump, you noticed the vapors escaping during filling. For combustion, the better the fuel vaporizes, the better it mixes with the air and the better it burns. So vaporization is very important for power.

Now it's time to discuss the two main alternate fuels, propane and natural gas, in more detail.

Fuel Comparison Chart

Fuel	BTU Content	Advantages	Disadvantages
Gasoline	110,000 BTUs per gallon	• Very Powerful	• Vented to the Atmosphere • Gums up carburetor parts • Vaporized poorly in cold weather • Often not available during power outages • Burns dirty-pollutes
Propane	92,000 Btu per gallon	• Powerful • Unvented-Very safe • No gum up problems • Vaporizes down to 44 below zero • Refilling available without electric • Large storage tanks • Will store for years with no negative results • Burns Clean	None
Natural Gas	70,000 Btu per gallon equivalent	• Unvented-Very safe • No gum up problems • Always a vapor • piped right to the building • Very dependable-piped in from other regions of the country • Often, very inexpensive • Burns Clean	None

Also we will look at what is involved in converting or changing over a gasoline engine so that it will operate on alternate fuel.

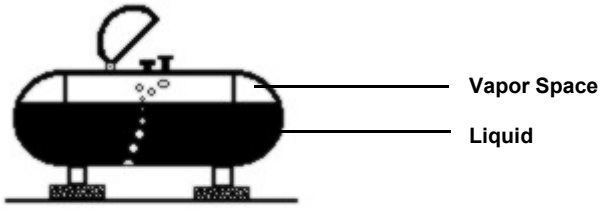
Section 5-THE PROPANE POWERED ENGINE

The most common use of a propane powered generator is one that is tied into an existing system at a home.

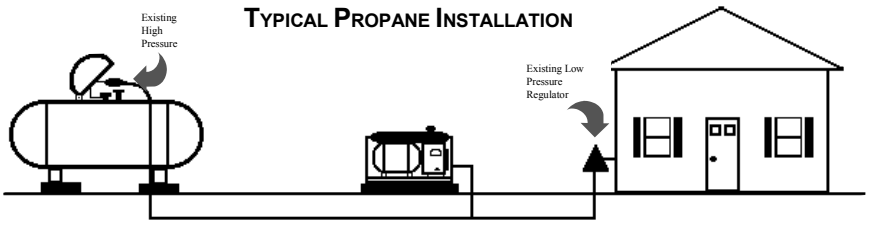
A typical system consists of a bulk tank on the property containing from 120 gallons to upwards of 1000 gallons. Because propane is environmentally friendly, no EPA regulations are involved. There are national codes that must be safely followed and these are well known by the local propane suppliers.

The bulk tank is filled with liquid propane to a maximum safe level of 80% capacity. This will allow the fuel to expand and contract based on ambient temperature and for vaporization. The fuel used for the home and the generator will be in vapor form as supplied from the upper area of the tank. As vapor is drawn off the top, the liquid will begin to boil and produce more vapor. Propane actually produces 270 times it's liquid equivalent. So a bar-b-q grill bottle that holds 4.7 gallons of liquid propane, will produce nearly 1269 gallons of vapor.

Illustration of a propane tank



Because the tank pressure can vary based on ambient temperature from around 80 psi to 250 psi, and for other safety considerations, a 1st stage or ***high pressure*** regulator is installed at the vapor outlet to reduce the pressure to a steady 10 psi. A small line is run from the high pressure regulator to the 2nd stage or low pressure regulator, which in turn drops the pressure to approximately 11” to 14" water column, (also stated as 8 ounces or 1/2 psi). The line after the low pressure regulator is larger to handle the load of the system and the size of the line is determined at the time of installation and often cannot accept any greater load than originally determined.



So the addition of a propane powered generator of almost any size to the secondary side of the system will overload the entire system.

However, the same is not true of the high pressure side of the system. Almost always, the line from the high pressure regulator to the low pressure regulator can accept more load than what is already on the system. This is the point where we want to tie a generator in for the best performance. The illustration on the previous page shows a generator tied into the high pressure side of the system.

With the addition of a “Portable Accessory”, the generator can be disconnected from the high pressure line of the home and connected directly into a gas grill type 20# (5 gallon) cylinder for portable use. Actually, cylinders of any size can be used including 100# (24 gallon) cylinders.

It is always a good idea to call the local gas company to do the final hook up to the generator and to make sure that the line size is capable of the extra load. If necessary, an additional line can be run from the high pressure regulator at the tank to the generator.

If your choice is to tie your generator into the low pressure side of the pipe system, please read the next section about natural gas. The same principles apply to low pressure propane.

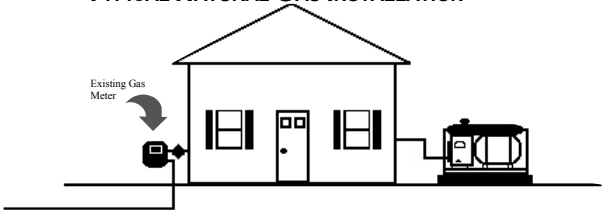
Section 6-THE NATURAL GAS POWERED ENGINE

The most common use of a natural gas powered generator is one that is tied into an existing gas system at a home.

As is true of propane, natural gas is environmentally friendly and no EPA regulations are involved. There are national codes that must be followed and these are well known by the local gas supplier and most licensed plumbers.

A typical system consists of a meter at the building. The main supply line form the road to the meter is usually at a pressure of about 10 psi. The meter/ regulator at the building drops the pressure from 10 psi to between 4 and 8 inches of water column or 1/4 of one psi. This is really low, low pressure. Because the pressure is so low, the pipe size has to be large to move more gas in a shorter period of time. By just adding very little additional load to the system, the overall pipe sizes must be enlarged. Many factors determine where on the system a generator can be added but almost always it has to be tied in right after the meter.

TYPICAL NATURAL GAS INSTALLATION



The illustration on the previous page shows a generator tied in well after the meter. This is perfectly fine ***if*** the piping system was engineered and designed to have the load of the generator at this point in the system. IF not, the generator or other appliances may "starve" for gas.

Just as an example of the distance a natural gas line can be run for a generator and the I.D. pipe size required, let's assume that a 10 horsepower engine/generator is added to a standard natural gas system and tied in at the meter. These are the distances the generator can be from the meter and the line size required to be that distance.

Distance in feet	Pipe Size Required	Distance in feet	Pipe Size Required
10	1/2	50	3/4
20	3/4	60	1
30	3/4	70	1
40	3/4	80-150	1

Some choose to have a second meter added by the gas company. This may be a viable solution if your system is not able to accept any more load.

To use the generator portably, a dedicated natural gas unit can be easily disconnected from the natural gas line and tied in to a 20# propane gas grill type cylinder by the use of a "Propane to Natural Gas Swap Accessory."

Section 7-CONVERSION METHODS

Dedicated

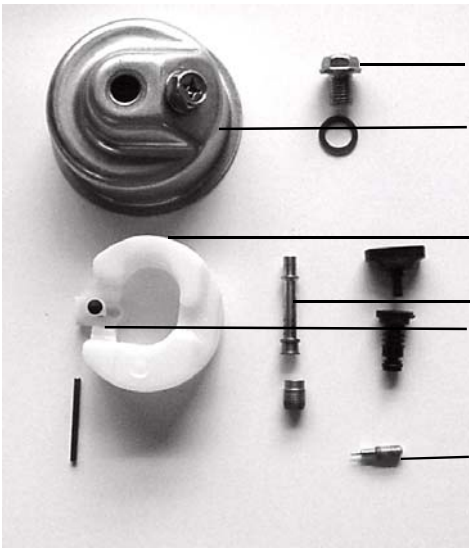
This is a true conversion. You dedicate the carburetor to deliver alternate fuel. Remember, an engine will run on any vapor that it can draw in and can burn. So we are not converting the engine. We are converting the carburetor. Once converted it can not be used for gasoline again.

The process is virtually the same for all engines. Here is a brief description.

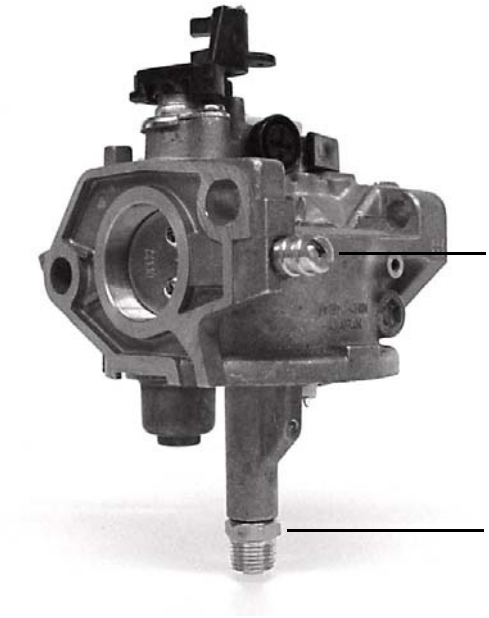
1) The gasoline carburetor is removed and disassembled.
2) The bowl plug, bowl, float, needle, high speed jet, etc. are discarded.
3) The main gasoline delivery to the air stream is made up through the center of the carburetor. This passage is too small to fit the new alternate fuel jet so it must be drilled a little bit bigger to usually 15/64 or 17/64. Most choose to hold the carburetor in their hand and drill it with a cordless drill.
4) The new alternate fuel tube is screwed in.
5) The gasoline idle mixture screw is removed, discarded, and a new brass vacuum fitting in installed. The center is drilled out to 5/64.
6) All holes and passages are sealed up using the supplied silicone sealant.
7) The carburetor is allowed to set overnight and then is reinstalled.
8) The engine regulator is mounted on the frame of the generator and hoses are cut and connected. That is it for the conversion.
9) Hook up a gas line and start your engine.

Dedicated Kits Prices
Propane **$165**
Natural Gas **$175**

Dedicated Removed Components

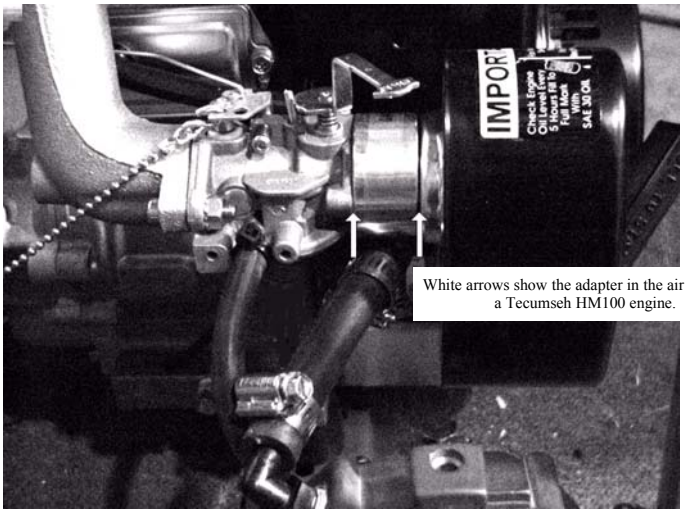


Dedicated Converted Carburetor



Bi-fuel

This is not a true conversion. You will mix the alternate fuel into the air stream above the gasoline carburetor as a way to deliver it to the engine. The gasoline throttle will still decide the engine speed but the fuel will come from the adapter installed above the carburetor.



White arrows show the adapter in the air stream of a Tecumseh HM100 engine.

The process is very simple for most engines. Here is a brief description.

1) Run the carburetor dry of gasoline.
2) Remove the complete engine air cleaner assembly.
3) The adapter plate it sandwiched between the carburetor and the air cleaner assembly. Use of longer screws or stud extenders are required and are supplied in the kit.
4) Reinstall the air cleaner assembly.
5) Mount the engine regulator on the frame and connect hoses.
6) Adaptation is complete.
7) Connect gas line and start your engine.

Most Bi-Fuel Kits Prices

Propane **$195**

Natural Gas **$205**

Section 8-CONVERSION MISCONCEPTIONS

Time to clear up some big misconceptions:

Converting will make the generator loose wattage.
This is just not true. Many feel that because propane and natural gas are lower in BTU content that the engine will have to loose power. This does have some merit. If you were converting a pickup truck to haul your travel trailer to the mountains, yes, you would loose high end power. Especially with natural gas. But there are some factors that have to be considered. Engine size for one. The smaller the engine, the smaller the intake manifold, the less time for the vapor to mix with the air stream. Alternate fuel is already a vapor so it seems to mix better and quicker than gasoline that is stored just below the air stream in a bowl as a liquid. The engines used on generators seem to have additional power that is not typically used. This may be due to anticipating that an owner may haul a generator up to 5,000 feet above sea level. What ever the reason, we have never had one customer report power loss of a dedicated converted engine.

Converting to alternate fuel will burn the valves.
This too is untrue. As with any fuel, correct mixtures are essential. A lean alternate fuel engine runs just as cool as gasoline.

Section 9-EXTRA FACTS AND BITS

Altitude

Every 1000 feet above sea level all engines will loose on average 3% total horse power. The thinner air will not rush in as fast during the intake stroke. An engine is nothing more than an air pump. Less air in means less power out.

Consumption

Propane and natural gas consumption is the same in Btu's. Use the formula to figure engine required Btu's then convert it to natural gas cubic feet or propane gallons, etc. Here is a basic formula:

CID* x **RPM** ÷ 1728 ÷ 2 x .85 = **CFM (a)**
CFM (a) x 60 = **CFH (b)**
CFH (b) ÷ 23.86 = **CFFH (c)**
CFFH (c) x BTU in **CF (d)** = **BTU per hour (e)**

***To Change CC to CID multiply cc x .06102**

Here is an example of the formula using a Briggs and Stratton 10 hp (19)G412 19 CID engine:

19 x 3600 ÷ 1728 ÷ 2 x .85 = 16.82
16.82 x 60 = 1009.2
1009.2 ÷ 23.86 = 42.30
42.30 x 2558 = 108,203 Btu of fuel per hour

Terms:

CID	Cubic Inch Displacement
RPM	Rounds per Minute
CFM	Cubic Feet per Minute
CFH	Cubic Feet per Hour
CFFH	Cubic Feet of Fuel per Hour
CF	Cubic Feet
BTU	British Thermal Unit

To convert the Btu results of 108,230 to your needs, use the following conversion figures.

1 cubic foot of natural gas contains 1783 Btu.
So 108,203 ÷ 1783 = 60.7 cubic feet

1 therm contains 100,000 Btu.
So 108,203 ÷ 100,000 = 1.08 terms

1 gallon of propane contains apx. 92,000 Btu
So 108,203 ÷ 92,000 = 1.18 gallons

1 gallon of gasoline contains apx. 110,000 Btu
so 108,230 ÷ 110,000 = .98 gallons

Remember, this is total 100% full load for a full hour. Most likely this will not be the case. You will notice most manufactures rate the fuel usage at a 50% load average because loads constantly change.

Internet Links and Sites

Installing a Backup Generator

This is a fantastic article with pictures from a magazine reprint of the March 1998 issue entitled Step-by-step hookup to your home fuse panel.

http://popularmechanics.com/popmech/homei/9803HIHIAM.html

Buying a new generator

www.yamahagenerators.com
www.southwestfastener.com

Section 10-TERMS USED IN THIS PUBLICATION

Alternate Fuel
A fuel other than gasoline. Most often associated with propane and natural gas.

Bi-fuel
The ability to use two different fuel types at different times on the same engine. Often accomplished by the addition of a venturi type adapter into the air stream of an engine.

High Pressure
A consistently regulated tank pressure typically from 8 to 12 psi with 10 being the average.

Inches of Water Column
The force required to move water in a tube upward one inch. Twenty eight inches of water column is equal to one pound of pressure. One pound of pressure applied to a piece of tubing full of water from below would move the water upwards 28” if measured with a ruler. So 14” WC would be equal to 1/2 PSI.

Low Pressure
One half of one pound of pressure or below often referred to in inches of water column or in ounces.

Ounces
Sixteen ounces of pressure equals one PSI. So eight ounces would be equal to 1/2 PSI.

Tank
A vessel used to hold propane in liquid form and properly fitted with a valve to draw vapor from the top space.

Tank Pressure
Unregulated variable pressure based on ambient temperature.
Tri-fuel
The ability to use three different fuel types at different times on the same engine. Often accomplished by the addition of a venturi type adapter into the air stream of an engine and a low alternate fuel pressure engine regulator.
Vapor
The gas formed by heating a liquid.
Venturi
A tapered constriction added to the air stream of an engine to create a reduction in air pressure that causes a regulator to release fuel.

Final Note.

We hope this guide is useful in helping you decide what fuel is best for you to power your generator. We happy to give this guide away, but due to copyright laws we require that individual copies be optained from our website.

If there is something that you feel was missed and would have liked to be discussed or that you found enjoyable about this guide, please call or e-mail your suggestion. The following numbers and addresses will get you to the right person.

Tech@USCarburetion.com to e-mail your suggestion.
Use GBG2001-ADV in the subject line.
1-800-553-5608
Mention GBG2001-ADV

Thank you and we hope you enjoy using alternate fuel.
Especially propane! The Author

Section 11-CONVERSION PICTURES

Illustration of a Devilbiss generator with a Tecumseh HM100 engine converted to dedicated high pressure propane.

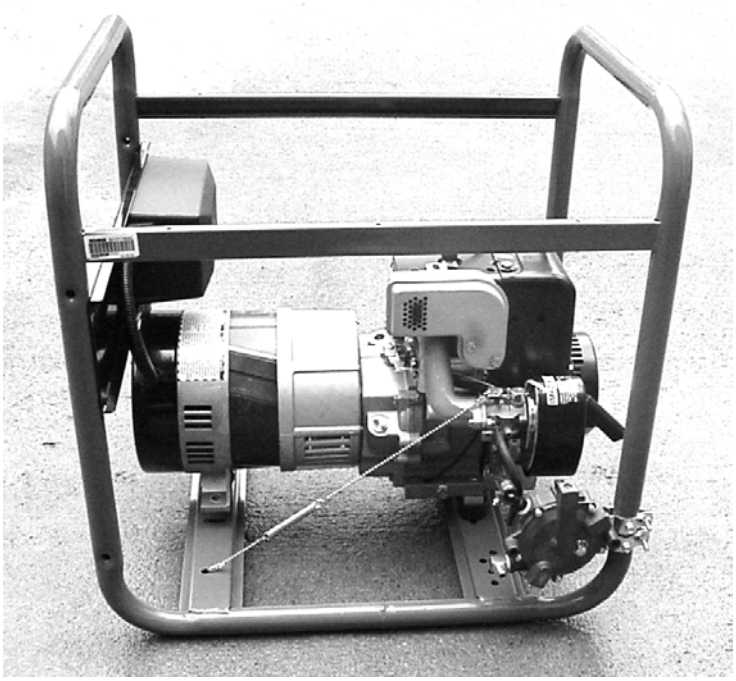


Illustration of a Devilbiss generator with a Tecumseh HM100 engine converted to dedicated natural gas and/or low pressure propane.