# Convert your Honda Accord to run on trash

by **jimmason** on January 4, 2009

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## Intro: Convert your Honda Accord to run on trash

We may not yet have a flux capacitor for time travel, but we do already have the equivalent of "Mr. Fusion", which if cleverly applied, will enable you to run your car on everyday "trash"-- today. This "magical" device is called a gasifier. And what it does is called gasification.

Gasification is the use of heat to tranform solid biomass, or other carbonaceous solids, into a synthetic "natural gas like" flammable fuel. Through gasification, we can convert nearly any solid dry organic matter into a clean burning, carbon neutral, gaseous fuel. Whether starting with wood chips or walnut shells, construction debris or agricultural waste, the end product is a flexible gaseous fuel you can burn in your internal combustion engine, cooking stove, furnace or flamethrower. Or in this case, your DeLorean. Well ok, how about a Honda Accord . . .

Sound impossible?

Did you know that over one million vehicles in Europe ran onboard gasifiers during WWII to make fuel from wood and charcoal, as gasoline and diesel were rationed or otherwise unavailable? Long before there was biodiesel and ethanol, we actually succeeded in a large-scale, alternative fuels redeployment-- and one which curiously used only cellulosic biomass, not the oil and sugar based biofuel sources which famously compete with food.

This redeployment was made possible by the gasification of waste biomass, using simple gasifiers about as complex as a traditional wood stove. These small-scale gasifiers are easily reproduced (and improved) today by DIY enthusiasts using simple hammer and wrench technology.

The goal of this project is to show you how to do it - using tools you can find at Sears!

Here's a video of us driving the finished Honda Accord around West Oakland - and over to Sears in downtown to pick up some more tools! Fire was kept only in the gasifier. And everyone made it home with smiles on their faces.


This is a really big project! We split the project into several Instructables to make it easier to understand.

- This instructable explains how to retrofit a Honda Accord (or nearly any car) with our Open Source Gasifier Experimenter's Kit (GEK) to power it. In this project we cover modifications to the standard GEK Gasifier that are needed, details specific to its installation into the Honda, and modifications to the Honda itself. All standard GEK Gasifier construction and operation details are covered in the sub-projects below.
- Check the Building the GEK Instructable to learn how to fabricate the standard GEK gasifier vessels.
- Check the Assembling the GEK Instructable to learn how to assemble the GEK vessels into a working GEK Gasifier
- Check the Running the GEK Instructable to learn how to start and operate the GEK to produce syngas.
- For more info and extra pictures about this project, see the main GEK site at: http://www.allpowerlabs.org/gasification/gek/index.html
- For general information on how gasification works, see: http://en.wikipedia.org/wiki/Gasification
- To learn about ALL Power Labs, the group that created the Trash Powered Honda and the Open Source Gasifier Experimenter's Kit, check our website: ALL Power Labs
- Inspired? Check out our No Petroleum Allowed Road Rally, the Escape From Berkeley.



**Image Notes**
1. We're off on yet another tool and supplies run!


## step 1: The Goal: Honda + Gasifier

We developed the open source Gasifier Experimenter's Kit as a flexible-fuel biomass processor to produce a gaseous fuel (syngas). The syngas produced by our GEK can be used to power generators, heaters and motors (nearly anything that could be run on propane), so we decided to build a concept car powered by our GEK unit.

How does that work?

In a normal car, liquid gasoline is injected into the cylinders while air is sucked in to burn it. The GEK produces a syngas fuel not a liquid - similar to natural gas. So we can't just dump it into the gas tank and run the engine as usual.

What we'll do is to disable the Honda's gasoline fuel injectors and route our syngas in through the engine's air intake. We'll install a somewhat modified version of our standard GEK unit into the trunk area, with a fuel tube going up to the Honda engine in front.

The only modification to the Honda engine is that we disable the fuel injectors, and tee the air intake to allow pulling in our syngas along with the air. In fact, the Honda engine still can be run on gasoline when we are finished - all that's needed is to flip a switch to re-enable the fuel injectors.

Easier said than done! Read on to see how to do it . . . maybe . . .


**Image Notes**
1. standard Honda Accord, assembled

## step 2: Tools and Parts

The vehicle was built at the ALL Power Labs shop. We've got a lot of fun tools, but you could build this project with just power tools you'd find at Sears. I'll note what your alternatives are below.

Tools we used:

- Power tools - we used all of 'em! drill, grinder, reciprocating saw, flashlight, belt sander, circular saw, etc.
- Socket set, wrench set, vice grips, etc.
- MIG welder, plasma cutter (hand and CNC). All you really need is MIG and a cutting torch, the rest of it was us just getting fancy. You could also use a reciprocating saw with metal cutting blade instead of a cutting torch, although that would take a bit longer.
- Bench chop saw with metal cutting blade is helpful but not required
- Sheet metal cutters, benders, rollers. This is because we fabricated entirely from sheet steel. To avoid the bending and rolling the easy thing is to start with a recycled metal tank as described in step 5.
- Car jack. We've got the fancy garage type lifter, but any car jack will do.
- Shop vac to clean up spilled fuel messes, and clean out reactor
- For the electronics - soldering tools, wire strippers, crimper

Parts:

The complete GEK Gasifier is designed so that it can be constructed from the lowest cost and most commonly available parts. It is nearly all common sheet steel and plumbing parts. The Honda conversion also does not use any expensive or hard to find components - total raw material and parts cost for this project is probably about $1000 if you build everything yourself.

- You need to supply a working vehicle. We used a 1987 Honda Accord, but most cars should be ok
- Our GEK Gasifier kit. We supply CAD files so you can fabricate totally from scratch, or you can purchase parts kits from us at various stages of assembly. Fabrication and/or assembly of the GEK using our plans or kits is detailed in our Instructables Series.
- Miscellaneous plumbing pipes, tubes and ball valves
- Sheet steel and a few square steel rods
- Miscellaneous nuts and bolts
- Reactor Control Unit (parts kit available soon from ALL Power Labs)
- I'm sure I forgot something :)

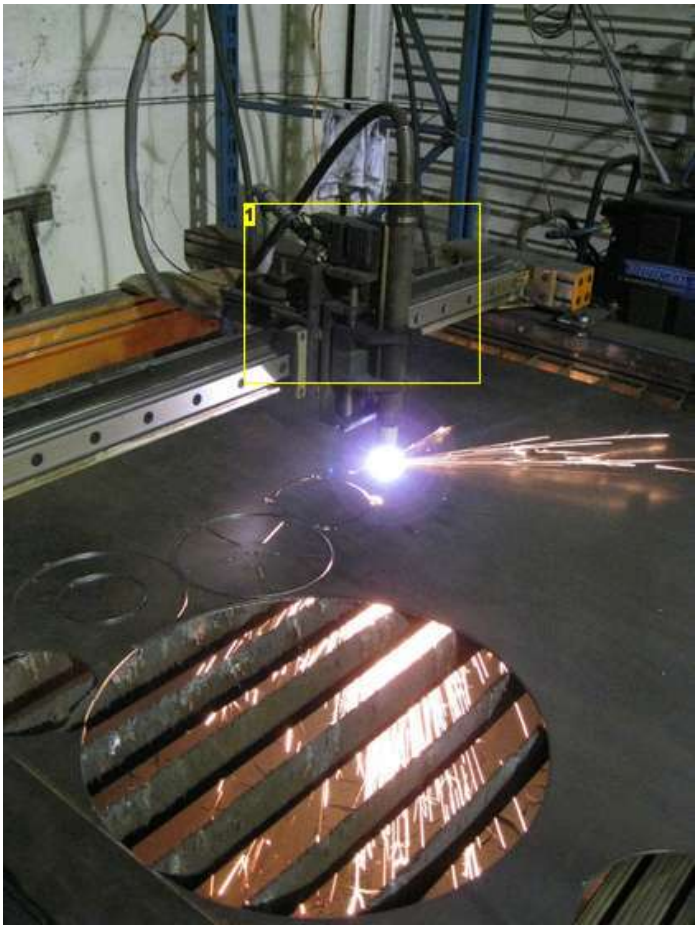



**Image Notes**
1. CNC Plasma Cutter - Our favorite toy! You could make do with a cutting torch...


**Image Notes**
1. not required, but very convenient!
2. MIG setups
3. MIG


**Image Notes**

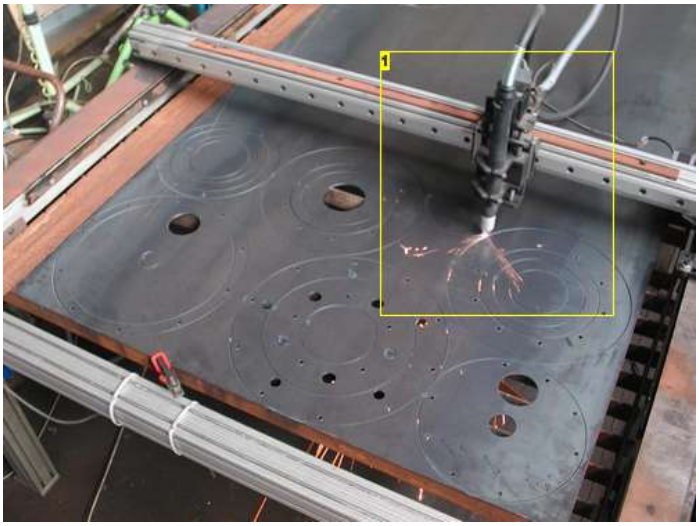



**Image Notes**

1. hopper
2. hopper
3. auger motor (not used)
4. reactor core
5. housing
6. not required, but really convenient

1. CNC plasma cutter

## step 3: Safety

There are a lot of potential dangers with this project.

We recommend you always have a responsible adult present when building your Trash Powered Honda.

- Cars are big! Heavy! And have lots of moving parts that can squash or grind you up!
- Gasifiers produce gases which are very good for engines, but very bad for humans. Thus please remember the following whenever you run a gasifer

Warning: A gasifier is a dangerous thermo-chemical device. Like most useful tools, it will do damage if used incorrectly. A gasifier purposely generates carbon monoxide and other dangerous volatile organic gases as an interim step before complete combustion of the gas in a flare or engine. Acute exposure to carbon monoxide can be harmful or fatal. It is colorless, odorless, and will quickly colonize your hemoglobin, leaving no sites left for oxygen to land. Exposure to other VOCs is similarly problematic. In short, it is somewhat like smoking cigarettes, just exponentially worse. In fact, a cigarette is an updraft gasifier, a close cousin to what you are building in steel with the GEK

So dont be an idiot. Don't smoke. And certainly don't smoke the equivalent of 100 cigarettes simultaneously by breathing in any leaking gas from your GEK. Always use a gasifier outdoors, and with extensive ventilation. Always stay out of the smoke and/or produced gas before it is combusted. Know that this is NOT typical campfire smoke. Do NOT treat it as if it were. The carbon monoxide concentrations in gasifier gas are higher than in other "smokes". You can get in trouble quickly, usually before you realize it. SO STAY OUT OF GASIFIER GAS AT ALL TIMES.

Always have a fast reacting carbon monoxide meter in the area where you are working. Ideally, hang one on a tether around your neck. Carbon monoxide meters are available at more hardware stores in the smoke detector section.

And remember that with just one extra oxygen, CO becomes CO2. It is a very easy oxidation pathway, thus why syngas burns so cleanly.

Anyone have a Prius we can challenge at the smog shop?

## step 4: History, Theory and Overview

The GEK gasifier design is based on a nozzle and constriction (Imbert type) downdraft reactor. This was the typical gasifier reactor type of WWII, and still the usual starting point for generating low tar wood gas to power internal combustion engines. The GEK design combines all common Imbert type variations into a single configurable reactor, with easy adjustability of all critical dimensions. Gasifier geeks will swoon to know that it supports:

- variable combustion / reduction zone size and shape (tube, bell, inverted V, hourglass)
- variable air nozzle position and size
- air preheating (or lack there of)
- active tar recycling into incoming air
- variable air injection architecture (air from top, bottom, or side annular ring)
- "monorator" type condensing hopper
- rotary grates/stirrer additions

The GEK Imbert reactor standard sizing and configuration is known to produce clean syngas when operated by a knowledgeable enthusiast. This default configuration will run 5-20hp engines. We've expanded the internal sizes for the Honda Accord project so it can support the 70HP or so Honda engine.

The graphics below show the usual components for a full gasification system: Gasifier, cyclone, filter, radiator, fan, burner. The GEK improves on the 60 year old standard a bit, which we will explore in more detail in the Fabricating the GEK Instrucable

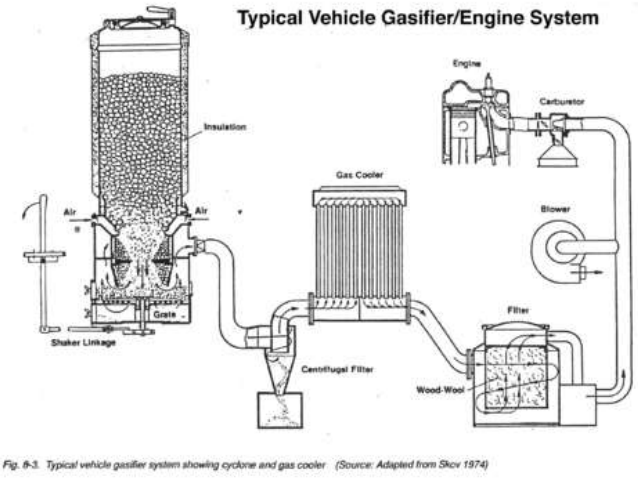



*Fig. 8-3. Typical vehicle gasifier system showing cyclone and gas cooler. (Source: Adapted from Skov 1974)*

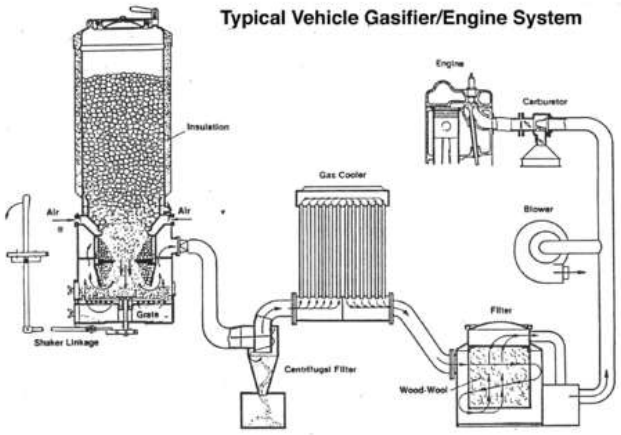
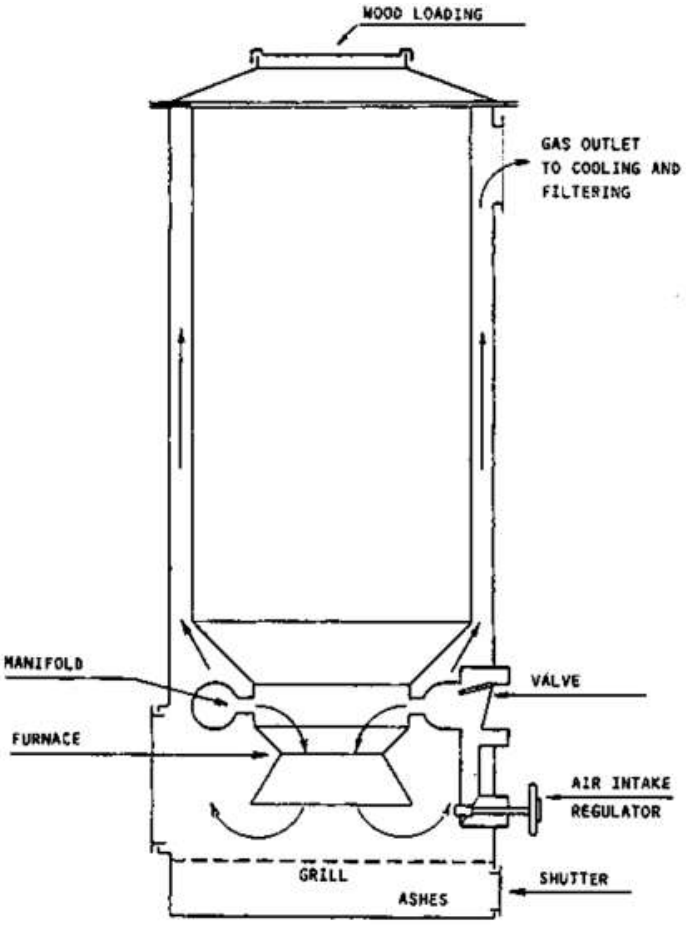
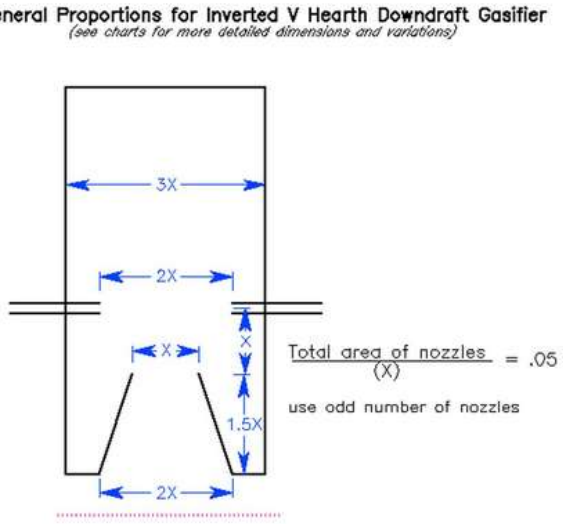



*Fig. 8-3. Typical vehicle gasifier system showing cyclone and gas cooler (Source: Adapted from Skov 1974)*

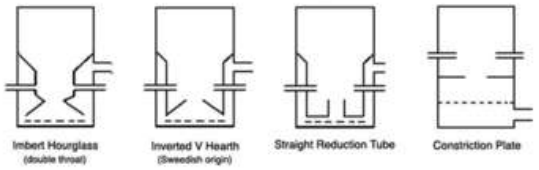


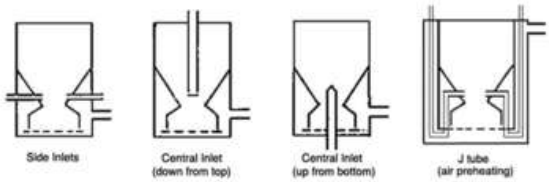

*ALL Power Labs June 16, 2008*

## Downdraft Gasifier Types

Nozzzle and Constriction Closed Top Designs (aka: Imbert type)




Air Inlet Variations
(shown with Imbert Hourglass single throat type)




Open Core Designs

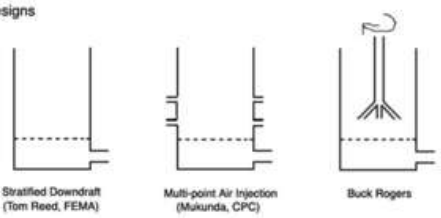
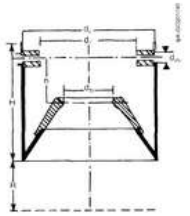



**Table 5-2. Imbert Nozzle and Hearth Diameters**

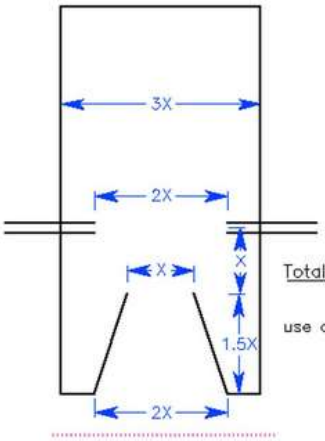
| $d_t/d_h$ | $d_h$ mm | $d_t$ mm | $d_r$ mm | h mm | H mm | R mm | A No. | $d_m$ mm | $\frac{A_m \times 100}{A_h}$ | $\frac{d_t}{d_h}$ | $\frac{h}{d_h}$ | Range of Gas Output max. $Nm^3/h$ | Range of Gas Output min. $Nm^3/h$ | Maximum Wood Consumption kg/h | Air Blast Velocity Vm m/s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 268/60 | 60 | 268 | 150 | 80 | 256 | 100 | 5 | 7.5 | 7.8 | 4.5 | 1.33 | 30 | 4 | 14 | 22.4 |
| 268/80 | 80 | 268 | 176 | 96 | 256 | 100 | 5 | 9.0 | 6.4 | 3.3 | 1.19 | 44 | 5 | 21 | 23.0 |
| 268/100 | 100 | 268 | 202 | 100 | 256 | 100 | 5 | 10.5 | 5.5 | 2.7 | 1.00 | 63 | 8 | 30 | 24.2 |
| 268/120 | 120 | 268 | 216 | 110 | 256 | 100 | 5 | 12.0 | 5.0 | 2.2 | 0.92 | 90 | 12 | 42 | 26.0 |
| 300/100 | 100 | 300 | 208 | 100 | 275 | 115 | 5 | 10.5 | 5.5 | 3.0 | 1.00 | 77 | 10 | 36 | 29.4 |
| 300/115 | 115 | 300 | 228 | 105 | 275 | 115 | 5 | 11.5 | 5.0 | 2.6 | 0.92 | 95 | 12 | 45 | 30.3 |
| 300/130 | 130 | 300 | 248 | 110 | 275 | 115 | 5 | 12.5 | 4.6 | 2.3 | 0.85 | 115 | 15 | 55 | 31.5 |
| 300/150 | 150 | 300 | 258 | 120 | 275 | 115 | 5 | 14.0 | 4.4 | 2.0 | 0.80 | 140 | 18 | 67 | 30.0 |
| 400/130 | 130 | 400 | 258 | 110 | 370 | 155 | 7 | 10.5 | 4.6 | 3.1 | 0.85 | 120 | 17 | 57 | 32.6 |
| 400/150 | 135 | 400 | 258 | 120 | 370 | 155 | 7 | 12.0 | 4.5 | 2.7 | 0.80 | 150 | 21 | 71 | 32.6 |
| 400/175 | 175 | 400 | 308 | 130 | 370 | 155 | 7 | 13.5 | 4.2 | 2.3 | 0.74 | 190 | 26 | 90 | 31.4 |
| 400/200 | 200 | 400 | 318 | 145 | 370 | 153 | 7 | 16.0 | 3.9 | 2.0 | 0.73 | 230 | 33 | 110 | 31.2 |

Variables not given in figure are defined as follows:
$d_m$ = inner diameter of the tuyere.
$A_m$ = sum of cross sectional areas of the air jet openings in the tuyeres.
$A_h$ = cross sectional area of the throat.
A = number of tuyeres.
Source: Kaupp 1984a, Table 5, Fig. 75.



## General Proportions for Inverted V Hearth Downdraft Gasifier

*(see charts for more detailed dimensions and variations)*




$$\frac{\text{Total area of nozzles}}{(X)} = .05$$

use odd number of nozzles

*ALL Power Labs June 16, 2008*

## step 5: Different ways to make the GEK

The GEK building scenario let's you decide the relative amount of "effort vs cost" you want to invest towards your finished unit. The basic vessel dimensions are based on common scrap tanks found in North America, so you can choose to build it for minimum money with the dimensions, instructions and CAD files provided here. The local junkyard will give you all the greasy obtainium scrap tanks you need. Or you can build the GEK from clean and purpose cut sheetmetal, also using the CAD files provided here.

For the obtainium route, you will need scrap tanks of 10", 12" and 14.75" diameters. 10" is typical for hand held air transfer tanks and some truck pony tanks. 12" is typical for 5 and 10 gal propane tanks. 14.75" is typical for a 100lb/25gal propane tank. (Warning: There's a surprising amount dimensional variation on "standardized tanks" between different tank manufacturers. This can complicate the fit of flanges and end plates to the scrap tanks.)

The more elegant way to build the GEK is from purposed cut and rolled sheetmetal. Sheet metal is still very inexpensive, and you will have better dimensional control than via the obtainium route.

You can cut the sheetmetal to make the vessel tubes, flanges and end plates, using a gas torch or plasma cutter. Potentially even a sawzall, but ugh! Ideally, the tool for the task is CNC plasma cutter, which can run off the CAD files provided here. Many "manufacturing on demand" providers offer cnc plasma cutting services, so you could order in perfectly cut sheet metal to get you started, and not spend all your enthusiasm fighting the prep work. ALL Power Labs can also provide readymade sheet metal and plumbing kits. See here for more information about readymade kits .

Hopefully one of the above scenarios will find a good match with your abilities, time and money available. Whichever route you choose to build the GEK, the final unit is the same, and thus experiments and customizations are easily sharable across the GEK user community.


**Image Notes**
1. scrap tanks are a convenient source for the GEK Gasifier cowlings


**Image Notes**
1. You can also use the GEK as a top-hat. Very stylish!


**Image Notes**
1. GEK got your arm??

## step 6: Fabricating the basic GEK

The standard GEK gasifier system consists of the following seven components. For the Honda GEK we made a few slight changes to the standard GEK design which are noted below (and detailed in later steps here).

Gas making:
1. Gas cowling and ash grate (for honda - cowling built into box, grate has motor mount)
2. Downdraft reactor (for honda: larger reduction bell)
3. Fuel hopper (for honda: shaped to fit behind rear window)

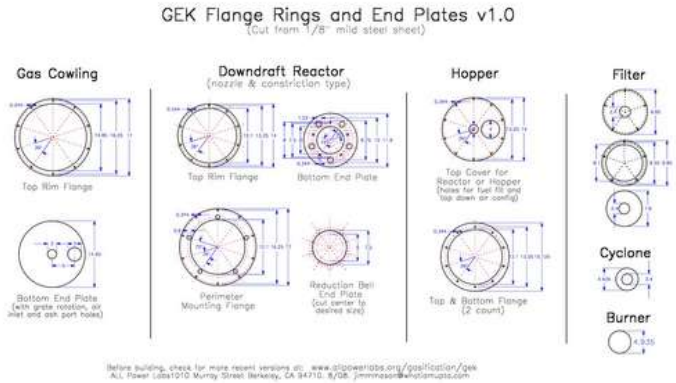
Particulate clean-up:
4. Cyclone (no change)
5. Packed bed filter (no change)

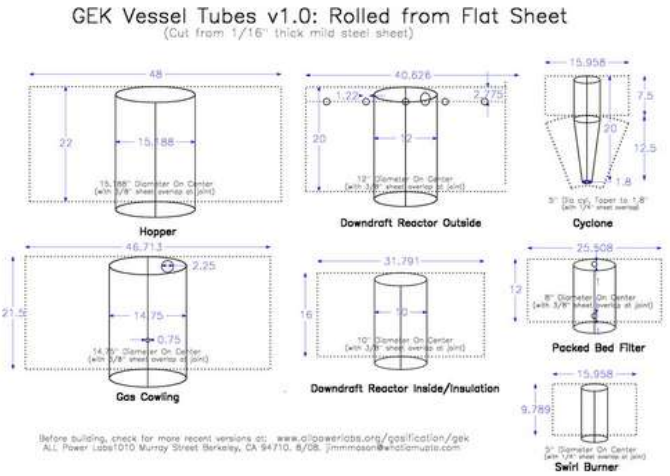
Gas combustion:
6. Centrifugal vac/blower (no change)
7. Swirl burner (no change)

We will be building each of these components separately in a "slight detour Instructable " dedicated to the welding project. After we're finished, we'll return right here to consider the final assembly and preparation for the first test run.

CAD drawings for all the sheet metal parts and assembled vessels are below, as well as on the download page of the main GEK site at:
http://www.allpowerlabs.org/gasification/gek/downloads.html

And now, get you MIG welders ready, its time to fabricate your GEK . . .




## step 7: Assembling the GEK and preparing for fire

With basic GEK welding complete, now we can assemble and prepare for fire. No Honda is required for this. When you are finished assembling your basic (or modified) GEK, it will look like one of these .

Well, you might have to apply a bit of paint first. You are welcome to paint your GEK in any manner you like. Though we do suggest you use high temp paint commonly found at any auto store. The 500F paint is fine. You do not need the 1200F paint

Once your paint is dry, there are seven components we'll be assembling, just like there were seven components we just welded together:

- Gas Cowling
- Downdraft Reactor Insert
- Cyclone
- Pack Bed Filter
- Axial Fan
- Swirl Burner
- Fuel Hopper

For the standard GEK: the gas cowling, reactor and hopper bolt together into a single vertical assembly. The cyclone, packed bed filter and blower similarly bolt together into a single vertical assembly. These two assemblies attach together via the gas outlet flange to the cyclone. A soft hose attaches the blower to the swirl burner. And then, fire!

The details of how to accomplish this require another "slight Instructable detour ", though we promise not to send you through the ringers of previous. You're now through the hard part. It's all downhill coasting from here to 88MPH.

Click here for the GEK final assembly and first firing preparation instructable.


**Image Notes**
1. apply seal strip

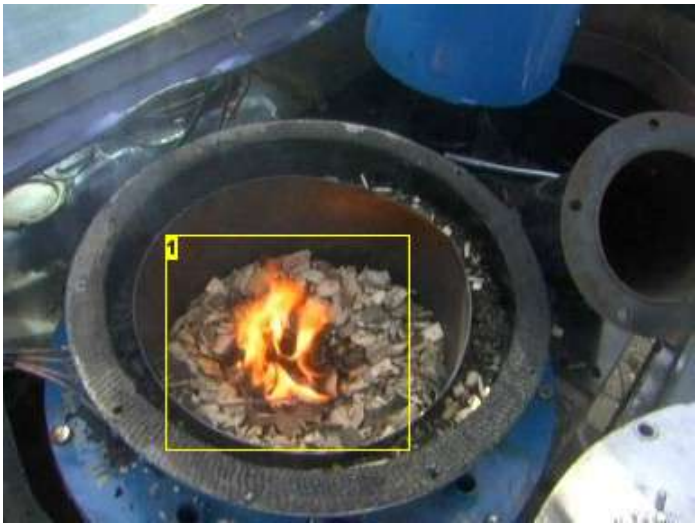



**Image Notes**
1. initial combustion start with a bit of lighter fluid


**Image Notes**
1. burning the output syngas

## step 8: Proof of concept testing: first fire

With the GEK now together, we hooked it up to a prototype of our electronic Reactor Control Unit (described later) and ran the output to a 2kw 4-stroke generator. This was to simulate more or less what we were planning for the Honda. Somewhat surprisingly, it worked!

CLICK TO PLAY VIDEO

Here's the separate Instructible for how to start and run a GEK design gasifier start and run a GEK design gasifier.

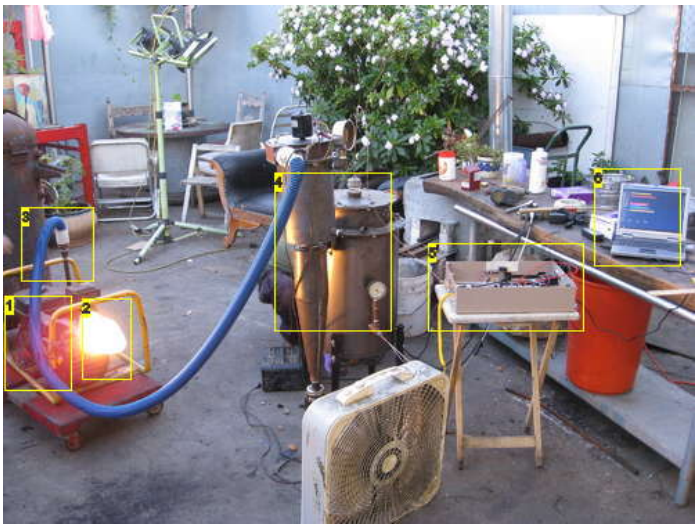



**Image Notes**
1. 2kw 4-stroke generator
2. 100 watt bulb powered by generator
3. syngas tube into the generator intake
4. GEK Gasifier
5. prototype of our Reactor Control Unit
6. laptop for sensor data display from RCU


**Image Notes**
1. burning the output syngas

## step 9: Prep the Honda Trunk Mount

The trunk of the Honda seemed like a good spot to put the GEK!

1) Cut out the trunk floor along the inside of the frame struts

2) Remove the trunk hatch

3) Fabricate 2 heavy duty mounting pins. The mount system allows rotating the mounted GEK for access, then pinning in place during driving.

4) Weld / bolt the mounting pins to the frame struts


**Image Notes**
1. trunk area with floor removed


**Image Notes**
1. frame strut
2. GEK will mount to this pin, and 2nd one on the opposite side

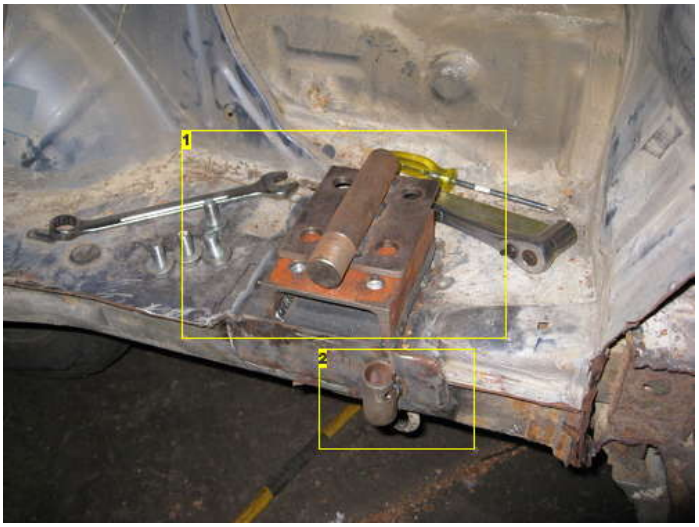



**Image Notes**

1. mount pin allows rotation of the gasifier
2. a sliding pin fits here, without the pin we can rotate the GEK for maintenance, then put in the pin to lock in place for driving

## step 10: Fabricate a frame for the gasifier

When we started out, we were going to get a bit fancy and have a hopper alongside the GEK to hold the fuel. This would be great because the GEK heat would help dry the fuel in the hopper, and the form factor would be more compact. Unfortunately - the alongside hopper requires an auger to move the fuel up and over into the GEK reactor, and this auger proved to be a difficult piece of engineering. So you'll see parts of the hopper with auger bits in them, but ultimately we have not yet gotten the auger fully functioning, and it is not needed with a much simpler over-head hopper.

The hopper box frame is sized to hold the GEK, and to fit into the trunk opening in the honda.

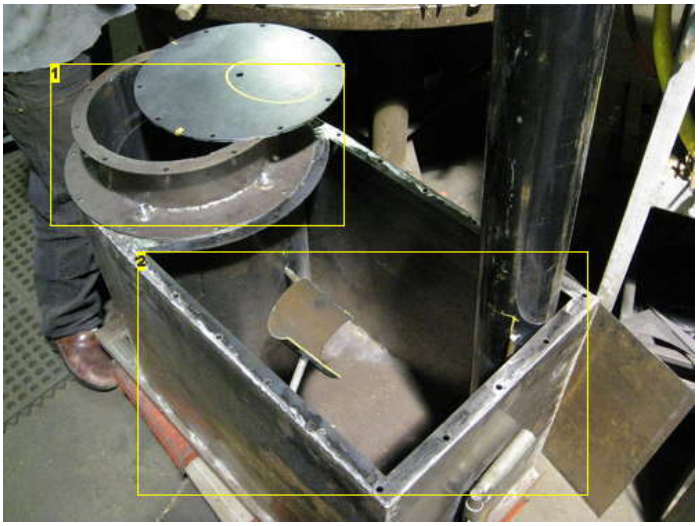



**Image Notes**
1. standard GEK internals
2. side-by-side hopper

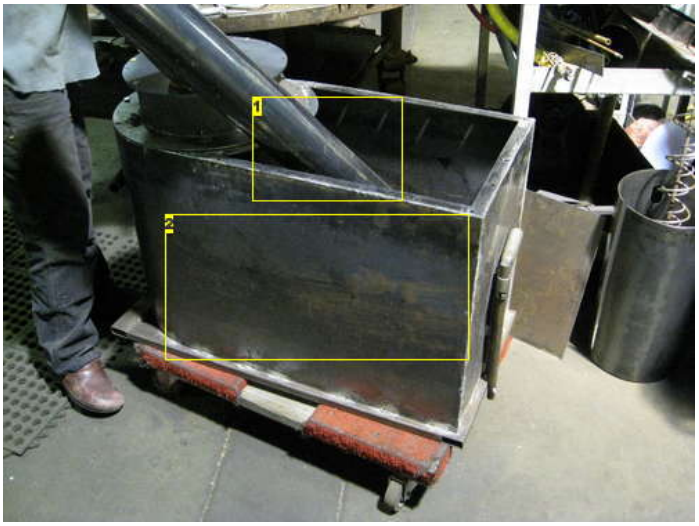



**Image Notes**
1. this is the auger tube
2. hopper frame

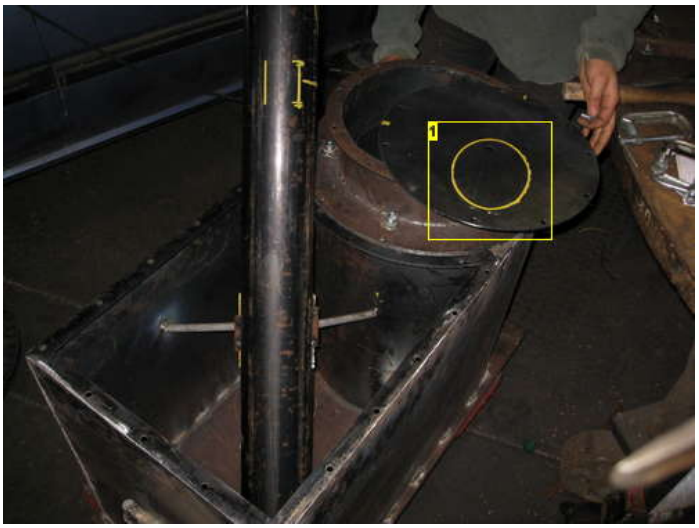




**Image Notes**
1. welding prep marks

**Image Notes**
1. MIG master rebecca


**Image Notes**
1. mounting block and lock-down peg

## step 11: Install the cyclone

We started with the standard GEK cyclone, and fitted it into the hopper/box as well.

In the photos here we also dropped the box into the car. Actually to be more accurate, we dropped the car onto the box using a car jack, the box just sat in place.


**Image Notes**
1. standard GEK cyclone, the condensate catch at the bottom is just shaped a bit differently.
2. this handle locks/unlocks the gek into the rotating pin mounts

## step 12: Install the grate, jigglerator, and dump ports

- At the bottom of the GEK cowling is the standard GEK ash grate for holding up the fuel in the gas producing reduction zone, and allowing ash to filter out the catch basin. In a standard GEK the grate has an external bar for turning by hand.

- We connected the grate drive shaft to a windshield wiper motor mounted to the bottom of the box, so that it can be turned automatically. We call it the JIGGLERATOR. although we do love its name, testing of the vehicle showed that at least in city driving, the car bumps around enough by itself to unclog any fuel jams.

- Also on the bottom are dump ports for ash and water condensate from the output syngas.

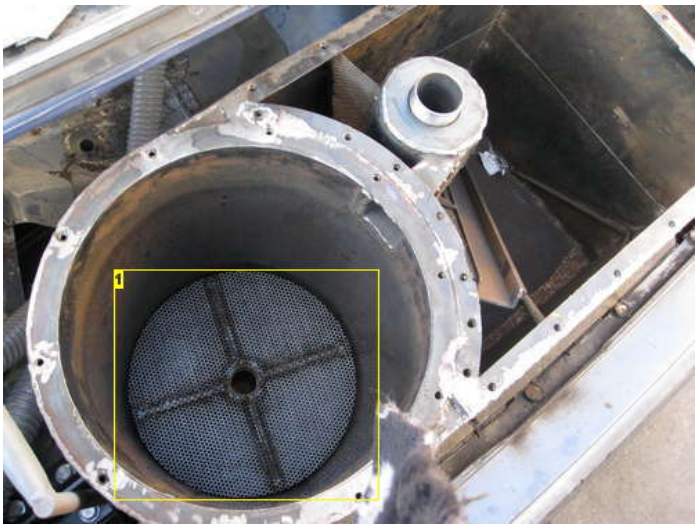



**Image Notes**
1. grate installed into cowling

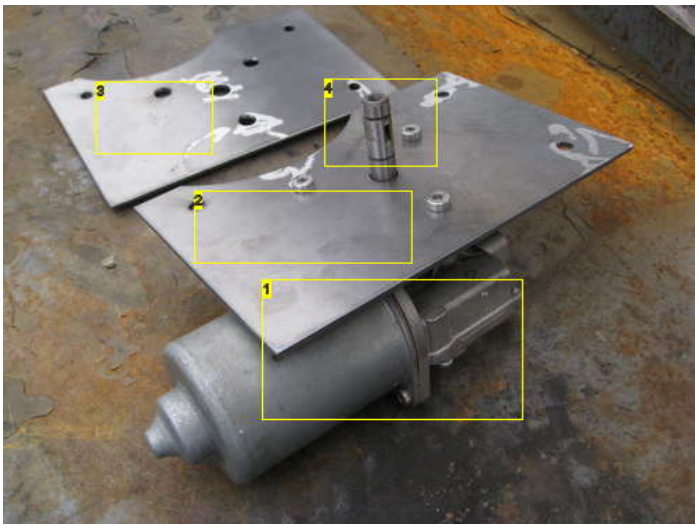



**Image Notes**
1. windshield wiper moter
2. plate 1
3. plate 2 - with holes to fit the screw heads
4. drive shaft for the grate

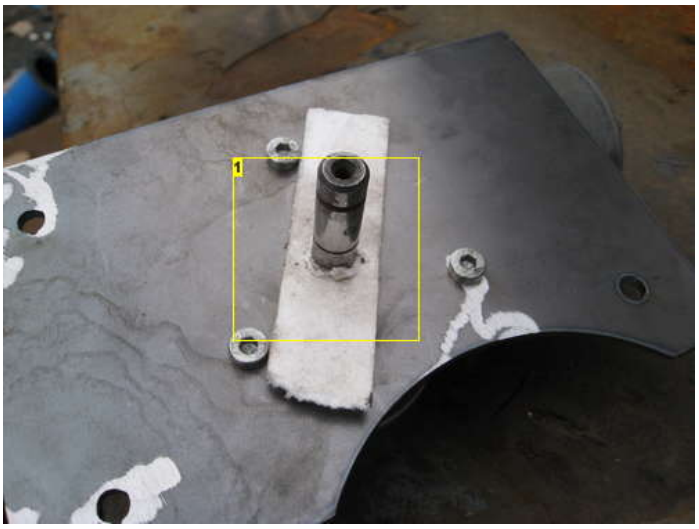



**Image Notes**
1. the gek cowling must be airtight, so we used this high-temp fiber as a bearing/airlock


**Image Notes**
1. 2nd plate stacked on top, its all flush now

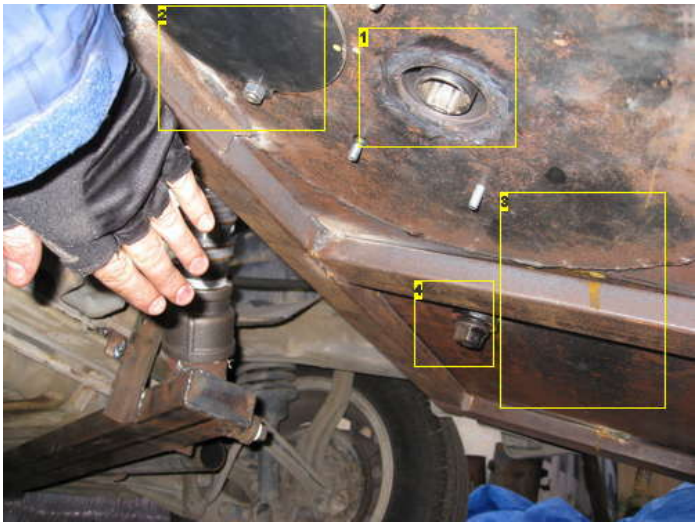



**Image Notes**

1. drive socket for the grate. its quite literally a hex socket that we welded to the grate drive shaft
2. access plate for dumping ash
3. bottom of GEK hopper/box
4. tar dump port at bottom of cyclone catch

## step 13: Air Intake With Butterfly Valve

The syngas and air are both going into the Honda engine via the original air intake. That means the Honda engine can no longer control its own fuel/air mix. We built a new air intake with a butterfly valve so that we can control the fuel to air mix ratio.

The fuel to air mix needs adjustment while the car is driving, so we added a servo control which can be operated from the driver seat.

- The new airtake starts with a length of 2" diameter PVC pipe.

- The butterfly valve is a fender washer that matched the ID of the pipe.

- The fender washer is screwed to a 1/4" diameter aluminum rod

- The aluminum rod goes through 2 holes drilled across the pipe

- The servo turns the rod to open and close the valve.

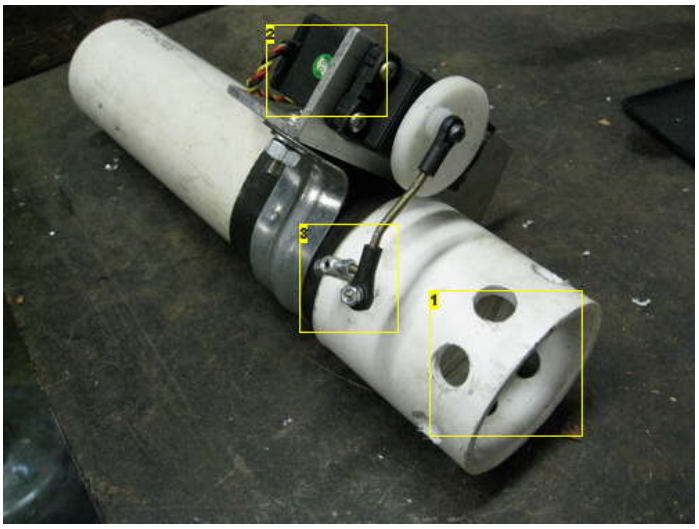



**Image Notes**
1. open end of air intake
2. standard high power hobby servo
3. set up the control linkage so that the servo can go end-to-end without bending anything.


**Image Notes**
1. valve closed. fill the center hole also.

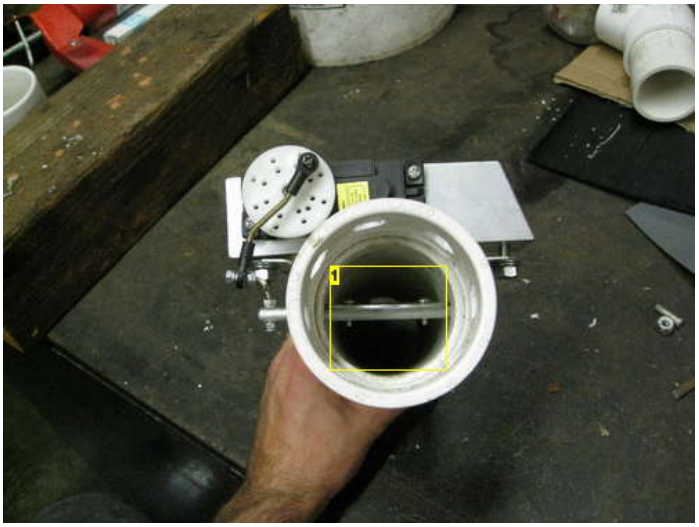



**Image Notes**
1. valve open

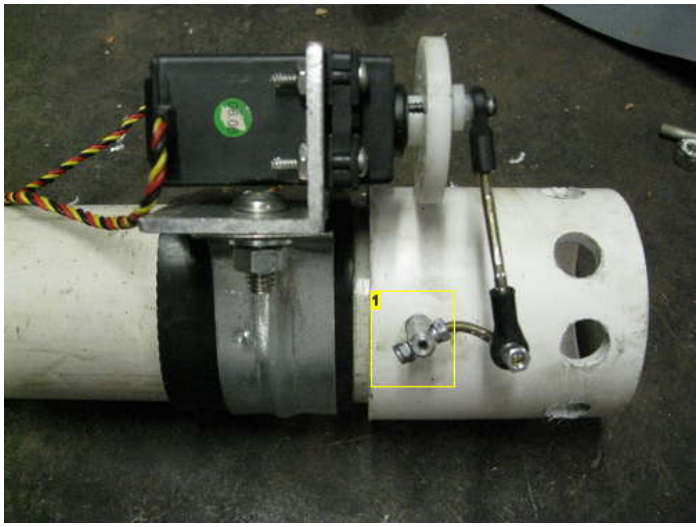



**Image Notes**
1. valve rod goes through center of pipe

## step 14: Syngas Piping from gasifier in back to engine in front

- Chop off the end of the air intake tube from the Honda

- Add a coupler and tee

- The syngas is routed to the back of the car - using flexible tubes in front and in the rear, underneath the car we made a rectangular steel tube for strength. See photo notes.

- Our custom servo controlled butterfly valve is installed as the new air intake. The valve lets us control the fuel to air mix now that both are going into the original air intake.

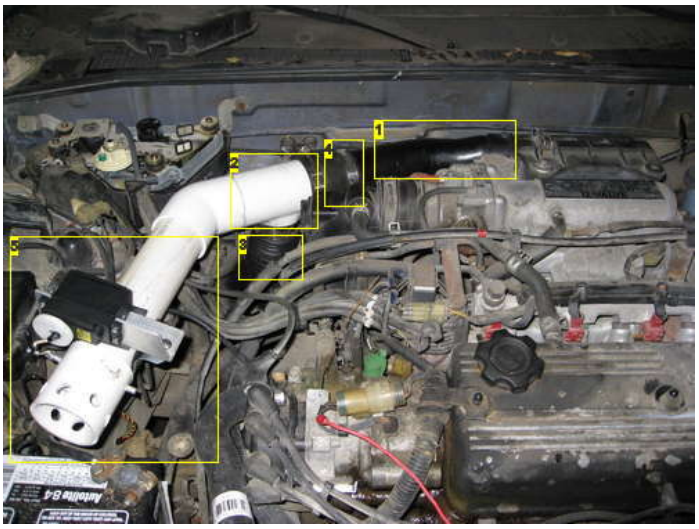



**Image Notes**
1. air intake from Honda
2. add a TEE
3. syngas tube goes to back of car
4. rubber coupler
5. our new air intake with servo-controlled butterfly valve


**Image Notes**
1. syngas tube goes to back of car

**Image Notes**
1. the syngas tube on the bottom of the engine - it connects to a metal pipe that runs the length of the underbody

**Image Notes**
1. syngas tube goes up to the GEK output port
2. steel syngas tube goes from back to front of the car
3. GEK box
4. right rear tire

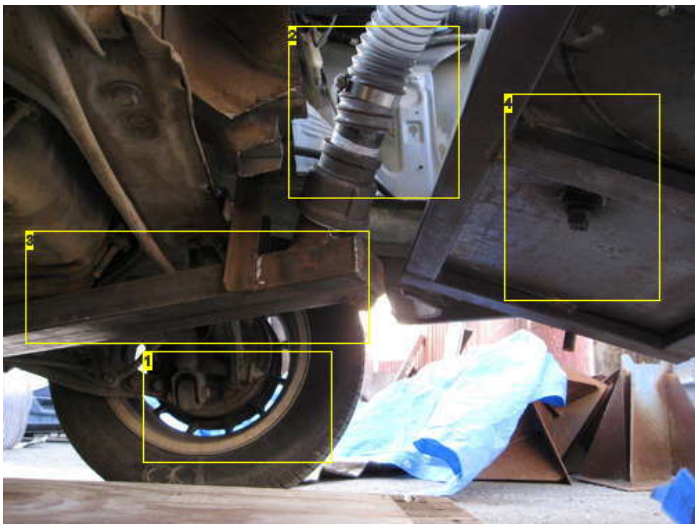


**Image Notes**
1. right rear wheel
2. syngas tube going to GEK output
3. front to rear steel syngas tube
4. GEK box

## step 15: Solid Fuel Auger - Not Used In Current Design

Originally we wanted to have the hopper alongside the GEK reactor to hold the biomass fuel. It had the advantage of a more compact form factor, plus the GEK heat could help dry the fuel to allow using wetter fuels. But, it requires a way to transport the solid biomass fuel up and over to load the GEK reactor

We built several solid fuel augers, but soon discovered that it is a difficult engineering problem when you want to run an auger up from horizontal, or in our case, about 45 degrees. We currently run the vehicle with the typical top-mounted gravity-fed GEK hopper, which is simple and reliable. We hope to get the auger working eventually but for now you can refer to our prototypes and hopefully learn something about all the ways that auger can *not* work.

We built and tested 2 different auger designs. Generally, they would work for certain fuel size and shape, but when the particulars changed, they would either jam or fail to move/lift the fuel. The GEK reactor will run on a wide range of solid biomass as long as it is chipped or chopped into chunky bits from about 3/8" to 1.5". All diagnoal designs we tested were much more fuel sensitive than the gasifier itself.

Here's a video of one of them running:

CLICK TO PLAY VIDEO

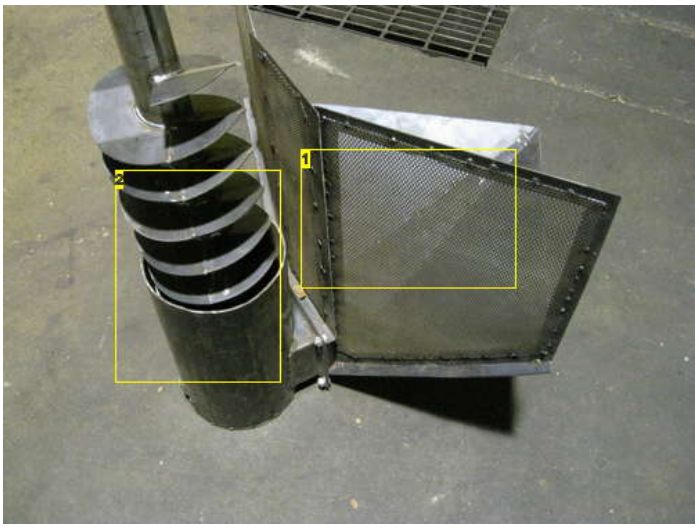



**Image Notes**
1. this part feeds the fuel into the bottom of the auger by gravity
2. auger design #1

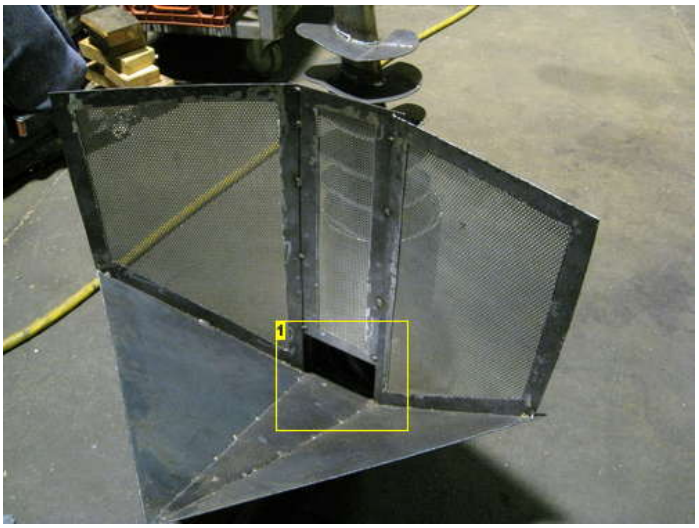



**Image Notes**
1. fuel goes in. or not. depending on whether its your lucky day.

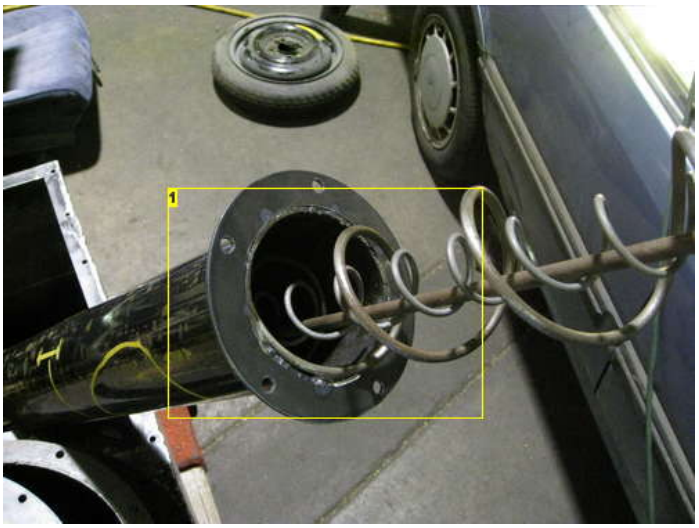
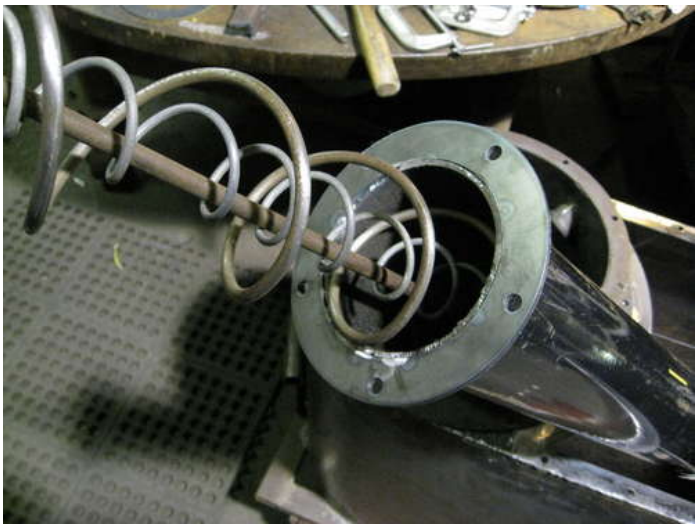



**Image Notes**
1. auger design #2



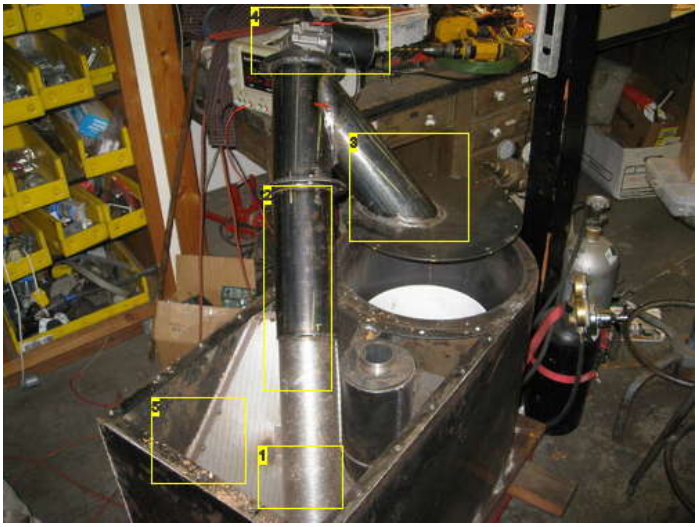



**Image Notes**
1. fuel enters at this end
2. auger moves fuel up this tube
3. fuel drops down this tube into open maw of GEK reactor
4. auger motor
5. load solid biomass fuel in here

## step 16: GEK Reactor Modifications and Instrumentation

We made a few changes to the basic GEK reactor design:

- Increased the size of the reduction bell, this increases power output compared to the standard GEK design, which was needed to produce syngas fast enough for the Honda engine

- Added instrumentation - 4 thermocouples and 2 pressure sensors. These aren't really needed for operation, but we built this as a research design so we like to know what is going on inside.

See the photos for how we routed the thermocouples into the GEK so that they are durable and don't interfere with operation.

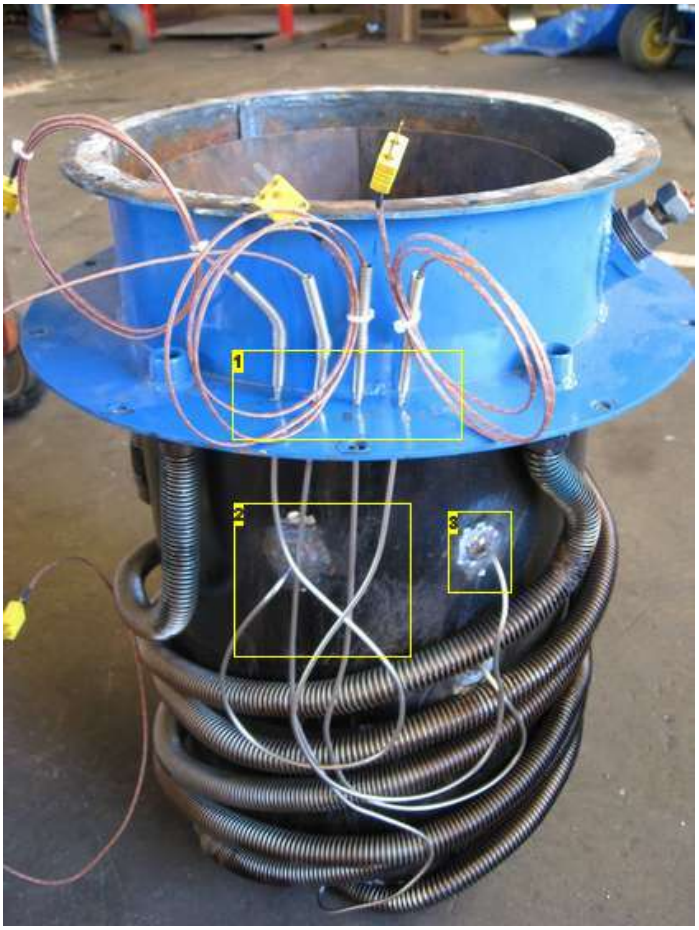


**Image Notes**
1. thermocouples enter the sealed portion of the reactor here. seal this off with silicone glue
2. bendable 1/8" stainless clad thermocouples from Omega, about $25 each.
3. 1/4" stainless tube welded through the cowling walls, thermocouple goes through the tube. high temp furnace cement seals the hole

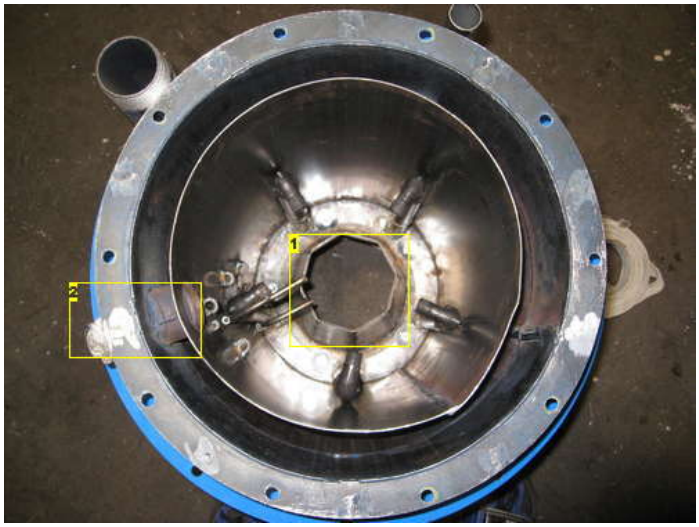
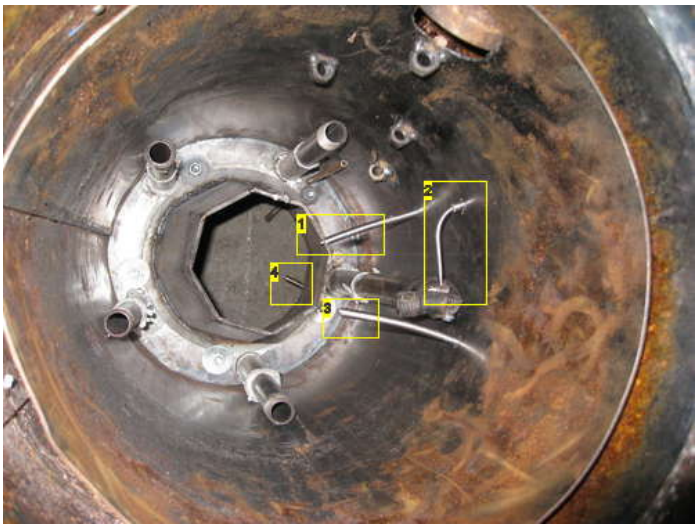


**Image Notes**
1. larger reduction bell than the standard GEK
2. we didn't end up using this port



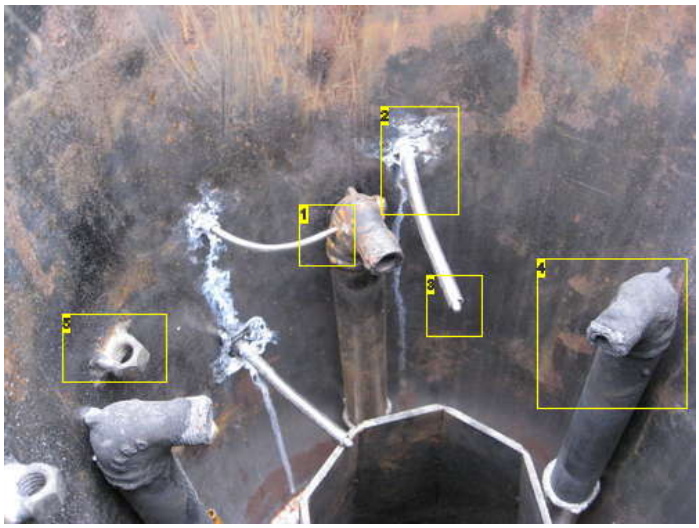


**Image Notes**
1. thermocouple to top of reduction bell.
2. thermocouple with tip fed into the air intake
3. thermocouple tip at height of the air intake (top of combustion zone)
4. thermocouple at bottom of reduction bell

**Image Notes**
1. drilled a hole into the air intake and inserted thermocouple
2. 1/4" stainless tubing welded through the GEK wall, the thermocouple itself is 1/8" stainless and feeds through the tube.
3. tip of thermocouple just pokes out
4. standard GEK air intakes
5. didn't use this


**Image Notes**
1. finished reactor - standard GEK with the small changes we noted

## step 17: Reactor Control Unit (RCU) - aka "THE BRAIN 2"

Any modern car has an Electronic Control Unit, or ECU, which monitors and controls the engine function and keeps everything working. It is often called the Brain of the car. One of the Honda ECU's main functions is to properly inject gasoline into the engine, and monitor the fuel/air mix. Since we are doing some Serious Monkeying Around with both of those pathways in order to replace the gasoline with our Gasifier produced syngas, we built our own Reactor Control Unit (RCU) - also known as THE BRAIN 2.

The RCU taps into the Honda ECU to bypass its control of the fuel injectors and fuel/air mix. It also has several other functions:

- Sense if the fuel mix is lean or rich. We use the existing oxygen sensor from the Honda and access it where it connects to the Honda ECU (Honda's stock ECU is their brain for running the car).

- Control our new fuel/air mix butterfly valve. We drive a servo from a dial mounted on the dash. We also have a switch on the dash that can toggle between Manual fuel/air mix control, and Automatic fuel/air mix control. In Auto mode our RCU uses a closed-loop feedback to automatically adjust the air/fuel mix, just like the Honda ECU does when running on gasoline.

- A control for the grate jigglerator motor (fuel unclogging system)

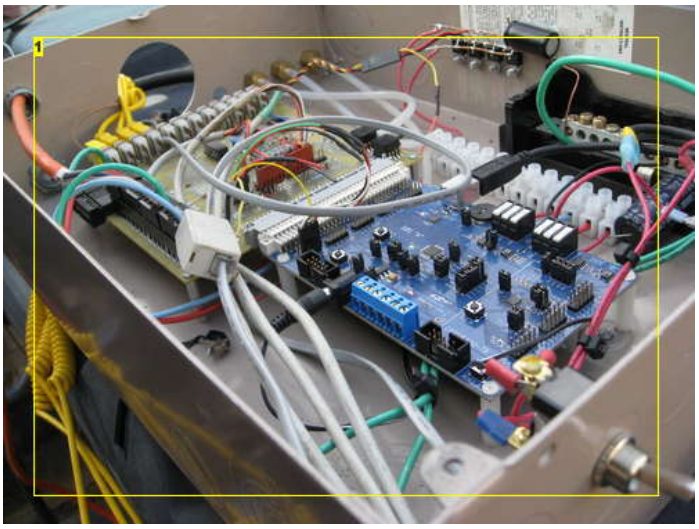
- A sensing and control loop for steam injection into the gasifier, when there is adequate heat. The GEK in the this Honda has a variety of heat recycling systems which result in a surplus of heat in the gasifier, heat which can be usefully consumed via more steam over the glowing char in the reactor, and thus a more hydrogen rich gas output.

- A solid fuel level sensor and auger motor control. Not used in the current non-auger design.

- A USB connection to a laptop, we send all the sensor data to the laptop to display it. The Co-pilot can check the readings on all the instrumentation - thermocouples, pressure sensors, oxygen sensor, and all the motors can be activated manually by the copilot.

- A switch to disable or enable the electronic fuel injection. we again tapped into the Honda ECU for this.

Our Reactor Control Unit is built with a SiLabs 8051 devkit with a custom expansion board plugged to it. There are 12 thermocouple jacks, 4 pressure sensors, 4 30-amp H-bridges for motor drive, a USB connection for a data display laptop, etc....



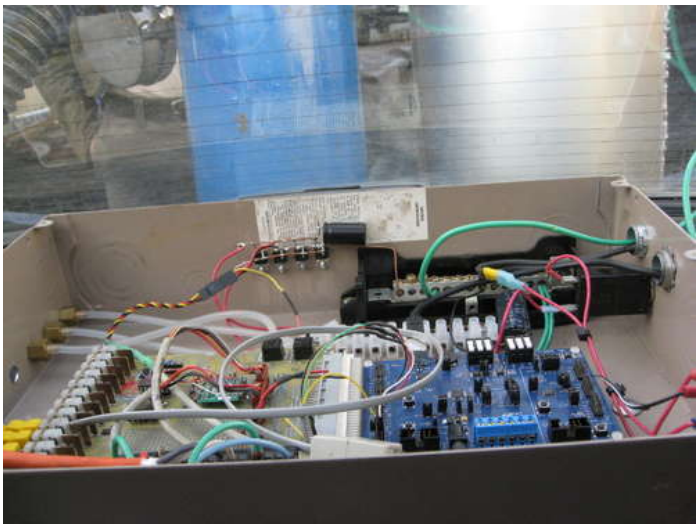



**Image Notes**
1. Our custom Reactor Control Unit. The blue PCB is a SiLabs 8051 devkit, the green one is our expansion board


**Image Notes**
1. pressure port in the side of the GEK box, it is ported into the side of the GEK cowling.
2. Reactor Control Unit mounted under rear window

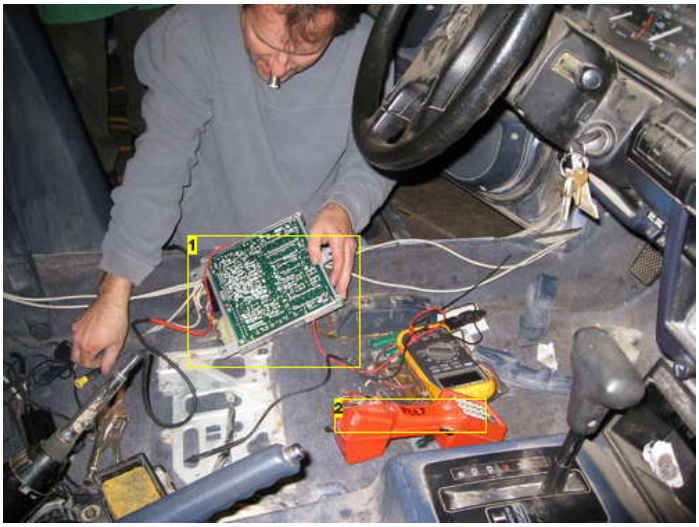



**Image Notes**
1. Honda ECU located under driver seat. We're trying to figure out where we can tap into the oxygen sensor and fuel injector
2. inductive signal tracer is very handy

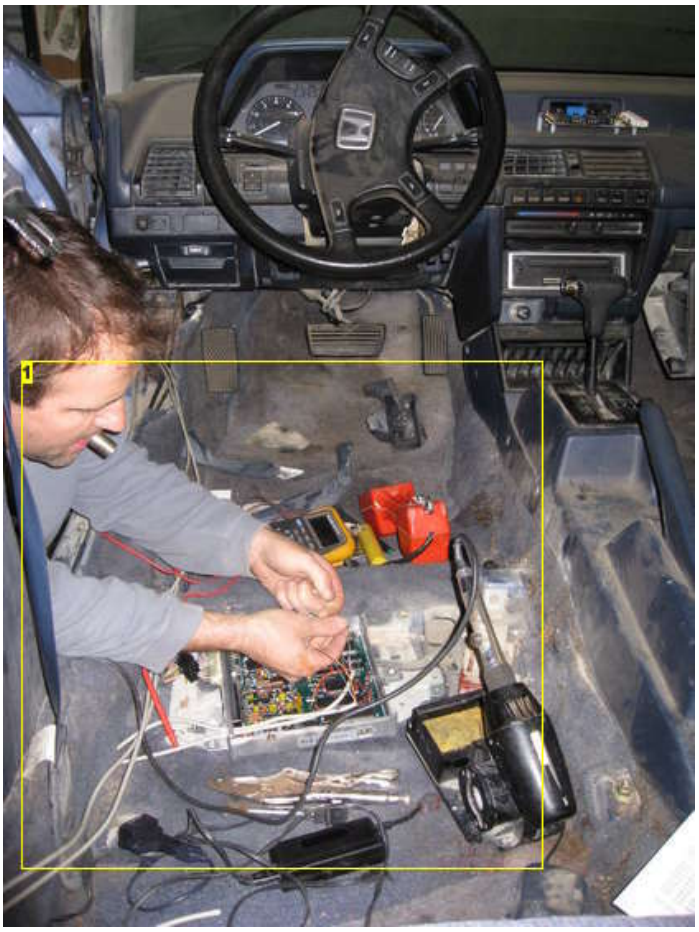



**Image Notes**
1. looks like brain surgery, because it is.

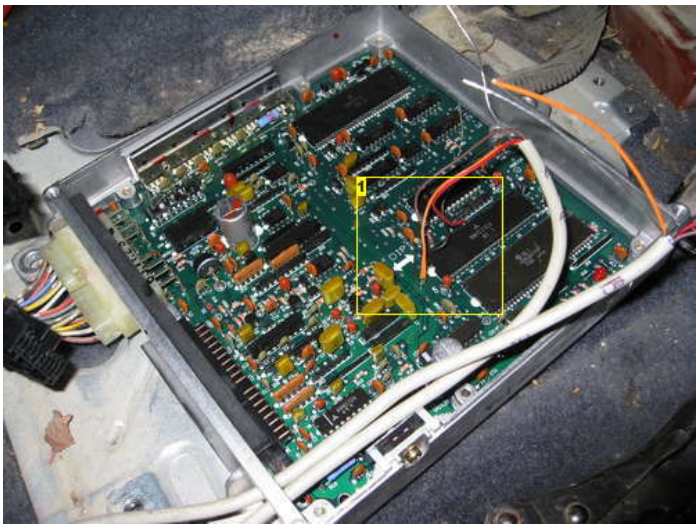



**Image Notes**
1. taps into the Honda ECU

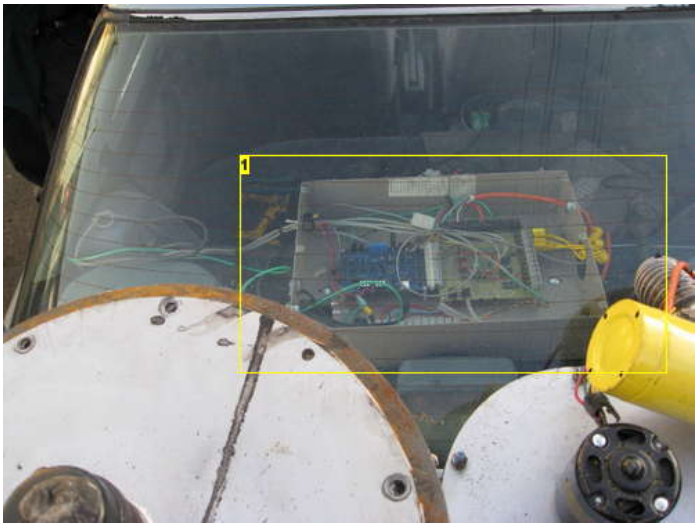



**Image Notes**
1. our Reactor Control Unit under rear window


**Image Notes**
1. wiring from the RCU to the engine area

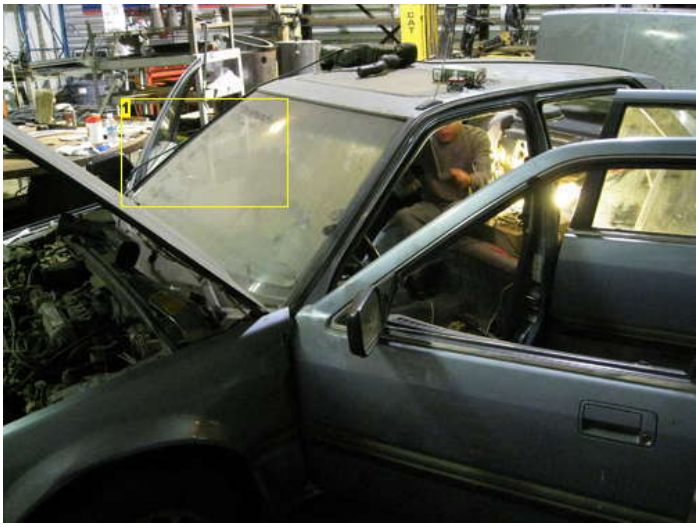



**Image Notes**
1. TODO list on windshield


**Image Notes**
1. debugging the RCU code

## step 18: Cockpit

The air/fuel mix knob and manual/auto switch are just next to the wheel for the driver.

The Copilot can watch all the sensors via the laptop display, and make changes to any of the motors or the air/fuel mix as well.

The laptop also logs the readings so we can see what worked and what didn't.


**Image Notes**
1. air/fuel mix dial, and auto/manual switch
2. sensor and actuator state display

## step 19: Final GEK reassembly for Honda

- Install reactor into cowling (standard GEK method with sealing tape)

- Add perlite between GEK inner and outer cowlings (standard)

- Bolt on the gas filtration unit (standard)

- Bolt hopper on top of reactor. We made a thinner hopper than the standard one so so it fits behind the rear window.


**Image Notes**
1. hopper
2. hopper
3. auger motor (not used)
4. reactor core
5. housing
6. not required, but really convenient


**Image Notes**
1. put reactor into cowling

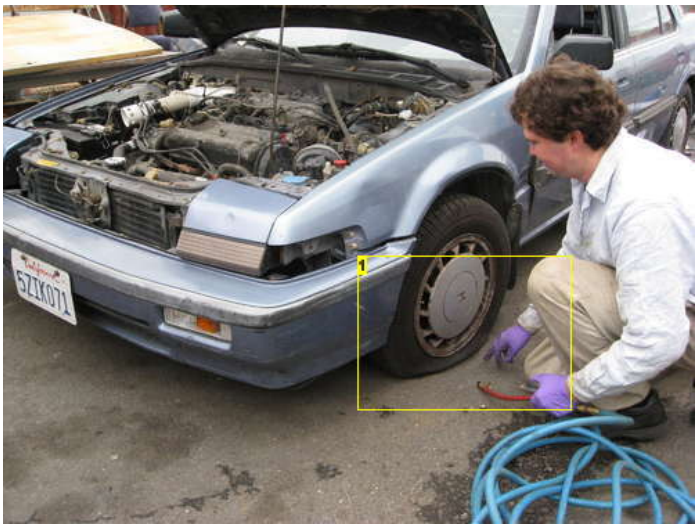



**Image Notes**
1. oops!

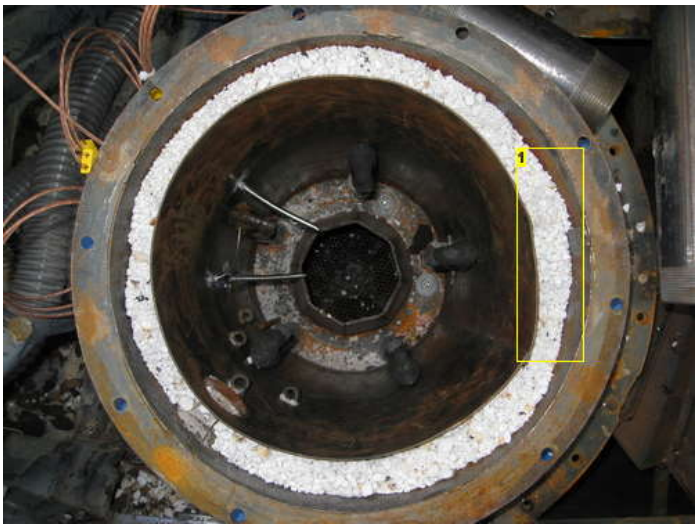



**Image Notes**
1. fill with perlite insulator


**Image Notes**
1. gas filter unit with pressure sensor

## step 20: Blow-off and output syngas valves

When starting up the GEK reactor its convenient to be able to get it going without having the Honda engine running. We put a tee on the GEK syngas output so we can send it either to the engine or to cyclone burner flare-off. Once the reactor is up to temperature and running well, we can shut off the cyclone and start the car on syngas.

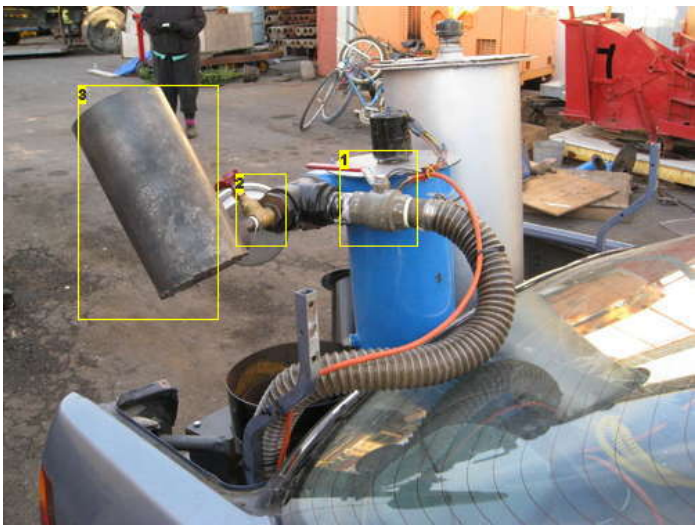



**Image Notes**
1. cut-off for fuel gas going to the Honda engine
2. cut-off for fuel gas going to the blow-off
3. blow-off cyclone burner

## step 21: Load Solid Fuel and Ignition!

Hey man, can i borrow your shoes? No? Well, how about some wood chips? Or those peanut shells you are throwing everywhere?

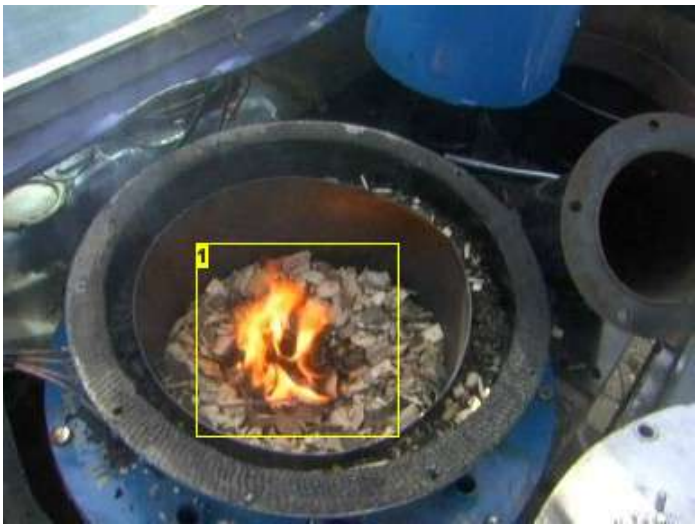



**Image Notes**
1. start combustion with a bit of lighter fluid or diesel


**Image Notes**
1. walnut shells
2. wood chips


**Image Notes**
1. try to keep a lid on it!


**Image Notes**
1. burn this stuff

## step 22: Ready!



**Image Notes**
1. pilot


**Image Notes**
1. co-pilot and control laptop

## step 23: GO! 88MPH here we come . . .

Here's a video of us driving the finished Honda Accord around West Oakland. No shots were fired. Fire was kept only in the gasifier. And everyone made it home with smiles on their faces.

CLICK TO PLAY VIDEO

If you like our Mr Fusion, please remember to vote for us in the Craftsman Workshop of the Future contest. Vote now using the "vote now" button at the top. Maybe we can win back half the tools we lost making this . . .


**Image Notes**
1. We're off on yet another tool and supplies run!



LIFETIME
LIMITED
POWERTRAIN
WAR
NTY


5ZIK071


5ZIK071


SEARS

## step 24: Assembly with auger - Not used in current design

We tested the auger-based design once, here are the fully assembled photos.

These include an optional system to eject the co-pilot out the sunroof, through a feed tube and into the hopper.


**Image Notes**
1. connects to sunroof


**Image Notes**
1. fuel gas output to engine

## step 25: More Information

Summary

- This instructable explains how to retrofit a Honda Accord (or nearly any car) with our Open Source Gasifier Experimenter's Kit (GEK) to power it. In this project we cover modifications to the standard GEK Gasifier that are needed, details specific to its installation into the Honda, and modifications to the Honda itself. All standard GEK Gasifier construction and operation details are covered in the sub-projects below.
- Check the Building the GEK Instructable to learn how to fabricate the standard GEK gasifier vessels.
- Check the Assembling the GEK Instructable to learn how to assemble the GEK vessels into a working GEK Gasifier
- Check the Running the GEK Instructable to learn how to start and operate the GEK to produce syngas.
- For more info and extra pictures about this project, see the main GEK site at: http://www.allpowerlabs.org/gasification/gek/index.html
- For general information on how gasification works, see: http://en.wikipedia.org/wiki/Gasification
- To learn about ALL Power Labs, the group that created the Trash Powered Honda and the Open Source Gasifier Experimenter's Kit, check our website: ALL Power Labs
- Inspired? Check out our No Petroleum Allowed Road Rally, the Escape From Berkeley.

## Related Instructables

**Assembling the GEK gasifier and preparing for fire** by jimmason

**How to start a Bio-mass Gasifier** (video) by allenergies

**Building the GEK Gasifier in seven parts** by jimmason

**Tree Powered Dump Truck** (video) by VictoryGasworks


**How To Enter The Earthjustice United States of Efficiency Contest** by lebowski

**Living a Greener More Energy Efficient Life** by tashiandmo

**Energy Efficiency All Automobile Owners Can Be a Part of** by hallyall

**100 Ways to Reduce Your Impact** by Brennn10

## Comments

**50 comments** **Add Comment** **view all 169 comments**

**joreknight** says:
what do you do with the gasifier when you park the car?, do you just leave it running or do you have to turn it off?

Mar 24, 2010. 11:21 PM **REPLY**

**k_man93** says:
they used this idea on that show... err, the compound? something about surviving in a post apocalyptic world

Aug 23, 2009. 1:20 PM **REPLY**

**cowscankill** says:
Yeah, I remember seeing that before a couple of times...

Mar 7, 2010. 5:43 PM **REPLY**

**ferrari484** says: Mar 6, 2010. 6:43 AM **REPLY**

not very areodinamic

---

**loatus** says: Feb 11, 2010. 6:57 AM **REPLY**

just need to find myself a De Lorean

---

**abadfart** says: Jan 12, 2010. 8:54 PM **REPLY**

very nice depending on what kills my car i might do this

---

**robot lover4evr** says: Jan 5, 2010. 4:55 PM **REPLY**

if it is alright with you i would like to use this as a science project. Thanks you in advance for whatever the answer may be. also i will give a patch if i get a good grade!!!

---

**mr monoply33** says: Dec 27, 2009. 9:49 AM **REPLY**

And the first gen of Mr Fusion is born

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**the rural independent** says: Dec 27, 2009. 8:25 AM **REPLY**

This is awesome. Might be a bit unsightly for the blue bloods in their Lexus SUVs, but that makes it all the more fun!!!

I think I may be able to work up something similar for a small farm tractor I need to do something with. Thanks for the great instructable!!

www.theruralindependent.com

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**bcnr33skyline187** says: Jan 22, 2009. 7:19 PM **REPLY**

isnt that second pic an ae86 corrola

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**Morganbarker** says: Dec 20, 2009. 8:19 AM **REPLY**

It's a 3rd generation honda accord hatch....86 to 89

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**XenonJohn** says: Aug 27, 2009. 9:29 AM **REPLY**

Thne other way is to make your gas at home and then store it in a huge bag on the roof of your car. You will look silly though! I think they did it this way in WW2 as well, or maybe had the gasifier on board to just make some more when the bag emptied.


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**Volectorus** says: Dec 15, 2009. 8:43 PM **REPLY**

I imagine that the bag made a good radiator, and would supply gas when the tank was low. (No interruption) Just a thought, no merit without proof though.

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**guitarman63mm** says: Sep 4, 2009. 8:30 PM **REPLY**

Sorry to burst your bubble, but I highly, highly doubt that is a pressurized canvas container. Looks like a rooftop carrier for someone who's moving.

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**BytePilot** says: Sep 7, 2009. 10:14 AM **REPLY**

No need to apologise, consider the chap's bubbled unburst.
Mainly beacsue that is indeed a gas container. It's rubberised canvas and the pressure is no more than a gnat's chuff above atmospheric, but this kind of storage was a common sight during petrol rationing.

http://green.autoblog.com/2007/10/16/exciting-new-fuel-for-1940-coal-gas/

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**zwheel** says: May 7, 2009. 10:53 AM **REPLY**

Does it have to be onboard? How hard would it be to tank the syngas? The gassifier could be stationary in a back corner of the back yard somewhere and you could still have a trunk, see behind you and a normal looking car. Or is it too unsafe to store? Or too hard/expensive to compress?

**Funk_D** says: Nov 26, 2009. 6:30 PM **REPLY**

I thought the same thing. I read somewhere (I think it was woodgas.com or something) that if you compress woodgas, the force makes the CO combine with the O in the woodgas to create CO2, and then it won't burn or something. Because I was totally gonna hook a gassifier up to an air compressor and just start piping it into propane tanks to fuel my car.



**evilfrogie** says: Dec 7, 2009. 6:36 PM **REPLY**

I think it would be dangerous to store as carbon monoxide poisoning is not a fun thing to have. You have shortness of breath and a few others things for at least a month. If you could store it safely then I would.

**Funk_D** says: Dec 9, 2009. 8:41 AM **REPLY**

Well if you think about it, we store a lot of things that aren't safe. lol. I can open my garage and find about 100 deadly chemicals just sitting around.

However, if I undertook a project such as this one, I'd mount a carbon monoxide monitor in the cabin of the car. Then if something did happen, I'd hear the alarm.

**Funk_D** says: Dec 7, 2009. 2:30 PM **REPLY**

Let me ask a question. I've read that you aren't technically gasifying until you add steam, because once you do some sort of chemical reaction occurs that makes true woodgas. Until then, you're supposedly just pyrolsising the wood. I've built a small "gasifier" kinda like the design from "The Colony" show and I'm gonna try to power an engine on it, but I was just curious if what I built is actually a gasifier or not.

**your dog** says: Sep 25, 2009. 5:41 PM **REPLY**

This was done on The Colony, a discovery channel tv show. they powered a truck, car, and generator.

**slimguy379** says: Oct 17, 2009. 7:28 PM **REPLY**

my thoughts exactly, i think that was one of the best shows discovery has put on since monster garage and junk wars lol

**Funk_D** says: Nov 26, 2009. 6:23 PM **REPLY**

I agree. The best reality TV show. And that includes Girls Next Door. :P

**Dr. Steel** says: Dec 5, 2009. 10:54 PM **REPLY**

Yeah, you wouldn't be saying that if you've seen GND in Mexico, they air(ed?) it uncensored.

**luvit** says: Apr 24, 2009. 8:58 PM **REPLY**

i rode in one of these. we traveled to 1972, and then went traveled to 2013. you will never guess who will be president.

**gateon** says: Nov 20, 2009. 2:35 PM **REPLY**

Oh no it's Chuck Norris is it!? Because once that happens, it turns from a dictatorship into a Chucktatorship!

**Gray-Fox** says: Oct 9, 2009. 8:15 AM **REPLY**

Lmfao nice :P

**natethegreat88** says: Oct 5, 2009. 6:27 AM **REPLY**

Ron Paul!

**sambb** says: May 18, 2009. 8:58 AM **REPLY**

Arnie?

**jmeister15** says: Jun 12, 2009. 5:03 PM **REPLY**

LOL

**Lokisgodhi** says: Oct 22, 2009. 1:55 AM **REPLY**

Seems to me that this might be good for off the grid living. You can use the motor to generate electricity, the heat from the engine for heating water for both heating the house and for potable water for bathing and consumption.

How much fuel does burn per hour to run it?

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**ArvindTheNinja** says: Oct 9, 2009. 8:49 AM **REPLY**

this is pretty cool

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**rosstheexplodingone** says: Oct 5, 2009. 12:23 PM **REPLY**

wow i want one ! ... i guess thats why u put instructions on it!

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**flanimal** says: Sep 27, 2009. 5:06 PM **REPLY**

great way to go green

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**ragdollman** says: Sep 1, 2009. 5:39 PM **REPLY**

Can I go back to future in it? Or have you not gotten that far yet? lol Great build man!

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**xc1024** says: Aug 15, 2009. 2:22 AM **REPLY**

Fit this:

**http://www.instructables.com/id/Flux-Capacitor/**

inside. If anyone who watched BTTF takes a look inside, you can snap a photo of the priceless face expression.

Seriously now, what you need is a unique name for your project, something that will make it identifiable. That could possibly push other people a bit further towards gasification research as the project could be more widely known and advertised.

BTW, what speed does it reach? Just curious.

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**Nicepolicy16** says: Aug 8, 2009. 11:08 AM **REPLY**

It would be less noticeable on the back of a pick up truck or inside a van. Although you said that 1 million people used it in World war 2, it is not a well known technology . People only know about using this fuel for steam engines to produce heat rather than extracting gas from the fuel to run motors .

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**KevinEdgar** says: Aug 1, 2009. 11:26 PM **REPLY**

"No shots fired." LOL!!!!

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**15krypto** says: Jul 26, 2009. 6:25 PM **REPLY**

2 quick questions 1. can you see out of your rear view mirror? 2. does anyone pop open their window and ask, "Um. What is that?"

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**macrumpton** says: Feb 20, 2009. 1:58 PM **REPLY**

It seems to me that one way to increase your miles/cord would be to make it a hybrid with an electric powertrain (so you can do regenerative braking ). I suspect you could cut the size of the unit to 1/3 its current size and use it to power a small generator that runs continuously charging a prius sized battery. At rest the battery is just charging. While accelerating the car takes power from the generator and battery and while running at cruising speed the generator is supplying most or all of the power. When braking both the generator and the brakes are feeding power into the battery. This scheme would add some cost, but it would make the car look almost normal and the car could have a short all electric range if you did not want to start up the fire.

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**charlieb000** says: Jul 19, 2009. 12:09 AM **REPLY**

another way is to make your car more aerodynamic, it increases your distance much, look up the aerocivic! http://ecomodder.com/blog/2008/02/07/crazy-ecomodder-gets-95-mpg-in-a-1992-civic/

**bigredlevy** says: Feb 23, 2009. 6:05 AM **REPLY**

although i am optimistic about the future of hybrid cars, i am doubtful that the prius has any real value as an environmentally friendly form of transport. i reckon that the power regenerated through braking would be lost in the much greater weight of the car because of the larger powertrain. a 'plug in' hybrid would of course be much better, with greater use of batteries for most trips. this gasification is an incredibly interesting concept, very innovative, although it is probably not saving the planet, haha. i think the problem lies in the use of the internal combustion engine. external combustion is much more controllable and MUCH cleaner. i wonder if you could fit a flash steam boiler, connected to a tesla turbine in a honda accord? hehe

**macrumpton** says: Feb 24, 2009. 5:18 AM **REPLY**

I don't quite understand your denigration of the Prius. There is no question that it is more fuel efficient than an equivalent sized ICE only car, and that is almost all due to it's regenerative braking (and using the electric motor to help accelerate). It's only big fault is that it is hard to save enough money on gas to recoup the additional cost.

On the other hand I don't think a plug-in hybrid makes much sense in this application because the size and weight of the required battery along with the gasifier would leave little room for the driver/passengers, not to mention the huge cost of the battery which is the big problem with plug-in hybrids.

Re the gasifier saving the planet: http://www.worldchanging.com/archives/007427.html

**zippydaspinhead** says: Apr 17, 2009. 10:08 PM **REPLY**

It has been proven that the emisions from hybrids, even if the entire world converted overnight, would not stop the problems associated with any gas vehicle, such as greenhouse gasses. The problem lies in gas, when combusted it causes pollution. The only real solution that causes the least envioromental impact would be a plug in fully electric charged car charged via solar and or wind. Otherwise somewhere in the process something is burned and thus some pollution occurs.

**Bludbunny** says: Apr 16, 2009. 5:05 AM **REPLY**

My biggest concern about hybrids is all the left over batteries, and the production of the batteries causing "alternative" environmental issues later on. While I know it is very early years, I don't really agree that we should all feel compelled to buy one. I believe in the future of alternative fuels probably more than electric hybrids, and think that this will be a more viable alternative to burning up 'dead dinosaurs' to get around.

**purplemonkeydishwasher** says: May 14, 2009. 6:16 PM **REPLY**

could you burn plastics and stuff like that. if so, this car could solve all of north america's litter problems.

**charlieb000** says: Jul 19, 2009. 12:02 AM **REPLY**

should be able to but not ones that emit toxic fumes like PVC but others should be fine... some people dont have garbage disposal services so they burn it in a furnace out back. most plastics are carbon and oxygen.

**Bartboy** says: Jun 25, 2009. 2:56 PM **REPLY**

Hahaha... I doubt very many people will actually *follow* this instructable.....

You might even call it a *dark matter engine.*

:P

**welder guy** says: Jun 17, 2009. 1:48 PM **REPLY**

i 'gasify' (singular of gasification) every time i fart to then?? i'm not trying to be gross or dumb or anythiing like that but isn't that what haooens when you far?

**natethegreat88** says: Apr 11, 2009. 3:46 AM **REPLY**

It would be cool if you used cow chips.

**view all 169 comments**