Preparing your own low cost A+B generic hydroponic nutrients at a small scale from raw salts

In a recent post about the cost of custom hydroponic nutrients, I talked about the cost of preparing nutrients equivalent to those of a commonly used brand (general hydroponics Flora series) at a small scale. We saw that the cost savings are not very significant when doing this with small amounts of salts, given that the cost of the salts only drops significantly at larger scales. However there are low cost alternatives to prepare viable hydroponic solutions. In today’s post I want to write about the DIY preparation of hydroponic nutrients and how you can do this from raw salts to arrive at a generic formulation that you can use for flowering plants.

Substance Name [click for url]	Formula	Mass (g) [Edit to fine-tune]	Preparation Cost
B - Potassium Monobasic Phosphate	KH2PO4	10.985	0.5
B - Ammonium Sulfate	(NH4)2SO4	2.331	0.1
B - Magnesium Sulfate (Heptahydrate)	MgSO4.7H2O	31.694	0.1
B - Potassium Sulfate	K2SO4	25.698	0.5
B - CH - micro	Ch micro	2.225	0.1
A - Calcium Nitrate (ag grade)	5Ca(NO3)2.NH4NO3.10H2O	68.705	0.5

Element	Result (ppm)	Gross Error	Instrumental Error
N (NO3-)	158.296	0%	+/- 0%
K	235	0%	+/- 0%
P	40	0%	+/- 0%
Mg	50	0%	+/- 0%
Ca	208.863	0%	+/- 0%
S	150.686	0.5%	+/- 0%
Fe	2.492	0%	+/- 0%
Zn	0.142	0.3%	+/- 0%
B	0.463	0%	+/- 0%
Cu	0.039	0.4%	+/- 0%
Mo	0.018	-1.1%	+/- 0%
Na	0	0%	+/- 0%
Si	0	0%	+/- 0%
Cl	0	0%	+/- 0%
Mn	0.712	0%	+/- 0%
N (NH4+)	20	0%	+/- 0%

Total Cost is 1.8

Values calculated for the preparation of 0.25 liters of A and 0.25 liters of B solution. Please use 4mL of A and B within every Liter of final solution

Predicted EC Value

EC=2.246 mS/cm

Stock Solution Analysis

Nutrient Ratio Analysis

Detailed Per Substance Contribution Analysis

Generic A+B formulation prepared using

The formulation shown above is meant to be a low cost formulation that is close to a Hoagland solution in as many nutrient concentrations as possible, using as few inputs as possible. The concentrated solution is meant to be prepared in distilled water and it is meant to be used in RO/distilled water as no mineral contributions from the incoming water have been taken into account for its making. The solution is prepared at a 250:1 concentration factor, meaning that a gallon of A and a gallon of B can be used to prepare 250 gallons of final nutrients. This is a concentration factor pretty similar to that of the General Hydroponics Flora series, with an intended dosage of around 15mL/gal of A + 15mL/gal of B. At this dosage the EC is expected to be around 2.2 mS/cm (but this should be experimentally determined!). With 250mL of concentrated solution you can prepare up to

62.5L of final solution (~16.5 gallons).

Note that I have decided to use a “chelated nutrient mix” instead of preparing a solution adding micros one-by-one, as this is not very convenient for people new to nutrient solution preparation, plus, some micros are only available in relatively larger quantities that are unnecessary to store for someone who is only interested in the preparation of small amounts of nutrient solution. The above preparation has a cost of around 25 USD/(gal A+ gal B), which is less than one third the cost of one gallon of Flora series. This cost will be significantly lower if you buy the fertilizers in larger quantities and/or if you buy all the micros and weight them independently.

To prepare this accurately at a small scale – as shown in the image above – you will need the following materials and chemicals:

- Class A Volumetric Flask (250mL)
- Beaker set
- A scale adequate for this range (+/- 0.01g , max 500g)
- Customhydronutrients chelated micro mix
- Calcium nitrate
- Ammonium sulfate
- Epsom Salt
- Monopotassium phosphate
- Potassium sulfate
- Distilled water
- air-tight 250mL Glass container for storage

You can follow this process to prepare the nutrients:

1. Prepare a clean and dry 250mL beaker, wash with distilled water (no soap)
2. Weight each raw salt on your scale, transfer to the beaker (use distilled water as necessary to ensure everything is transferred)

3. Add more water and heat – if necessary – to ensure everything is dissolved (add *less* than 200 mL of water)
4. Transfer the liquid to the volumetric flask (use distilled water as necessary to ensure everything is transferred)
5. Take to the final volume using distilled water and homogenize
6. Transfer to the final storage container

I have also made a video to show you how this entire preparation process is carried out, which I will be sharing shortly! Note I used a potassium sulfate I had previously purchased, which was of significantly low purity (mined potassium sulfate), the link above is for a refined potassium sulfate source, which should give you significantly less problems than it did for me and lead to higher quality solutions (my B solution was cloudy and contained some solids, which were impurities from the potassium sulfate).

If you want to prepare these solutions at a larger scale, then you will face other problems. For example how to accurately measure the final volume of these solutions. **Lines in tanks and buckets are terrible volume indicators**, flow meters also are also not enough since the salts take a very significant amount of the volume as well (remember we care about the volume of water+salts!). How to properly mix, homogenize, heat and dissolve larger amounts of solution is also not trivial. These are all problems we will be discussing in future posts and videos!

Can you use regular soil

fertilizers in hydroponics?

If you have just started your journey into hydroponics you're probably wondering why you need to spend your money in hydroponic specific nutrients when there are so many cheaply available soil fertilizers sold out there. Certainly there are all plant food and there must be some way you can use all these cheap soil fertilizers to create a suitable replacement to feed your hydroponic crop. In this post I want to explain some of the key differences between hydroponic and soil fertilizers, when soil fertilizers can be used in hydroponics, how they can be used and when it is definitely a bad idea to try to use them.

Some slow release soil fertilizer being added to plants

To understand the difference between soil and hydroponic fertilizers we must first understand the difference between both growing setups. In hydroponics we try to grow plants in sterile and chemically neutral supporting media where all the nutrients are expected to be provided by the nutrient solution while in soil the media is not intended to be inert – it contains organic matter, minerals that can dissolve and living microbes – and we expect some of these to provide nutrition to our plants. Fertilizers for soil are intended to aid this process – provide material for microbes to process and supplement some of the lacking elements in the soil – while hydroponic fertilizers intend to provide all required nutrition in the forms that are mostly favorable for plants. Fertilizers for soil are often also meant to be applied once or very occasionally, while fertilizers for hydroponics are expected to be fed to the plant very frequently.

In chemistry terms, this means that fertilizers for soil will tend to contain forms of nitrogen that can be processed slowly by microbes in soil – urea and ammonium salts – while hydroponic fertilizers contain mostly nitrate salts. It is rare for soil fertilizers sold to home growers to contain large amounts of nitrates because these are easily washed aware by rain, are strong pollutants of underwater ground sources and are only shortly available for plants due to their high mobility in soil. However ammonium and urea are a terrible idea in hydroponics since ammonium fed frequently strongly acidifies the media and plants supplied their nitrogen only from ammonium in solution will tend to show toxicity issues quickly. Soil fertilizers rely on bacteria to convert this ammonium and urea to nitrate in a slow process, hydroponic fertilizers do not, they contain nitrate which is the final form of nitrogen that plants prefer for healthy growth.

— GUARANTEED ANALYSIS — F1144

Total Nitrogen (N)	18%
1.62% Ammoniacal Nitrogen	
2.46% Nitrate Nitrogen	
13.89% Urea Nitrogen	
0.03% Other Water Soluble Nitrogen	
Available Phosphate (P_2O_5)	18%
Soluble Potash (K_2O)	21%
Magnesium (Mg)	0.50%
0.50% Water Soluble Magnesium (Mg)	
Boron (B)	0.02%
Copper (Cu)	0.05%
0.05% Water Soluble Copper (Cu)	
Iron (Fe)	0.10%
0.10% Chelated Iron (Fe)	
Manganese (Mn)	0.05%
0.05% Chelated Manganese (Mn)	
Molybdenum (Mo)	0.0005%
Zinc (Zn)	0.05%
0.05% Water Soluble Zinc (Zn)	

Derived from Ammonium Sulfate, Potassium Nitrate, Urea, Soy Protein Hydrolysate, Monopotassium Phosphate, Sulfate of Potash, Magnesium Sulfate, Boric Acid, Copper Sulfate, Iron EDTA, Manganese EDTA, Sodium Molybdate, and Zinc Sulfate.

Information regarding the contents and levels of metals in this product is available on the Internet at http://regulatory-info-sc.com

Guaranteed Minimum Analysis

Total Nitrogen (N)	**20%**
Nitrate Nitrogen	12.1%
Ammoniacal Nitrogen	7.9%
Urea Nitrogen	0%
Available Phosphoric Acid (P_2O_5)	**8%**
Soluble Phosphorus	3.4%
Soluble Potash (K_2O)	**20%**
Soluble Potassium	16.6%
Calcium (Ca)	0%
Magnesium (Mg)	0.25%
Chelated Iron (actual) (Fe)	0.100%
Chelated Manganese (actual) (Mn)	0.050%
Chelated Zinc (actual) (Zn)	0.050%
Chelated Copper (actual) (Cu)	0.050%
Boron (actual) (B)	0.020%
Molybdenum (actual) (Mo)	0.015%
EDTA (chelating agent)	1.24%

Comparison between a couple of typical water soluble soil (left) and hydroponic (right) fertilizer labels.

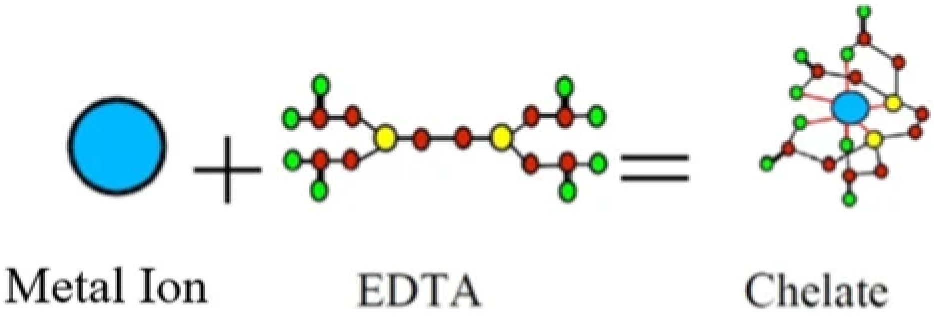
The image above shows you a comparison between the labels for a water soluble soil and hydroponic fertilizer. In terms of NPK they both seem to be similar fertilizers, but the hydroponic fertilizer will have most of its nitrogen as nitrate while the other fertilizer has most of its nitrogen as urea. There are some other differences, mainly that the amount of phosphorous in the soil fertilizer is more than double that of the hydroponic fertilizer, which is also common given that phosphate is fixed rapidly in soil and therefore a higher excess is often added to ensure plants get enough supply. At an application of 1g/L the soil fertilizer would provide 75+ ppm of phosphorous while the hydroponic one would provide around 35. Also note that none of these two fertilizers would be enough to provide total plant nutrition since they both lack a source of Ca, which is commonly provided via a separate product in both cases.

So can any soil products be useful in hydroponics? Yes. First you need to completely avoid products that contain N mainly as urea or ammonium. Useful products to get for your hydroponic grow will be fully water soluble and will either contain nitrogen solely as nitrate or no nitrogen at all. A very coarse DIY formula can usually be put together using something like a micro nutrient containing 0-10-10 bloom fertilizer (which contains no nitrogen) coupled with a source of nitrate, like agricultural grade calcium nitrate. You can use Hydrobuddy – my open source hydroponic nutrient calculator – to figure out the nutrient contributions of each one of the products you decide to get or have easily available and create an acceptable formulation from their use. The program also contains a long list of readily available raw salts that you can use to make your own fertilizer formulations from scratch if you wish to do so.

In the end, soil products for home growers are not designed for hydroponics use and should therefore be avoided except as a last resort if raw salts or hydroponic specific nutrients cannot be purchased. If you're interested in saving money, learning how to prepare your own fertilizers from raw salts will always be the best and cheapest option, provided you have the time and desire to learn how to do it properly.

How to prepare a low cost chelated micronutrient solution

Micronutrients constitute only a small portion of a plant's nutritional requirements but are still vital to growth and development. They are mainly comprised of heavy metals (Fe, Zn, Mn, Cu, Mo) as well as a single non-metal, boron (B). Since they are used in such small concentrations – normally in the 5 to 0.01 ppm range – they are normally put into concentrated nutrient solutions in small proportions and included with other components such as Ca and Mg, which are present in concentrations much more in line with macro nutrients like N, P and K.



Simple model of the metal chelating process

The advantage of micro nutrients is that they are available cheaply and in high purities as heavy metal sulfate salts. These however have the problem of leading to relatively unstable cations in solution, making the preparation of concentrated micro nutrient solutions with pure sulfates impractical (unless you want to see how a gallon of rust looks like). However we can chelate the cations as they come out of these sulfates, using a chelating agent, in order to prevent any precipitation issues. In this article I am going to walk you through the preparation of a DIY chelated micronutrient concentrated solution. This is much cheaper than buying the heavy metal chelates, which can be 3+ times more expensive. To prepare this solution you'll need to buy the chemicals shown in the table below. The table includes links to buy all the different substances mentioned plus their cost (without shipping).

Link	Price USD/lb	Weight g/gal
Disodium EDTA	22.96	17.0600
Ferrous sulfate heptahydrate	15.99	9.4211
Zinc sulfate monohydrate	9.49	0.1039

Manganese sulfate monohydrate	14.99	1.1646
Copper sulfate pentahydrate	20.99	0.0595
Sodium Molybdate	19.99	0.0191
Boric acid	10.95	3.3384
Total Cost	115.39	

List of salts to prepare a DIY chelated micronutrient concentrated solution. This concentrated solution is to be used at 5mL per liter of final feeding solution.

In order to prepare the solution you also need a scale that can weight with a precision of +/- 0.001g (this is my low cost recommendation) and a container where you can store 1 gallon of solution. Please note that these solutions *have to be prepared with distilled water*, with RO water you might still run into some issues in the process. To prepare the solution carry out the following steps (the weights to be used are specified in the table above):

1. Wash your container thoroughly with a small amount of distilled water
2. Fill your container with half its volume of warm distilled water (30C, 86F)
3. Weight and add the disodium EDTA, stir until it is completely dissolved (this can take a while).
4. Weight and add all the remaining micro nutrients one by one in the order given above, stirring till each one is fully dissolved before adding the next.
5. Fill the container to its final volume using warm distilled water.
6. Let the solution cool before closing the container.
7. For longer half-life transfer to a container that is opaque to UV light.

This solution is prepared to give you the heavy metal concentrations of the Hoagland nutrient solution (a very common set of ratios used in scientific research for growing plants) when used at a ratio of 5mL per every liter of final feeding solution (18.92mL per gallon). The links given above are for 1lb of each product, with this you should be able to prepare at least 53 gallons of the concentrate, which will allow you to prepare 10,600 gallons of final feeding solution. The first salt you will run out of is Fe, but some are used so sparingly that you should be able to use them for the rest of your life without needing to buy any more (like copper sulfate and sodium molybdate). For less than 120 USD you will be able to have enough solution for probably the rest of your life – if you're a hydroponics aficionado – or even an entire crop cycle if you're a commercial grower.

This preparation is not without problems though, since the chelates are all prepared *in situ* they will take a substantial amount of time to reach their thermodynamic equilibrium, meaning that it cannot be used to soon or some of the metals might not be fully chelated. To obtain the full metal chelating effect an excess of around 25% of disodium EDTA is also used, which means that this micro nutrient solution contains more free EDTA than a solution prepared with the chelates. Another issue is that all heavy metals are chelated with EDTA, which might not be optimal depending on your growing conditions. The EDTA chelates are also less stable against UV light and are also more easily attacked by oxidants. Another final issue is that the solution above contains no preservatives and fungi generally like to feast on this sort of micronutrient containing solutions. It is therefore reasonable to avoid preparing any large amounts of the above, as a solution prepared as instructed is normally expected to spoil in 3-4 weeks.

With this in mind, the above is not a perfect but a low cost and practical solution for those who want to start preparing their own nutrient solutions and avoid paying the high prices of some commercial nutrients just because of their micro nutrient contents. The above gives you a versatile micro nutrient concentrate that is bound to be adequate for growing almost all plants.

DIY Warm white LED lamp PAR measurements, not so exciting after all!

If you read my last few posts about DIY LED lamps built using 150W warm white LED cobs (which do not require an independent driver) you might have been excited by some of my claims. I previously stated that you could probably get around a 1000W HPS equivalent using just two of these lamps, which meant an energy saving of around 60% relative to the HPS equivalent. However to really verify these claims I wanted to get new PAR and lux meters to perform proper PAR and lux measurements. The results my friends, are disappointing.

42	56	20
53	220	76
43	62	24

Previously I thought that these lamps were close to half of an HPS equivalent based on initial lux measurements. At the same distances, directly below the lamp, I could get around half the lux equivalent of your average HPS lamp, I thought from the warmer spectra of these white warm cobs that the PAR contribution would be significantly higher than that of a regular HPS but it seems that – due to the inefficient use of a white phosphor to produce the spectra – basically the PAR efficiency is equal to that of an HPS lamp.

The PAR (Photo-synthetically Active Radiation) basically measures the number of photons that can be used in photosynthesis that you get per square meter per second off a given light source. I will write a more in-depth post about PAR in the future, but it basically tells you the plant-usable photon flux you get. It is therefore measured in $umol*s^{-1}*m^{-2}$.

I performed classic PAR measurements with a 150W lamp 15 inches above a target center with measuring points around a 4 square feet area (to compare with the variety of HPS measurements you can find here). The results, in the first image in this post, show you the map of PAR values across the 2 feet by 2 feet area. This shows that the lamp is basically giving you 1466 $umol*s^{-1}*m^{-2}$ per 1000W at its highest point, which is below the PAR/watt of even the poorest HPS models. With this lamp model using 150W cobs you will therefore need at least 7 lamps to reach the same equivalent of a 1000W HPS in terms of actual photo-synthetically active radiation.

Not only that but without any focusing or dispersing elements the PAR decay as a function of light distance is much more dramatic than for regular, reflector mounted HPS lights. **With all these information it now seems clear that these warm white light LED cobs are NOT a good HPS replacement**.

However the idea of the zip tie lamp is not dead! I found out that there are actually "full spectrum" LED cobs that are specifically designed to be grow lights (so basically a combinations of red and blue LED lights). These cobs come in 20, 30 and 50W formats and they should have a much more favorable PAR than the 150W warm white LED cobs. I have now ordered some of these cobs (here) to rebuild my zip tie lamp and see if I can indeed get a much better PAR/watt and watt/dollar compared with normal HPS lights.

Cheap DIY high power LED grow lights: Introducing the Zip-tie lamp

Make sure you also read this post, where I studied the PAR of these lamps and realized they are not as good as I thought!

Several months ago I wrote a post about using high power LED cobs that do not require an external driver in order to build a high power DIY LED lamp. However I hadn't built a practical lamp using these cobs at that particular point in time so I just gave a general idea of why I would use these diodes and how the particular lamp setup would work. Today I want to talk about how to build one of these lamps in practice using an aluminum heat sink, a 150W warm white LED cob, a fan and some zip ties. The setup lacks the use of any adhesives and should provide you with roughly a 40-50% equivalent of a 1000W HPS. With two of these lamps you should be able to run the equivalent setup to 80-100% of a 1000W HPS in terms of PAR with around 60% less power consumption.

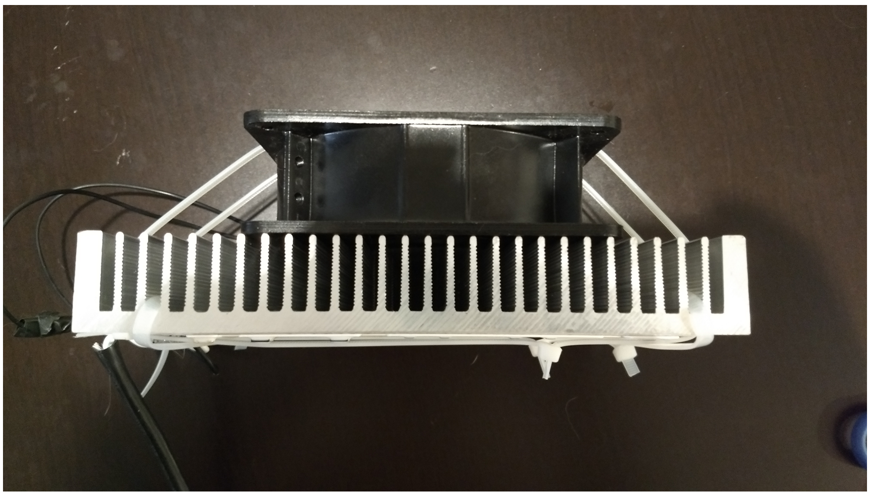
The idea of this post is to help you build a very affordable DIY lamp. However please note that this lamp involves work with mains voltages which are dangerous. Please familiarize yourself with all the precautions needed when working with high voltages. All the information herein in is provided as-is for educational purposes with absolutely no guarantee, either expressed or implied.

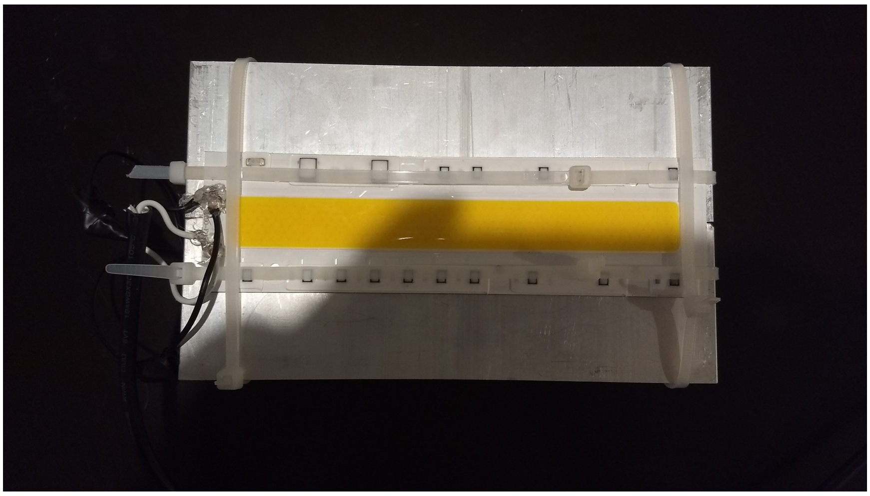
To build this lamp – showed above – you will need these materials (note that if your country uses another voltage you will need to buy the appropriate pieces for the voltage in your country):

- Warm white 150W LED cob
- 200x60x30mm aluminium heat sink (2 needed)
- 110V-120V AC fan
- Nylon zip ties 30cm
- Cable and wall connector
- Thermal compound (optional)

Initially I wanted to build a lamp using a high power warm white LED cob by gluing the cob to the heatsinks using a thermally conductive glue. However the problem with this is that these glues very permanently bind the cob to the heatsink so if for any reason the cob fails you would lose the heatsinks because the cob would be bound to them. For this reason I decided to use zip ties instead, which provide an easy way to secure the entire ensemble and allow you to easily replace any failing part rather quickly. I used nylon zip ties but you can also use stainless still ones if you want the setup to be more resilient (although things will be harder to cut if you make a mistake).

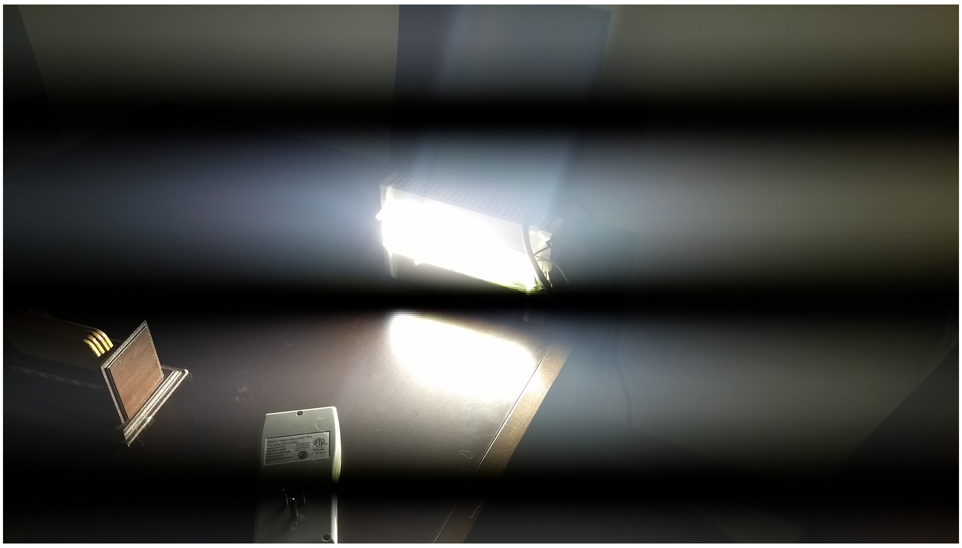
To assemble the lamp I basically used 4 zip tie lines two horizontal and two vertical. For the lines that go the width of the heat sink I just had to use one zip tie but for the other two lines – that also go above the fan – I had to use two zip ties for each line (you can connect one zip tie to another to have a larger zip tie). You need to tighten the zip tie very hard to ensure the cob is in direct contact with the aluminum along all its length, you can also use some thermal compound (like the one you use for CPUs) between the cob and the aluminum heat sink for maximum heat transfer. The pictures below show you a bit better how I performed the entire assembly. *When putting the fan on top of the heat sinks make sure the airflow is towards the heatsink (flow arrow in the case pointing down) and that the fan can spin freely).*





Finally I connected the cob directly to the AC line by soldering the appropriate live/neutral cables to the connectors at the left size of the cob (in the above picture). I then covered the soldered spots with silicon glue to ensure that the connections were as electrically isolated as possible. Make sure you solder as small portion of wire as possible and make sure the wire makes absolutely no contact with the aluminum heat sink or you will have a short. I also soldered the fan cables to the live/neutral as well since the fan can be driven directly by AC as well.

Since you have the zip ties you can also use them to hang the lamp, you can also add screws to the fan screwing ports and use those to hang the lamp from the ceiling. When I turned on this lamp its power consumption was around 220W – measured directly from the wall – meaning that it consumed a bit more power than what was advertised (which is not uncommon for these cobs). Since my voltage is a bit higher than 110V – which is the minimum rating for this cob – I actually get a slightly higher light/heat output than someone using it at a lower voltage. The fan – which takes around 12-15W on its own, also contributes to this consumption level.



When you power on this lamp – image above (sorry about the camera not being able to handle the light intensity) – you'll immediately notice how the heat sink starts to heat up. I have tested the lamp through 2 hours of continuous operation up until now and the heat sink reached a stable temperature of around the 120°C (~ 250F), the final temperature you reach will of course depend on your ambient temperature and how well you assemble the components. It is however very important for you to test each one of these lamps for 12/24 hours to ensure that they don't heat up excessively. *Nylon will melt at around 220°C so you definitely don't want your lamp to ever reach even close to that temperature (to be safer you can use stainless steel zip ties)*. However it is very likely that the LEDs will burn out way before this happens if your temperature rises too far. You can also add a second fan or use a larger heat sink if your temperature is too high.

In the end the setup is extremely simple to build and you can get roughly 40-50% of a 1000W HPS with one of these lamps. With two of these lamps you will run at around 450W which is 55% less power than an equivalent HPS setup. Although heat generation is no joke here, it is indeed much less than the comparable heat output of a 1000W HPS. With a cost of less than 80 USD per lamp you will be able to build these lamps at a far lower cost than the very expensive grow lights you can get online (which can often go for thousands of dollars for a single 1000W HPS equivalent). *If you read my earlier post you will notice that I previously thought you needed 4 cobs to reach the equivalent of a 1000W HPS, turns out you only need two 110V cobs running at 120V!*

I have made some PAR, lux and temperature measurements but I want to keep those for a future post where we will look at some of the spectral and thermal characteristics of this lamp vs other lamp types.

Building your own DIY high power LED lamp: Part One

It is no mystery that LED technology has evolved greatly during the past several years. We are now up to the point where anyone can buy LED lamps to replace HPS fixtures, with full spectrum LED configurations that have showed to be just as good – or sometimes even better – at growing crops (see here for a post about LED lights Vs HPS). However these lamps are often very expensive – most commonly around thousands of dollars to adequately replace a 1000W HPS. Within these series of posts I am going to talk about how you can build your own LED lighting to replace HPS lights for pennies on the dollar compared to commercial LED fixtures.

WARNING: Mains voltages (110-220V) can be extremely dangerous. Please make sure that you know what you're doing if you're going to follow these instructions. All of this information is provided "as-is" with educational purposes only. Make sure you follow all safety precautions when working on mains electricity.

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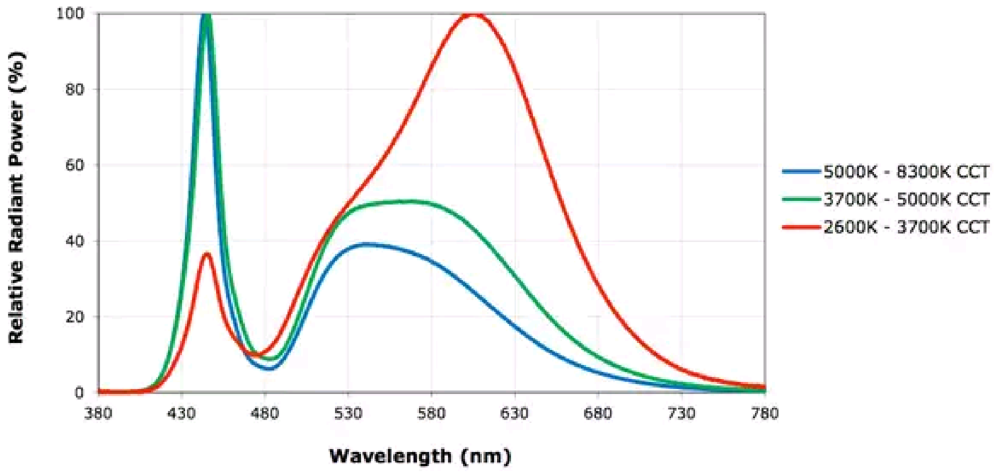

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There are several ways in which you could build your own LED lamps. This usually involves building an aluminium case with fans, putting an LED driver inside and then using that driver to power rows of different light emitting diodes. A driver is basically a transformer not unlike a computer PSU that takes voltage from the mains and dials it back down to a lower voltage that you can use across a row of diodes. Most commonly commercial lamps use combinations of 3W diodes with narrow focusing elements with sometimes higher wattage elements with wider focusing elements. Building a configuration like this can be done but it is a laborious that we can avoid using some of the latest advances in LED technology.

To make a simple high power LED lamp we should absolutely forget about putting together LED elements of different colors. This involves a lot of wiring and makes the lamp fundamentally more expensive. To replace them we can use white diodes instead which although far less efficient – as they are basically blue diodes whose light is absorbed and re-emitted by a phosphor – can give us all the different colors we need in the proportions we need them. The image above shows you the spectrum of different white diodes, as you can see we don't want the 5000-8000K or 3700-5000K LEDs – which emit a lot of blue light we don't need – but we need the much "warmer" 2600-3700K diodes which produce a lot of light in the red region of the spectra, with enough blue to provide us with close to a 1:3 ratio. Although this light spectra is still not ideal compared to what plants absorb it will easily able to replace a 1000W HPS.

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To make things very simple and avoid using a separate driver we can use 150W LED cobs that include their own driver and are fed directly with 120/240V electricity (like the ones [here](#)). As I mentioned we want the lower temperature spectra white diodes so go for the “Warm white” and make sure the temperature description says it is at least 3200K or lower (if you’re looking at another source). The publication above contains 150W cobs that can do 2500-3200K so they can be considered ideal for this application. For every 150W cob you install you should also install a 2A AC fuse for that cob only to ensure that if anything bad happens the power will be cut almost instantly. *Since these cobs are wired directly to mains electricity you should be specially careful with having proper safety precautions (proper soldering of the wires, solders protected with isolating material (like silicon) fuses for each cob, etc).*

Of course the cobs are only half the setup. We need to place these cobs on top of an appropriate heatsink and then also ensure we have fans for it. You can buy a properly sized aluminium heat sink here. Since cobs measure 16×40 we can comfortably glue two cobs to the bottom of a heat sink of profile A (146x22mm) with a length of 400mm. To glue the cobs to the heatsink you should use proper arctic silver thermal adhesive (you can find it here). For fans you can place 2 12cm Fans on top of the above. There are several fans that work with 120-240AC that you can use, for example these fans work with 120V. This setup will give us a 300W LED lamp, with 2 fans that should be able to keep the heatsink temperatures in check. All of this for a total of around 83 USD, let's call it 100 USD after adding fuses, cable and other parts you might require.

The above lamp will not replace a 1000W HPS on its own, for this you will need at least 4 cobs – meaning two of the above lamps – which should give you 600W of LED power that should be close to the PAR of a 1000W HPS light. This for the cost of only 200 USD (far less than the commercial LED replacement lights). I am in the process of making my own so I will be able to give you some additional details as soon as I get the parts and finish building my own setup. In part No.2 of this series of posts I'll show you the results of my work and what it does in terms of photon flux and PAR.