

Hello All,

I just wanted to take some time to share a really cool project that I am working on that I am calling the "Aquarius Alpha." This will be a prototype for a new computer that I may be building in the spring of 2015 if I see that it works and has longevity as the claims have promised. To start with, most of the people that know me well know that I am a pretty extreme computer nerd so what I am about to show you may sound a little scary at first but realize that this experiment is being done by experienced and knowledgeable hands.

First, a little bit of history:

A few years back, I made the decision to make the swap from desktops to laptops because it seemed like that was the direction that everything was going and the performance of laptops had increased dramatically since I first started using them back in college. Since then, I have mourned the fact that there really aren't a lot of bare bone kits where you can completely build your laptop from the ground up. That was a feature of desktops that I absolutely loved and the customizability assured that I would be able to overcome the common performance bottlenecks in most mainstream commercial computers. This was a great feature and I was able to build a desktop that took 4 years for the market to be able to match in performance which is when I converted to laptops. Since then, I have found laptops to be a lackluster in performance, I have had 4 of them now and they all had to be replaced within 2 years and one of them even less than that because the high demands that I placed on them fried it.

This brings me to my most recent laptop, I decided to splurge a little bit and get something with a bit more performance - the ASUS republic of gamers G75 model which was ranked the number 2 gaming laptop of 2013. The computer that beat it was an alien ware that would have cost over twice as much and I wasn't looking to spend THAT much. So I got the G75 and custom modded it to have a bit more RAM and I upgraded the standard hard drives to solid state drives in a RAID 0 configuration. Overall, I am very pleased with how the build worked out, the case is designed to have really good airflow so, even when maxing the performance, it still remains very quiet and I have not been able to crash it in about the 9 months that I have had it. That being said, even with such a high performance laptop, I still run into situation where it struggles with some of my higher demands. That means that I am considering re-entering the desktop market and that leads me to this experiment.

The Concept:

One of the things that I really disliked about my desktop was that, while it performed exceptionally well, it was also very loud because of the system fans. This was the case even though I took every precaution I could to keep the noise down, including adding a fan control so that I could slow the speed of the fans down when they weren't needed. When the fans were set to low, they sounded like a semi-muffled hair drier and, when turned up, it almost got as loud as my old Dodge Durango. That being the case, I have done some research on alternative means of cooling the system. I had heard of using water cooling in the past but, at the time that I originally researched it, it was still very experimental, expensive, and I didn't have the kind of money necessary to have something like that. Since then, things have apparently improved a lot in that market and I decided to start looking into that again. As I was going through all of the information on it, I can across this experimental system created by Puget Systems:

Video Demonstrating the system:

<https://www.youtube.com/watch?v=PtufuXLvOok>

A history of what they have learned from each of their builds:

<http://www.pugetsystems.com/mineral-oil-pc.php>

Looking at the claims that they made, as well as the pure "awesome" factor of the system, I was pretty impressed so I decided to learn more. It turns out there have been many people that have built systems like this. Of course, because it's on the internet, it must be true, right? Just ask the people that tried to make glow sticks out of mountain dew! I still am a little cynical about this idea but I have 2 sources that I consider to be reliable so I trust that this could really work:

The first source I found was a Revision3 System episode; I have always liked how they tell both the good and bad sides of things in their reviews:

<https://www.youtube.com/watch?v=ChOe6F1rZKQ>

My second source is Tom's Hardware, which has always been my go to place for hardware information:

<http://www.tomshardware.com/news/Server-Cooling-Hardware-mineral-oil,17348.html>

Finally, in many of the blogs and other information places that I went to, there seemed to be a general consensus that, while it may work, the cooling performance would be terrible. This goes against the claims that Pugen makes on their history page and a lot of the people that said it would do a terrible job had all said that they would never do it which meant to me that they have not even tried it. So I decided to look for people that have actually done it and made comparisons on the actual cooling performance of the system and this video of a custom build was the last straw that has sold the idea to me:

<https://www.youtube.com/watch?v=6sP45uBj4-k>

They hit on a lot of the points that I have had questions about and confirmed what I was hoping for that the system would be silent. So, with that, I have placed orders for all the parts that I need in my prototype (see details below) and I hope to have everything in the next week or 2 to start putting everything together. I will also see if I can do the same heat performance monitoring myself to see how well it works. I will be getting a temp sensor for the case but I don't know if the PC will have CPU monitoring capabilities.

Parts for the Aquarius Alpha Prototype:
(I will be posting pictures as the parts arrive)

The Computer Tower
AKA - the cheap computer I got off eBay
HP Compaq dc5700 specs:
CPU: Intel Core 2 Duo @ 1.80 Ghz
RAM: 2 GB
Hard Drive: 80 GB
Graphics: Integrated on the motherboard

There was no specific reason for choosing these specs for the computer, I just chose this tower because it was cheap and the listing specified that the insides had been cleaned out so there was no dust or gunk in there. This is important because you will want to keep your oil clean or it will look bad and possibly have negative consequences.

Since the UI hardware will have to be partially submerged in the oil to connect to the computer, I also picked up:
Cheap Walmart keyboard
Cheap Walmart mouse
Cheap Walmart mouse pad

Made a rough guess at how big of a tank I would need so I measured out a cheap Walmart tote that I think will work. It holds about 7 gallons which is close to consistent to the other smaller systems that have been built using this method.

I also had a spare monitor cable lying around as well as an old Wi-Fi antenna that will be used in this build. The wireless adapter will save me from having to string a LAN cable over and then having to scrap it when done. The adapter also has a USB extender/stand so I do not have to put the adapter itself in the oil so I can use it on another computer later if I need. It is a Rosewill RNX-N180UBE.

Monitor: Viewsonic 17" LCD with build in speakers.

Again, I didn't have a special reason for getting this monitor; it was just the cheapest one that I could find that was in working condition. I also like the aspect that there are speakers in it so that, if I decide I would like to try audio on it, I can just buy a cheap wire to connect it up.

5 Gallon Bucket of Mineral Oil

This will leave some additional room inside the tote so that I don't have to worry about spilling it everywhere while it should still cover all of the computer parts inside. This was definitely the hardest thing to find so make sure you call around a bit to see what you can get if you are planning a system like his for yourself. It is also not cheap; you are looking at about \$20/gallon for this stuff so make sure you are serious if you really want to do this. I may also get a funnel or siphon hose in case I want to destroy the prototype and reuse the oil or want to move it without worrying about spilling it.

Temp Sensor: XSPC LCD Temperature Sensor - Blue

This is the same sensor that Pugen systems uses and they had it mounted inside the case so there should be no major issues with submerging it in oil.

And last, but certainly not least, the most important part in this project:

Kidde 466204 Pro 10 MP Fire Extinguisher

I cannot stress the importance of safety enough for an experiment like this. This extinguisher has 10 pounds of extinguishing agent which should be enough for any issues that arise while still being light enough for me to be able to use it effectively.

The Future of this project:

Assuming everything works well with this, I want to build a new desktop completely from scratch, including the acrylic case sometime in the summer of 2015. These links show a guy that did the same thing completely customizing his own and he provides some good documentation on how he did it:

Finished Product Demo:

https://www.youtube.com/watch?v=XGcW7Ii_BKo

Blog where he kept track of his progress:

<http://forums.bit-tech.net/showthread.php?t=196511>

There are also several videos out there that show you how to make a fish tank using acrylic so I can think about that more when the time comes. Wish me luck; this should be an interesting experiment. ^_^

Updated 3/25/2014:

Most of the parts have now arrived and are assembled. The only thing outstanding at this point is the monitor, the one I received from eBay was damaged and I am ordering another which should be here by Friday. The mineral oil also just arrived today and it is still very cold from being outside so I will give that a few days to come back up to room temp. I may also pick up a spare USB hub from the store while I am there to avoid getting the rest of the cables dirty, I noticed how well that could work when I tried it with the USB ports on the main power switch and the length is short enough that I could probably get a laptop one and it would still work well. Other than that, I am very pleased with how well this has all been working so far.

There were a few bumps like the HP PC tower was entirely assembled using star screws (you have no idea how long it took to find my star screwdriver!) and there were a couple of layout changes to make everything fit but it is all coming together nicely. I have been taking notes about design improvement ideas when I build the real machine like this and there were a few things that you just don't learn until you actually assemble one for yourself. Assuming there are no issues with the monitor arriving on Friday I hope to have some test results this weekend.

Updated 3/30/2014:

Initial test results:

Overall I am very pleased with how the system works. On putting the oil in, it dropped the case temp by 10 degrees Celsius immediately. The same is true that when the PC is booted from a cold, room temp state, the temp stays lower than the air cooled system for quite a while, including the hour or so that it took to do my tests.

As a side note, when I was filling the case with oil, I heard a buzzing noise that I was afraid might have been frying circuits at first but when I looked, it turned out that it was just that the case fans were cutting through the oil so fast that it was creating a lot of noise and splashing, something to keep in mind if you do this yourself. Also, knowing that the splashing occurs while you are filling it, it is very important to make sure that whatever container you have it in is completely sealed. It turned out that the seal on the tote was not as tight as I thought it was and I ended up with a bit of spillage from all the splashing getting through the seal. Not a big deal, as soon as I noticed the problem, I just the system down and finished filling it and haven't had a problem since. If you make the same mistake yourself, dish soap is an excellent degreaser for mineral oil.

In regards of the noise reduction, I can confirm that the noise is almost entirely reduced. There is a slight gurgling noise, like a typical fish tank, but I believe that is only because the CPU fan is raised slightly and it is strong enough to pull air bubbles down. When I was feeling around the case, I could feel vibrations that matched the sounds and they were the strongest around the CPU fan. A note for future builds to make sure all fans are COMPLETELY submerged to make sure there is no noise. Another note for that, make sure you set your case in a place where it can be level so you can fill the tank full enough to do that. I did not think that through well enough and had to prop up one side to make sure everything was as covered as it could be.

On the topic of fans, a note should be made that the fan speed will be reduced by a lot as they are not used to pushing something as heavy as oil but I can confirm that they do still work great and create a lot of current in the oil to spread the heat out evenly. On air, my fans ran at about 1100 rpm and in oil they were around 190 so you're looking at probably about an 80% loss in rotation speed. All the sources that I have heard from say that this will not damage the fans over the long term and they have been continuing to work well in my system. I will post later with an update to this with any long term potential issues.

Finally, in researching this, I had heard that pin based processors (as opposed to slot based) can sometimes have issues in oil. The idea behind it being that oil has very low electrical conductivity and that can sometimes interrupt the connection between the pins and the motherboard. The processor in this system is pin based and I have not seen any performance issues with it. My guess is that this is related to the fact that they were using vegetable oil and I am using mineral oil. If you have concerns about this in your system, either use a cleaner, more pure oil or find a way to seal off your CPU to prevent this from happening - I have heard that others just use a silicone caulk and that works fine.

Cooling performance:

Again, this is something that I am very pleased with. I will post the actual results at the end of this section but I will discuss the details of what went into my testing to help get a fuller picture. Note, based on how much heat your system dissipates and how big your tank is, your results may vary.

Running in the tote with air ran consistently about 5-10 degrees warmer than the oil in all tests. It should also be noted that the oil runs were about the same 0-5 degrees warmer than just running the system in its stock case. So, the question would be, why even bother with this if it's not going to make things cooler? Well there is a bit of a discussion with that and it relates to the fact that the system that I built was strictly a prototype and not designed to deal with the heat as effectively as a real system like this should be able to.

The ideology behind what makes this a great idea is that it makes the system pretty well completely silent, which is nice by itself, and a real system should have a radiator attached to it so that the plastic case does not trap the heat inside. The problem is that oil tend to retain a lot of heat and, with plastic compounding the problem, there is nowhere for the heat to go. This was evidenced in my later burn test where I pushed the temperature as high as I could to see how high it would go.

In terms of the burn test, this experiment was a failure, I allowed the system to get up to 60 degrees Celsius and I became concerned about the safety of the system so I had to shut it down. Granted, the test took several hours (I believe it was around 10 hours total) which should be sufficient for most people's uses. You can always use more oil if you need more time than that. But, the radiator is supposed to be able to help dramatically with that so that is something I will have to test on my next build.

Another great side note on this is, after shutting the system down, I noticed it was cooling down to the touch very rapidly, even with room temp around 30 degrees, I was able to drop the temp to 41 degrees after about 90-120 minutes of the system being off and it is continuing to stay at 43 with me typing this up now so it is only with extreme power uses such as gambling for say 10 hours that you may have to exercise some caution.

Final Thoughts:

Again, overall I am very pleased with this build and it is a project that I would like to continue expanding in the future. I will warn you that this is definitely not cheap, the oil itself cost just under \$90 and, if building something bigger, I will probably have to get a real tank and not just a \$5 tote from walmart. The radiator and pumps will also not be cheap when I get around to buying those bit that is all stuff that I will cross the bridge when I get there.

Oh, also, one thing you might not think of is the system is INCREDIBLY heavy. Five gallons of mineral oil adds about 40 lbs to the weight of the system, given that most modern systems that are actually going to be put through a torture test could easily use 10-15 gallons, you're looking at potentially 150-250 lbs if you include the weight of the tank itself, make sure you have a desk that can handle that.

One additional note is that the in case temp sensor that I had the display gradually started fading, now all the numbers are gone but the light is still on. I am not sure if this is a factor of the oil ruining it or if I just got a defective unit. Regardless, I will be making a design change in future models to not submerge it.

Test results (all temps in Celsius):

Stock computer in the stock case it came in	Stock system in tote Before Oil	System immersed in oil
computer idles around 31-32 on core 50-51 on mb	computer idles around 37-39 on core 58 on mb case temp 42.2	computer idles around 31-33 on core 56 on mb case temp 35.9
highest sustained in generals 42 on cores 60 on mb	Highest ever in generals 51-52 on cores 69 on mb case temp 46.9	highest ever in generals 43-45 on cores 62 on mb case temp 40.3
highest sustained in passmark 42 on cores 60 on mb	highest ever in passmark 53-54 on cores 66 on mb case temp 46.0	highest ever in passmark 46-48 on cores 63 on mb case temp 40.6
highest ever in 3dmark 2006 43-45 on cores 63 on mb	highest ever in 3dmark 2006 53-54 on cores 71 on mb case temp 46.0	highest ever in 3dmark 2006 46-47 on cores 66 on mb case temp 41.3
highest ever in 3dmark 2005 42-44 on cores 61 on mb	highest ever in 3dmark 2005 52-53 on cores 70 on mb case temp 46.4	highest ever in 3dmark 2005 46-47 on cores 67 on mb case temp 42.0
highest ever in 3dmark 2003 41-43 on cores 61 on mb	highest ever in 3dmark 2003 52-52 on cores 70 on mb case temp 46.3	highest ever in 3dmark 2003 46-48 on cores 66 on mb case temp 42.8

Update 4/8/2014:

I have noticed a few things since my last update that are worth mentioning so I am posting a quick update about how things are going.

The first thing is that I have been asked if I experienced the same wicking issue that Pugen mentioned where the oil creeps up the submerged cords and drips. I can confirm that this is a real problem, I have not had enough oil to cause it to drip yet I can see a film of oil building on some of the cords and I need to wipe them off somewhat frequently.

I think that this issue may be related to another problem that I noticed that the oil is also having some problems with evaporation. The warm oil evaporates through the holes that I cut into the lid and have been leaving deposits on the hardware on the lid. So I need to reinforce my point from my comments before about making sure that the case is not only sealed but that you will also want to make sure that the system is steam proofed as well.

Finally, I have been noticing that there are black fluffy specks that are starting to show up in the oil. I am not sure if this is mold or just accumulated dust that had built up in the system and I wasn't able to see before that finally unlodged. When I did research on it though apparently mineral oil is supposed to be really good at preventing mold growth so I doubt at this point that it is a major problem but I will continue to watch it so see what happens.