Monday, June 9, 2008

Homemade Air Conditioner Version 4

I recently completed my latest creation. It's a very different design from what I had previously. This version attempts to deal with the small issue I encountered with my last design with regards to condensation buildup in the heat exchanger. Depending on how humid it is, you will get water pooling on the bottom of the heat exchanger (bottom of the "U"). This happens when the exchanger walls are at or below the dew point temperature. The level of water condensing isn't a lot, certainly not enough to block the flow of air, but I got around half a glass or so which I have to pour out after a day of use. Not a big deal, but it got me thinking on how I can modify the design so that I wouldn't have to bother with that. This led me to constructing a horizontal heat exchanger as shown in Figure 1-3. It's basically a flattened tube constructed out of the usual aluminum sheet I've been using so far.

The construction was fairly simple. It only took me a few hours. I used a 20 litre plastic container to house the heat exchanger and also hold the cooling medium which is ice-water in this case. I made the heat exchanger roughly 7 mm (0.7 cm) wide and 20 cm high to promote a high rate of cooling, and also to compensate for a shorter flow length than was used in the previous version. To prevent leakage the gaps were sealed with silicone (which happens to be DAP 100% silicone for this particular project - great stuff and it cures fast!).

Figure 1: Air intake

Figure 2: Air exit

Figure 3

The heat exchanger is tilted slightly downwards so that the end where the air exits is slightly lower than the intake end. This allows the condensate to flow "downhill" and into a small container I conveniently place just underneath the mouth where the air exits. See Figure 4.

Figure 4

The intake end (where the fan sits) was a little trickier to construct as I had to create an opening for the fan to fit snugly inside and transition that to the narrow intake gap. To do this I attached a flexible rubber funnel constructed out of silicone baking mats (left over from another project) and joined that to a sheet aluminum ring using a strip of old table cloth. See Figure 5-7. Everything was sealed and joined together with silicone as it's a great adhesive.

Figure 5

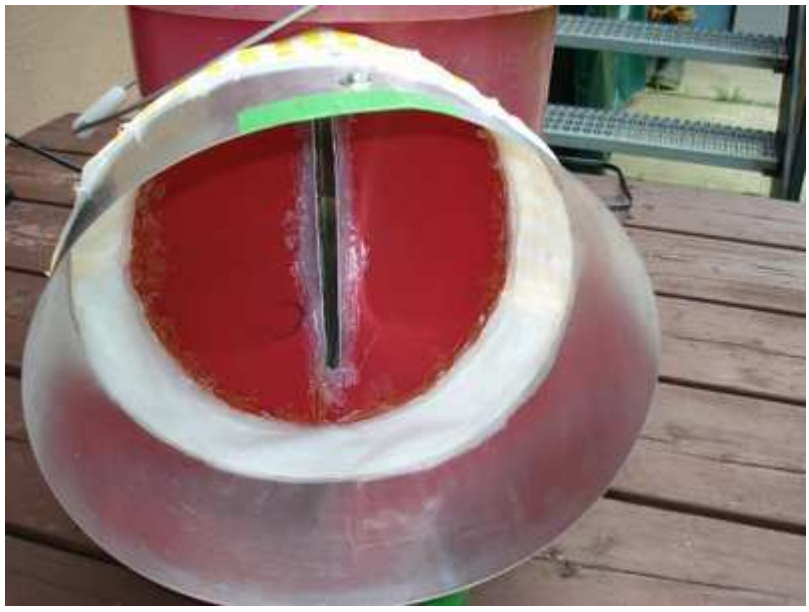

Figure 6

Figure 7

I measured the level of cooling to be slightly less than with the previous version. This was a bit surprising for me, especially given that the internal gap was a lot smaller than in the previous version. Also, the exiting air temperature distribution was quite uneven from top to bottom with the top being around 2 degrees Celsius cooler than the temperature of the air exiting at the bottom. The reason for this is twofold. First, the water pressure tended to push the two sides of the heat exchanger together creating a slight "pinch" at the middle. This separated the flow somewhat into two streams above and below the "pinch" region, resulting in poorer mixing (less heat transfer), especially for the bottom stream. And secondly, the flow length was somewhat short and straight. This discourages mixing

and heat transfer as well. With the previous version there was a longer flow length and the air was additionally forced around a bend (bottom of the "U") which encourages mixing/cooling and also results in a more even air temperature distribution at the exit - there was less than a 1 degree difference between the center and the two ends, with the center being cooler.

To reduce the "pinching" due to water pressure I filled the container with water only up to the top edge of the heat exchanger (Figure 8).

Figure 8

With a cooling medium (water) temperature of 16 degrees Celsius, and an ambient air temperature of 26 degrees, the air was cooled to roughly 22-23 degrees on average, between inlet and outlet.

Regardless, this version is decent enough, although you do have to turn the fan speed to maximum (or use a more powerful fan or blower) to get appreciable air speed coming out the exit (the air speed is less than with the previous version at the same fan setting). And the fan running at maximum is pretty loud which is a bit of a disadvantage. In the previous version, I can turn the fan on low and still get good air speed coming out. Good air speed is important because it helps cool the room faster.

If you're looking for something better than a stand-alone fan but maybe not quite as potent as a store-bought A/C, then this type of unit can work well. It probably works best if it's in close proximity to you, such as when you're sitting or sleeping.