Subject: Re: Heat exchanger effectiveness
Posted by Wayne Parham on Tue, 18 Jul 2006 20:34:20 GMT
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What I did last year was to measure temperatures and power levels, and to find out what power level would cause failure of a LAB12. I wanted to discover its most common failure modes, and found damage to be consistently due to thermal stress. I am sure that some mechanical failures occur in the field, but I found the driver to be durable in this regard. What always caused failure in my tests was thermal.

My tests consisted of running the driver with a test signal having a predetermined voltage level for a set duration (2 hours). After the run, I immediately measured DCR with a multimeter and temperature with a digital thermometer. Then the drive signal was increased after each test run and done again.

I measured to find the thermal limit in terms of time/power/heat, and I found it to be 1.5 hours at 40VRMS, using a 40Hz sine on for 15 seconds, then shut off 15 seconds and repeated. This was about 375 watts and resulted in approximately 195º Fahrenheit (90º Celsius) at the pole piece.

When the heat exchanger was installed, I could run the LAB12 at 60VRMS using the same signal indefinitely. That alone was enough for me to conclude that the cooling plug was useful.

cooling plug alone.

I intended to resume testing at some point, and some of the tests you've described were interesting to me as well. I think that the data I've provided is useful, but more could be learned. It is really a matter of time and resources. I've had a lot of projects to divide my time between.

But I do think that the cooling plug concept has more than proven itself. If the results weren't so overwhelmingly conclusive, I would have probably continued the tests last year to include more types of data.

As it was, I concluded that voice coil temperature is determined by several factors:

1. Ambient temperature
2. Direct "filament" heating from voice coil current
3. Re-radiated heat from the pole piece

The voice coil is rapidly heated by a large signal, and some of this heat is carried away by air through the cooling vent. This cooling mechanism has not been interfered with by the cooling plug. Air cooling is neither improved by or impeded from the cooling plug.

I don't think voice coil air cooling can be improved much, because the air moving through the cooling vent is not heated by the voice coil. That means not much heat is getting transferred into the air in the first place, so forced air cooling would probably not improve cooling by a significant amount. That is why I abandoned the idea of improving air cooling with the air-to-air heat

exchanger arrangement.

However, a great deal of heat is radiated into the pole piece, which then re-radiates back into the voice coil. This heat is not carried away by the cooling vent. Radiated heat is removed by the cooling plug exclusively. Without a cooling plug, the heat remains in the motor.

Since the cooling plug reduces temperature of the pole piece by a significant amount, it is able to reduce the re-radiated heat. I think this is a very important factor for durability, and the tests confirm that the LAB12 is able to sustain higher power levels with the cooling plug installed.