Subject: Loudspeaker motor cooling methods
Posted by Wayne Parham on Fri, 15 Sep 2006 15:18:39 GMT
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Lots of loudspeaker companies are looking into the use of radiated heat as a transfer mechanism these days. I think the use of forced air convection is good, but it has pretty much been fully explored. I'm not sure why the use of radiation as a transfer mechanism had been overlooked, because it has proven to be very effective. Now, this technology is rapidly gaining acceptance and becoming popular.

Before coming up with the cooling plug idea, I had made a prototype cooling system that used forced air cooling with an intercooler to remove heat. It used the speaker cone as an air pump, and it ducted hot air out to a heat exchanger. A valving mechanism was used to introduce unidirectional flow. No moving parts were required, the valves used air turbulence to direct airflow. In my system, attention was paid to making sure that airflow was good but also that there were no pressure differentials that would adversely affect loudspeaker performance. A pressure differential across the cone causes cone offset and nonlinear cone movement. This causes distortion. So my system was designed to avoid this.

The heat exchanger idea I came up with was fairly simple, just a couple of valves, some ducts and a heat exchanger. It worked very well. But as I was testing the prototype, I realized that the air cooling mechanism provided by venting already worked pretty well. The cone was a very strong pump, somewat inefficient because it isn't valved, but still able to provide a lot of airflow and a good amount of forced air cooling.

Another possible forced-air cooling method is to use a separate air pump to pump air through the voice coil gap, using either positive or negative pressure. Of course, this brings the potential problems of cone offset and added complexity. Whatever you do to provide airflow requires a pressure differential. No air flows unless pressure is provided. Air pressure in the gap requires air pressure against the back of the cone, which causes offset. That in turn generates an asymmetry, which causes distortion and reduced excursion capacity. A mechnism could be made which sealed the voice coil from the cone, but this is a whole lot more complex. And I would argue that if one were to do this, it might be better to go one step further and fill the sealed gap space with a better heat conductor like ferrofluid or oil. So the bottom line is that the use of forced air cooling is somewhat complex to do properly. To do it improperly will hurt performance, making sound quality suffer at the expense of improved power handling.

I decided to abandon the air-cooled mechanism. The benefits were far overwhelmed by the added complexity. My measurements also indicated to me that the forced air convection from the cooling vent was working pretty well all by itself. Additional forced air might help some, but not nearly as much as what I could get by conducting the radiated heat away. This had not been explored, and so it is where I could get the most benefit.

Heat is transfered by convection, conduction or radiation. Any of these mechanisms can be used to remove heat from the voice coil. Forced air convection using a fan is a common-sense approach, but it is not the only way. Radiation is also very effective.
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