Wet Inductor Tests

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Large, hopefully high Q, inductors are used at the base of most LFMF transmitting verticals, normally out in the weather 24/7. Some form of enclosure usually covers the coils but they can still be quite damp and perhaps even have some icing. Other than blocking off any low spots in my inductor enclosures to prevent puddles when raining I've given very little thought to the effect of moisture. Recently Brian, K6STI, sent me a link (http://www.n3ox.net/tech/coilQ/) to a note reporting some experiments on wet inductors. The news was not good, moisture does not benefit Q! After some discussion with Brian I ran a few simple experiments on two large coils using an HP4342A Q-meter to judge the effects on Q. All the Q measurements were made at 475 kHz. In each test the Q-meter Cr was adjusted to re-resonate by adjusting for peak Q on the meter. Most of the experiments were repeated to check consistency.

Experiment 1

I had on hand the bucket inductor shown in figure 1. L≈650uH.

Figure 1 - Bucket inductor.

I began with the coil dry: Q=460. Using a spray bottle, I sprayed water over the outside of the winding to simulate rain: Q=200! The coil was not happy being wet!

Experiment 2

The next test used the bare #12 wire coil on a PVC cage shown in figure 2. L≈1 mH @475 kHz.

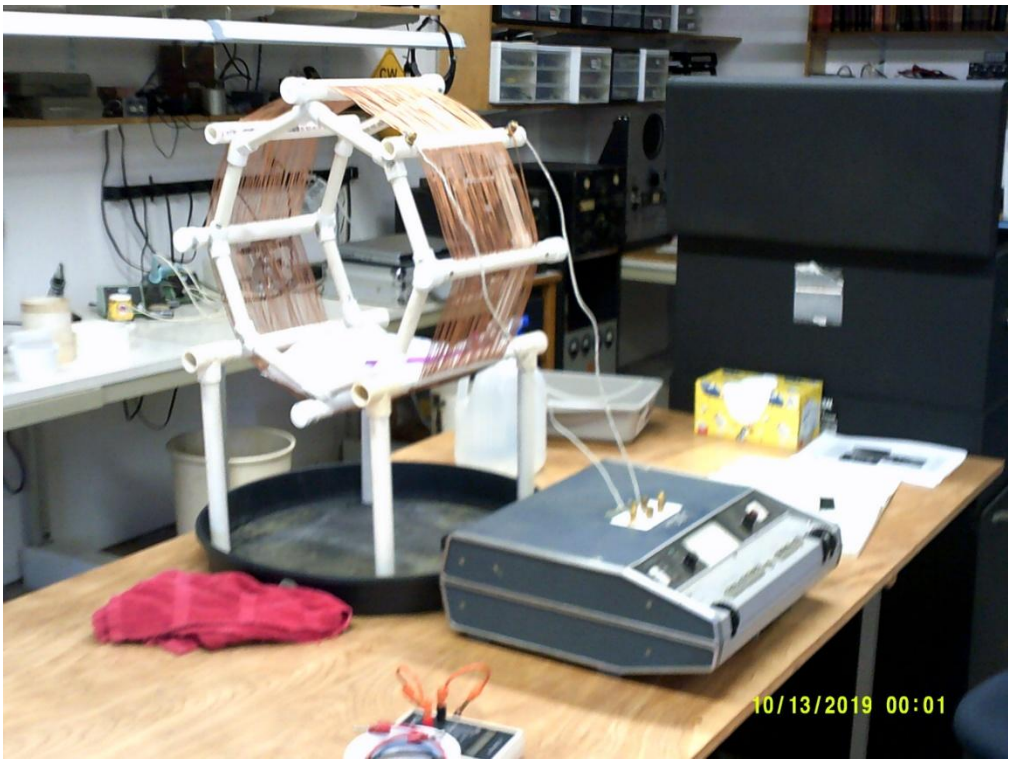

Figure 2 - PVC cage inductor.

Note: in the photo there is a plastic bag of ice lying in the bottom of the coil. The ice was placed there later in the experiment. The initial test was a dry coil, Q=700 which was then sprayed: Q=400. Wiping the coil with a towel the Q increased to 500 and slowly rose as the coil dried returning to 700 after some hours. This coil was very sensitive to even a small film of moisture.

The water used for the initial test was from my well which has a very small amount of salt in it. As a check I bought a gallon of distilled water, rinsed the spray bottle carefully, and when the coil was again dry, re-sprayed it with distilled water: Q=530. Then I switched back to well water and re-sprayed: again Q=400. One might argue that rain water is closer to distilled water than my well water but any inductor outside will have deposits from the air and rain water also brings down local pollution so I don't think the improvement using distilled water is cause for joy. Up to this point the shift in Q-meter Cr was very small, a pF or so, essentially all the variation in Q was due to additional loss not a shift in self-resonant frequency (fr).

Experiment 3

Brian had suggested that ice might have higher losses than water so I ran a test. As shown in figure 2 I placed a bag of ice from my refrigerator inside the coil: Q=250, not good! To see if ice had more loss than water I allowed the ice to thaw completely and then put the now water-bag back in the coil: Q<200. That looks like the ice is less lossy than water but I think that's deceiving. The ice was pretty lumpy and the contact with the winding intermittent but when thawed the bag of water lay much closer to the winding. In practice I think the ice and water have the same effect. Outside in icing conditions the ice might very well build up a much thicker layer on the winding than a thin film of water so the effect might be much greater.

Experiment 4

I wanted to see if water on the outside of an enclosure would have any effect so I placed a plastic bag over the cage inductor as shown in figure 3. Note, the bag is quite close to the coil. I sprayed the outside of the bag with the coil connected to the Q-meter: no observable effect. Now if the bag had heavy icing then maybe it might make some difference but I was not able to run that experiment.

Experiment 5

During all the earlier experiments the shift in Cr was quite small, a pF or so, even when Q was severely reduced. Just for the heck of it I placed the one gallon jug of distilled inside the coil: Q dropped from 700 to 360 and Cr was reduced by 5 pF. This was the only time I saw a significant shift in Cr, which would be a dielectric effect.

Figure 3 - Coil with plastic cover.

Conclusions

This series of experiments were hardly rigorous, I'm not expecting any Nobel nominations, but I think they convincingly give the message: keep your coils dry and out of the weather <u>and condensation</u>. To fight condensation the enclosure needs to be, drained and ventilated but be careful, don't make the vent holes large enough for the bees and wasps to get in. A hornet nest in the coil does not improve Q!

The rule of thumb suggesting the walls of any enclosure, soil or other objects be at least one coil diameter away from the coil seems like reasonable advice.