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To further understand the effect of heat and temperature on the stability of thermally upgraded magnet wire paper, Cindus Corporation in cooperation with Cooper Power Systems conducted the following study.

The two papers studied differed in how the insuldur upgrade was added. The insuldur upgrade was added either by Lydall on the paper machine or by Cindus during the creping process. These two papers were conditioned at three different elevated temperatures. Conditioning times were selected with the intent of using time/temperature combinations equivalent to 100 C for 20.5 years. The three conditioning times were calculated using the proposed IEEE Std. C57.100-1999 test procedure equation A-2.

The % tensile retention did not respond as predicted by equation A-2. Based on equation A-2, the % tensile retention should be statistically the same at all three of the time/temperature combinations, but they are not. (See attachment) Likewise, the CO gases evolved should be the same at all three of the time/temperature combinations tested and they are not. (See attachment) The constants A and B used for the calculation over-estimate the conditioning time required at elevated temperatures. This leads to more thermal decomposition at the higher test temperatures than the 100 C for 20.5 years that the conditions are intended to simulate. By extrapolation, the % tensile retention at 100 C after 20.5 years for the two samples tested would be over 90%. Assuming a similar response curve at other nitrogen contents, using the single temperature data point available for Cindus at 0.30% nitrogen from a previous study extrapolation predicts over 90% tensile retention after 20.5 years at 100 C, which safely exceeds the minimum target of 50%.

There is another flaw in equation A-2. There is no reference to the temperature range over which its use is appropriate. Attempts to use this test procedure at temperatures much above 170 C would result in interference from oil breakdown and at still higher temperatures could result in paper combustion.

A conflicting effect needs to be considered in selecting the ideal insuldur content. As the insuldur content is increased the insulation properties of the paper decrease as measured by the aqueous extract conductivities. (See attachment) The decision on desired insuldur content becomes how to balance the thermal aging with the insulation properties. I would submit that a broader range of nitrogen contents result in the desired results than the flawed equation A-2 would predict.

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