Thermal Analysis of HV Cabling

Notes

This is a heat transfer analysis of $16mm^2$, $20mm^2$, and $25mm^2$ standard Coroplast 1000V DC cable. This analysis uses the below equation to predict temperature gain found in ”Fundamentals of Heat and Mass Transfer 7th ed.”.

$$\frac{dT}{dt} = \frac{I^2 R'_e - \pi D h (T - T_\infty) - \pi D \varepsilon \sigma (T^4 - T_{surr}^4)}{\rho c (\pi D^2/4)}$$

Where:
I = Current
R_e = Specific Electric Resistance
D = Conductive Core Diameter
h = Convection Coefficient
ε = Emissivity
σ = Boltzmann Constant
ρ = Conductor Density
T = Conductor Temperature
T_∞ = Black Box Temperature
T_{surr} = Ambient Surrounding Temperature

The above equation is solved in Matlab and a current profile from a worst case Autocross run is applied. This profile assumes thermal constraints from the tractive system are not active (i.e. motor derating) and a step torque request during all straights in the 2015 Michigan Endurance course (reverse Autocross course). This profile also assumes a 600V pack.

The initial conductor temperature is assumed to be at ambient for this analysis, with the ambient temperature increases through the simulation from 303K to 318K.

The Coroplast 1000VDC cable has the following characteristics:

Table 1: Coroplast Characteristics

Cross Section [mm^2]	Diameter [mm]	Resistance [mΩ/m]	Max Temperature [K]
16	5.8	1.16	453
20	6.9	0.96	453
25	7.2	0.743	453

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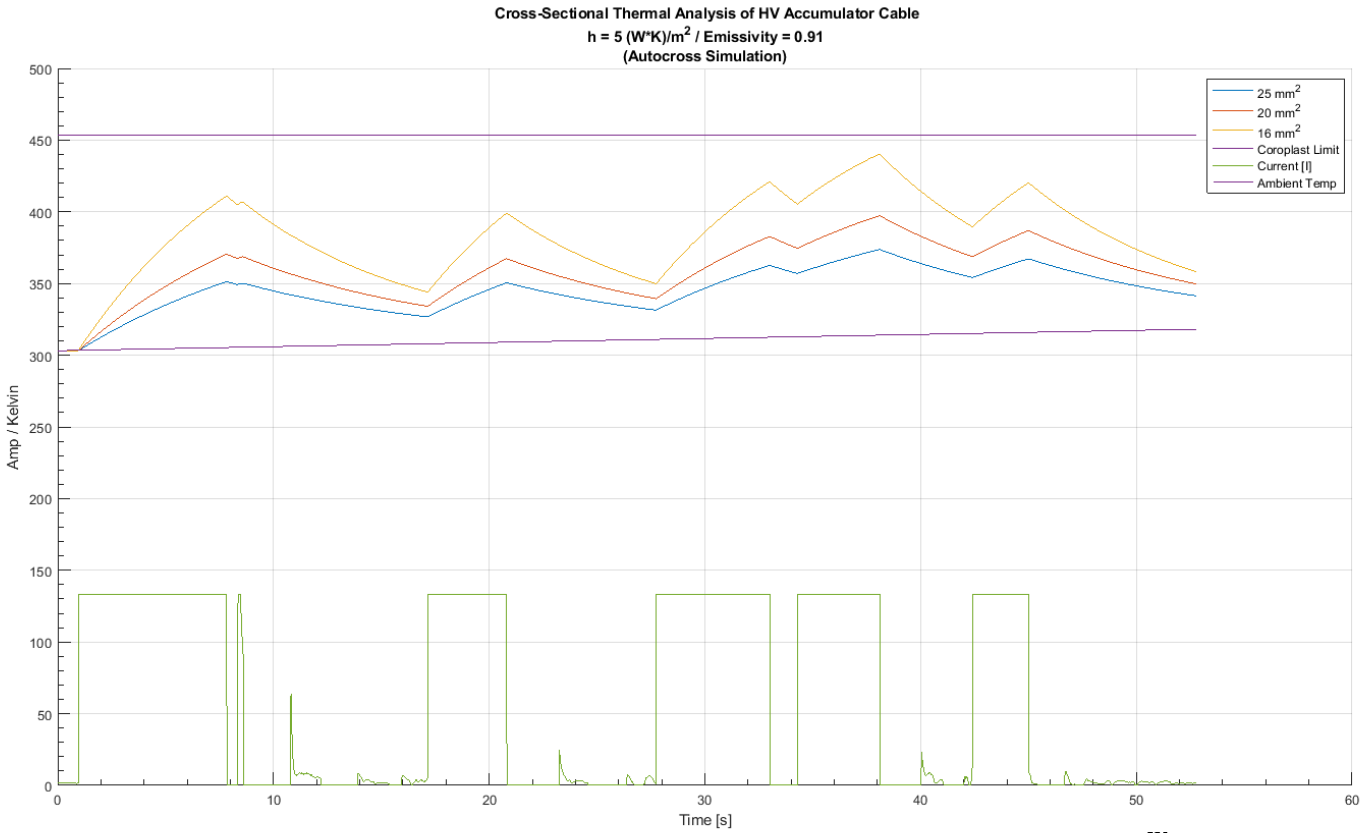

Figure 1: Autocross HV Cable Simulation with a Convection Coefficient of $5\frac{W}{m^2}K$

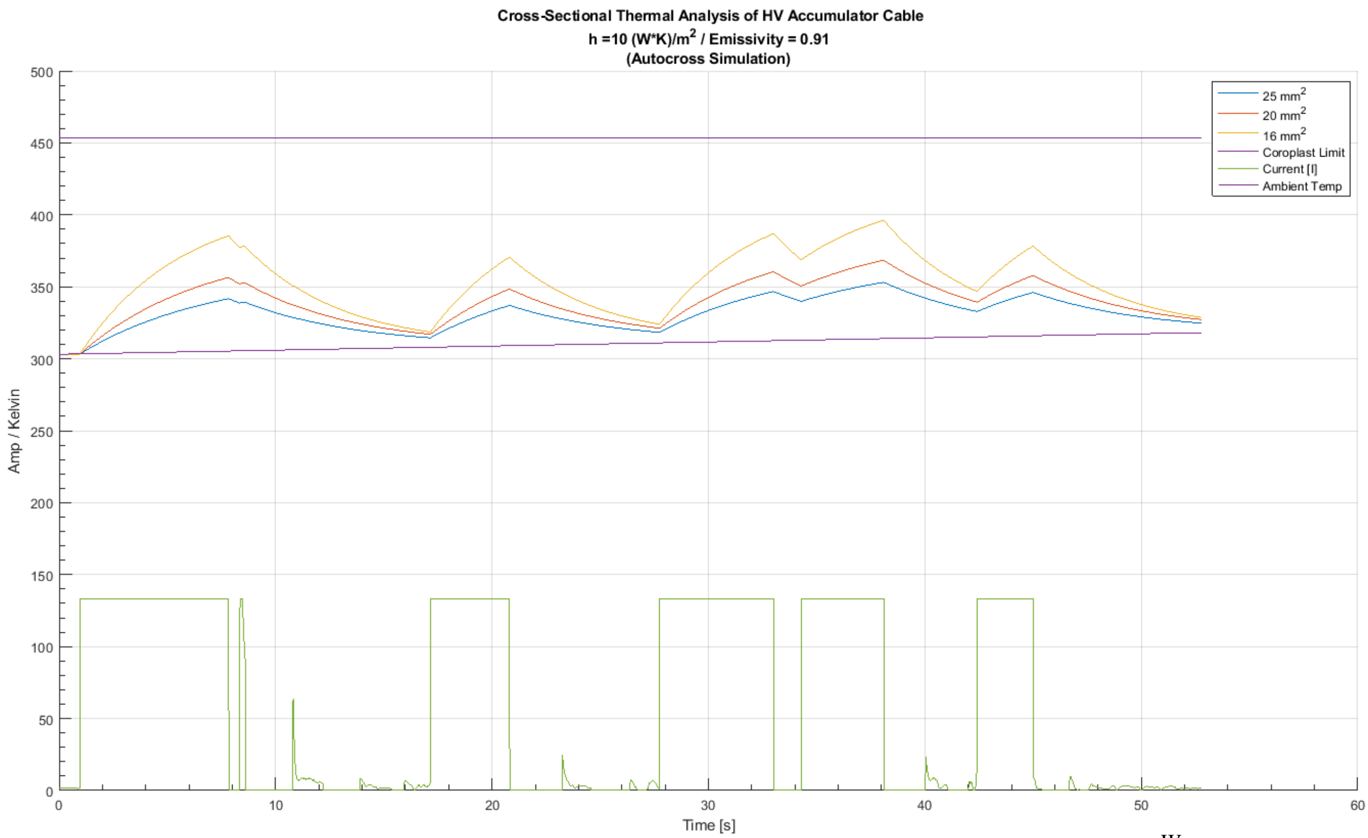

Figure 2: Autocross HV Cable Simulation with a Convection Coefficient of $10\frac{W}{m^2}K$