2D Simulation of Crimping Process for Electric Vehicle Battery Charge Cable

O. Ozgonenel[1], O. Bostan[2], S. Guzel[2]
1. Electrical & Electronic Engineering, Ondokuz Mayis University, Samsun, Turkey
2. Research & Development Unit, DE-KA Elektroteknik, Kocaeli, Turkey

INTRODUCTION: In this study, the design of the domestic Electric Vehicle Charging Cable will be implemented in accordance with IEC 62196-2 standards and different from similar products, in which high performance values can be guaranteed in terms of electrical and physical characteristics. Of utmost importance in appliance design and manufacture are the features for protection from fire and for personal safety. Appliance engineers are continually in pursuit of better, longer-life appliances that will provide both lower cost to the consumer and lower energy consumption. Therefore, a 2D simulation of crimping process has been proposed using COMSOL® software. Convective and conducting heat analysis results may help engineers decide the optimal crimping shape and process.

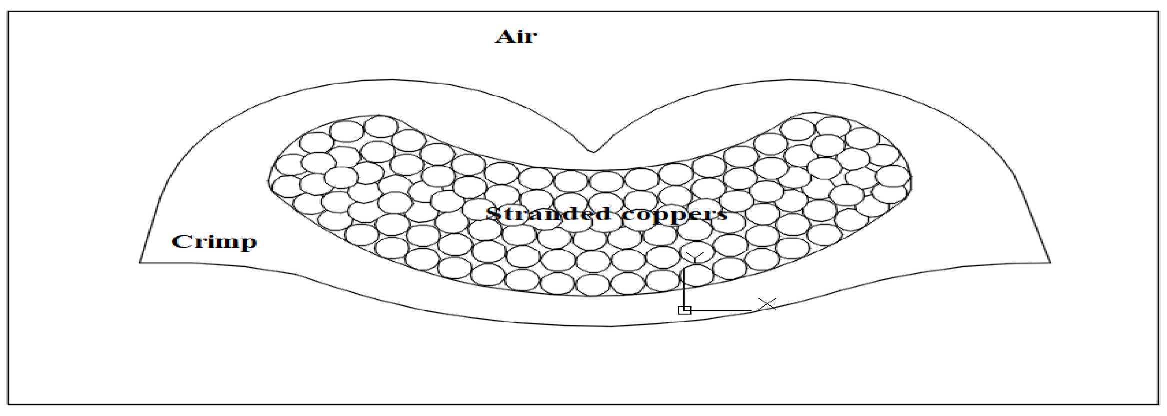

Figure 1. The proposed crimp structure

COMPUTATIONAL METHODS: 242-stranded copper wire with a diameter of 0.2mm is used in crimp process. Crimp material is chosen as silver and surrounded by air in the COMSOL® model. Nominal electric current of 63A is defined as rated current representing battery charge cable for electric vehicle. The model uses both electric current and convective heat transfer modules. Heat source is the total power dissipation density from electric current physics. The simulation time is set to 60min as defined in standards. Then performance curves of temperature and power dissipation are obtained. According to the simulation results highest temperature is 71°C and total power dissipation is 2.04mV/mm^3. The model has the following modeling strategies.

a) Electric Currents physics and

b) Heat Transfer in Solids.

Heat source is the ***total power dissipation density*** from electric current physics. Stranded copper wires are defined as '***terminal***' as a source current while the outer boundaries are defined as ***ground***. Heat transfer in solids physics consists of convective heat flux and surface to ambient radiation sub-features. Time dependent solution is chosen as Study Step with a relative error of 0.01. The time interval is defined as ***range(0,1,60)*** with time unit of min. Materials are defined as follows:

a) Air for the crimp environment,

b) Copper for the stranded conductors, and

c) Silver for the crimp.

RESULTS: One of the most important concept for charging cables is the design of crimping structure. For this reason, this paper investigates the possible crimping structure in comply with the IEC 62196-2 standard. The proposed crimping design is found suitable in terms of related standard.

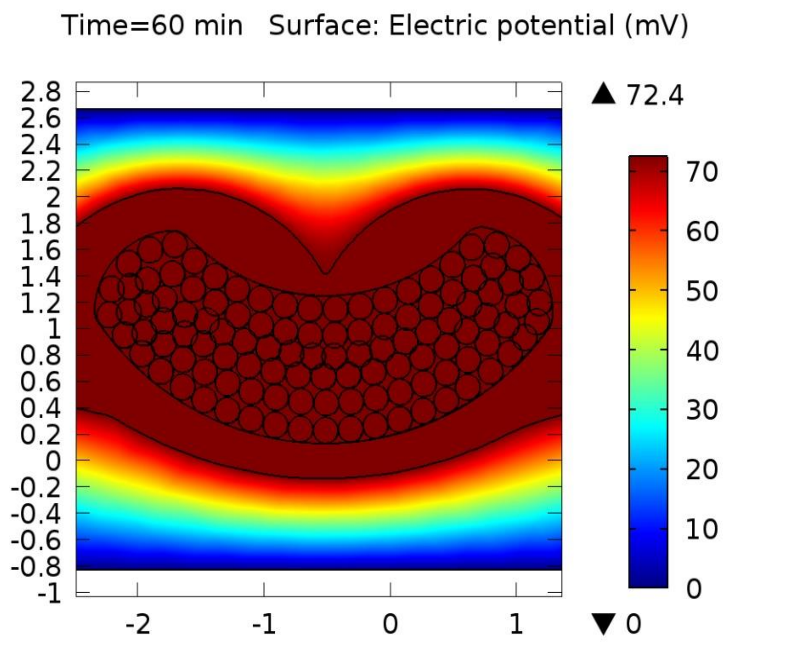

Figure 2. Electric potential distribution

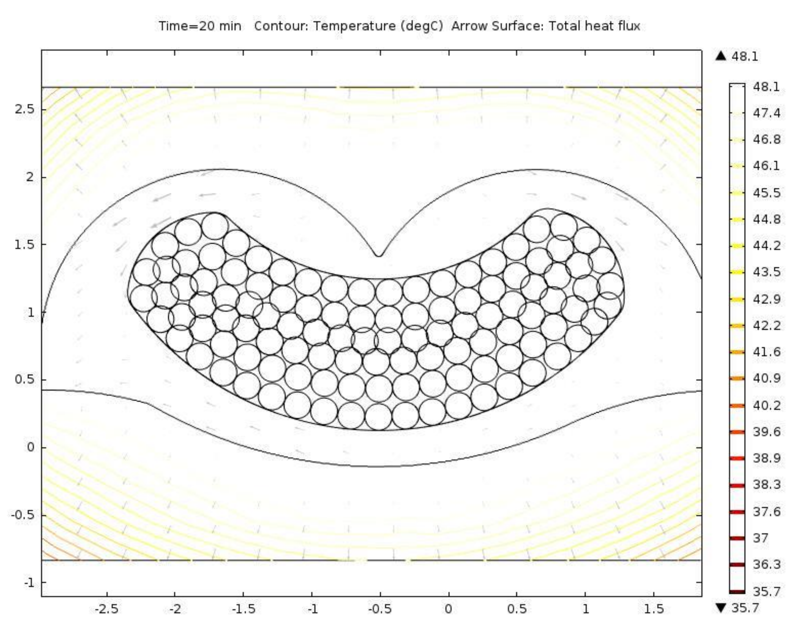

Figure 3. Temperature distribution

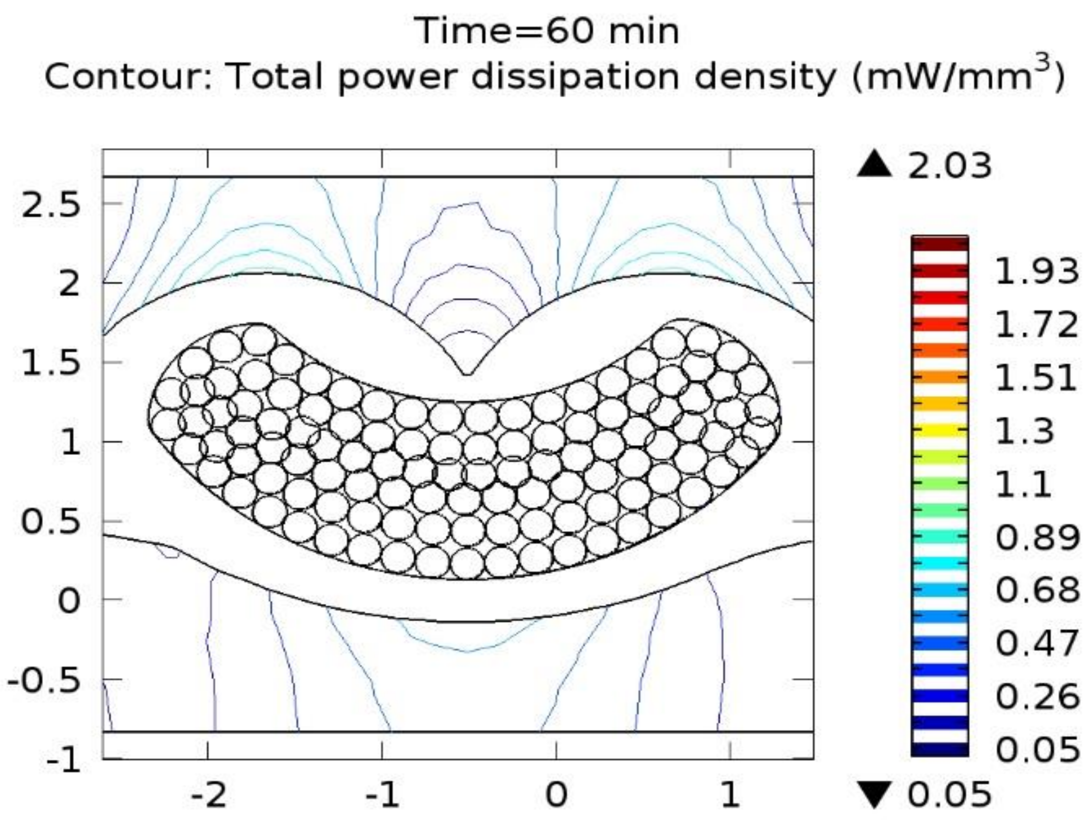

Figure 4. Total power dissipation

CONCLUSIONS: Today, most European automobiles, including Tesla, as well as BMW, Audi, Porsche, Volvo, Porsche and Mercedes, use a Type-2 charging cable in most car connections. The vast majority of public charging points have also implemented charging points that provide service through Type-2 connectivity. All cars except Tesla brand cars can be charged with the same Type-2 plug. Tesla vehicles can be charged with specially designed "Type-2 Mennekes" plugs that allow 80% battery charge in 30 minutes and no other vehicle can be charged with this cable. The proposed crimping structure is found compatible with Type 2 plug.

REFERENCES:

1. X. Li, H. Xu, P. Dai, Y. Bai, J. Zhu and Y. Chen, Research and discussion on electric vehicles charging cable testing methods in different standard systems, 2015 5th International Conference on Electric Utility Deregulation and Restructuring and Power Technologies (DRPT), Changsha, 2630-2633, 2015.
2. H. Zhang, Z. Hu, Z. Xu and Y. Song, "Optimal Planning of PEV Charging Station With Single Output Multiple Cables Charging Spots," in IEEE Transactions on Smart Grid, vol. 8, no. 5, 2119-2128, 2017