Design of Blood Warmer Medical Device

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Abstract

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Abstract
Multiphysics simulations were performed for designing the blood warmer accessory of a dialysis machine. As part of the design and development of the blood warmer the multiphysics simulations were performed to study the functional performance. The entire design and development path of this project was from the product requirement specifications to the finished product prototype. Though the complete product design and development involves multiple engineering teams, only the multiphysics simulations driven product design is the focus of this study. The study was done for a Medical devices OEM which designs, develops and manufactures dialysis machines.
Dialysis is a process in which the impure blood is cleaned and infused inside the body. There is an issue called hypothermia which occurs if the blood is infused at a temperature lower than 37.6 °C inside the human body. Blood warmer is an accessory device in the dialysis machine which has to be precisely controlled in order to avoid this fatal condition of hypothermia.
The Blood warmer assembly consists of the heater plates, the heater coils, the blood flow path and the control system. The multiphysics simulations involve coupling of Electrical, thermal and fluid physics.
Multiphysics Simulations played a central role in design and selection of electrical heaters, design of enclosure and blood flow path. giving inputs to control systems team.
In the initial base design, the heating coil was placed over the entire heater plate. The fluid flow path was optimized by designing a customized heating coil over the flow path.
The interpretation of spatial thermal distribution results revealed that hot spots were created at the bends. At the bends, low velocity regions are created because of which higher heat energy is absorbed. The temperature values across the depth and breadth were plotted from the thermal distribution plots, which was used for precisely locating the heat sensor. The power vs Flow rates graph was used to plug in the control system algorithms.
This blood warmer is energy efficient compared to other existing blood warmers, with less than 400W for 450 ml/min flow rate. The blood warmer with the highest precision of within ± 0.5 °C will be launched soon.