simulation-aided design of a medical blood and fluid heater.

CFD FOR DESIGN IMPROVEMENT

CORE COMPETENCIES

1. Product development
2. Computational fluid dynamics
3. Thermal flow
4. Experiments

Goal

The Surgical Company has introduced the Fluido®. With this medical device, blood and fluids can be heated in a controlled way. It is used in hospitals during operations when patients require a blood transfusion. The Fluido® can be a life saver when the blood is added at body temperature instead of room temperature, or even lower, especially when the patient requires a large quantity of blood.

Demcon advanced mechatronics b.v. and Indes have developed and optimized a new heating principle and temperature control. The device contains a disposable with a liquid which is heated up to body temperature with Infrared Radiation (IR) before it can be injected in the patient's blood circulatory system. The liquid may consists of a saline, but also of a blood-like substance with 60 volume percent red blood cells, referred to as blood plasma.

Figure 1 The Fluido device

DEMCON | MULTIPHYSICS

Approach

During the development of the blood heater it appeared that the flow pattern in the disposable is critical during the heating process. In previous experiments it was found that due to 'dead' zones and recirculation regions in the disposable, some red blood cells became too 'hot', leading to a risk of degradation of these blood cells.

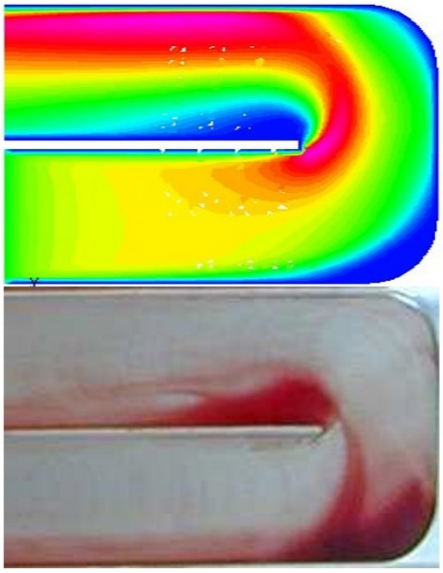

Figure 2 Comparison of simulation results with experiments

In this study the geometry and the flow pattern of the disposable were optimized, in order to remove these recirculation and dead zones and to improve mixing of the fluid. A main focus in this study is the reduction of the dead zones in a single flow turn in the disposable.

The flow was optimized using CFD-calculations with the use of ANSYS CFX. We started with the comparison of CFD-results with experiments to obtain the correct settings for the CFD-calculations. Subsequent calculations were performed on geometries that were defined based on advancing insight.

Results

Different geometries were investigated. First, the flow turn was optimized such that the recirculation region was resolved. Subsequently, vanes have been added in the flow turn to improve mixing between cold and hot regions. As a criterium for the performance, the flow and temperature variance on the outlet area of the disposable were used. In the final design, the flow and temperature variances were significantly reduced. This is considered to be a major improvement.

Figure 3 Disposable heat exchanger

The final geometry was tested experimentally. This product performed very well and eventually led to a successful market introduction. The Surgical Company obtained a patent on the final geometry, which ensures protection of their Fluido®. The Fluido® was granted CE-marking, which means that the fluido can be sold worldwide. Also, the Fluido® is Cardiac Floating, which is the most strict electrical safety degree. As a result the Fluido® can be applied everywhere, on all catheters and central lines, even directly into the hart.