

The heat fluid analysis that drying and the humidification of the mucous membrane in the nasal cavity

Kazuyoshi Kitagawa (0810018)

School of Information Science,
Japan Advanced Institute of Science and Technology

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1 Background and purpose of research

The nasal cavity is space between the throat from the hole of the nose, that has complex sharp. The nasal cavity is an important organ related to breathing, that have various functions. The main function is temperature control, humidity adjustment. Other functions are a function to remove garbage, a function to select a voice as, sense of smell functions. Suction air is warmed in moderate temperature or it is cooled and that is humidified the moderate humidity in the nasal cavity. It is thought that these effects are big. In this paper, I focus attention on the function of temperature control and the humidity adjustment. The nasal cavity wall surface is covered with a mucous membrane and there is secretion from a mucosa on the surface. These coordinate a capacity and quantity of secretion depending on outside environment. In the previous study, it simulated temperature and the humidity with a thermal conduction model and a humidity model. In the present study, I study the influence that a change of the humidity gives to a change of the temperature. I clarify temperature in the nasal cavity and relations of the humidity in the nasal cavity.

2 Method

In this research, heat fluid analysis using three dimension nasal cavity shape structured by computed tomography images. I apply a heat of vaporization model for boundary condition of the nasal cavity shape, and perform heat fluid analysis. About a heat of vaporization model, There is the wall of the same temperature distribution between a nasal cavity wall surface and air, and the nasal cavity wall surface is always covered with a film of the water with enough water. A heat of vaporization is expressed by the product of mass flow rate and latent heat of vaporization. So this heat of vaporization term combine with the thermal conduction model, It can know the influence that the heat of evaporation gives to a temperature change in the nasal cavity. Basis equation are equation of continuity, Navier-Stokes equation, energy equation and advection-diffusion equation of water vapor. I solve these equation all together.

3 Result of CFD

At first, I performed heat fluid analysis with a simple model. And I compared the calculation result of the heat of vaporization model with the calculation result of the conventional model, I confirmed the effect of the heat of vaporization model. Secondly, I adapted myself to nasal cavity shape, and a heat fluid analyzed a heat of vaporization model. And I compared the calculation result of the heat of vaporization model with the calculation result of the conventional model, I confirmed the effect of the heat of vaporization model in the nasal cavity. In addition, I examined it about temperature distribution and humidity distribution when I changed temperature and relative humidity of the suction air. In the result, When I used a heat of evaporation model, I showed that a warming function, a cooling function and a humidification function were high. Finally, I compared it with the temperature, the humidity in the real nasal cavity and the calculation result of the heat of vaporization model.