

Title	潜熱の影響を考慮した鼻腔壁面モデルを用いた鼻腔内流れに関する研究
Author(s)	埴田, 翔
Citation	
Issue Date	2014-03
Type	Thesis or Dissertation
Text version	ETD
URL	http://hdl.handle.net/10119/12105
Rights	
Description	Supervisor:松澤 照男, 情報科学研究科, 博士

Simulation of Nasal Cavity Flow using Heat and Vapour Transport Wall Boundary Model

Sho Hanida

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

March, 2014

Abstract

Among the several functions of the nasal cavity, temperature and humidity adjustments are important for preserving the trachea and lungs. The functions of the nasal cavity have been clarified in experiments investigating the condition in the nasal cavity. However, the difficulties of noninvasive measurements have rendered nasal cavity simulations an attractive alternative. Data are readily obtained from a simulated result.

In this study, airflow, temperature, and humidity transfer in the human nasal cavity were investigated in nasal cavity wall model of temperature and humidity transport. The nasal cavity wall model was examined by simple geometry such as straight pipe. The simulated result was verified by comparison with experimental data. A reasonable agreement was attained between experimental data and a model incorporating the latent heat effect. The model simulates heat and water exchange in the nasal cavity.

The four inhalation cases (hot-dry, hot-humid, cold-dry, and cold-humid) were simulated. In all cases, temperature and humidity of inhaled air were adjusted to suitable physiological values. Temperature and humidity gradients were highest at the front of the nasal cavity. The influence of latent heat was clarified by comparing simulation results with and without latent heat under several inhaled air conditions. In the hot-humid inhaled air case, temperature in the Kiesselbach area was increased by latent heat of condensation, and relative humidity declined. In the other inhaled air cases, the temperature in the Kiesselbach area was decreased by latent heat of evaporation, while relative humidity increased. Latent heat effect was particularly influential in the dry inhaled air case. The latent heat is one of the key factors of temperature and humidity adjustment function.

The breath is an unsteady phenomenon that consists of inhalation and exhalation. The nasal cavity simulation under unsteady conditions was examined. A little unsteady characteristic of nasal cavity flow was observed. However, the nasal cavity simulation under steady conditions is possible to examine flow, temperature and humidity in the nasal cavity.

Moreover, the several nasal cavities were simulated to examine individual characteristics of the nasal cavity. The difference in flow, temperature, humidity distribution was not observed between several nasal cavities.

The physiological function of the paranasal sinus was examined by computational fluid dynamics (CFD). In this examination, the maxillary sinus that has the largest volume

in the paranasal sinus was focused. The flow, temperature and humidity was examined by CFD. The difference of flow, temperature and humidity in the nasal cavity was not observed. It is assumed that the maxillary sinus has not supporting function for heat and humidity adjustment.

Key Words: Nasal Cavity Simulation, Nasal Cavity Wall Model, Latent Heat, Temperature, Humidity, Computational Fluid Dynamics