Proceedings of the World Congress on Mechanical, Chemical, and Material Engineering (MCM 2015)
Barcelona, Spain – July 20 - 21, 2015
Paper No. 300

Inverse Heat Conduction Analysis on the Input Parameter in a One-Dimensional High Pressured Tube Using Thermal Resistance Network and Kalman Filter

Jung-Hun Noh, Won-Geun Kim, Se-Jin Yook
School of Mechanical Engineering, Hanyang University
222 Wangsimni-ro, Seoul 133-791, Republic of Korea
ysjnuri@hanyang.ac.kr

Extended Abstract

There are various causes for the failure mode of high pressured tubes. High pressure-temperature propellant gas produces excessive expansion and burst. Repeated combustion of the propellant causes the fatigue failure. Also condition of high pressure-temperature leads to mechanical and chemical actions such as erosion, wear, and corrosion. Since propellant gas of high temperature is one of the major factors for the degradation of performance, it is important to know temperature distribution and heat flux for optimal design (Blackwell, 1981). In this study, the high pressured tube was considered to be a one-dimensional hollow cylinder which was composed of the chrome and steel layers. The numerical model assumed that the chrome layer was exposed to the heat flux from propellant gas and the steel layer was exposed to the ambient air. For numerical heat conduction modelling, the thermal resistance network (TRN) scheme was used and time-varied heat flux was considered (Mellor et al., 1991). The heat flux estimation utilizing a measured temperature was calculated by input estimation method. The recursive input estimation algorithm consisted of the Kalman filter and real-time least squares algorithm (Chen et al., 2008; Alifanov et al., 1978). The temperature field and heat flux was predicted using the numerical model developed in this study. The present model was able to correctly predict the heat flux with the error of less than 0.1%. When the heat flux change with time was considered, the inverse heat transfer model was able to accurately predict the shape and value of the time-varied heat flux. The numerical model developed in this study can be utilized to produce reference data in future studies of the design and optimization of the high pressured tubes.

This work was supported by the Global Frontier R&D Program on Center for Multiscale Energy System funded by the National Research Foundation under the Ministry of Science, ICT & Future Planning, Korea (NRF-2012M3A6A7054863).

Blackwell, B.F. (1981). Efficient Technique For The Numerical Solution Of One-Dimensional Inverse Problem Of Heat Conduction. *Numerical Heat Transfer,* 4, 229−238.

Mellor, P.H., & Roberts, D. (1991). Turner DR. Lumped Parameter Thermal Model For Electrical Machines Of TEFC Design. *Electric Power Applications,* 138(5), 205−218.

Chen, T.C., & Liu, C.C. (2008). Inverse Estimation Of Time-Varied Heat Flux And Temperature On 2-D Gun Barrel Using Input Estimation Method With Finite-Element Scheme. *Defence Science Journal,* 58, 57−76.

Alifanov, O.M., & Mikhailov, V.V. (1978). Solution Of The Nonlinear Inverse Thermal Conductivity Problem By The Iteration Method. *Journal of Engineering Physics,* 35, 1501−1506.

Cengel, Y. A. (2003). Heat transfer 2nd edition. Mc Graw-Hill.