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APPLICATION OF INVERSE CONCEPTS TO DRYING

ABSTRACT

This paper deals with the application of inverse approaches to estimation of drying body parameters. Simultaneous estimation of the thermophysical properties of a drying body as well as the heat and mass transfer coefficients, by using only temperature measurements, is analysed. A mathematical model of the drying process has been developed, where the moisture content and temperature fields in the drying body are expressed by a system of two coupled partial differential equations. For the estimation of the unknown parameters, the transient readings of a single temperature sensor located in an in finite flat plate, exposed to convective drying, have been used. The Levenberg-Marquardt method and a hybrid optimization method of minimization of the least-squares norm are used to solve the present parameter estimation problem. Ananalysis of the influence of the drying air velocity, drying air temperature, drying body dimension, and drying time on the thermophysical properties estimation, that enables the design of the proper experiments by us ing the so-called D-optimum criterion was conducted. In order to perform this analysis, the sensitivity coefficients and the sensitivity matrix determinant were calculated for the characteristic drying regimes and the drying body dimensions.

KEYWORDS

inverse approach, drying, thermophysical properties, heat and mass transfer coefficients

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REFERENCES [view full list]

1. Kanevce, G. H., Kanevce, L. P. and Dulikravich, G. S., Moisture diffusivity estimation by temperature response of a drying body, in M. Tanaka, G. S. Dulikravich eds., Inverse Problems in Engineering Mechanics II, Elsevier, Amsterdam, 2000, pp. 43-52
2. Kanevce, G. H., Kanevce, L. P. and Dulikravich, G. S., Influence of boundary conditions on

moisture diffusivity estimation by temperature response of a drying body, Proc. of 34th ASME National Heat Transfer Conf., Pittsburgh, PA, U.S.A., August 20-22, 2000, ASME paper NHTC2000-12296.

3. Kanevce, G. H., Kanevce, L. P., Mitrevski, V. B. and Dulikravich, G. S., Moisture diffusivity estimation from temperature measurements: influence of measurement accuracy, in P. J. A. M. Kerkhof, W. J. Coumans, G.D. Mooiweer, eds., Proc. 12th International Drying Symposium, IDS'2000, Noordwijkerhout, The Netherlands, 2000, pp. 337
4. Kanevce, G. H., Kanevce, L. P. and Dulikravich, G. S., Simultaneous estimation of thermophysical properties and heat and mass transfer coefficients of a drying body, in M. Tanaka, G. S. Dulikravich, eds., Inverse Problems in Engineering Mechanics III, Elsevier, Amsterdam, 2002, pp. 3-12
5. Kanevce, G. H., Kanevce, L. P. and Dulikravich, G. S. and Orlande H.R.B., Estimation of thermophysical properties of moist materials under different drying conditions, Inverse Problems in Science and Engineering, (2005), Vol. 13, No. 4, pp. 341-353.
6. Dantas, L. B., Orlande, H. R. B.. Cotta, R. M., De Souza, R. and Lobo, P. D. C., Inverse analysis in moist capillary porous media, 15th Brazilian Congress of Mechanical Engineering, Sao Paulo, Brazil, 1999
7. Dantas, L. B., Orlande, H. R. B., Cotta, R. M. and Lobo, P. D. C., Parameter estimation in moist capillary porous media by using temperature measurements, in M. Tanaka, G. S. Dulikravich eds., Inverse Problems in Engineering Mechanics II, Elsevier, Amsterdam, 2000, pp. 53-62
8. Dantas, L. B., Orlande, H. R. B. and Cotta, R. M., Effects of lateral heat losses on the parameter estimation problem in moist capillary porous media, in M. Tanaka, G. S. Dulikravich eds., Inverse Problems in Engineering Mechanics III, Elsevier, Amsterdam, 2002, pp. 13-22
9. Luikov, A. V., Teplomassoobmen, Energia, Moscow, Russia, 1972
10. Dulikravich, G.S., Martin, T.J., Dennis, B.H. and Foster, N. F., 1999, Multidisciplinary Hybrid Constrained GA Optimization, Chapter 12 in EUROGEN'99 - Evolutionary Algorithms in Engineering and Computer Science: Recent Advances and Industrial Applications, (eds: K. Miettinen, M. M. Makela, P. Neittaanmaki and J. Periaux), John Wiley & Sons, Ltd., Jyvaskyla, Finland, May 30 - June 3, 1999, pp. 231-260.
11. Marquardt, D. W., An algorithm for least squares estimation of nonlinear parameters, J. Soc. Ind. Appl. Math., 11, (1963), pp. 431-441
12. Beck, J. V. and Arnold, K. J., Parameter Estimation in Engineering and Science, John Wiley & Sons., Inc., New York, USA 1977
13. Fletcher, R. and Powell, M. J. D., Rapidly convergent descent method for minimization, Computer Journal, (1963), vol. 6, pp. 163-168.
14. Rao, S., Engineering Optimization: Theory and Practice, Third edition, John Wiley Interscience, New York, 1996
15. Pshenichny, B. N., Numerical Methods in Extremal Problems, Mir, Moscow, Russia 1969
16. Nelder, J. A. and Mead, R., A simplex method for function minimization, Computer Journal, (1965), vol. 7, pp. 308-313.
17. Goldberg, D. E., Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley, 1989
18. Storn, R., Differential evolution - A simple and efficient heuristic for global optimization over continuous spaces, Journal of Global Optimization, (1997), Vol. 11, No. 4, pp. 341-359.
19. Kanevce, G. H., Numerical study of drying, Proc. 11th International Drying Symposium, IDS'98, Halkidiki, Greece, August 19-22, 1998, Vol.A, pp. 256-263
20. Kanevce, G. H., Stefanovic, M. and Pavasovic, V., Experimental determination of the diffusivity of moisture within capillary porous bodies, Drying'80, Vol. 1, Hemisphere (1980), pp. 128-131

21. Ozisik, M. N. and Orlande, H. R. B., Inverse Heat Transfer: Fundamentals and Applications, Taylor and Francis, New York, 2000
22. Kanevce, G. H., Kanevce, L. P. and Dulikravich, G. S., An inverse method for drying at high mass transfer Biot number, Proceedings of HT03 ASME Summer Heat Transfer Conference, Las Vegas, Nevada, U.S.A., July 21-23, 2003, ASME paper HT20003-40146.

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