Thermal conductivity of wood and wood-based panels - review of experimental methods

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Introduction

The precise data on the thermal properties of wood and wood-based materials are required for:

- predicting heat transfer during processing and manufacturing.

Introduction

Traditional experimental methods are limited when determining thermal conductivity of wood and wood-based panels. It is due to the following features:

- anisotropy,
- dependency on temperature and moisture content,
- resistance contact between a sample and heating elements.

Objectives

To assess the methods for thermal conductivity determination and to analyze the accuracy of temperature predictions for the thermal conductivity values obtained by different experimental methods.

Guarded hot plate apparatus

The method assumes that tested materials should be:

a) isotropic and homogeneous,

b) oven-dried,

c) in perfect contact with the heater and cooler plates.

Heat flow meter apparatus

The method assumes that tested materials should be:

a) isotropic and homogeneous,

b) oven-dried,

c) in perfect contact with the heater and cooler plates.

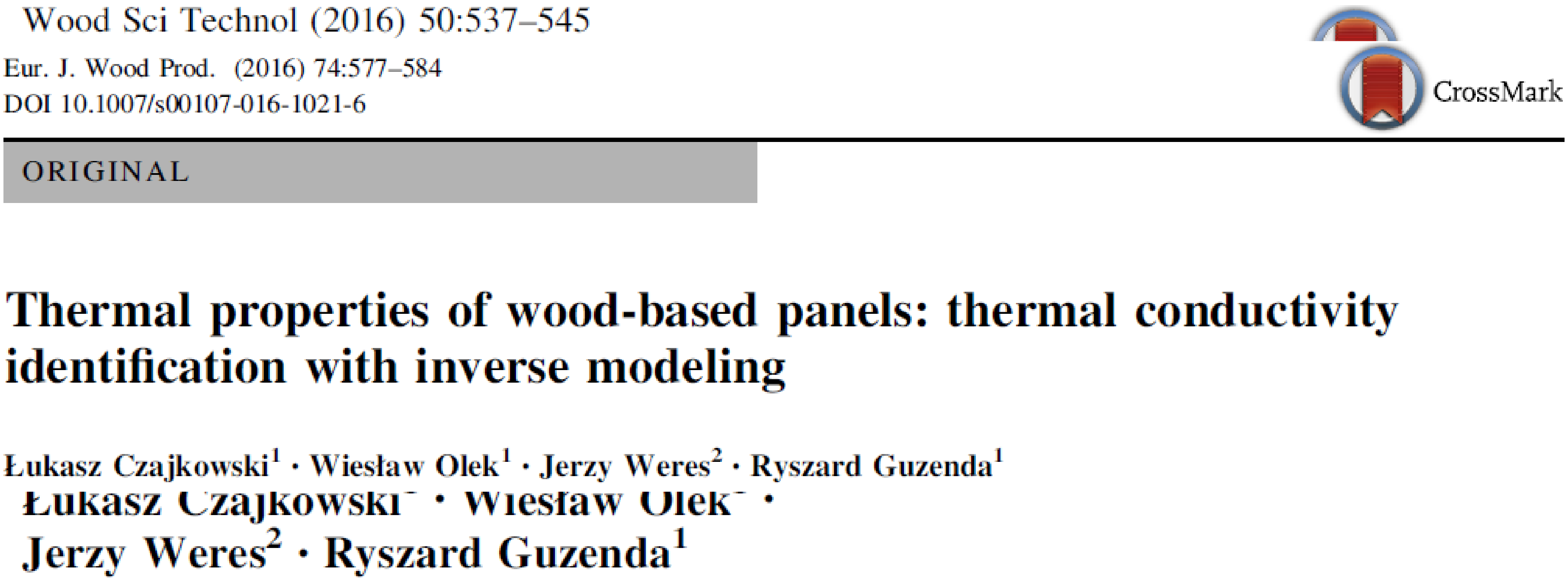
Methods disadvantages

a) long duration of measurements
b) lateral heat flow across the gap and trough a specimen
c) average value of the property over the range of temperature between hot and cold plates
d) low roughness of the specimen surfaces

Measured thermal conductivity values are obtained for a wide range of temperature (problems in determining the property dependency on temperature).

New approach for determining thermal properties of wood and wood-based panels:

- specific heat – a water calorimeter adequately designed and constructed,
- thermal conductivity – identification based on the computer-aided inverse analysis.



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ORIGINAL

Thermal properties of wood-based panels: thermal conductivity identification with inverse modeling

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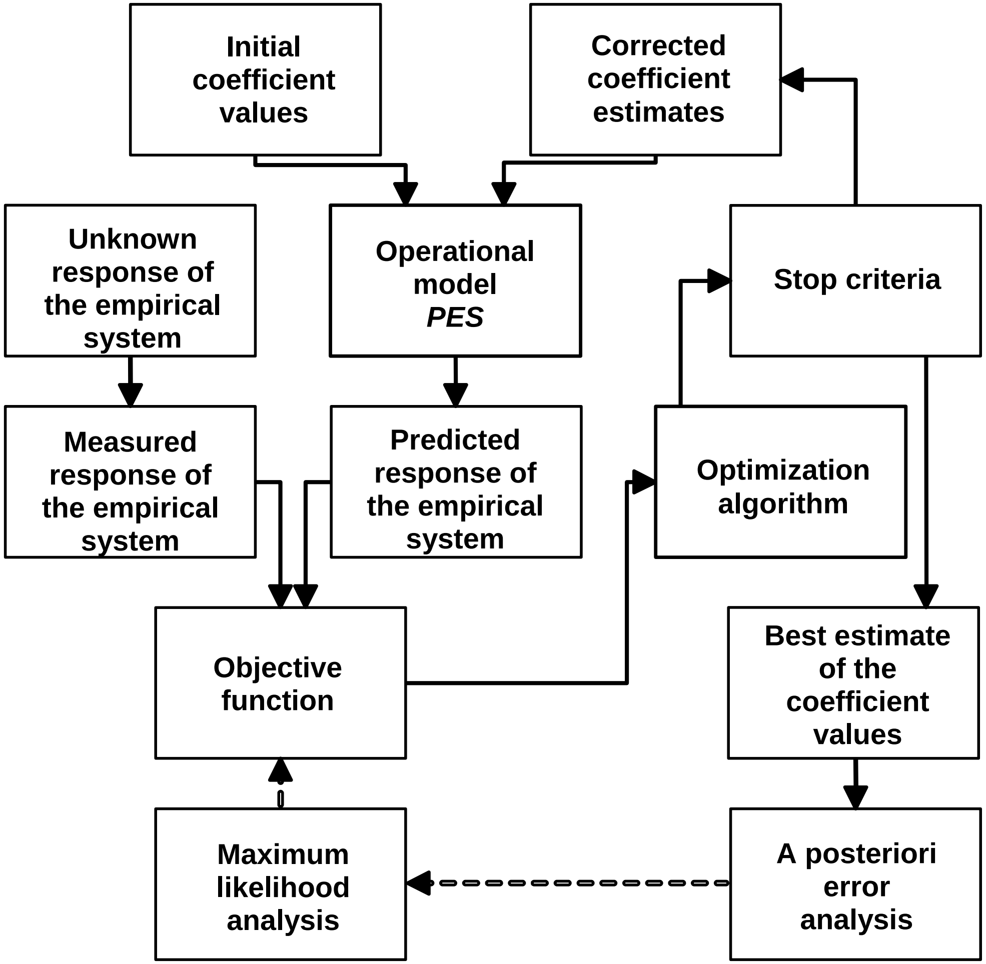
Jerzy Weres[2] · Ryszard Guzenda[1]

Inverse identification

Experimental setup for collecting input data



Initial coefficient values

Corrected coefficient estimates

Unknown response of the empirical system

Operational model *PES*

Stop criteria

Measured response of the empirical system

Predicted response of the empirical system

Optimization algorithm

Objective function

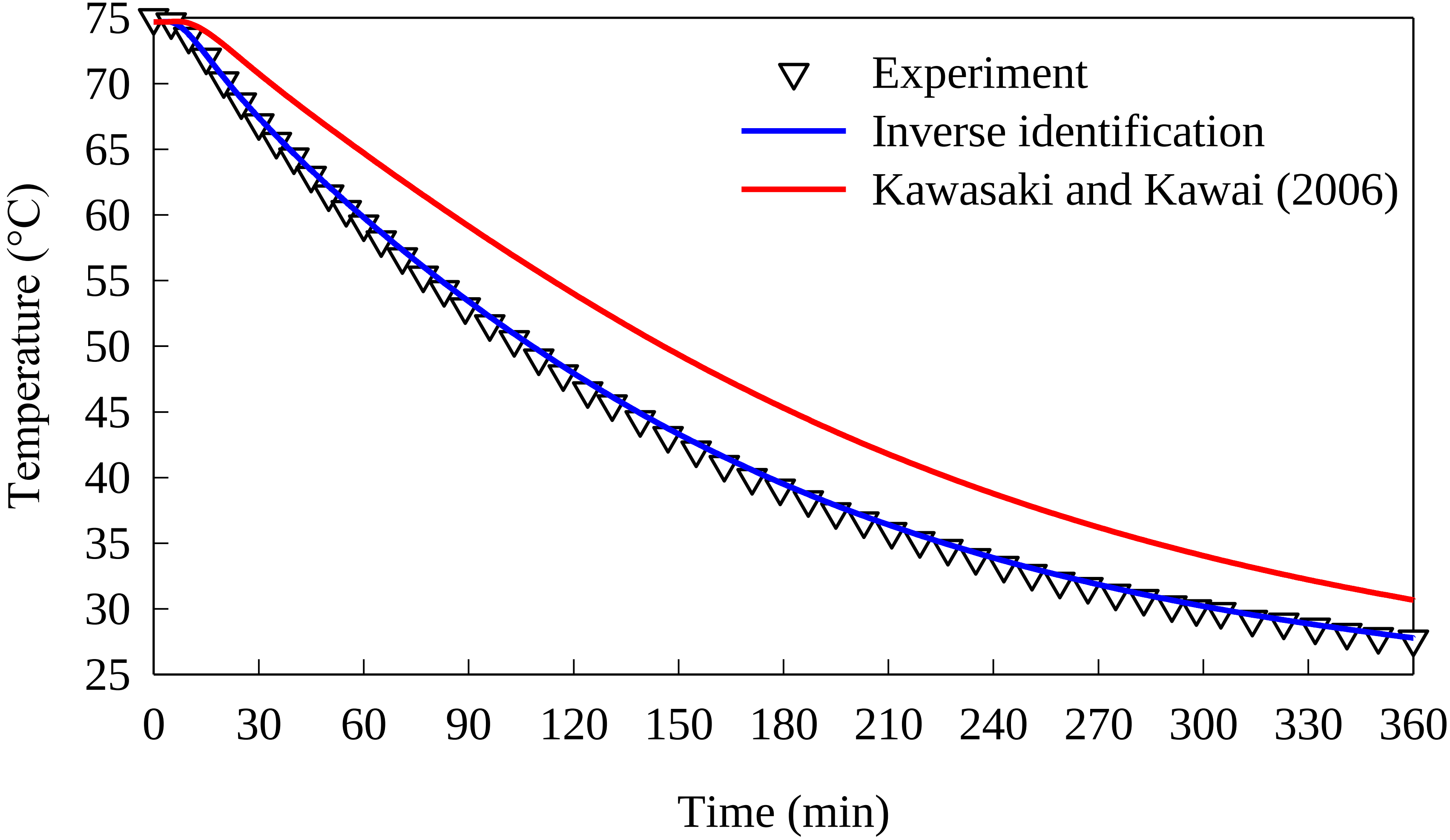
Best estimate of the coefficient values

Maximum likelihood analysis

A posteriori error analysis

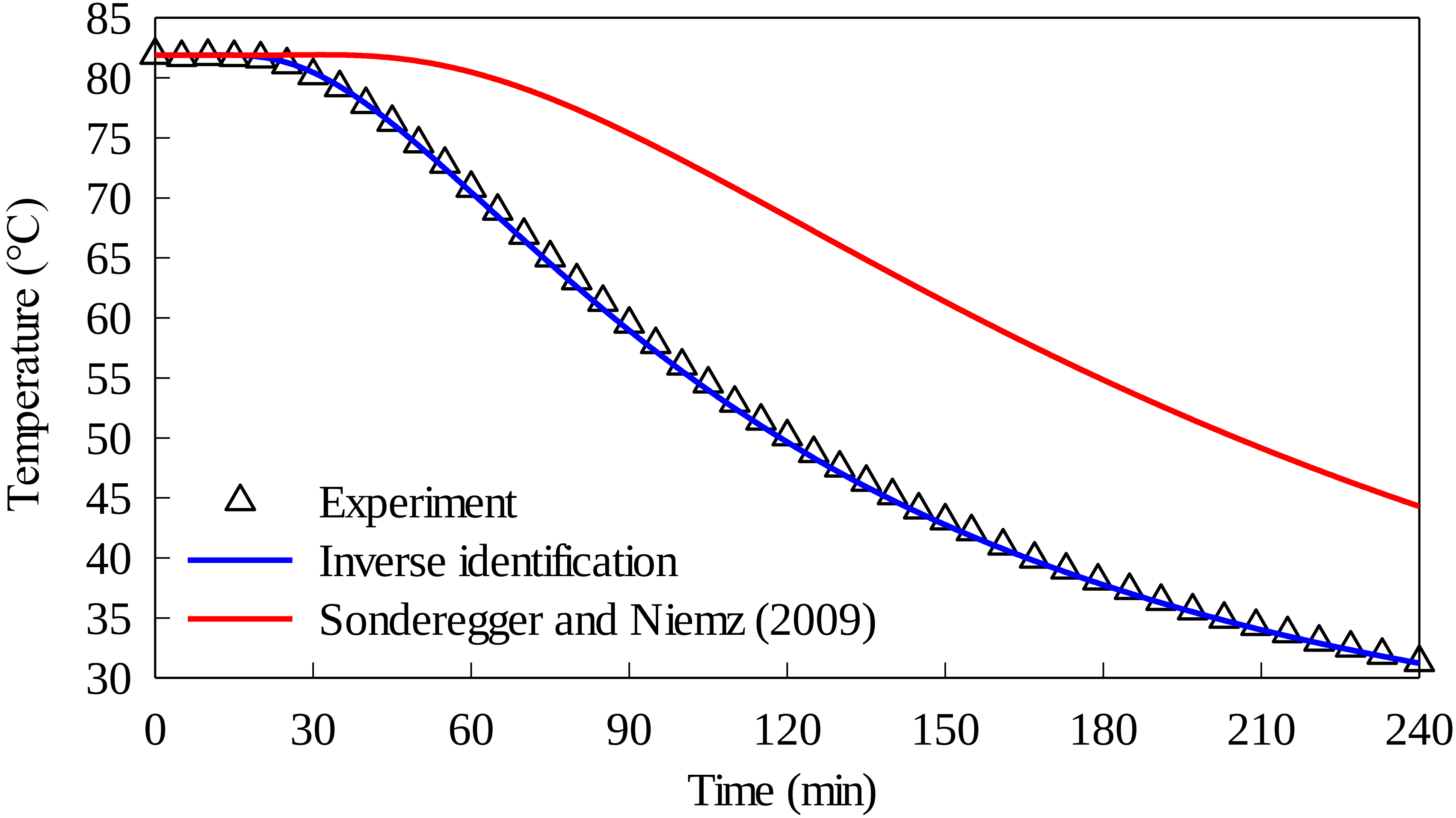
Scheme of computer aided identification

Validation



OSB, temperature vs. time: modeled for thermal conductivity obtained with inverse identification and measured with heat flow meter apparatus (Kawasaki and Kawai 2006) both compared to experimental data

Validation



Particleboard, temperature vs. time: modeled for thermal conductivity obtained with inverse identification and measured with hot plate apparatus (Sonderegger and Niemz 2009) both compared to experimental data

Conclusions

1. Traditional experimental methods are unable to account for temperature dependence and anisotropy of thermal conductivity.
2. The developed approach for determining thermal properties ensured high accuracy of the identification.
3. The credibility of the thermal conductivity values has to be validated by a comparison of results of heat transfer modeling and experimental data.

Thank you for your