Accepted Manuscript

Research Paper

Unsteady temperature fields of evaporating water droplets exposed to conductive, convective and radiative heating

G.V. Kuznetsov, M.V. Piskunov, R.S. Volkov, P.A. Strizhak

PII: DOI: Reference:	S1359-4311(17)36382-2 https://doi.org/10.1016/j.applthermaleng.2017.12.021 ATE 11542
To appear in:	Applied Thermal Engineering
Received Date:	4 October 2017
Revised Date:	2 December 2017
Accepted Date:	3 December 2017



Please cite this article as: G.V. Kuznetsov, M.V. Piskunov, R.S. Volkov, P.A. Strizhak, Unsteady temperature fields of evaporating water droplets exposed to conductive, convective and radiative heating, *Applied Thermal Engineering* (2017), doi: https://doi.org/10.1016/j.applthermaleng.2017.12.021

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Unsteady temperature fields of evaporating water droplets exposed to conductive, convective and

radiative heating

Kuznetsov G.V., Piskunov M.V., Volkov R.S., Strizhak P.A.*

National Research Tomsk Polytechnic University 30, Lenin Avenue, Tomsk, 634050, Russia *Corresponding author. Tel.: +7 (3822) 701-777, ext. 1910 E-mail: pavelspa@tpu.ru

Abstract

In this paper, we present the rates and typical durations of high-temperature heating and evaporation of water droplets determined for the dominating conductive, convective or radiative energy supply. We developed three setups for heating a water droplet: on a substrate (conduction), in a muffle furnace (radiation), and in a heated airflow (convection). The heating temperature is up to 1,000 °C to correspond high-temperature technologies, namely thermal cleaning of fluids, polydisperse fire extinguishing with low water consumption, etc. With the help of a high-speed video recording system, we determine the water droplet lifetimes (the times of their complete evaporation). Using Planar Laser Induced Fluorescence, we establish the quantitative differences between the water droplet heating rates (heating time to lifetime ratios) on the three setups. Maximum temperatures are determined that the water droplets reach when exposed to different heating mechanisms. Furthermore, we obtain the criterial dependences to connect the main attributes of temperature field generation of an evaporating water droplet with the heating conditions. Finally, we identify possible implications of the research findings and ways to further improve the newly developed experimental approach.

Keywords: conductive, convective, radiative heating; water droplet; unsteady temperature field; Planar Laser Induced Fluorescence; heating and evaporation rates.

1. Introduction

Adding solid nontransparent particles (of clay, sand, silt, soot, etc.) to water intensifies the suppression of flaming combustion and thermal decomposition of various materials. Therefore, water slurries are widely used for extinguishing fires of different complexity [1–3]. Water slurries and specialized solutions may have fire-retardant, wetting and other capacities necessary for effective fire extinguishing. The most important fire suppression mechanisms of water slurries [1–3] are as follows: significant temperature reduction in the combustion zone due to energy-consuming endothermic phase transformations, formation of a vapor buffer layer preventing the oxidizer from reaching the combustion zone, and pouring water over the surface of the substances, materials, and systems prone to thermal decomposition (pyrolysis).

Volkov et al. [4] present an approach to producing water slurries with fine solid particles to enhance vaporization in the flaming combustion zone. The rates of heating and evaporation of water Download English Version:

https://daneshyari.com/en/article/7046196

Download Persian Version:

https://daneshyari.com/article/7046196

Daneshyari.com