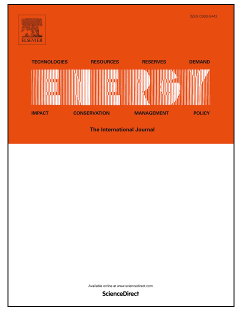
Accepted Manuscript



Physics of direct-contact ultrasonic cloth drying process

Chang Peng, Saitej Ravi, Viral K. Patel, Ayyoub M. Momen, Saeed Moghaddam

PII: S0360-5442(17)30321-3

DOI: 10.1016/j.energy.2017.02.138

Reference: EGY 10431

To appear in: *Energy*

Received Date: 26 December 2016

Revised Date: 9 February 2017

Accepted Date: 24 February 2017

Please cite this article as: Peng C, Ravi S, Patel VK, Momen AM, Moghaddam S, Physics of direct-contact ultrasonic cloth drying process, *Energy* (2017), doi: 10.1016/j.energy.2017.02.138.

Physics of Direct-Contact Ultrasonic Cloth Drying Process[I]

*Chang Peng[1], Saitej Ravi[1], Viral K. Patel[2], Ayyoub M. Momen[2], and Saeed Moghaddam[1]**

[1]Department of Mechanical and Aerospace Engineering, University of Florida
Gainesville, FL, USA

[2]Building Equipment Research, Energy and Transportation Science Division, Oak Ridge National Laboratory, TN, USA

*Corresponding author: Prof. Saeed Moghaddam, saeedmog@ufl.edu, phone: 352-392-0889

Abstract

Existing methods of drying fabrics involve energy-intensive thermal evaporation of moisture from clothes. Drying fabrics using high-frequency vibrations of piezoelectric transducers can substantially reduce drying time and energy consumption. In this method, vibrational energy generates instability on the liquid-air interface and mechanically ejects water from a wet fabric. Here, for the first time, the physics of the ultrasonic fabric drying process in direct-contact mode is studied. The kinematic and thermal responses of water droplets and fabrics on piezoelectric crystal transducers and metal mesh–based transducers are studied. The results suggest that on piezoelectric crystal transducers, the response of a droplet subjected to ultrasonic excitation is dictated by the relative magnitude of the surface tension and the ultrasonic excitation forces. The drying process for a fabric on the studied transducers consists of two regimes—vibrational and thermal. When the water content is high, the vibrational forces can eject bulk water rapidly. But the more strongly bound water within the smaller fabric pores evaporates by the thermal energy generated as a result of the viscous losses. This study finds that a metal mesh–based transducer is more suitable for dewatering fabrics, as it facilitates the ejection of water from the fabric–transducer interface to the opposite side of the mesh. A demonstration unit developed consumes 10–20% of the water latent heat energy at water contents greater than 20%.

Keywords: Ultrasonic fabric drying; Droplet atomization; Kinematics; Thermal effect

[I] This manuscript has been authored by the University of Florida in collaboration with UT-Battelle, LLC under Contract No. DE-AC05-00OR22725 with the U.S. Department of Energy. The United States Government retains and the publisher, by accepting the article for publication, acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this manuscript, or allow others to do so, for United States Government purposes. The Department of Energy will provide public access to these results of federally sponsored research in accordance with the DOE Public Access Plan (http://energy.gov/downloads/doe-public-access-plan).