Applied Thermal Engineering 37 (2012) 373–379

Contents lists available at SciVerse ScienceDirect

Applied Thermal Engineering

journal homepage: www.elsevier.com/locate/apthermeng

Energy losses by air leakage in condensing tumble dryers

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ARTICLE INFO

Article history:
Received 23 January 2010
Accepted 23 November 2011
Available online 2 December 2011

Keywords:
Energy balance
Tumble dryer
Leakage
Textile
Domestic

ABSTRACT

Tumble dryers, used for the drying of textiles, consume a considerable amount of electricity due to the large number of dryers in use. A large amount of this electricity is produced from coal, making it important to reduce the electricity use and, hence, the carbon dioxide emissions. Earlier studies made on the condensing tumble dryer have pointed out that leakage is one of the parameters affecting the electricity use for the drying process. With a view to reducing the energy use, leakage was estimated through measurements and modelling. Energy balances were used in order to verify the leakage. The energy balance showed good agreement with the results from the model and confirms that the leakage out from the dryer arises mainly between the heater and the drum where the air is hot and has low relative humidity. Large leakage at this location is detrimental for the energy efficiency of the dryer, meaning that the leakage must be reduced in order to obtain a reduced energy use. Results from the model also point out that even small changes in the size of gaps, or changes to the pressure in the internal system, result in a significant change in leakage from the dryer.

1. Introduction

Traditionally, the drying of textiles has taken place out of doors where the drying rate is enhanced by the wind and the sun. The drying process is negatively affected by bad weather conditions. In today's society, the lack of space to hang the textiles and a need to reduce the drying time have made artificial drying more common. Domestic appliances, such as tumble dryers, consume a considerable amount of energy due to the large number of units. In the EU, 4.9 million tumble driers for residential use were sold in 2005. Approximately 40 million tumble dryers are estimated to be in use in European households [1]. According to the International Energy Agency [2], the energy use for drying of clothes in the OECD countries has risen by 32.7% since 1990, i.e., to 77.1 TWh in 2000. Coal is often used to produce electricity on the European electricity market. Thus, even a small improvement in the tumble dryers would lead to reductions in the use of electricity, and, hence a reduction in carbon dioxide emissions. Energy labelling is used for household appliances to be a guide for consumers and to encourage the production of more energy efficient products. According to Stawreberg and Wikström [3] improvements of the energy labelling to focus on drying loads normally used by consumers are needed in order to reduce the electricity consumption for drying clothes in households.

The condensing tumble dryer has a closed internal system where the drying air is heated in a heater, humidified by the wet textiles in the drum and dehumidified in a heat exchanger after which it is led to the heater. Due to pressure differences inside the internal system and the surroundings there are leakages of air in and out from the system. It seems to be difficult to determine the amount of leakage and its location due to the compact design, rotating parts and irregular ducts in the condensing dryer. In the venting tumble dryer leakage of air is not sensitive to the energy efficiency of the drying process unless the air leaks out between the heater and the drum. However, most venting dryers are constructed with the fan at the air outlet creating a vacuum pressure at the drum inlet meaning that there is no leakage out from the system. Bassily and Colver [4] investigated the performance of a venting tumble dryer. They found a leakage into the dryer on both sides of the drum and saw that an increased leakage decreased the drying time. As we understand it, this is due to leakage into the dryer has gained heat that otherwise should have been lost to the surrounding (from the heater) in order to reduce drying time.

Stawreberg and Nilsson [5] present a model over the condensing tumble dryer showing how the parameters power supply, internal and external airflow affect the energy efficiency and leakage of water vapour from the internal system. Settings providing the best energy efficiency also gave the highest amount of water vapour leakage of up to 56%. However, the location of the leakage was not

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1359-4311/$ – see front matter
doi:10.1016/j.applthermaleng.2011.11.051