DESIGN, FABRICATION AND PIV TECHNIQUE ANALYSIS OF SOLAR DRYER SUITABLE FOR MID-LATITUDE APPLICATIONS

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In this study, an indirect natural convection flow updraft solar dryer was designed with objectives to; suit mid-latitude applications, analyse air-flow distribution using PIV (Particle Image Velocimetry) technique, visualise temperature distribution on drying surface, analyse the solar dryer performance. The dryer was fabricated using low cost and locally available materials. The main parts of the dryer are; hinged flexible angled solar collector, drying chamber consisting of three drying trays, updraft chimney with metallic collector. To visualise the distribution of airflow in the drying chamber, smoke was introduced by use of an electronic smoker and recorded via high speed camera of 30 fps for purpose of analysis by use of PIV software. Thermal vision camera was used to capture temperature distribution on surface of the trays showing a variation of 1.4°C in four different sections. For performance analysis, experiments were carried out to dry sliced apples of 2.5 mm in thickness. Temperature and relative humidity of airflow were taken at the collector inlet, drying chamber inlet and outlet using data loggers. Airflow inlet to solar collector and from drying chamber were determined using hot wire anemometers, irradiance in W/m^2 was measured using radiation meter. PIV results were achieved indicating fair airflow distribution across the drying bed with high correlation coefficient average at around 0.9 and low velocity standard deviation of below 0.004 in a frame across the sections. Turbulent kinetic energy was also analysed. Experiments conducted on solar dryer also indicated good airflow distribution across the drying trays confirming the PIV results obtained. Fresh apples of 772.45 grams (MC 86%) were dried to 137.4 grams (MC 13.74%) within 8hours 40 minutes, the dryer achieved overall efficiency of 16.49% at an average horizontal irradiance of 525.29 W/m^2. The dried apples were found to have good texture, colour and taste.

Key words: natural convection, PIV technique, moisture content (MC), performance analysis