Performance Analysis of a Solar Dryer with Silica Gel Integration for Outlet Air Dehumidification

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Abstract:

This paper presents an experimental study on the integration of silica gel as a desiccant bed in a two-chamber solar dryer to improve outlet air conditions for reuse in drying applications. The system comprises a flat-plate solar air collector (forced convection via four fans-powered by solar PV), Drying Chamber 1 (DC1), a packed bed of silica gel for dehumidification, and Drying Chamber 2 (DC2). Mee wantan was used as the test product under low solar radiation conditions (average 452 W/m²). Seven measurement points were instrumented with temperature and humidity sensors, and solar irradiance was recorded using a pyranometer. Results show that the average outlet air temperature from DC1 increased from 37.88 °C to 39.29 °C after passing through the silica gel bed, while the average relative humidity decreased from 59.75% to 55.07%, indicating enhanced drying potential in DC2. The final product moisture content reached 21% in DC1 and 23% in DC2, with the small difference attributable to the improved air properties dehumidification and the short experimental window due to rain. The silica gel bed exhibited an approximate mass increase of 11 g, confirming the adsorption of moisture from the air

by the silica gel. The regeneration by solar heating is proposed for continuous operation. The study demonstrates a practical, hygienic approach to reduce ambient dependency in solar drying and supports hybrid desiccant solar dryer designs for food processing.

Keywords:
Solar drying, silica gel, desiccant, hybrid dryer, food drying, renewable energy, moisture control.