MICROWAVE DRYING AS A STEP TOWARD ENERGY VALORIZATION OF TOMATO RESIDUES

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Abstract

In the wide and many-sided framework of biomass exploitation, huge amounts of residues from agri-food processing at industrial sites are an important issue. Tomato is the second most cultivated vegetable in the world, and its industrial transformation represents a traditional, high-quality production in Italy and one the prevailing industrial activities in the Campania region. The waste peels and seeds from tomato processing, sent to landfill or used for animal feed, pose a disposal problem; alternatively, they may be turned into a resource for energy valorization or extraction of organic constituents as valued chemicals. However, it is necessary to deal with the high moisture content of peels (up to 75% wt.).

First of all, it is necessary to dry tomato peels and seeds to bring their humidity to a value final compatible with downstream valorization uses. In order to dry biomass, hot air drying is a well consolidated technology. However, there is a growing interest in microwave drying, because this latter technology has been shown to considerably reduce drying times, with the same raw material.

Almost all microwave dryers, starting form kitchen appliances, work in "constant magnetron energy" mode. In this work, an experimental program was designed according to a different approach, with the use of a microwave dryer with “variable energy of the magnetron”, but “constant drying temperature”; to this end, a laboratory microwave oven, equipped with instruments for real-time measuring of temperature (pyrometer) and weight of the sample being tested, a measuring and monitoring camera, a regulation system for maintaining a constant biomass temperature and a data acquisition card, all connected to a PC.

Experimental batch tests were carried out "in duplicate" at three different “target” temperature, i.e., 50, 60 and 70 °C, to investigate the progress of drying, in particular by recording the decrease of the sample mass over time, until a plateau value was reached. "Control" tests were also conducted with convective drying at the same “target” temperatures, after a suitable adaption of the same oven.

The first striking result is that microwave drying times are comparatively much lower than the convective ones. Then, the experimental results have been carefully worked out and fitted to a simple, but reliable empirical model: this yielded a microwave drying kinetics correlation, which was not existing in the scientific

literature, as a function of the biomass moisture ratio and temperature.
The microwave drying kinetics has been used in a lumped-parameter mathematical model of a continuous steady-state dryer, and this latter incorporated within an Aspen Plus™ flowsheet for simplified sizing and simulation studies of the microwave dryer. Such a flowsheet represents the starting point for subsequent simulation and exploitation studies aimed at energy valorization (e.g., torrefaction, gasification, etc.) or recovery of organic constituents.