Accepted Manuscript

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PII: S0378-5173(17)31184-5
DOI: https://doi.org/10.1016/j.ijpharm.2017.12.040
Reference: IJP 17232

To appear in: *International Journal of Pharmaceutics*

Received date: 16-7-2017
Revised date: 20-12-2017
Accepted date: 22-12-2017

Please cite this article as: Peters J, Teske A, Taute W, Döscher C, Höft M, Knöchel R, Breitkreutz J, Real-time process monitoring in a semi-continuous fluid-bed dryer – microwave resonance technology versus near-infrared spectroscopy, *International Journal of Pharmaceutics* (2010), https://doi.org/10.1016/j.ijpharm.2017.12.040

Real-time process monitoring in a semi-continuous fluid-bed dryer – microwave resonance technology versus near-infrared spectroscopy

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Highlights:

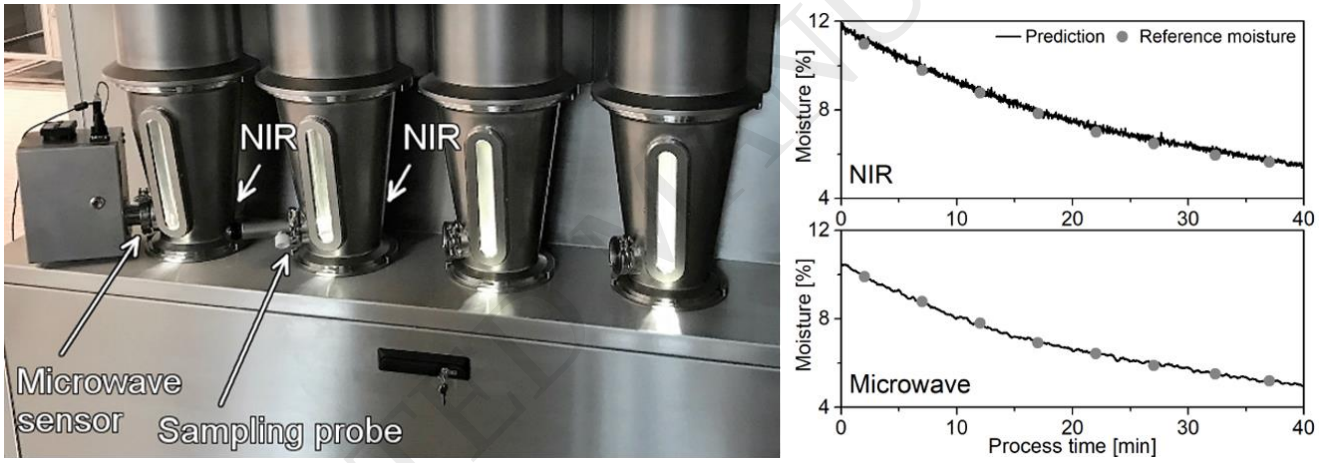
Simultaneous applicability of multi-resonance MRT and NIR spectroscopy for granule moisture monitoring within a semi-continuous dryer was demonstrated.

Quantitative calibrations by MLR (microwave sensor) and PLS (near-infrared probe) could be established.

In-line moisture determination during the entire drying process from 12 down to 5.5 % was feasible with RMSEPs below 0.20 % for both methods.

General suitability of both PAT tools to monitor semi-continuous drying processes between 4 to 20 % granule moisture was confirmed.

Graphical abstract



Moisture monitoring in semi-continuous fluid-bed drying unit Bohle BCD 25

Abstract:

The trend towards continuous manufacturing in the pharmaceutical industry is associated with an increasing demand for advanced control strategies. It is a mandatory requirement to obtain reliable real-time information on critical quality attributes (CQA) during every process step as the decision on diversion of material needs to be performed fast and automatically. Where possible, production equipment should provide redundant systems for in-process control (IPC) measurements to ensure continuous process monitoring even if one of the systems is not available. In this paper, two methods for real-time monitoring of granule moisture in a semi-continuous fluid-bed drying unit are compared. While near-infrared (NIR) spectroscopy has already proven to be a suitable process analytical technology (PAT) tool for moisture measurements in fluid-bed applications, microwave resonance technology (MRT) showed difficulties to monitor moistures above 8 % until recently. The results indicate, that the newly developed MRT sensor operating at four resonances is capable to compete with NIR spectroscopy. While NIR spectra were preprocessed by mean centering and first derivative before application of partial least squares (PLS) regression to build predictive models (RMSEP=0.20 %), microwave moisture values of two resonances sufficed to build a statistically close multiple linear regression (MLR) model (RMSEP=0.07 %) for moisture prediction. Thereby, it could be verified that moisture monitoring by MRT