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Revealing resonances in technical dehydration of ethanol

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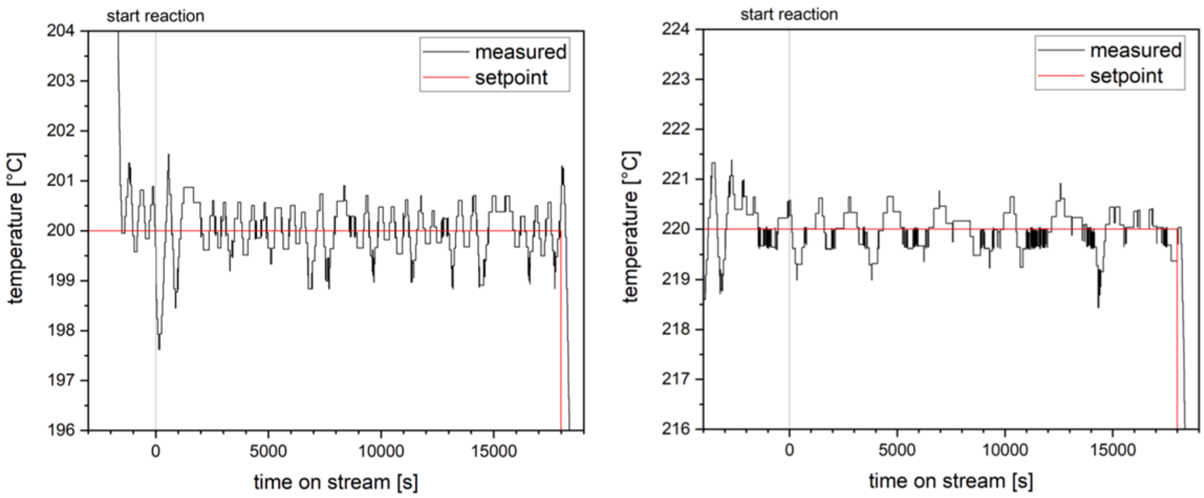
The description and understanding of chemical processes based on balances (mass, heat, momentum, finance) is inevitably coupled with proper quantification of process dynamics to enable process control. For the showcase of continuous conversion of ethanol over a solid-acid catalyst different dependencies between process parameters (T, p), steady-state flows (heat, carrier, feed) and chemical conversion parameters (conversion, selectivity, heat formation) are analyzed to show quantitative interconnections. Control of test units by design for specialized purposes provides/enables opportunities to control T, p and flow profiles, as well as to limit measurement and control errors from actuators and sensors. [1] [2]



Steady-state temperature with time on stream: (left) 200°C, (right) 220°C.

Beyond limits of process automation errors, this work reveals options to observe and quantify a complex interplay between setpoint and parameter oscillation (see *Fig.*) using different types of phase analysis. While classic routines for quantifying process dynamics often simplify dependencies between steady-state chemistry and reaction engineering (e.g. heat flows), phase analysis circumvents many simplifications.

References:

[1] L.A. Haufe, F. Bismark, J. Tippner, M. Seifert, J.J. Weigand, (2025), Design recommendations of fixed bed reactor test rigs for catalyzed alcohol conversion, Elsevier B.V., Results in Engineering, Amsterdam, 107302, https://doi.org/10.1016/j.rineng.2025.107302

[2] J. Tippner, M. Seifert, L.A. Haufe, J.J. Weigand, (2026), Forschen mit System: Automatisierung als Brücke zwischen Labor und Industrie, Vereinigte Fachverlage GmbH, INDUSTRIELLE AUTOMATION, Mainz, 12-15, 02, https://digital.industrielle-automation.net/industrielle-automation-2-2026/71065327