Structured H_∞-control of a continuous crystallizer

L. Hosseini-Ravanbod, D. Noll [1]
Université Paul Sabatier, Institut de Mathématiques.
P. Apkarian [2]
ONERA

Abstract

Structured H_∞ control with time domain constraints is introduced and applied to control a continuous crystallizer.

Keywords

H_∞ control, structured control laws, continuous crystallizer, population balance, mole balance, time domain constraint, frequency domain constraint.

37.1 Method

Structured H_∞-control [1] is a new control paradigm which extends the rationale of H_∞ control to controller structures $K(\mathbf{x})$ preferred by practitioners, such as reduced-order, PID or decentralized controllers.

If $T_{w\to z}(K, s)$ denotes a closed loop performance specification, then one computes $K(\mathbf{x}^*)$ such that

$$\|T_{w\to z}\left(K(\mathbf{x}^*), \cdot\right)\|_\infty \leq \|T_{w\to z}\left(K(\mathbf{x}), \cdot\right)\|_\infty \tag{37.1}$$

for all closed-loop stabilizing controllers with the same structure $K(\mathbf{x})$, where $\|\cdot\|_\infty$ is the H_∞ norm. Here we extend this design method to include time domain state and control constraints on certain trajectories of the non-linear plant.

37.2 Application: KCl crystallizer

To demonstrate the ability of the new method, we use structured constrained H_∞ control to operate a continuous crystallizer [2] modelled by a mole balance (an integro-differential equation) and a population balance (a hyperbolic PDE). Control inputs are solute feed and the fines dissolution rate, measured outputs are solute concentration and overall crystal mass. It is known that if operated in open loop, crystallizers show sustained oscillations which affect product quality, hence the need for feedback.

[1] Université Paul Sabatier, Institut de Mathématiques, 118 route de Narbonne 31062 Toulouse cedex 4, France. E-mail: lalehravanbod@yahoo.fr, noll@mip.ups-tlse.fr

[2] ONERA Centre de Toulouse - 2, av. Edouard Belin BP 4025 - 31055 Toulouse Cedex 4, E-mail: apkarian@cert.fr

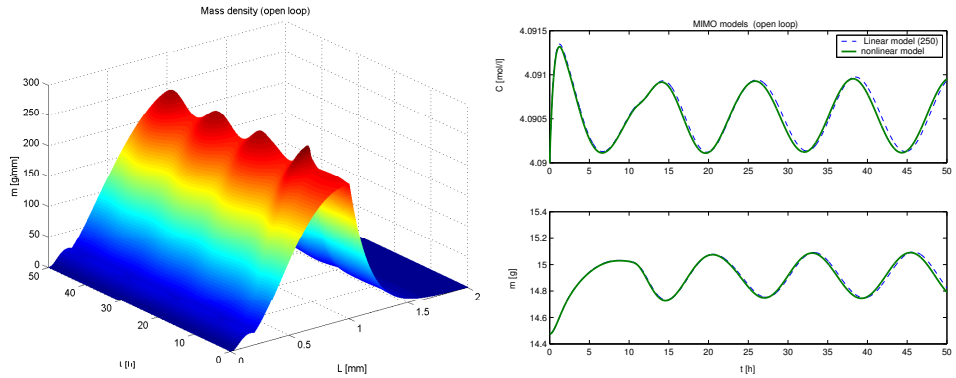

Figure 37.1: Sustained oscillations of slurry rate and solute in open loop.

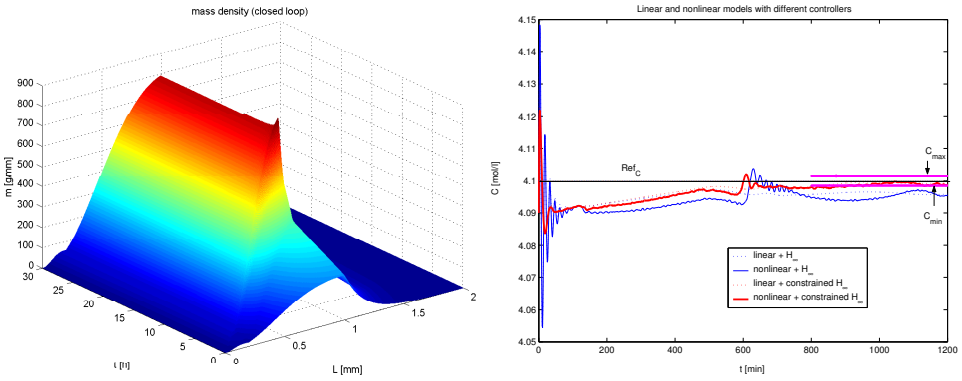

Figure 37.2: Closed loop with constrained structured H_∞ controller

37.3 Results

A reduced order model with 250 spatial steps was used to design a structured H_∞ controller satisfying a constraint on solute concentration and an anti-saturation constraint on solute feed. Tests include MIMO PIDs and reduced-order H_∞ controllers.

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