Real Time Optimization of the Sterilization Process in a Canning Industry

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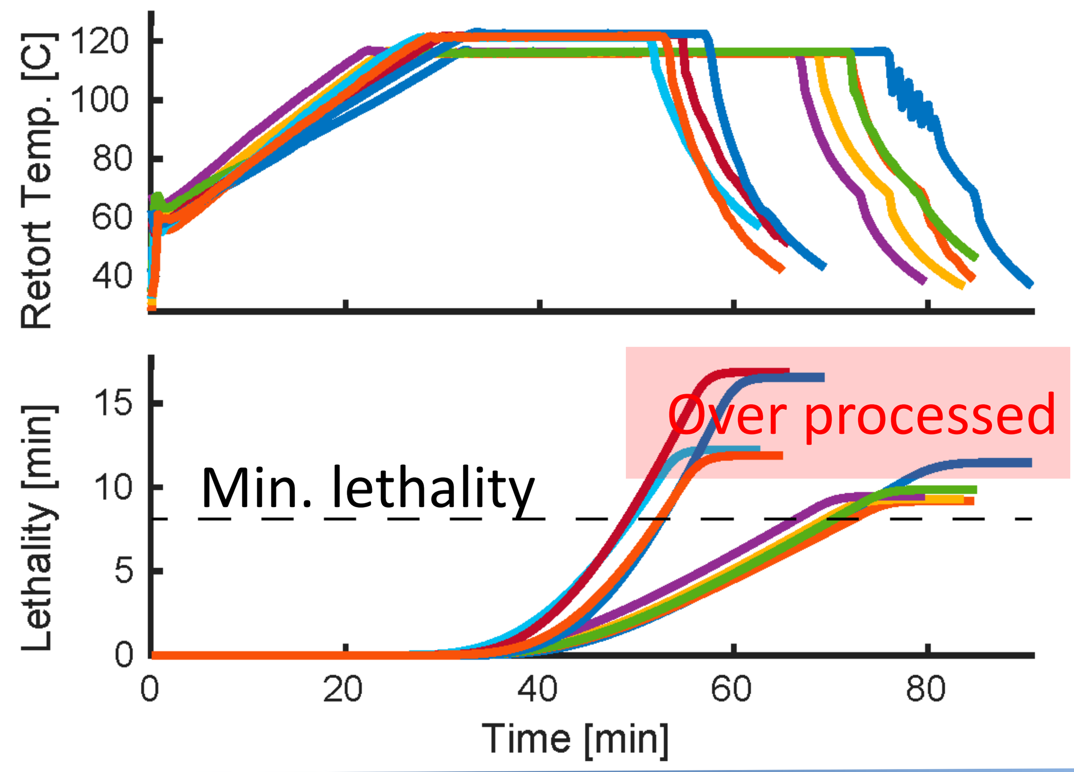
MOTIVATION AND OBJECTIVE

Sterilization process is aimed to inactivate harmful microorganisms present in food. Drawbacks:

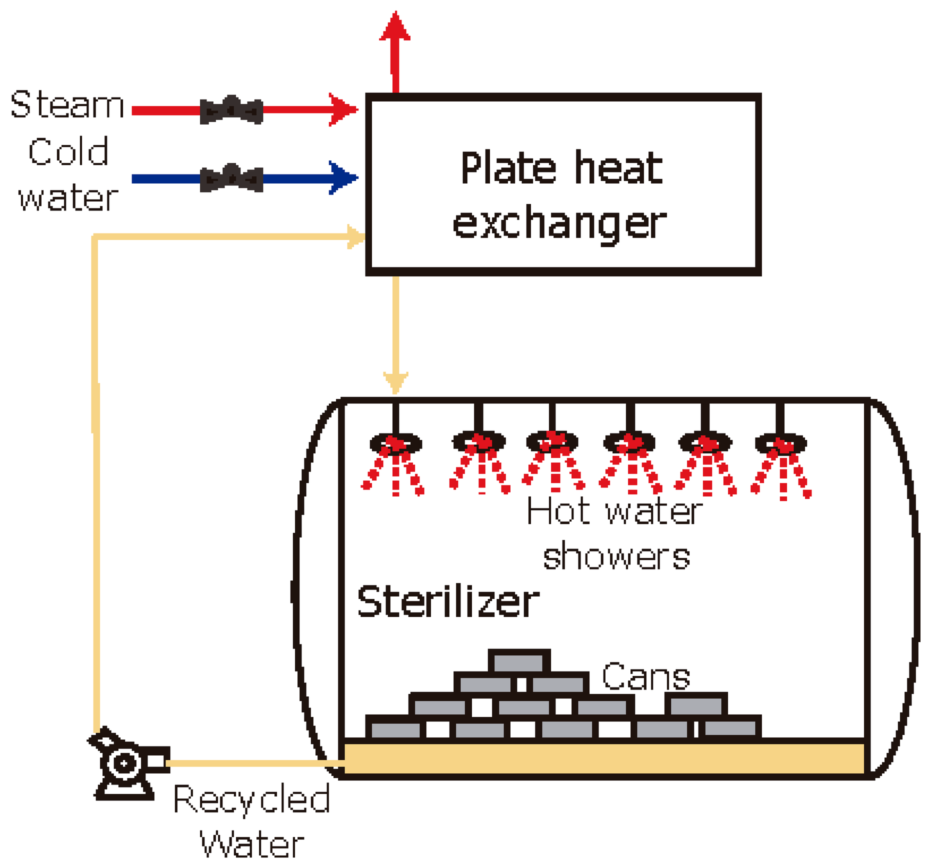
- It is a demanding operation in terms of energy and time consumption.
- It adversely affects food quality [1].
- Plant perturbations may lead to food safety/quality problems [2].



Objective: To design a model-based RTO strategy able to correct the influence of unexpected perturbations.

- Food safety/quality, process time and energy consumption are taken into account.
- Food quality refers to surface color.
- Food safety refers to microbial lethality (F_0).

PROCESS AND RTO SCHEME



A mathematical model of the process was derived.

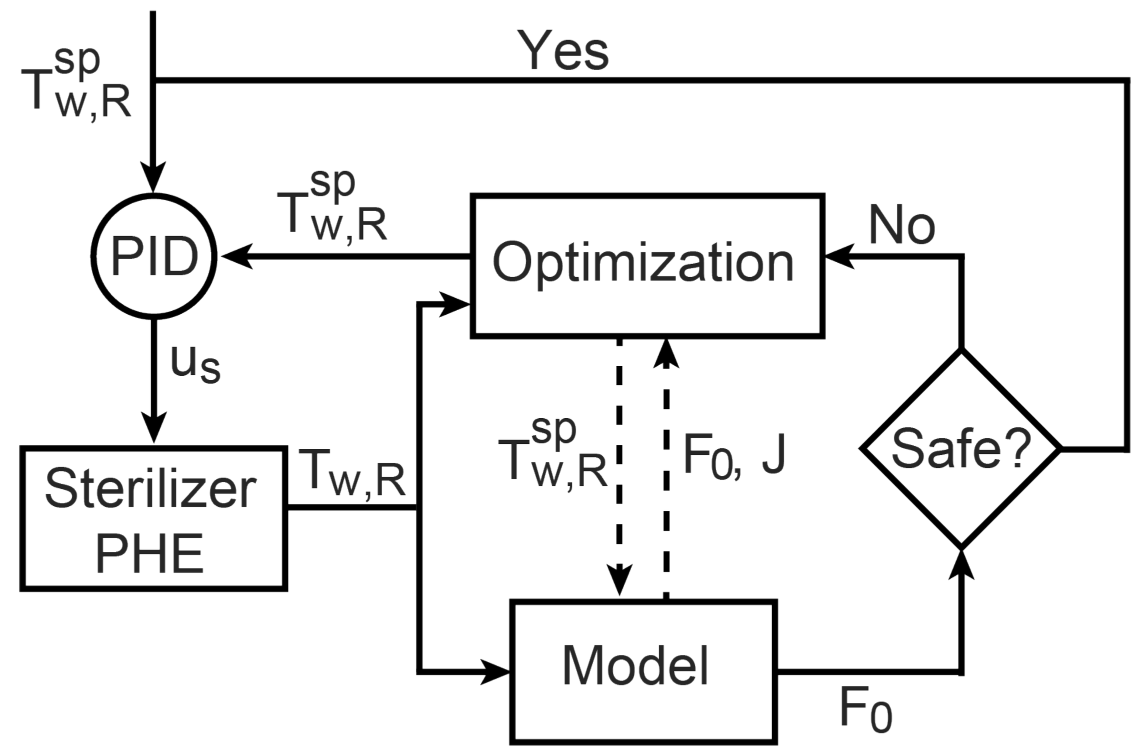
Simulation efficiency is improved using reduced order techniques.

The sterilization process

- Cold water is heated with steam using a plate heat exchanger (PHE).
- Hot water from PHE is introduced in the sterilizer.
- Food cans are heated at a given T during an amount of time.
- Cold water is introduced at the end to cool down the food cans.

The RTO Scheme

- Temp. set point and process time are fixed at the beginning.
- The mathematical model combined with on-line plant measurements is used to assess final product safety.
- If the model predicts safety problems a new Temperature set point is computed through optimization.
- The optimal profile is implemented in the plant.
- Constant profiles were considered (legislation issues).



RESULTS AND DISCUSSION

Optimization problem:

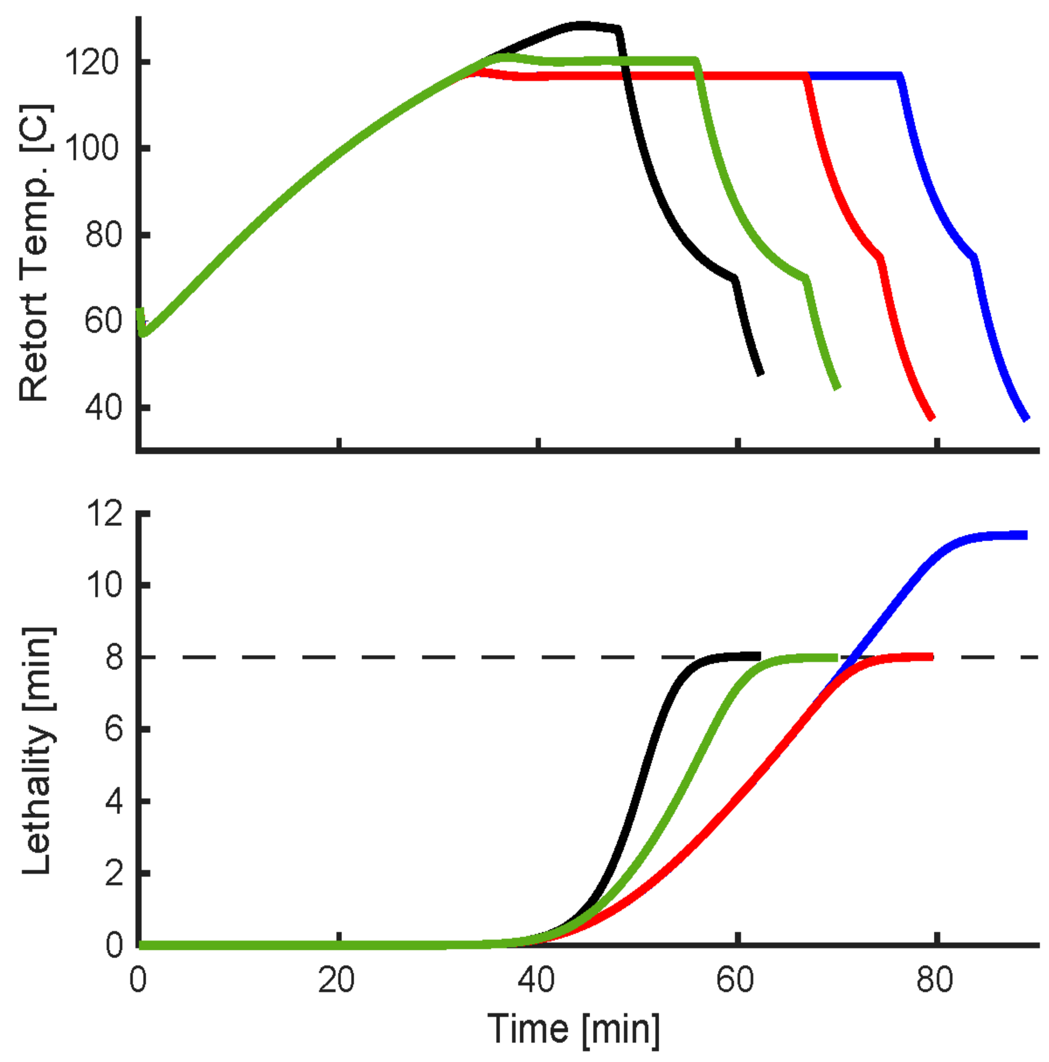
$$\min(J) = w_1 E + w_2\left(100 - C(t_f)\right) + w_3 t_f$$

Subject to:

- Model equations
- $110\ ^\circ C \leq T_{w,R} \geq 130\ ^\circ C$
- $F_0(t_f) \geq 8\ min$

Improvement (in %) of the RTO profiles with respect a real implemented profile (blue line)

	Energy	Color	Time
RTO1	2,7	2,8	10,7
RTO2	-5,7	8,0	30,0
RTO3	1,3	5,7	21,1



Blue line: Batch implemented in a real canning plant (over processed)

Three profiles were obtained:

- In RTO1 (red line), only process time was allowed to change. It improves the original profile in all senses (time, energy and color).
- In RTO2 (black line) temperature was also allowed to change. It is the most aggressive and the shortest one. It provides the best color and the largest energy consumption.
- In RTO3 profile (green line) weights in *J* changed. It improves the process in all senses allowing to reduce cycle time.

CONCLUSIONS

- Typical sterilization cycles in the canning industry are conservative and lead to food overprocessing (particularly in the event of unknown perturbations).
- The RTO approach allows:
  - designing cycles that ensure food safety while optimizing food quality and process costs.
  - taking into account unexpected process disturbances to minimize their effects.
- Larger improvements are expected using variable retort temperature (VRT) profiles instead of constant ones.

REFERENCES

[1] A. A. Teixeira, G. S. Tucker (1997). On-line retort control in thermal sterilization of canned foods. *Food Control*, 8:13–20.

[2] A. A. Alonso, et al (2013). Real time optimization for quality control of batch thermal sterilization of prepackaged foods. *Food Control*, 32(2):392–403, 2013.

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