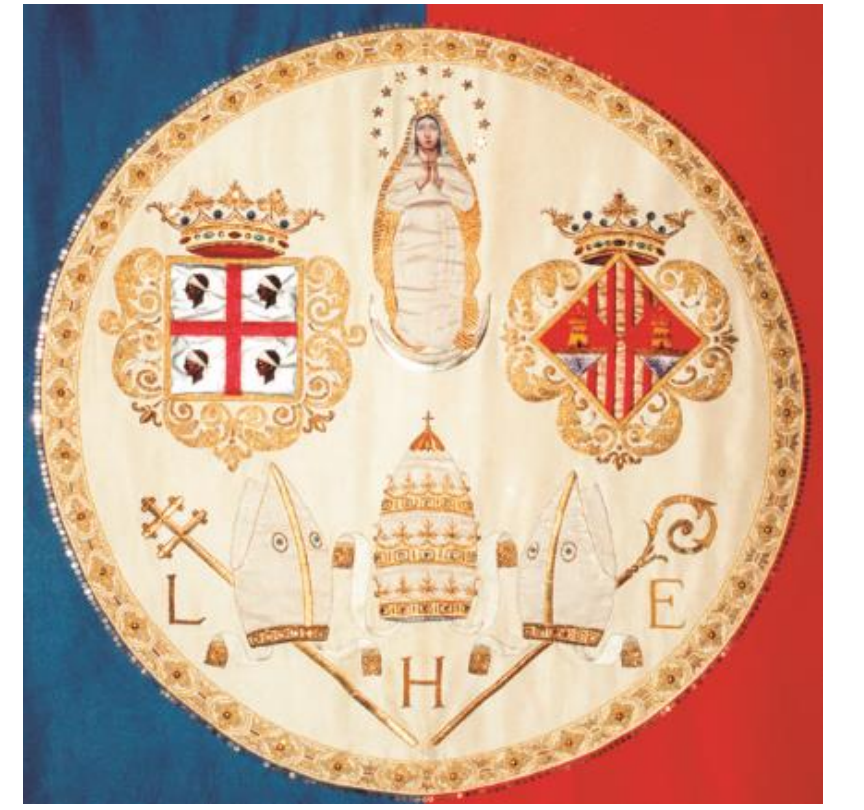


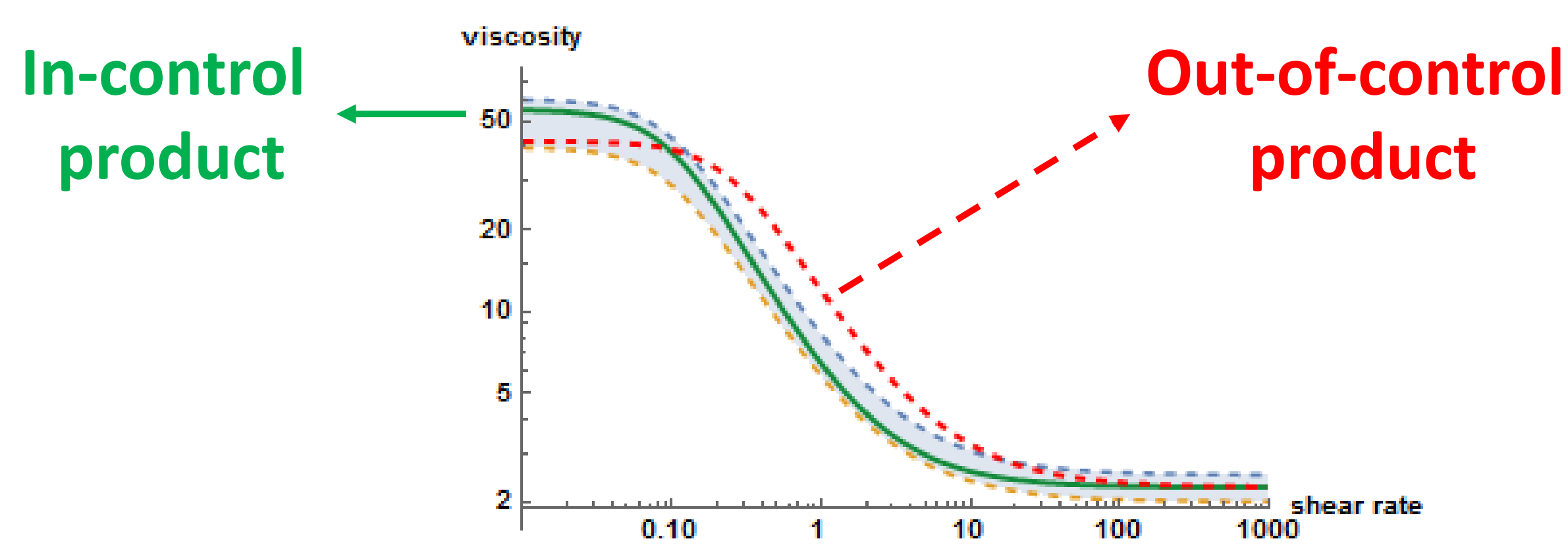


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Motivations

To develop a **control** system capable to maintain the **viscosity curve** of a non-Newtonian fluid inside a range of target viscosity values during the continuous production process

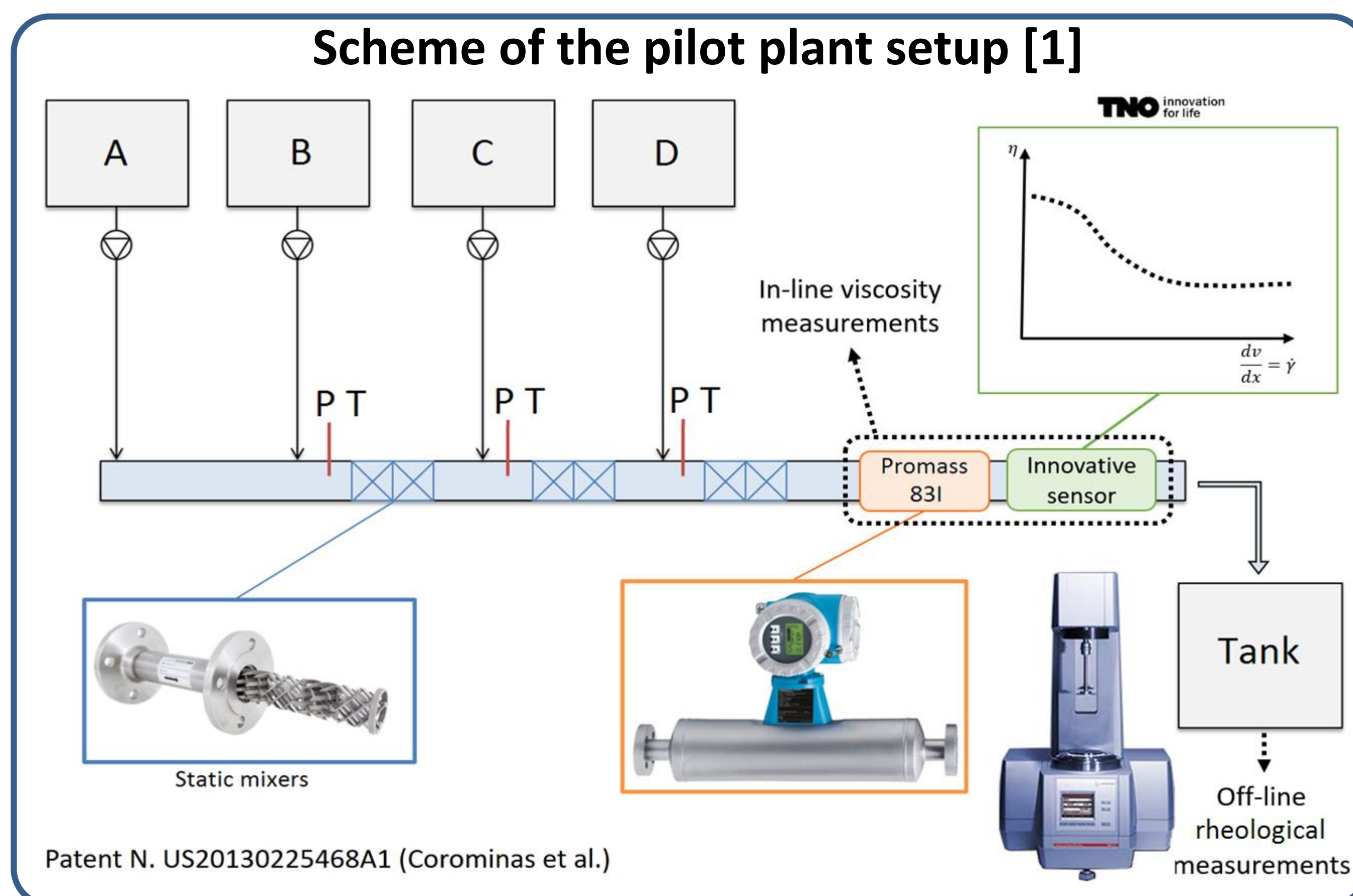


Case study

Mass production of **water free detergents**

Cooperation with P&G

- blend composed of different components
- rheology strongly depends on
 - composition
 - temperature
 - flow rates



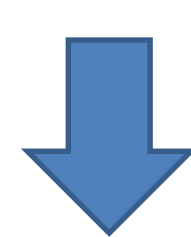
State of the system monitored through

- online measurements of pressure and temperature
- online Endress-Hauser Promass flowmeter (point measurement of viscosity)
 - online rheological sensors provided by TNO will be exploited in the future
- offline measurements (rheological measurements) [2]

Data acquisition

Experiments were carried out at Brussels Innovation Center (P&G R&D)

- Step variations of one ingredient (structurant)
- Temperature varies during experiments



Rheological model

Dynamics characterization

Problem statement

Issues

- Only **one** manipulated input: structurant flow rate
- infinite possible** control outputs: viscosity curve

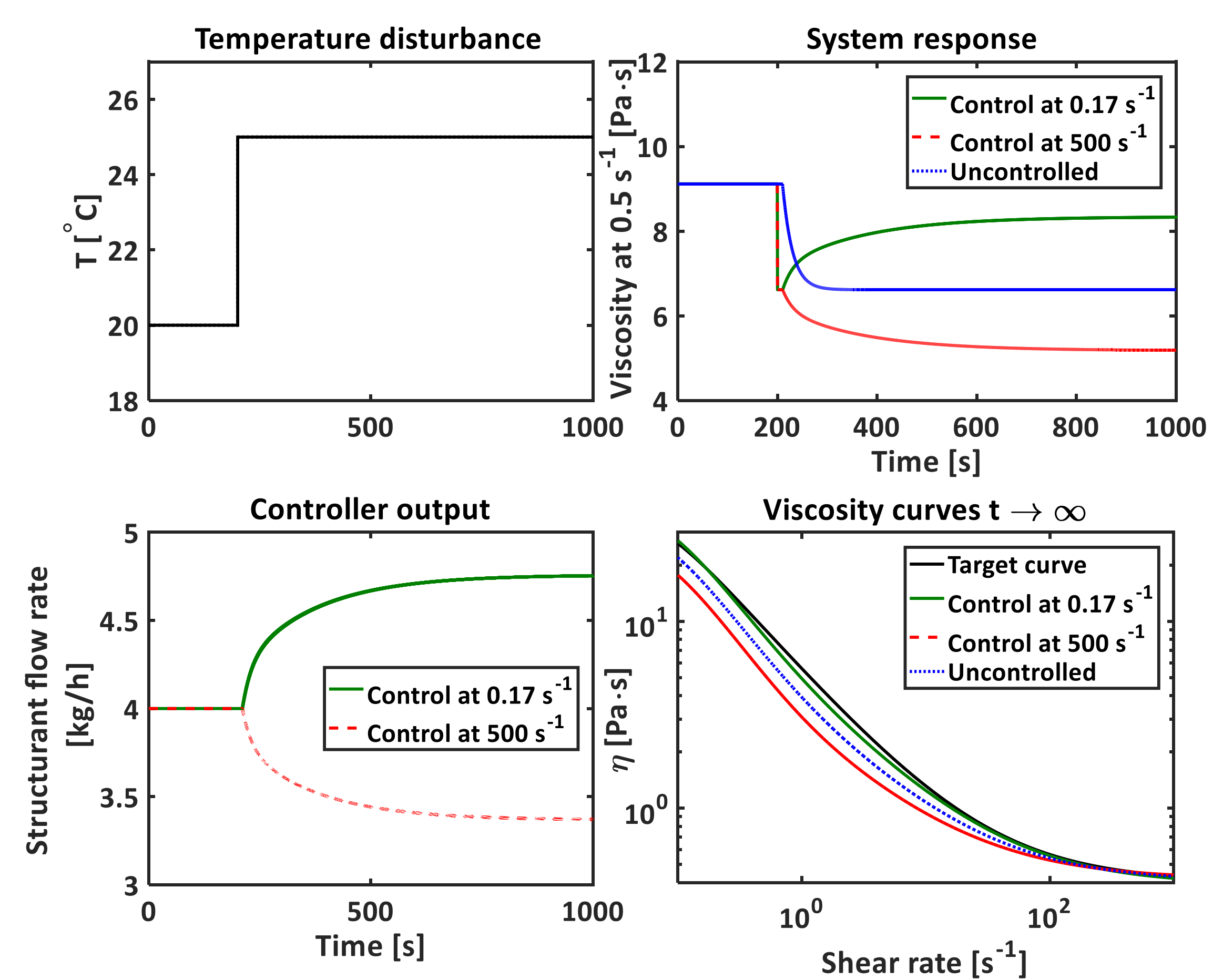
Strategy

- Sensitivity analysis of experimental data
- Construction of a **data based simulation model** to mimic **dynamic behavior** of rheology and **dependence on temperature**
- Design of a **one-point viscosity controller**
- Selection** of the controlled viscosity output on the rheological curve to achieve the target rheological properties

Results

Example: disturbance is a temperature increase

- controllers at low and high shear rate viscosities behave differently



Discussion and conclusions

The location of controlled output on the rheological curve is **crucial**. If the controlled variable is:

- viscosity at high shear rate, controller reveals to be detrimental
- viscosity at low shear rate, controller rejects disturbances

The approach can be applied to other system requiring control of the rheological properties.

References and Acknowledgements

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- Macosko, C.W., 1994, Rheology: Principles, measurements, and applications. New York: Wiley-VCH Verlag GmbH



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