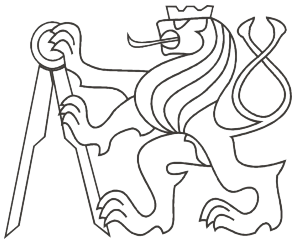
KONTAKT 2011



Modeling and identification of a chemical storage tank

Author: Ondřej Bruna (brunaond@fel.cvut.cz)
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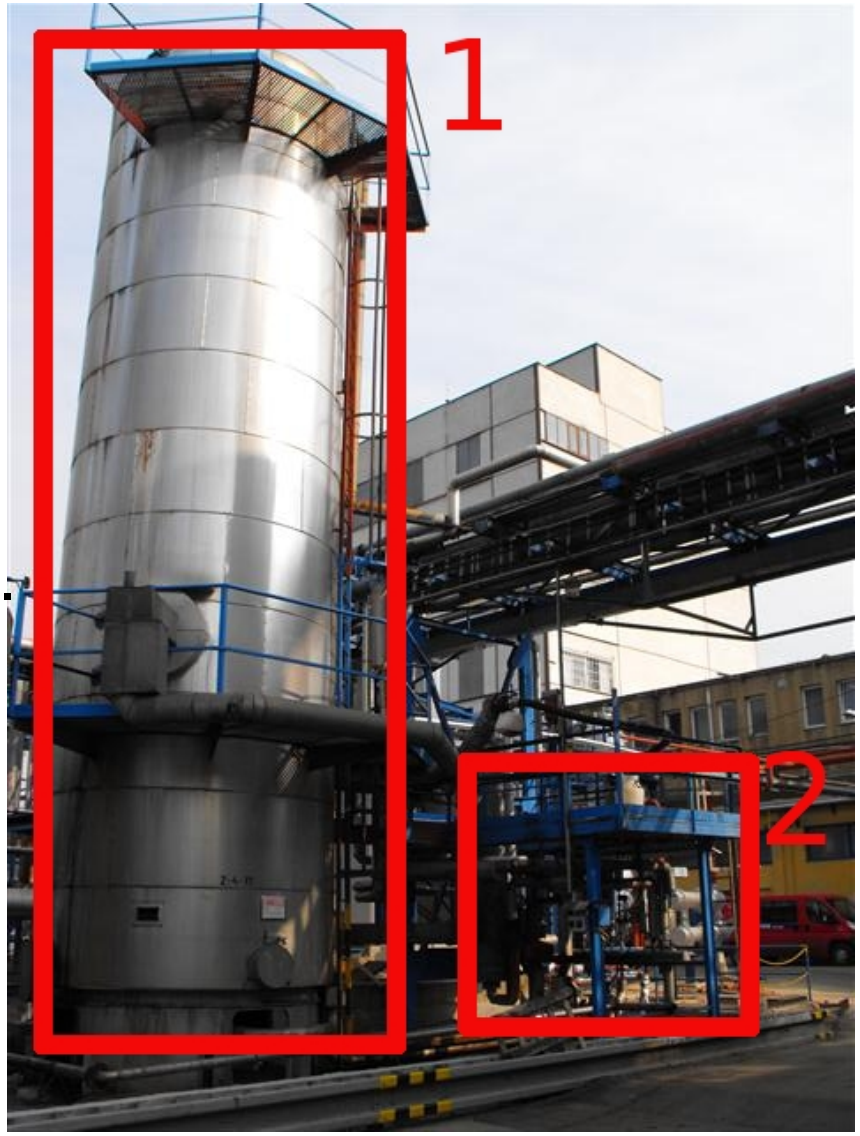
Modeling and identification of a chemical storage tank

Introduction

- Aim:Reducing costs.
- Avoid:Supply water temp. set manually.
- Consider weather.
- Maintain ABESON's temp.

- Model predicitve control.



Modeling and identification of a chemical storage tank

- Created model:

$$\dot{T}_i = \frac{p_1\,\alpha}{h}\left(T_i - T_{sw}\right) + \left(p_2\,\beta + \frac{p_3\,\beta}{h}\right)\left(T_i - T_a\right)$$

Estimation of α and β using:

- PEM,
- Subspace,
- ACADO software,
- Linear parameter varying model.

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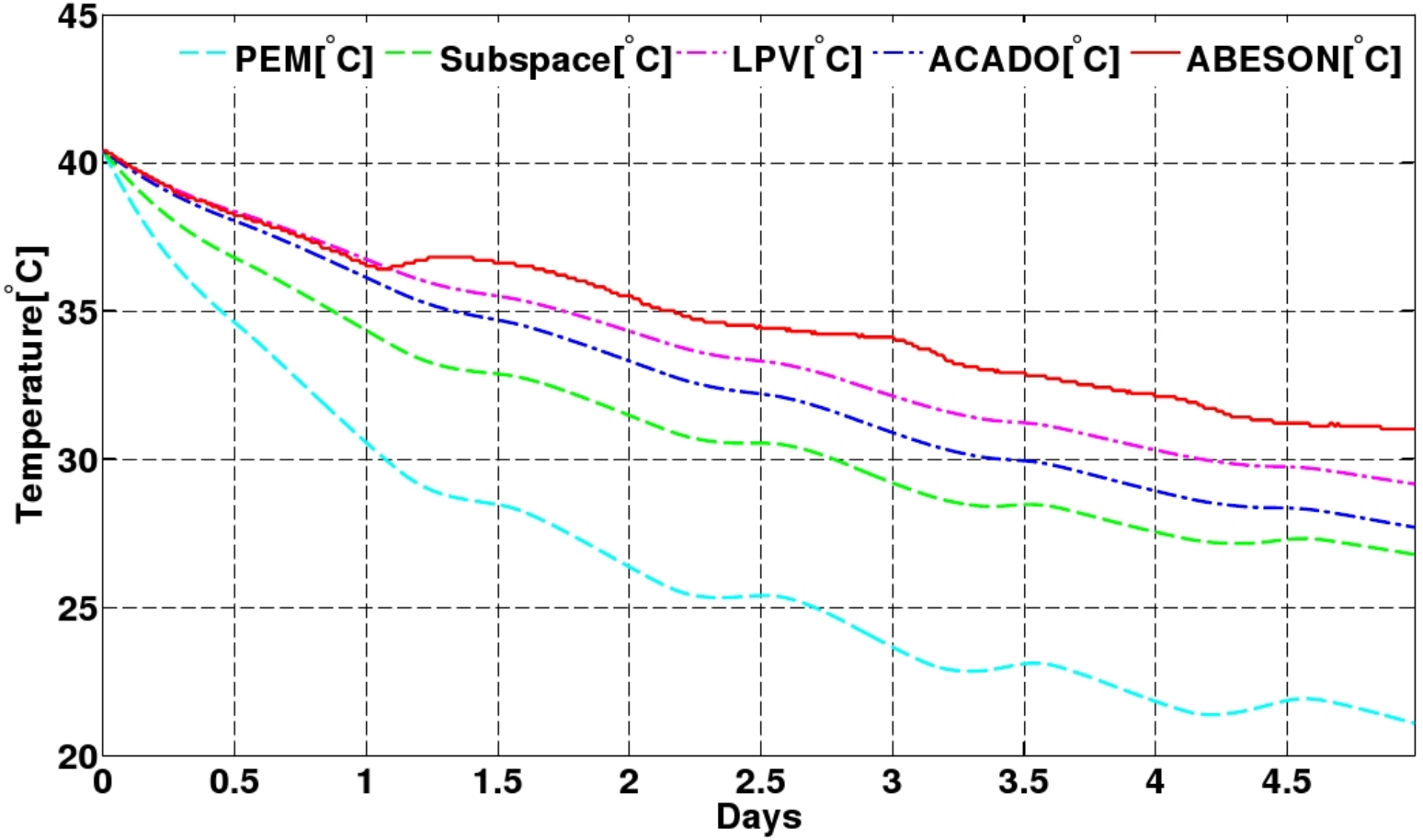
Results

- Temperature was estimated in range ±2.5°C.



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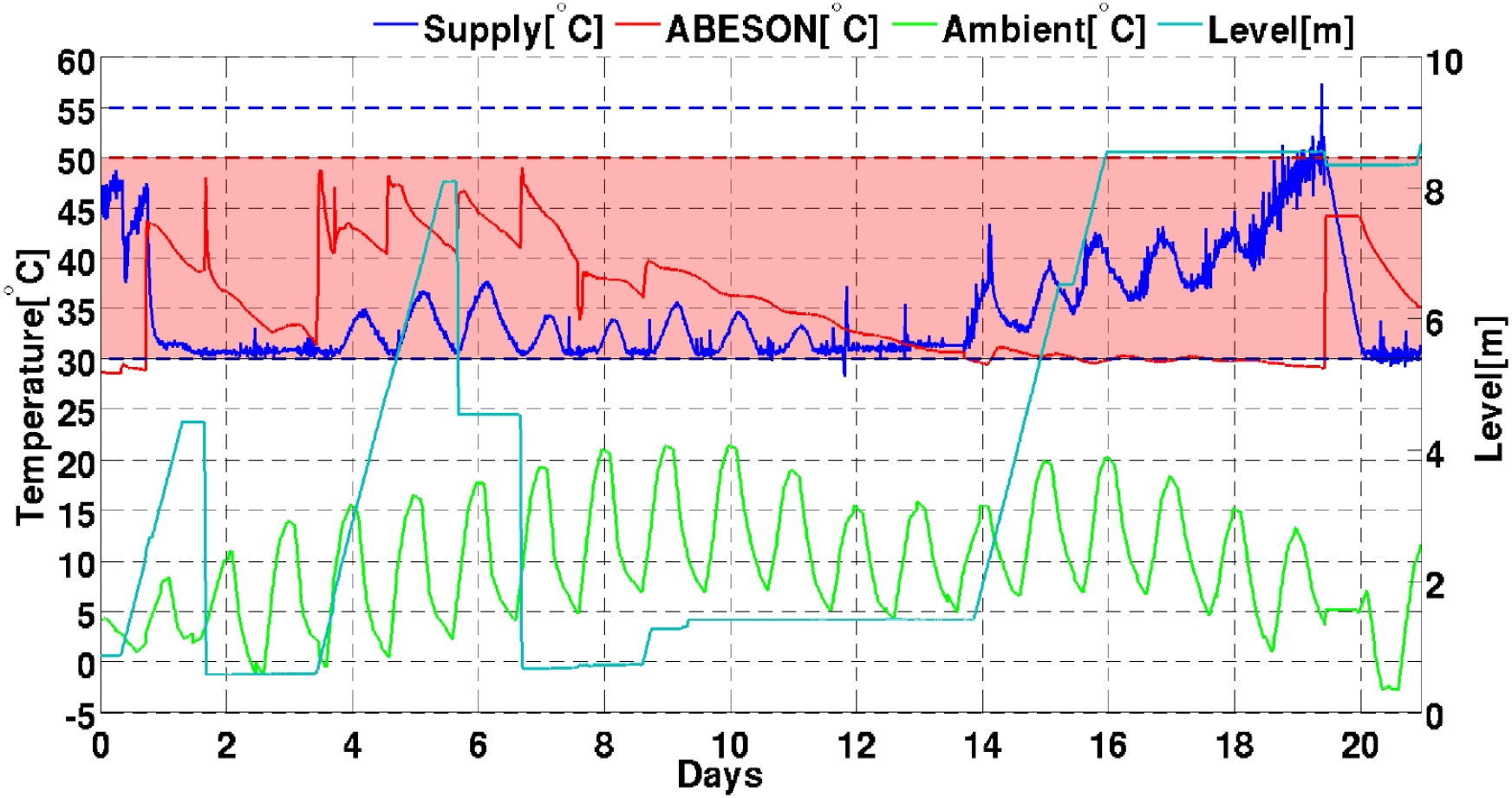
Results

- ABESON's temperature kept at 30°C.



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The objectives of this diploma thesis are to learn about thermodynamical processes in a chemical industry and to create and to identify a model of a thermo-dynamical process in a real chemical tank. Both linear and nonlinear approaches are used.

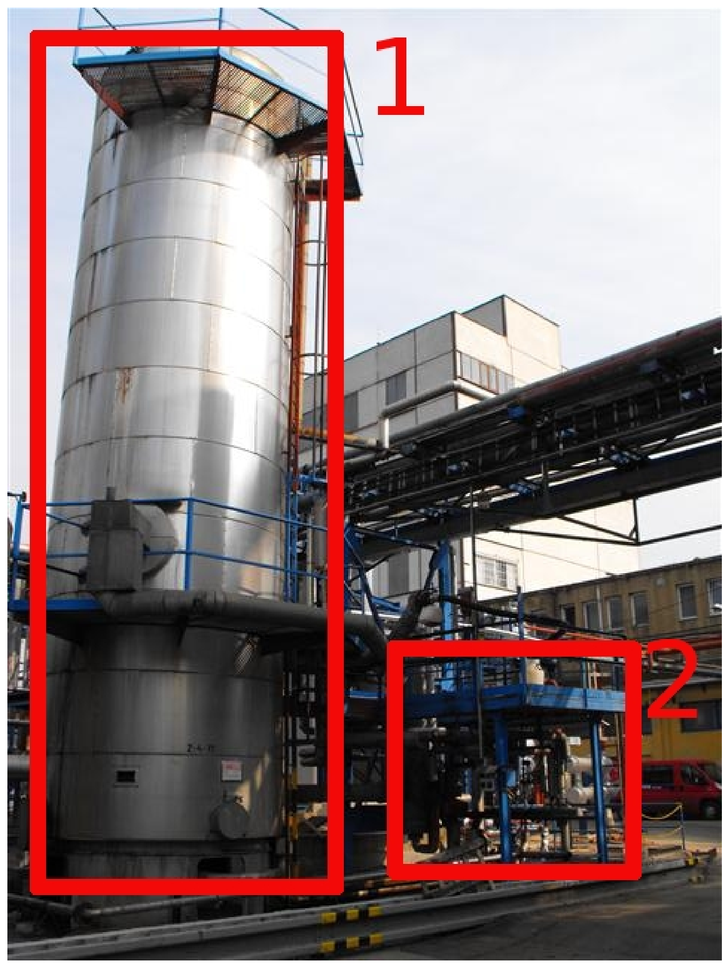

Figure 1: Chemical tank(1) and control station(2).

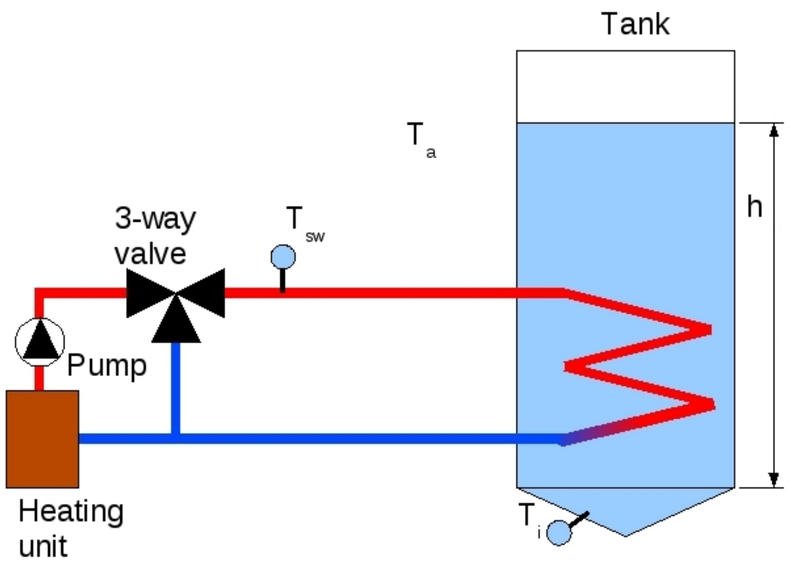

Figure 2: Schematic description.

GOAL

The chemical tank is shown in the Figure 1. It serves as a storage for ABESON, which is an intermediate product for making of shampoos and liquid soaps. ABESON is required to be maintained within certain temperature range, which ensures it will keep its qualities. Current control approach (manual) is not satisfactory. By creating a model of ABESON's temperature and applying model predictive control, requirements will be met.

MODEL

The proper temperature range is maintained by supply water. How the supply water and ABESON's temperature is affected is shown in Figure 2. Taking into account the physical properties of ABESON and geometrical features of the tank, mathematical model of ABESON's inner temperature is created. See below:

$$\dot{T}_i = \frac{p_1\,\alpha}{h}\left(T_i - T_{sw}\right) + \left(p_2\,\beta + \frac{p_3\,\beta}{h}\right)\left(T_i - T_a\right)$$

Model covers the development of ABESON's temperature T_i in time, considering ambient and supply water temperature (T_{sw} and T_a) and ABESON's level h. Unknown parameters α and β are subject of estimation. To estimate parameters linear (Subspace and PEM) as well as non-linear (ACADO software) approaches were used. The resulting models are compared in Figure 3.

Figure 4: Pump for mixing ABESON

PROBLEMS

Artefacts in data sets caused problems with estimation. The artefacts were coming from: e.g. mixing (see pump for mixing in Figure 4), drops of level, data loss. To avoid these problems the tank is considered linear parameter varying (LPV) system. The LPV model is used for estimation.

RESULTS

Parameters α and β estimated by LPV approach were most plausible. The model was able to simulate the ABESON's temperature in a range ±2.5°C from its measured value. ABESON's temperature after use of model predictive control is shown in Figure 5.

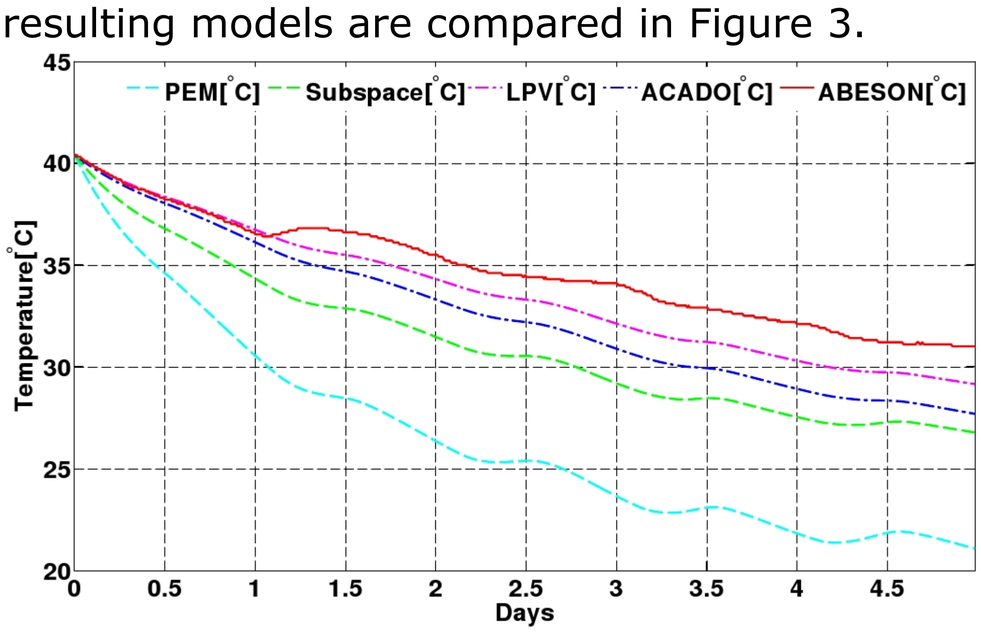

Figure 3: Comparisement of models.

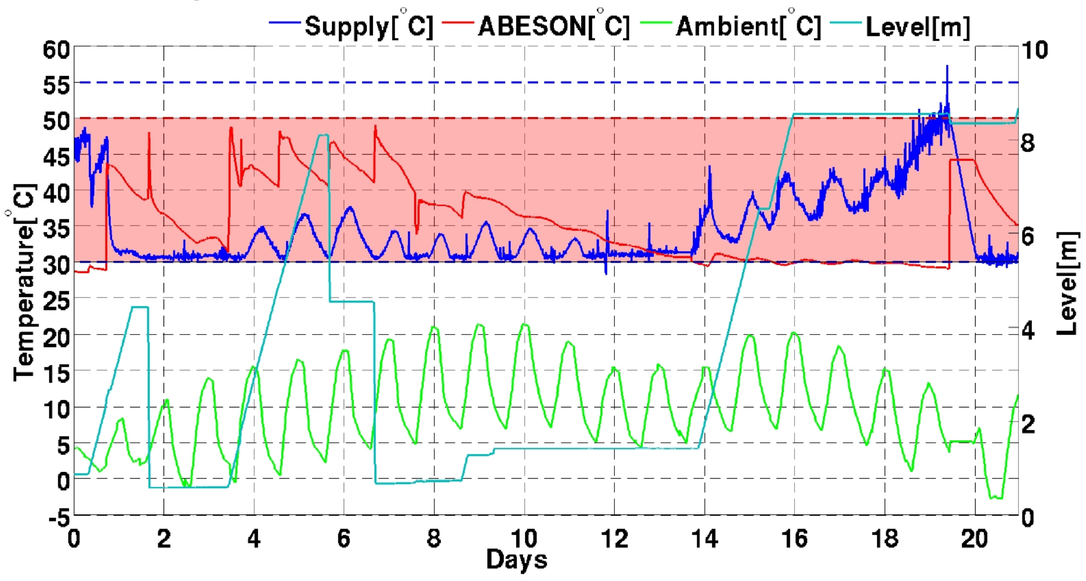

Figure 5: Model predictive control.