Válasz doktori (PhD) értekezés bírálatára

Opponens: Dr. Dörgő Gyula Ádám

Dolgozat címe: Model–Based Analysis and Optimization of Industrial MDI Manufacturing

Jelölt: Horváth Gergely

Témavezetők: Dr. Varga Tamás†, Dr. Kummer Alex

Tisztelt Dr. Dörgő Gyula Ádám!

Nagyon szépen köszönöm az alapos és tartalmas véleményét a disszertációm formai és tartalmi részei kapcsán, észrevételei és javaslatai nagy mértékben hozzájárultak ahhoz, hogy a dolgozatom minőségét tovább emelhessem és elnyerhesse végleges formáját.

What are the next steps towards the industrial application of the findings (especially, the published soft-sensor solution)?

Thank you for your question!

In my opinion, such data-driven approaches will become increasingly important in the chemical industry as well, supporting production and decision-making processes.

During the internal discussion, I presented that we are currently developing similar machine learning models at BorsodChem, which I believed – according to our schedule – will be successfully implemented for live testing in the first quarter of 2026. The machine learning model now is implemented, we are able to monitor the performance and it is indeed performing well, therefore it became possible to compare laboratory measurements with the model's estimates in real-time. The target of this machine learning model is to estimate the MDA ring distribution based on industrial operational data, which is directly related to my dissertation. As a next step, I would like to implement the MDI color estimation model, as this is a parameter that is very difficult to calculate or estimate as I demonstrated in my dissertation.

What infrastructural, workforce, training, business process, etc. requirements are needed for a successful implementation, especially taking into account the CRISP-ML(Q) methodology discussed in the thesis?

Thank you, very good question!

Since I have had the opportunity to implement a similar machine learning model in an online environment over the past few months, I would like to refer to Figure 4 in my dissertation, as I clearly followed the steps outlined in that figure and in the CRISP-ML method. The method's first 3 phases mainly relates to the development of the machine learning model, while phase 4 to 6 mainly focuses on quality assurance and implementation. During the implementation process there are many questions which need to be answered or challenges which needs the modeler's attention in order to implement the machine learning model in an online environment successfully, for example:

- How we are able to collect real-time operating data?
- How should we use the data – as hourly averages, as raw data, etc.
- How we would like to visualize results or how we can calculate metrics to evaluate the performance of the model?
- Is it possible or necessary to add batch-type or online retraining feature?
- How we treat time delays, missing data, outlier or parameters that fell outside the training boundaries?
- Can we explain model results as we change operating parameters?

There are many other aspects to consider when integrating the machine learning model into a real-world environment, but in every case, it is important to carefully consider what resources are available (data, softwares, etc.), in what system should implement it (e.g. DCS), what our goals are for the model (monitoring or controlling), how we will evaluate its performance (metrics, visualizations) and how will we be able to fine-tune the model's parameters (quality and performance assurance)?

Kazincbarcika, 2026.04.09.

Horváth Gergely