Samuli Bergman*, Tomi Lahti, Alexandre Boriouchkine, Toni Oleander

Artificial Intelligence and Machine Learning in Process Industry

Keywords: Machine Learning, Process Optimization, OPC UA, Industrial Application

***Corresponding Author: Samuli Bergman**, Neste Engineering Solutions Oy
E-mail: Samuli.bergman@neste.com

Other Authors: Tomi Lahti, Alexandre Borouchkine, Toni Oleander, Neste Engineering Solutions Oy,
E-mail: tomi.lahti@neste.com

1 Introduction

Many actors in chemical process industry think that the profitability of their plant has reached the maximum level, but by utilizing machine learning and artificial intelligence it is possible to take the profitability to the next level. It is crucial for competitiveness to guarantee the profitability of the production under any circumstances. As market prices of feedstock fluctuate and operating conditions vary, this has become more and more challenging.

The objective of the usage of machine learning (ML) and artificial intelligence (AI) is to refine data and turn it to valuable information, knowledge and insight that help either to run the plant in a more optimal way, to detect and identify abnormal events or to do maintenance at the most ideal time-point (prescriptive maintenance). There exist real-life process industries challenges that can be solved with ML and AI which have own characteristics that need to be taken into account. Especially implementing ML and AI requires big amounts of data for model creation and streaming data for actual AI deployment, so up to date operational production data infrastructure is essential for success.

2 All starts with data

The first practical challenge is to access all relevant and available data. Traditionally plant operation (or process-related decision-making) is mostly based on process measurements in the process control system (DCS). However, other data sources are often needed to get a full picture on all the related circumstances. Such sources are e.g. laboratory information management system (LIMS) or data on logistics operations in enterprise resource planning system (ERP). Modern IT communication technologies, such as OPC UA, enable safe and secure communication between these different systems and the digitalization platform.

3 Know your context

Another challenge is caused by complex interactions and dynamic phenomena present in chemical processes. Whereas typical process instrumentation enables monitoring of hundreds of temperatures, pressures, flow rates or liquid levels in a single operating unit, these quantities only contain a weak and variant correlation with many economically important phenomena. Examples of such important phenomena are e.g. side- and by-reactions caused by some substances present in very low concentrations in the feedstock; slow degradation of reactor catalyst because of poor operation conditions; fouling of process equipment; or circumstances that create corrosion. Data-based methods can help to solve this challenge. Models based on artificial intelligence, machine learning in particular, have proven to be powerful tools for refining the data into information on unhidden phenomena that cannot be directly observed by monitoring the time series of single measurements. This is, however, not enough, but the insight on hidden phenomena must be available in real-time. The key benefits will be achieved only if this real-time insight is utilized continuously by advanced optimization and automation solutions to push the process towards the optimum. In conclusion, with the help of artificial intelligence and machine learning it is possible to better understand what currently goes on in processes and in process equipment, and this knowledge enables to better foresee the future and to optimize the operative actions. This means that the production can be run

at the maximum level with the maximum profit safely.

4 Know your business

Third challenge is posed by the need to operate plants in an agile operations way. The market demands vary, which is materialized in the plant floor level by a wide variety of different product specifications. At the same time, the feedstock palette has become more volatile. E.g. oil refining industry is featured by two trends. Firstly, heavier crude oils with higher sulfur content need to be processed and, secondly, different bio-based feedstocks are used more and more. This means that processes are more often in a transient state and that optimal process conditions may be very different from the ones that have been accustomed with. Simultaneously a new generation of process operators is entering to the labor market. All this calls for redefining the way processes should be run and how operators could be assisted to perform their tasks in an optimal way. AI can be a beneficial tool in this. AI can learn best practices to operate process in various situations and help operators to achieve their targets. This type of applications builds a bridge between traditional paradigms of process modeling and competence development.

5 Conclusion

The use of artificial intelligence does not remove the need for human workforce, nor does it remove the responsibility of human operators. This makes the digitalization a leadership challenge. The new information that AI provides will change the way operators work. They need to understand the new methods and learn to trust this new information. Therefore, digitalization projects in chemical industry should never be left solely for ICT or automation departments. It pays off to involve plant engineers, shift supervisors and panel operators and trainers already in the early phases of digitalization.