The Evolution of Soft Sensors for Predicting Quality Indicators in the Process Industry Since 2000

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Abstract:

Machine learning has become essential for predicting process quality indicators in manufacturing plants. However, conducting real-time assessments can be quite daunting. Soft sensors, leveraging machine learning to forecast process quality measures, have gained significant attention since 2000 due to their numerous advantages: enhanced process stability, minimized product rejections, and improved energy and fuel efficiency. Initially, industries such as oil distillation, polymers, cement, and steel were at the vanguard of developing soft sensors for quality indicators, with more industries subsequently embracing these models owing to their benefits. Machine learning algorithms for process soft sensors have evolved from basic linear algorithms to complex deep-learning models. Neural networks, support vector machines, and tree-based models are extensively employed in this domain. This paper presents a synopsis of the methodologies employed for soft sensor technology in the current century. It offers an analysis and discussion of a comprehensive selection of articles covering diverse processes that utilize machine learning algorithms. As data availability and computing power continue to surge, deep learning algorithms are poised to assume the central focus in soft sensor research. This pivotal advancement is anticipated to reduce energy consumption, enhance production rates, and thus reduce the CO2 footprint.

Keywords:

Soft Sensor, Quality Prediction, Process Manufacturing, Machine Learning.