The TOP-REF approach for identification of critical process parameters for process monitoring and optimization

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The TOP-REF Project

TOP-REF project aims to develop and validate specific indicators, methodologies, and non-invasive tools devoted to the improvement of resource efficiency in energy-intensive continuous industrial processes in the non-ferrous, chemical, and petrochemical sectors. These methodologies and tools will constitute to the following targets:

- To path the way for achieving the SPIRE2030 objective of reducing non-renewable, primary raw material intensity up to 20% and fossil energy intensity up to 30%, both compared with current levels.
- Reduce production costs up to 15% compared with the current levels.
- A significant reduction of the environmental impacts (CO2 emissions, water footprint, pollutants, hazardous emissions, etc.).

To achieve these impacts, TOP-REF develops and demonstrates a robust, resource-efficiency-focused and cross-sectorial methodology based on novel, exergy-based resource indicators. This methodology is implemented in three specific, non-invasive on-line monitoring and control tools adapted to three specific continuous energy and resource intensive processes: solid fertilizers, petrochemical and chemical. The tools developed are validated through demonstration under real conditions in three pilots, one in each sector. One crucial step within this overall approach is the identification of critical process parameters and generation of optimized settings for these parameters.

Identification of critical process parameters and generation of optimized operation settings

The approach to identify the critical process parameters for the observed production processes is based on detailed process models validated by the industrial partners. These process models are too complex for using them in the global sensitivity analysis to identify the critical process parameters. Therefore, simplified mathematical surrogate models are derived prior to the global sensitivity analysis. These surrogate models are trained and validated based on the detailed process models, and result in a significantly reduced computation time while still achieving high accuracy. Afterwards, a variance-based global sensitivity analysis is performed for all process parameters to identify the most influential parameters on the key resource indicators (KRIs), which have been developed within the TOP-REF project. The use of a variance-based sensitivity analysis enables the consideration of
interaction effects among the process parameters. Finally, the identified critical process parameters are optimized benchmarked by the KRI. Also, the allowed operation window of the production processes will be taken into account during the optimization based on key performance attributes (KPA) defined by the industrial partners.

Within the contribution, we will explain the role of the described approach within the overall workflow of the TOP-REF project, demonstrate its application to the three industrial processes, and highlight experiences made during the application.

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