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At La Hague plant, the PUREX process [1] recycles spent nuclear fuel. Uranium and plutonium are recovered and purified by solvent extraction. The PAREX code [2] simulates the partitioning of the species, the transfer and chemical kinetics. Industrially, high consideration is given to a specific set of hard sensors on main fluxes needed for operation, control and safety issues (multiple sensors, regular checking). A project has been launched in order to automatically estimate the process state thanks to data reconciliation and the knowledge-based simulator PAREX. The first step is to make use of secondary sensors. However, these additional data can have biases that cannot be detected with prior data. This paper offers a methodology to identify and estimate significant and numerous biases within connected fluxes.

Plant data inventory and analysis (position and type of hard sensors…) allow to determine process observability and redundancy with graph theory. First, gross error detection and identification are carried out for mass balance with linear data reconciliation (LDR): Iterative Measurement Test (IMT), Simple Serial Compensation Strategy (SSCS) and Modified Serial Compensation Strategy (MSCS) are used. Biases were only detected on secondary hard sensors in different operation conditions. This is consistent with process knowledge. However biases are not correctly shared among the inconsistent data as no test was able to detect all biased fluxes. Their performances are limited in disrupted cases: the study simultaneously displays multiple flows between two units, numerous gross errors and significant ratio between gross error and measurement variance [3].

As no main flux, hence no inflow, is biased, PAREX simulations can be used for identifying all secondary sensor bias locations. With the redundancy analysis, an offline step establishes a map of the process consistent with expert knowledge, to identify reconcilable data. Then, bias value estimation employs an online iterative approach based on PAREX and nonlinear data reconciliation (NLDR). NLDR is based on a reduced model, taking into account observable variables. PAREX code is needed to provide all flux characteristics (temperature, composition…) including bias estimation for the next NLDR. Once PAREX and NLDR bias and data estimations converge, iterations stop. This methodology reconciles data thanks to NLDR with a reduced model as known constraints and PAREX code as non-explicit constraints.

Data reconciliation and simulation are combined to locate and estimate multiple biases and to make data consistent in the case of disrupted hard sensors measuring connected flows.

References:

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