



# Ammonia Syngas Plant: Process Improvement by application of Multi-Input-Multi-Output (MIMO) Surrogate Models

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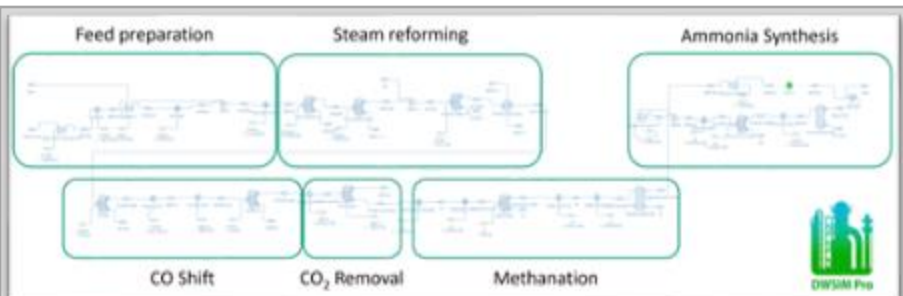
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Work with Flowsheets, smarter

Improvement of a complex process



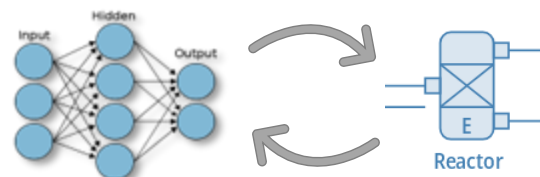
The Ammonia Syngas Plant is a challenging use case for process improvement

- Strongly non-linear process behavior due to complex unit operations (many reactors)
- High temperatures and pressures that directly influence economic results
- Utility-intensive and energy-consuming process where small changes strongly influence the overall energy consumption
- Rigorous optimization can be difficult or even impossible due to the number of reactors (convergence)

Challenge: Data-driven optimization of complex processes

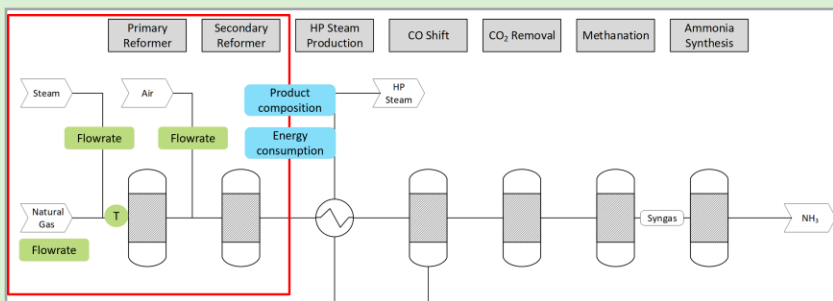
Approach: Create a surrogate model (SM) from process data

- Process data (from simulator or PCS) can be used to train a SM
- Process simulators are a reliable source for process data based on physical principles
- The SM can replace the simulator's pre-built unit operations



Surrogate models support optimization

We built a surrogate model of the reforming section



Design space

- Inputs: Latin Hypercube Sampling
- Outputs: Multidimensional Sensitivity Studies

4 inputs

7 outputs

Model training and evaluation

Training of an *Artificial Neural Network* in DWSIM Pro (Keras/TensorFlow)

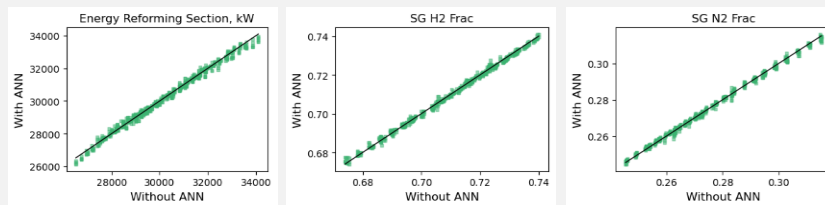
1. Data import from .xlsx
2. Input/Output assignment
3. Definition of the model architecture
4. Automated training and evaluation
5. Verification of the model performance



...and implemented it in the flowsheet



THE SIMULATION WITH SM EMBEDDED SHOWS GOOD ACCURACY AND BETTER CONVERGENCE



546/648 (84.3%) converged simulations without the ANN

612/648 (94.4%) converged simulations with the ANN

Conclusions

- SM use process data more efficiently (interpolation)
- SM improve the convergence by replacing complex unit operations or entire process sections

