FUDIPO

Future Directions of Production Planning and Optimized Energy and Process Industries

Start date	1st October 2016
Duration	48 months
Budget	5,740,676.25 €
Coordinator	Prof.Erik Dahlquist, MDH

FUDIPO project aims to develop an integrated set of methods combining mathematical modelling and simulation to optimize all the processes in a factory or technology from an holistic point of view. The applications will be for both improvements of existing processes of a factory or technology as well as for developments of totally new production system solutions, where experience from existing processes is gathered in the simulation models. These models will be tested in 5 pilot and full-scale facilities:

Industrial use cases

Heat and Power Plants

Increasing the uptime of the field trial systems and commercial system

Prediction of fuel quality by models

Pulp and Paper

Predicting the kappa number from the Wood properties by NIR measurement

Oil refining plant

DHP Unit Optimization with Model Predictive Control, and new soft sensors based on NIR and RF.

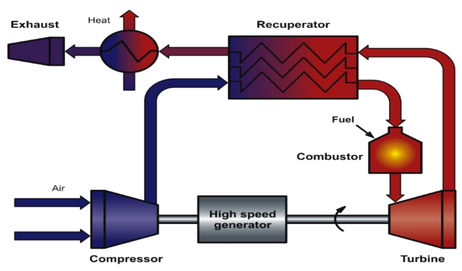
Biological waste-water treament

Increasement of biogas production and performance through robust control

Micro-CHP power plant: MTT

Current situation:

The current system (called EnerTwin) has **limited set of sensors, large variation and large dataset,** which might make **trending, model and algorithm development difficult.**



Improvement potential:

To increase the uptime of the field trial systems and later the commercial system by changing the maintenance model from a fixed maintenance interval (every 5000 hrs) to a condition based maintenance interval, significantly lowering the maintenance cost, and decreasing the total cost of ownership.

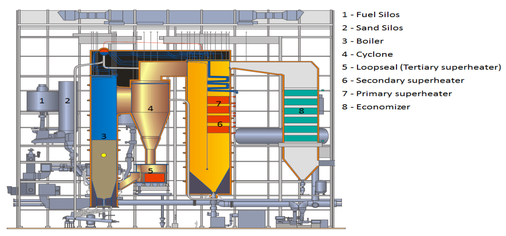
Large-CHP power plant: Mälarenergi

Current situation:

Block 6 of line process uses waste fuel as a feed stock into a CFB boiler and is used to provide a portion of the heat and power. If the fuel characteristics and composition are not well known, the operating conditions may be difficult to manage. Fuel coming into the system with a high moisture content may lead to a drop in the boiler bed temperature, which can be problematic.

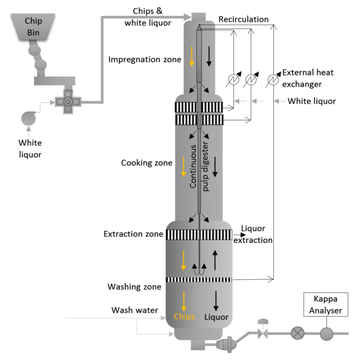
Improvement potential:

By incorporating measurements from the fuel feed line into a physical model, a clearer perspective of the fuel's quality can be obtained, by analyzing process variations. With an end of goal of being able to control the boiler T profiles better. FUDIPO models will be implemented for Block 6.

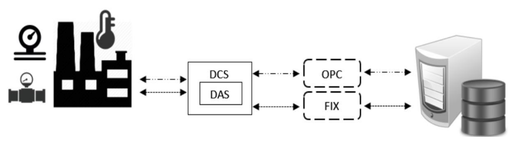


Current situation:

The main task of the fiber-line is to produce pulp with a good quality and as high yield as possible for the board machines.

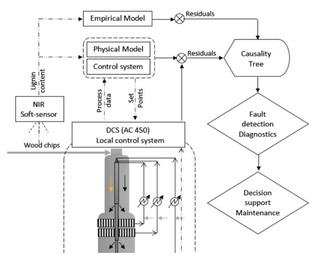


In pulp digesters the goal is to remove a certain amount of lignin from the fibers, measured as kappa number. Billerudkorsnäs are using PI as a database to store data.



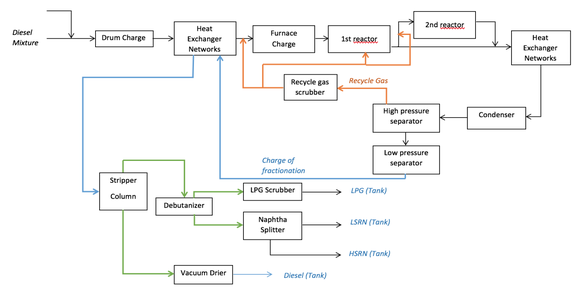
Improvement potential:

The functionality desired is to predict the Kappa number from the Wood properties of Wood coming into the fiber-line by measuring NIR spectra of the incoming chips. Another goal is to develop an architecture for process diagnostics with the help of Bayesian network. The plan is to develop such architecture by using the physics based and machine learning approach. The scope of the process diagnostics is limited by detecting digester hang-ups, screen clogging and channelling of liquor inside the digester.



Current situation:

The main task of the refinery is to **convert crude oil into usable end products**. going through a distillation process to separate the different fractions. One of the units aiming at increasing the quality of diesel is the diesel hydrotreating unit (DHP). During 2015, TUPRAS purchased approximately 20 different types of crude oil, which were changed approx. three times per week. Each blend changed the feed properties of the DHP, especially T95. Nevertheless, **the T95 of the inlet stream is not measured on-line, but in lab experiments in relatively long intervals.**



Improvement potential:

Economic optimization of the DHP unit by optimizing the feed blenc procedure with the help of current Model Predictive Control (MPC). **Adaptive learning functions of FUDIPO will be used to enhance MPC**. The main target of the demonstration is to produce the maximum amount of diesel at given specifications. Current measurements are to be upgraded, with new soft sensors included in the model, based on NIR and RF, which will allow to know the T95 of the feed to operate the unit more efficiently. A subsequent challenge is to **build robust models for prediction of the feed properties** from NIR-spectra correlated to data like the T95.

Current situation:

For waste water treatment plants using activated sludge processes it has been identified the possibility to combine algae with microorganisms and thereby eliminate the aeration demand, giving at the same time more biomass and hence biogas as well.

This industry normally uses very basic control system, so **the performance can be really improved through the implementation of the methods with control, based on various quality measurements of incoming waste.**

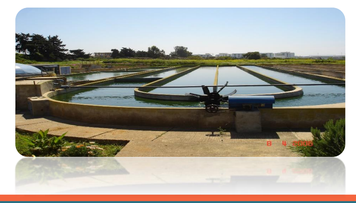
Improvement potential:

Aeration demand constitutes 50% of the electric energy demand in current waste water treatment plants and corresponds to about 2% of the total electric energy demand in developed countries.

As the total consumption of electricity in EU is around 3400TWh/year the savings potential is in the range of 60-80 TWh(el)/year.

With a cost of electricity at 100€/MWh this means electricity savings in the range of 3-4B€/year.

At the same time the biogas production can be increased by some 25% in those plants utilising sludge for biogas production, and much more where biogas is still not produced.



Expected Impacts

The impact of the process industry on the environment is a global concern and **the sector is under considerable pressure to adapt to new energy situation**. In the European Commission's Energy Roadmap for 2050 highly ambitious targets have been set in order to tackle climate change.

FUDIPO advanced on-line control, monitoring and diagnostics solutions are aimed at **improving energy and resource efficiency while reducing operating costs.** The Project will also support the **transition from fossil fuels to biomass** and waste fired power plants capable of producing additional products while operating on the backbone of on-line process simulation and control models coupled with novel sensor technologies

- ✓ **Energy efficiency**
- ✓ **Resource efficiency**
- ✓ **Better process control**
- ✓ **Better product quality**
- ✓ **Increase EU competitiveness**
- ✓ **Lower costs**
- ✓ **Qualified employment**
- ✓ **Efficient use of waste and biomass**
- ✓ **Lower emissions**

This Project has received funding from the European Union's Horizon 2020 Research and Innovation Program Under Grant Agreement nº 723523