'PiT Navigator' Power

Combustion Optimisation System for Coal Fired Power Plants

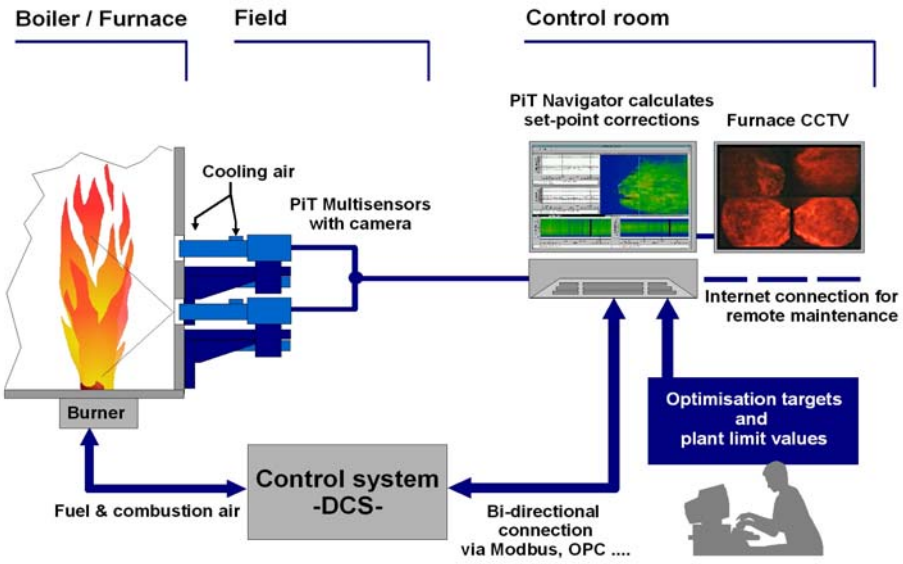
Short Description:

The PiT Navigator System consists of specially developed sensors for the combustion chamber – PiT Multisensors, image processing software for flame analysis as well as self-learning adaptive information compressing modules and control modules based on neural nets.

NMPC (Non-Linear Model Predictive Control):

The parameters extracted by the PiT Multisensors are combined with conventional process data to create statistical models of the process in the combustion chamber. These non-linear process models makes it possible to predict the most important process results and hence to steer the process in the most optimal way. The information that Powitec uses is based on e.g. changes of the combustion air (amount of transport air, temperature of transport air / temperature when leaving the mill, amount of secondary air, distribution of secondary air etc.) and the amount of fuels (position of classifier, amount on feeder etc.).
The adaptivity of the process model is the main characteristic of the PiT Navigator, and is due to the its self-learning and non-linear multi-variable control features.

The optimiser can be combined with all existing control systems. The control is based on the correction of set point values and linked with the DCS.



The optimisation targets can be set alone or in combination with other process goals (examples):

	Local fuel/air ratio	
AND/OR	***Total NO_X***	**automatic control**
AND/OR	***Total 0_2***	**increase of efficiency**
AND/OR	***Total CO***	**automatic control**
AND/OR	***Boiler End Temperature***	**increase of capacity**

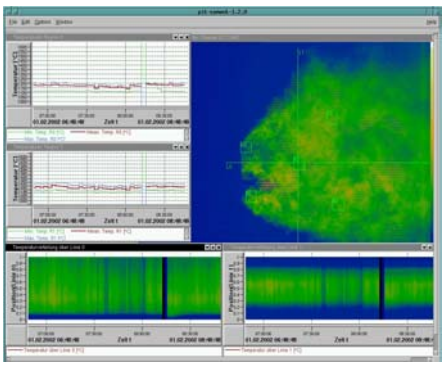
PiT Multisensors

The number of the air-cooled PiT Multisensors depends on the combustion chamber design. The name PiT Multisensor is due to the fact that one sensor can contain two cameras that nevertheless are directed at the same display window.The PiT Multisensor disposes a high-speed camera (CMOS-technology) as well as a digital colour camera. These cameras provide information of the combustion process with high spacial - and time resolution. The parameters are obtained via digital image processing, complex pre-processing of data and information compressing. Depending on the target of the optimisation it is possible to work with only one of these cameras.

PiT Multisensor with pneumatic retraction system on a 220MW coal fired boiler

The control proposals provided from the PiT Navigator are extracted from the flame body and detected online by the PiT Multisensors. This brings a constant revision of the process model which rectifies itself where observed necessary as well as a continuous optimisation in order to reach the set objectives. This is especially valuable when the process conditions are irregular.

The control adjustments primarily optimise the air distribution. However, the valvular setting is not the focal point but the set points corrections in the given control system. Which control variables that are most usable in order to reach the optimisation targets are defined by an earlier made significance analysis, the so called 'Data Mining sensor supported'.



The system computer visualises the analyses data during the operation. It also uses these input parameters for the PiT Navigator to reach the optimisation targets and the threshold values of the plant.

PiT Slagging & Fouling Detector can be included:

The PiT Slagging & Fouling Detector is a sophisticated tool to measure the amount of boiler surface pollution using image processing.

The PiT Navigator can use this process information to develop automatically concepts to reduce the slagging by self-learning control (load balance).

PiT Navigator Software:

1.) Process Navigation using adaptive Non-linear Model Predictive Control (NMPC):

- Adaptive, multi-variable, self-learning controller with process models applying neural net technology on the base of recurrent statistical analysis
- The process models are self-supporting and automatically adjust themselves to changing process parameters, also after initial training
- Digital image processing for online process characteristics by pattern recognition includes the combustion process in the process models (no black box optimisation!)
- System permanently steers the process to its technical optimum – according to the objectives of the operator (quality functions) and plant limit values – using current and stored data
- Flexible definition of of optimisation targets (quality functions) – could also compete each other
- Significance Analysis: detection of the relevant and important process parameters with regards to optimisation targets
- Non-linear process control by means of adaptive neural net models
- No limitation of the amount of input signals/channels
- Permanent data validation of plausibility of incoming channels
- Real-time simulation of expected process results
- Development of an analytical-statistical process model by using conventional measurement and control signals in combination with image processing parameters from the combustion

2.) Digital Image Processing Parameters

- System specific optical sensors (PiT Multisensor) based on high-speed cameras (CMOS)
- Consideration taken to the process changes caused by fuel characteristics as calorific value, ignition behaviour, ash content etc.
- Consideration taken to the process changes caused by plant wear by graininess of the input coal (from the mill), distribution of coal on the burners (classifier and pipes), degree of contamination of the evaporator walls (fouling) etc.

INPUT:
- Conventional process parameters / instrument signals
- Optimisation targets (as quality functions)
- **Digital image processing** (as geometric and statistic characteristics from pattern recognition of the burner near field)
- Historic process data from system own data base

Examples of measurement and control signals from the control system as INPUT for the PiT Navigator:

Location	Signal
Feeder, mill, classifier	rotation speed of feed, position of classifier, primary air, temperature of primary air, etc.
Burner	Amount of secondary air, twist of secondary air, amount of tertiar air, amount of fumes in recirculation, temperature of air preheater etc.
Combustion chamber	temperatures
Steam	flow rate, temperature, pressure
Flue gas	NO_X, CO and residual O_2 content

OUTPUT:- Optimised adjustment of target values (control variables) of the control system. Enables online-control of the combustion process with consideration taken to the specific limiting values of the plant.

Examples of control variables as the PiT Navigator's OUTPUT:

Location	Possible Actuator
Feeder, mill, classifier	rotation speed of allocator, primary air, securing etc.
Combustion chamber	amount of total air
Burner	amount of secondary air, twist of secondary air, amount of fumes in recirculation
Mill/Burner	amount of alternative fuels

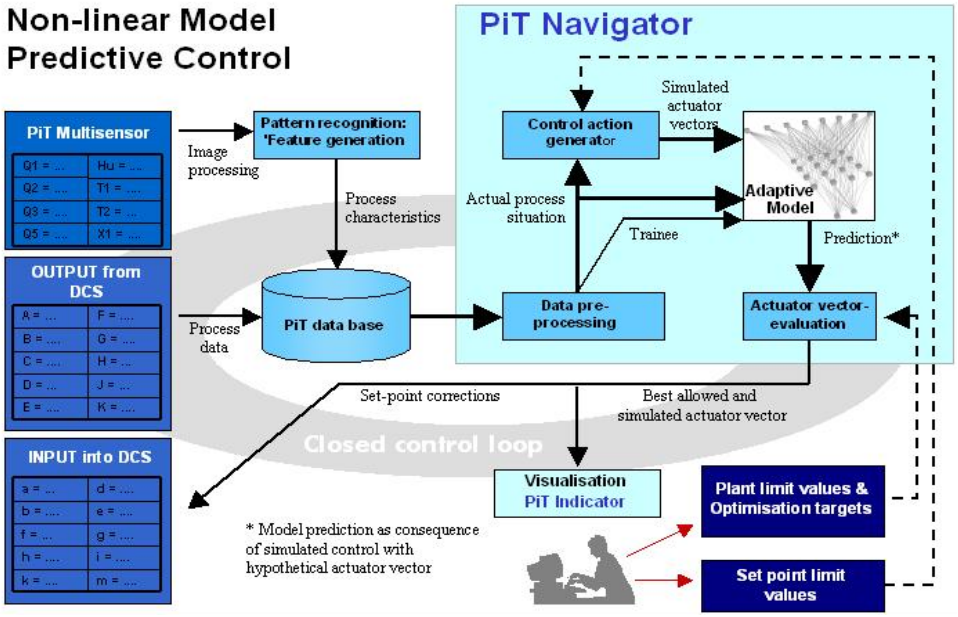
Process Interface between Control System and 'PiT Navigator':

- bi-directional digital data link/bus (e.g. file interference, OPC, MODBUS, Profibus etc.)

Remote Maintenance

- the LINUX-Platform allows for 100 % remote maintenance including software updates and frequently monitoring of the system functionality
  permanent connection using ssh/VPN

Control functionality:



References:

RAG Saarenergie, Power Plant Fenne
Völklingen, Germany (1 Unit) 230 MW

Vattenfall, HEW Power Plant Tiefstack
Hamburg, Germany (2 Units) 135 MW

KEPCO, Power Plant Seocheon
Seocheon, South Korea (2 Units) 220 MW

In case of question or to prepare a detailed quotation please be not hesitate to contact us!

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