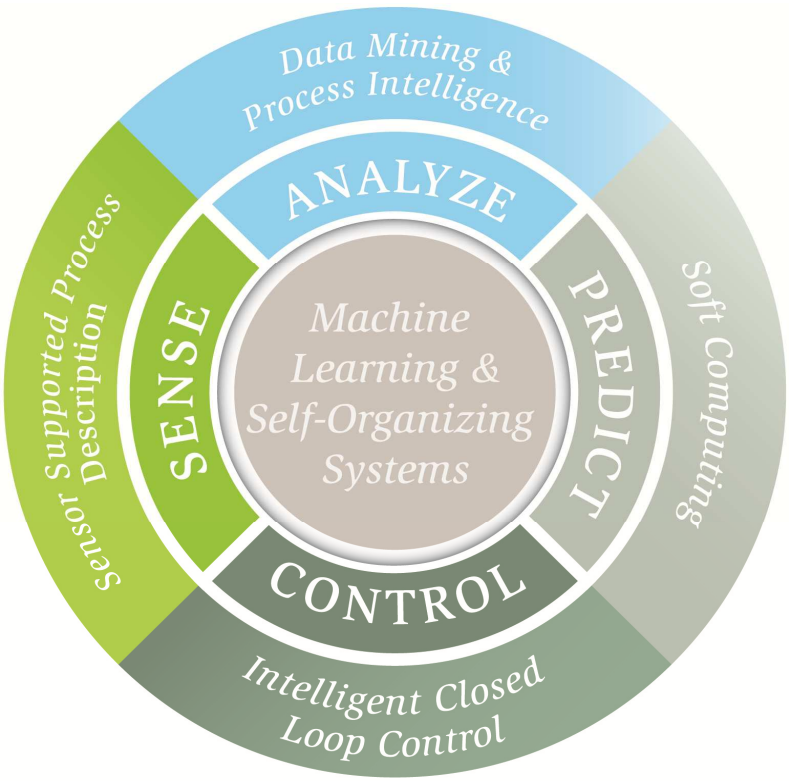
Powitec
Solutions for the Cement Industry



Upgradable intelligent solutions for process optimisation

SENSE *Sensor Supported Process Description*
Generation of high resolution on-line process characteristics
PiT Indicator

ANALYSE *Data Mining and Process Intelligence*
Mathematical-statistical correlation analysis via intelligent algorithms
PiT Data Mining

PREDICT *Soft Computing*
On-line computation of expected development for selected process values
PiT Predictor

CONTROL *Intelligent Closed Loop Control*
Auto-optimising closed loop control for complex processes
PiT Navigator

PiT = Powitec Intelligent Technologies

for

- Kiln (system of preheater, calciner, kiln, burner)
- Cooler
- Mills (raw meal mill, clinker mill, coal mill)
- Flue Gas Cleaning

Kiln (system of preheater, calciner, kiln, burner)

SENSE

ANALYSE

PREDICT

CONTROL

Cooler

SENSE

CONTROL

Mills (raw meal mill, clinker mill, coal mill)

SENSE

CONTROL

Flue Gas Cleaning

CONTROL

Solutions for the
Kiln
(preheater, calciner, kiln, burner)

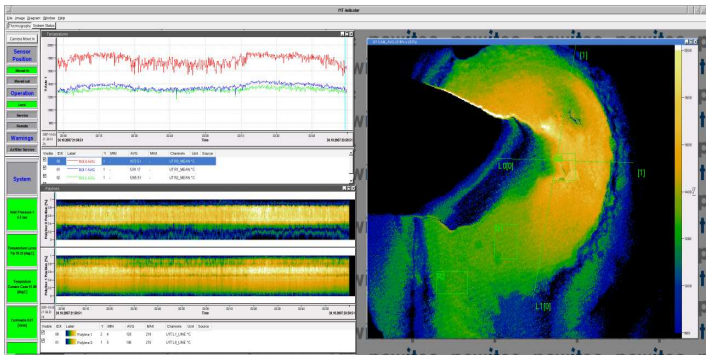
SENSE:

PiT Video
Video camera for permanent visual flame inspection.

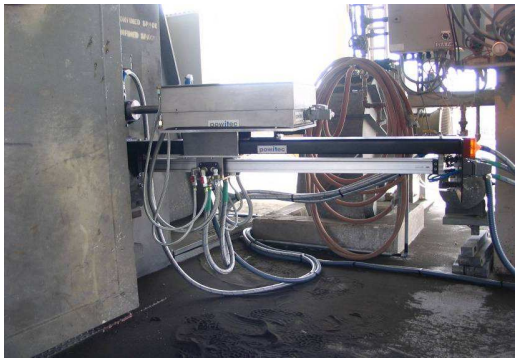
Benefits:
- Flame inspection allows for in time reaction
- Supervision of slagging at burner mouth and coating of kiln walls

Features:
- Rugged German design
- Endoscope: Electronic is temperature protected
- Air or water cooling
- Supervision of temperatures and cooling media supply
- High availability

PiT Indicator
Intelligent CCD or IR-Thermography for indicating temperature and flame variations in their transient behaviour



Benefits:
- Chronological flame variation and temperature profile displays allow active flame management
- Clear view
- Refractory protection (tempera-ture variation reduction)
- Quick adaptation to changing fuel properties



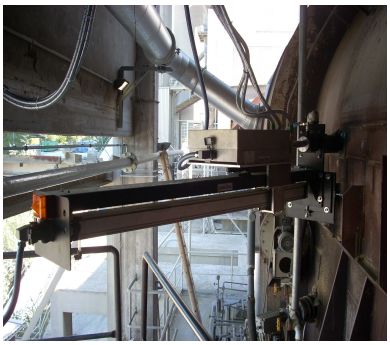
Features:
- Polyline: Temperature trend information
- RGB camera technology: Precise
- Adaptive Electronic Dust Filter: Clear View
- High availability, security features
- Free definable regions of interest and measuring points
- Output for DCS / expert systems / Intranet
- Upgradable to PiT Predictor and PiT Navigator

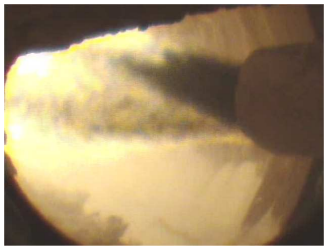
PiT Indicator Side View

Intelligent Thermography from the kiln hood side for indicating plum length – especially for kilns having a high alternative fuels rate

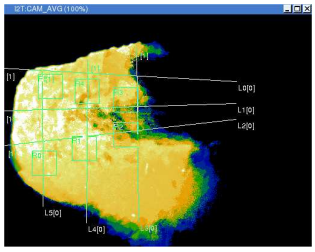
Benefits:

- Chronological information about plum-size and -position as well as about flame-ignition point and -diameter
- A must have at kilns having high alternative fuels rate
- React in time and increase alternative fuel ratio at constant or improved quality
- Detect combustibility of alternative fuels with faster readjustment after fuel changes
- Impact of flame shape and/or fuel on clinker quality
- Increased alternative fuel rates of alternative fuels which really do contribute





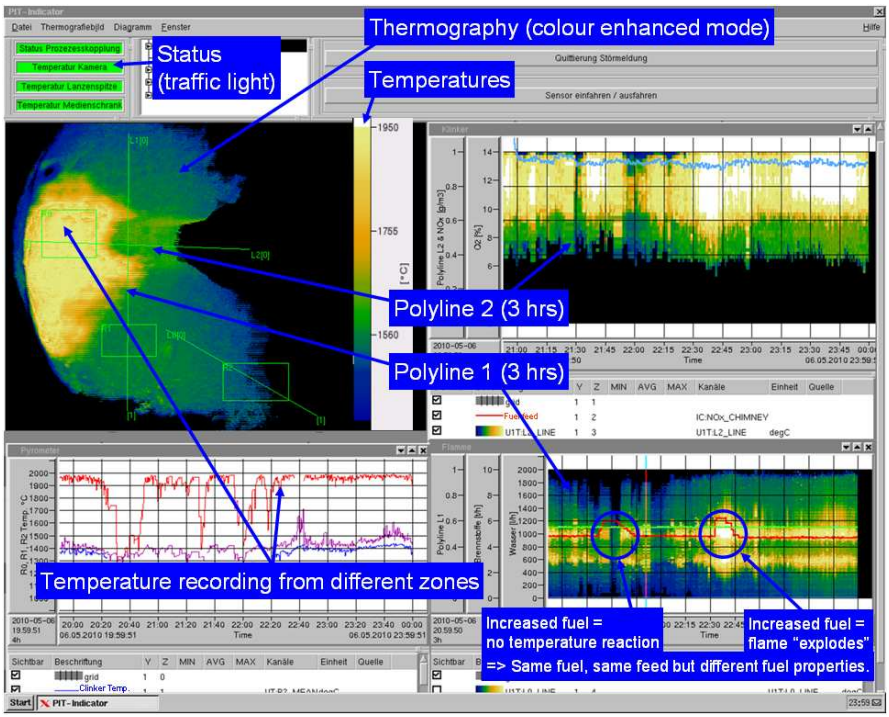
Video



Thermogram

Features:

- Polyline: Temperature trend information
- RGB camera technology: Precise
- Adaptive Electronic Dust Filter (AEDF): Clear View
- High availability, security features
- Free definable regions of interest and measuring points
- Output for DCS / expert systems / Intranet
- Upgradable to PiT Predictor and PiT Navigator

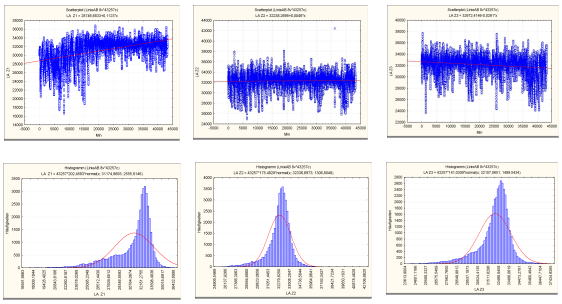


ANALYSE:

PiT Data Mining

Analysis of historical DCS/PCS data towards optimisation potential with the aid of statistical software and neural nets; recommendations for hardware modifications; on site test measurement with mobile optical sensor

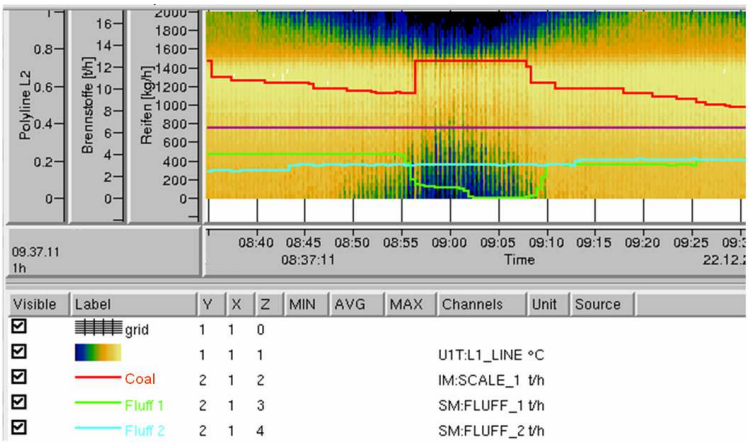
Benefits:



- Optimisation potential with calculated amortisation time
- Information about priorities depending performance
- Comparability of different production lines
- Findings of new significant correlations
- Discovering new optimisation potentials

Features:

- Data mining supported with mobile sensor (PiT Indicator)
- Data significance analysis with
  - Classification and cross correlation
  - Deviation Analysis
  - Dependence Analysis
  - Multidimensional regressions
  - Clustering
  - Impact Prognosis
- Identification of the most important process channels or process information
- Elimination of idle time through the process sequence
- Recognition of interdependencies
- Generation of models representing the behaviour of processes
- Finding potential areas for optimisation and drafting solution strategies
- Explanation of unusual situations and phenomena of the processes

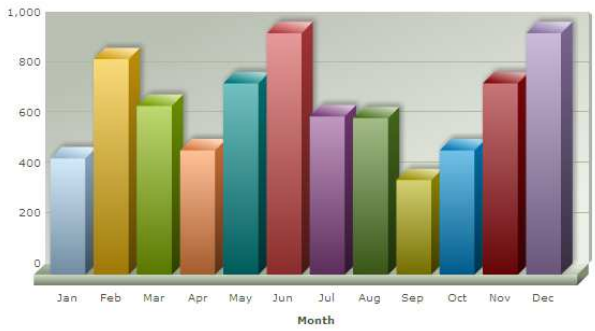


PiT Process Performance Monitoring

Online analysis of actual and historical DCS/PCS data towards optimisation potential with the aid of statistical software and neural nets.

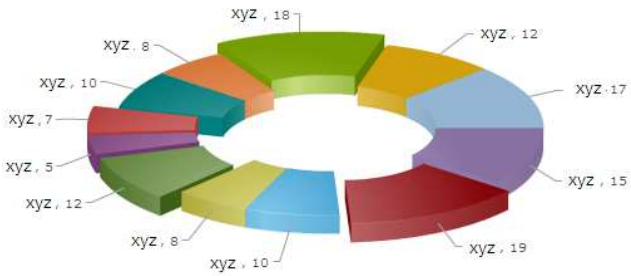
Benefits:

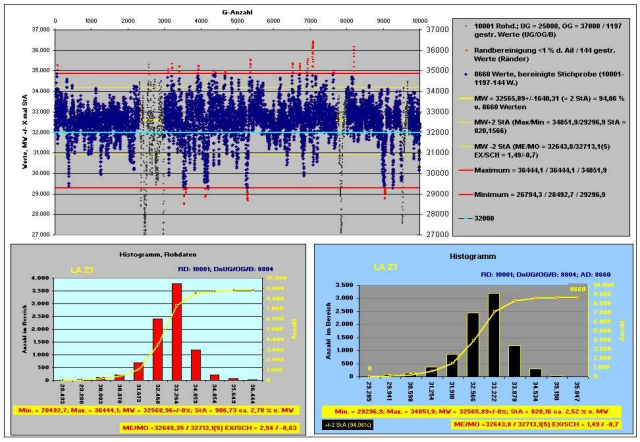
- Online overview: Data becomes information
- Information about priorities depending performance
- Comparability of different production lines
- Findings of new significant correlations
- Fast and clear availability of historical data
- Discovering new optimisation potentials

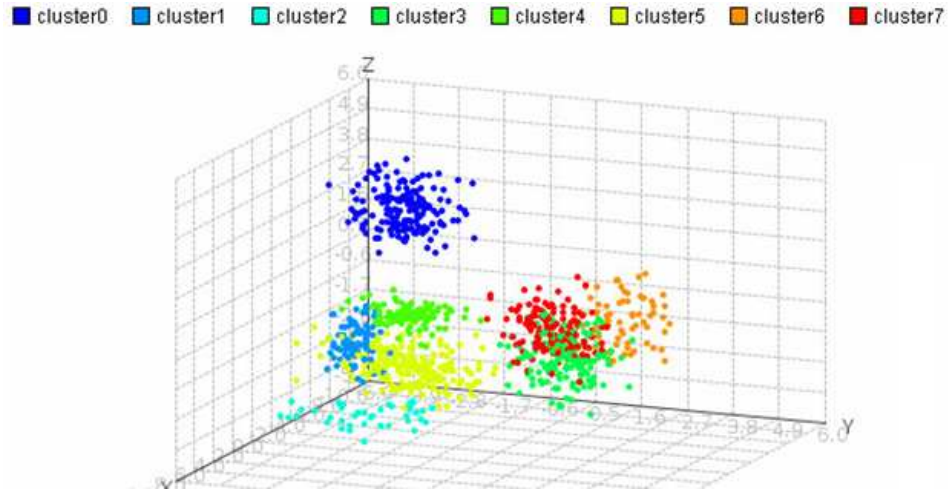


Features:

- Data significance analysis with
  - Classification and cross correlation
  - Deviation Analysis
  - Dependence Analysis
  - Multidimensional regressions
  - Clustering
  - Impact Prognosis
- Benchmarking
- Full automatic feature-extraction, -selection and –reporting
- Scoring
- Manual or full automatic reporting
- Export-Function







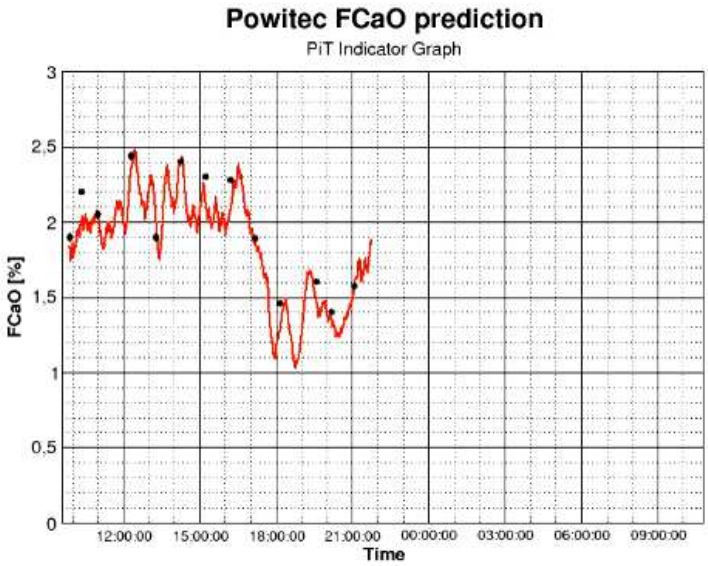
PREDICT:

PiT Predictor

Timely knowledge of process changes through permanent on-line information on process values like NOx, C3S, FCaO.

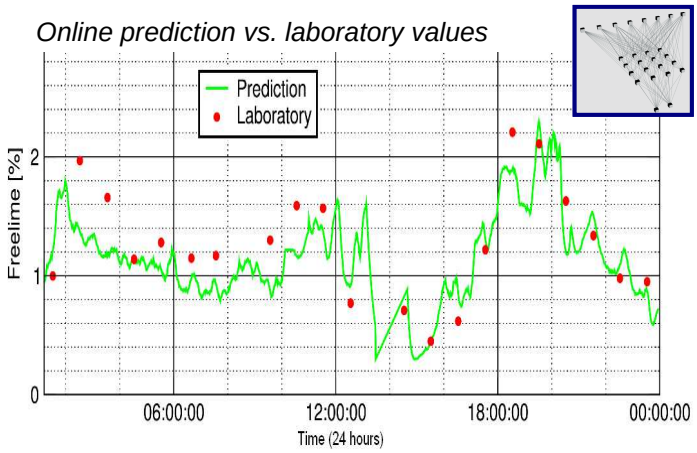
Benefits:

- Accurate prediction of i. e. NOx, C3S, FCaO;
  Prediction **accuracy worldwide unbeaten**
- Timely knowledge of process changes through permanent on-line
- Reduction of off spec filter ash
- Energy saving
- Process stabilisation



Features:

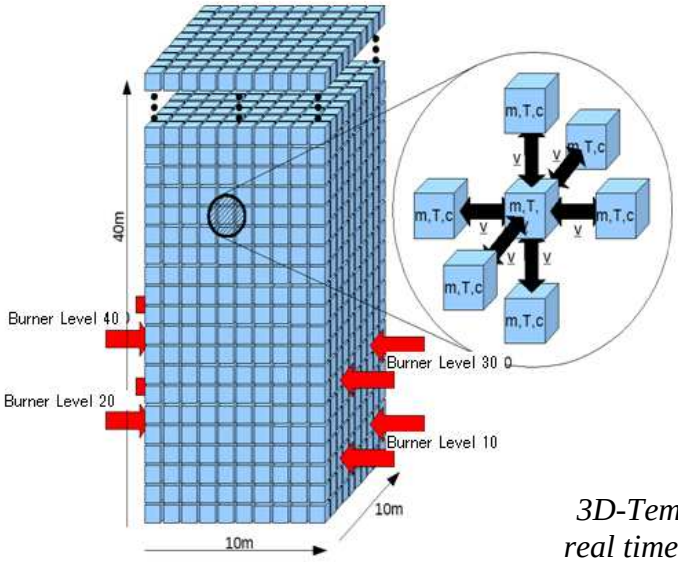
- Continuous Online-Prediction of key process parameters
- Self learning adaptive software based on Neural Nets
- Integration of additional Information from the process (PiT Indicator, PiT FluxStylus, PiT VibraSensor) where helpful
- High availability, security features
- Upgradeable to PiT Navigator



The average prediction of FCaO over 14 Powitec systems with included optical information for a period of 150 days showed a correlation coefficient value of 0.89

PiT Online CFD

- Calculation of temperature distribution by dividing the rising duct into many small volume elements. For each of these elements, physical parameters, such as mass, density, velocity and temperature are modelled. Mutual interactions are described by mathematical-physical equations.
- Online-calibration with existing and new Powitec measurements
- Continuous on-line description of the temperature distribution with update rates of 10 to 30 seconds



195 MWel + 80 MWth shifted boxer firing with 8 burners
Online-3D-Temperature-Modelling: Separation of the first draft into volume elements (boxes)

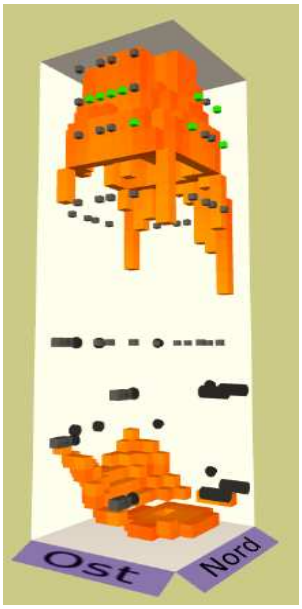
For each box modelling of the flue gas parameters:

- *Temperature*
- *Mass*
- *Density*
- *Speed in x, y and z direction*

3D-Temperature-Analysis in real time (update each 15sec)

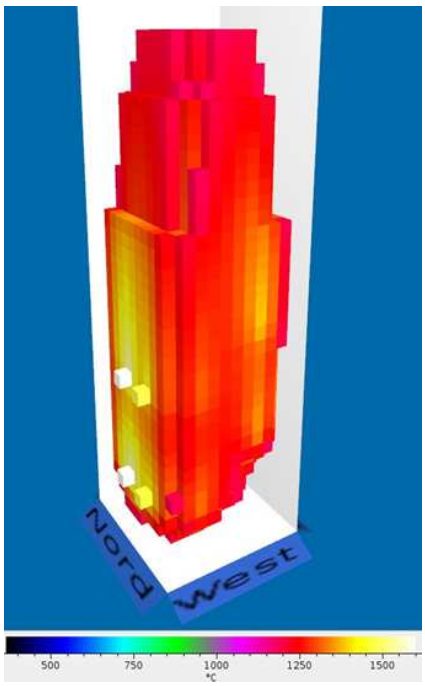
Temperatures according to colour scale at the lower picture boarder.

Significant influence of 4 burners in the north wall



Exclusive display of the optimal temperature window for injection (900 – 1,000°C) SNCR (3rd party): 60 lances and 5 levels: green: active nozzle; gray; inactive nozzle

<u>Result through Powitec Control:</u>
Reduced NH4OH-consumption at reduced NH3-slip



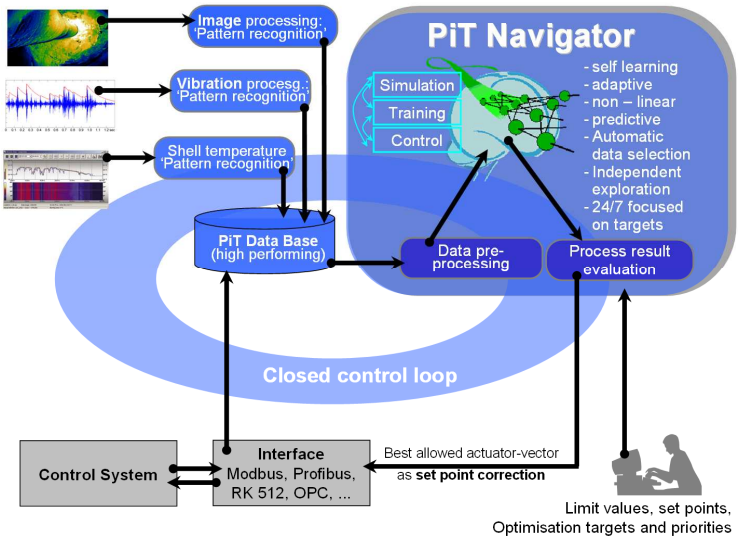
CONTROL:

PiT Navigator

Advanced Auto-Optimiser for permanent process optimisation

Benefits:

- Stabilized kiln operation and clinker quality
- Increased clinker production volume (up to 5%)
- Energy efficiency increase (up to 5%)
- Increased alternative fuel usage (up to 100%)
- Reduced emissions (NOx and CO2)
- Increased kiln availability
- Fully automated sintering process



Features:

- Adaptive self learning software
- Integration of optical information
- Quick commissioning time and low involvement of operating personal
- Permanent optimizing software for calciner, kiln, burner
- High availability, security features
- PiT Navigator includes features of PiT Predictor

PiT Navigator Burner

Advanced Auto-Optimiser for a permanent optimisation of fully automated burners

Benefits:

- Process stabilisation
- Increased efficiency

Features:

- CCD camera (PiT Indicator) observes the flame
- Process data from the PCS are permanently correlated with optical information through a software based on neural nets
- Self learning adaptive software based on Neural Nets, adapting themselves to changing process situations
- Integration of expert knowledge and improving this knowledge self-learning

Solutions for the Cooler

SENSE:

PiT Video Cooler

Video Image from the cooler inside for in time reaction to process changes.

Benefits:

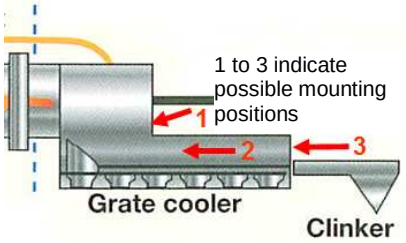
- Clinker bed inspection allows for in time reaction
- Supervision of height and distribution

Features:

- Rugged German design
- Endoscope: Electronic is temperature protected
- Air or water cooling
- Supervision of temperatures and cooling media supply
- High availability

PiT Indicator Cooler

Intelligent CCD or IR-Thermography for indicating secondary air and clinker bed variations in their transient behaviour

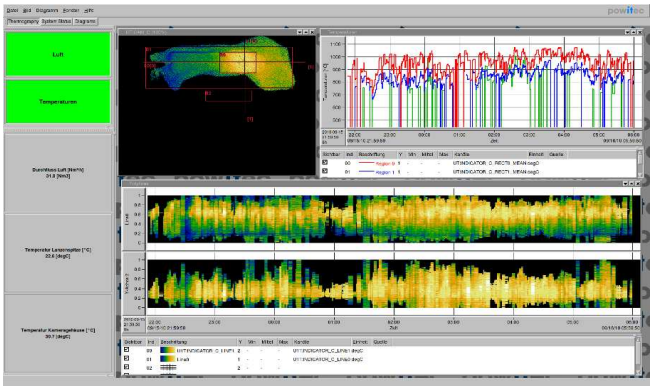


Benefits:

- Analysis of secondary air temperature to find influences on burner flame and thus the clinker
- Control the cooler to stabilise flame and clinker quality
- Proper combustion of WDFs
- Usage of the cooler as a fast responding temperature storage

Features:

- Polyline: Temperature trend information
- RGB camera technology: Precise
- Adaptive Electronic Dust Filter: Clear View
- High availability, security features
- Free definable regions of interest and measuring points
- Output for DCS / expert systems / Intranet
- Upgradable to PiT Navigator Cooler



CONTROL:

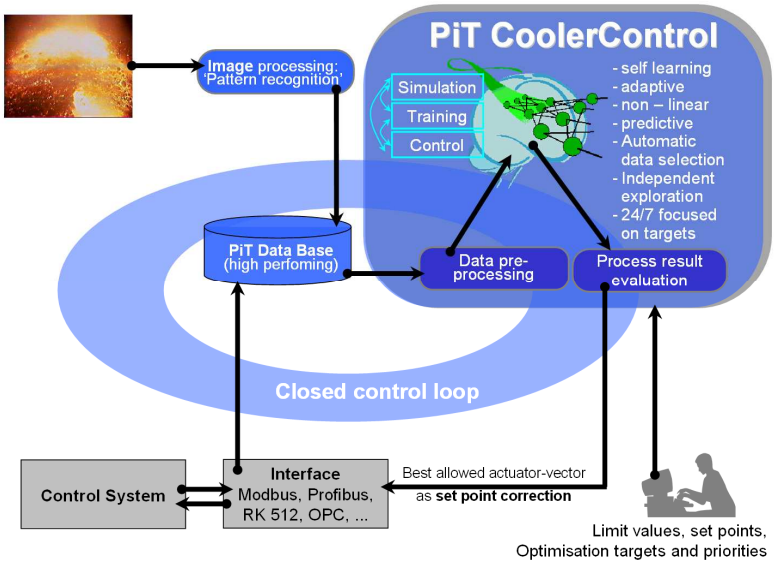
PiT Navigator Cooler

Advanced

Advanced self-learning adaptive control of the cooler with additional information from secondary (cooler) air and clinker bed temperatures and clinker bed form to increase secondary fuel ratio and improve stability.

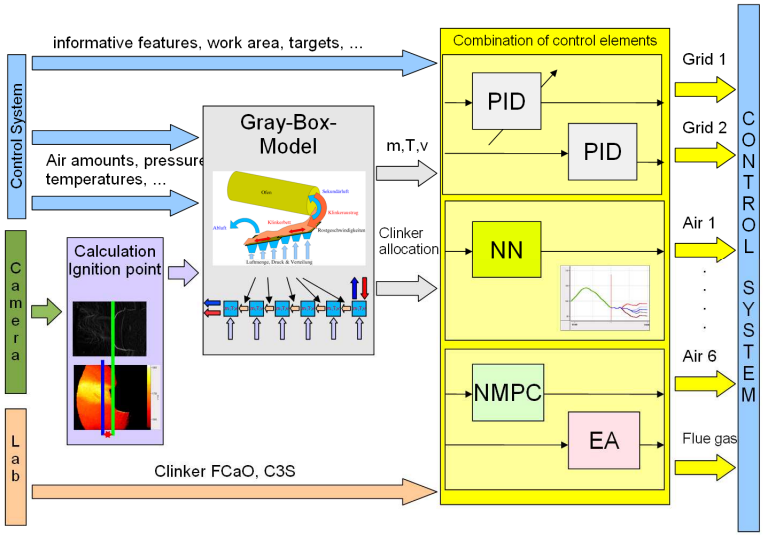
Benefits:

- Reduced control deviation secondary air temperature with defined clinker end temperature
- Increased burner flame stability
- Fast cooling
- Improved clinker quality
- Fast adaptation to process changes



Features:

- Integration of temperature information from cooler inside
- Adaptive self-learning software
  - Permanently optimising
  - Permanent on-line 3D-CFD analysis of temperature distribution in the cooler inside
  - PiT Navigator includes features of PiT Indicator Cooler
- Modular system: Upgradeable to Calciner-Kiln-Burner-Optimiser



Solutions for
Mills

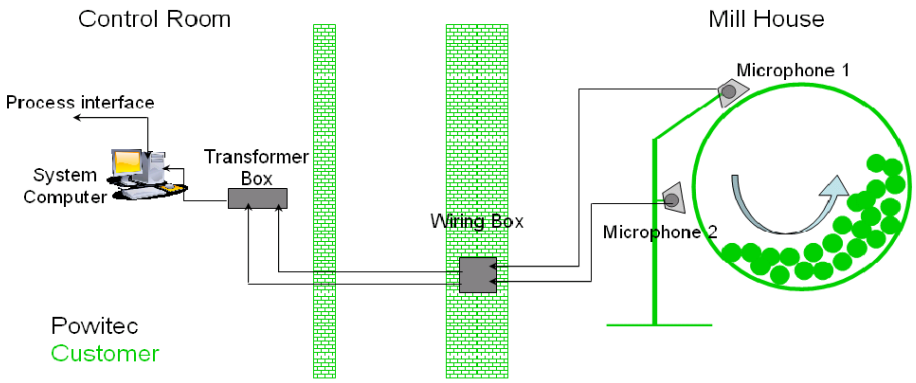
SENSE:

PiT Indicator Mill

Suitable for vertical mills (ball and roller) and horizontal ball mills
Indication of mill filling degree.

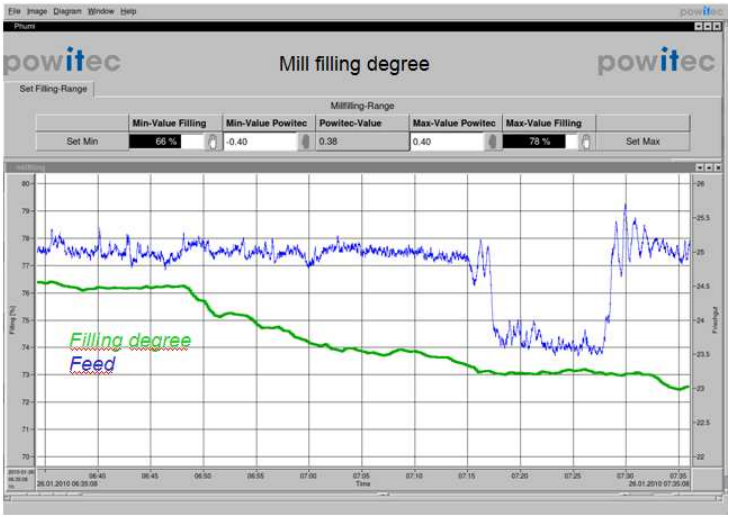
Benefits:

- Exact analysis of mill filling degree even in multi mill set-ups at the same place
- Scalable: Easy and inexpensive to scale to multiple mills



Features:

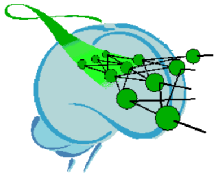
- Calibrate measured filling degree in the control room against „expected filling degree“ including graphical user interface with trending and alarming
- Two microphones per mill to allow for advanced signal processing and to eliminate influences by disturbing sounds (i. e. other mills)
- Calculation of filling degree by using advanced signal processing with pattern recognition on acoustic measurements
- Automatic feature selection and extraction (significance ranking) of existing process data
- Option: Process interface to e. g. OPC server, Modbus RTU Master, Modbus TCP Client, ProfibusDP Master, Analogue etc.
- Modularity: Possibility to upgrade to PiT Navigator Ball Mill



CONTROL:

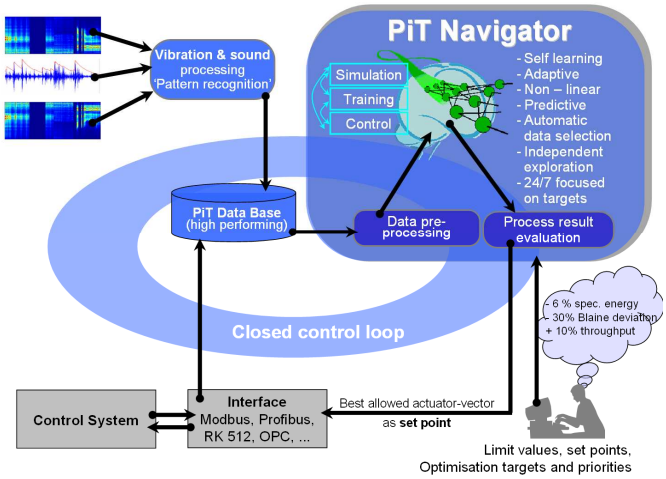
PiT Navigator Mill

Advanced Auto-Optimiser for permanent optimisation of mill and separator.
Suitable for vertical mills (ball and roller) and horizontal ball mills



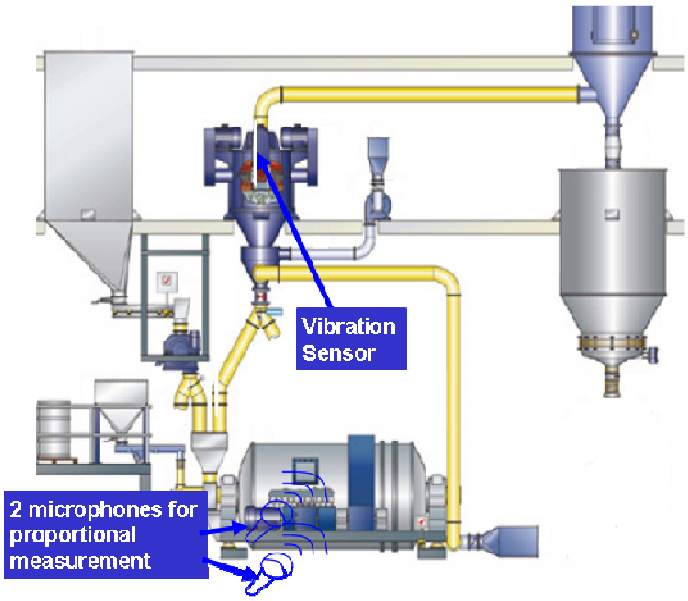
Benefits:

- Reduced grinding degree deviation (Blaine) by up to 30%
- 2% and 6% less specific energy consumption
- 8 to 15 % increased throughput
- Full automatic closed-loop control
- Clinker type and recipe independent optimisation
- Elimination of lab delay through **Blaine prediction** by a sophisticated soft sensor
- Optimised mill start up
- Fast adaptation to process changes and changes in clinker types



Features:

- Online vibration monitoring of separator allows for **Blaine prediction** and quality based throughput maximisation
- Recipe independent closed-loop control by using filling degree, Blaine prediction and Advanced Process Control
  - Self learning of controller parameters for different recipes
  - No re-parametrisation at new recipes
- Fast and stable control for less specific energy consumption
- Intensive usage of existing process data
- Automatic feature selection and extraction (relevance ranking)
- Remote support included
- Integration of existing mill monitoring systems



Solutions for

Flue Gas Cleaning

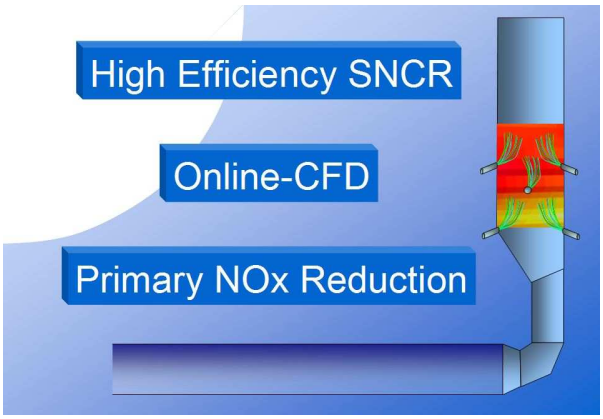
CONTROL:

PiT Navigator SNCR

Complete multi stage SNCR with single lance control, including all necessary components plus advanced optimiser with Online-CFD and permanent estimation of the build-up in the riser duct for continuous optimisation of spray amount, slip and NOx peaks

Benefits:

- Safe limit compliance
- NOx reduction <200 mg/Nm³ (0.15 lb/MMBtu) possible
- Avoidance of investment in SCR
- Low slip at low reagent consumption
- Reduced operating costs = fast amortization
- Upgradable with PiT Navigator to reduce primary NOx



Features:

- Software
  - Adaptive and self learning software; permanent dynamical optimisation through autarkic learning and therefore saves the manual adaption to process changes
  - Autonomous process exploration within given limits; as a process expert constantly working on process optimisation
  - Internal prediction of future developments at NOx, temperature, coating etc.
  - Online-CFD: Continuous on-line description of temperature distribution by dividing the rising duct into many small volume elements.
  - Online-calculation of the ideal spray amount (considering the future and current levels of NOx, O2, temperature, deposition rate and slip)
- Hardware
  - Multi level SNCR
  - Single lance control
  - Additional temperature measurement of different depth in the refractory material of the rising duct to estimate the current coating in the riser duct
- Modularity: Possibility to upgrade to PiT Navigator to reduce the primary NOx by up to 150mg/Nm³

References:

- Holcim
- Lafarge
- Cemex
- Buzzi/ Dyckerhoff
- Titan
- Cimpor
- plus several family owned producers
- plus several burner producers and consultants

- *100+ rotary kilns equipped with Powitec*
- *10 cement kilns in closed loop operation*
- *35 closed loop optimisations world wide*
- *15 mills in closed loop operation*
- *200+ optical sensors in the field*
- *100+ acoustical sensors in the field*

Approved Competency:

2010: German Innovation Award Climate and Environment for Outstanding and Sustainable Technology. Powitec prevailed against a 145 companies field. Scientific evaluation through Fraunhofer-Institute for System and Innovation Research (ISI).

Dr. Röttgen: German Environment Minister, F. Wintrich: Technical Director Powitec, B. Beyer: Commercial Director Powitec
Dr. Schnappauf: CEO BDI, Prof. Töpfer: Former German Environment Minister and Director UN Environmental Program

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