Temperature measurement on rotary kilns and clinker coolers for process control and optimization

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Product quality and variety, environmental protection awareness, as well as increasing production costs all require a sensitive plant operation with maximum utilization of control ranges. In modern control rooms production facilities of a cement plant are centrally supervised and controlled. Customized control and optimization systems for the improvement of product quality, environmental protection and usage of resources are increasingly important.

GESOTEC and SIEMENS - a manufacturer of infrared-line-scanner systems and a well known systems integrator - have introduced a future-oriented "multimedia-concept" for the state-of-the-art temperature- and Infrared-TV Monitoring in cement plants.

CEMAT-KCS (Kiln- Control System, see Fig.1), and expert system has been developed for the specific requirements of the cement industry. Is a good example that clearly justifies the requirement of such kind of modern systems. However, the introduction of an automation and/or optimization system does presume a skilled process planning to ensure the reliability of the utilized equipment.

SIEMENS products, like the kiln-shell temperature-scanner system CEMAT-SCAN (Infrared-Line-Scanner) or the gas analyzer system CEMAT-GAS, for example, embody minimum maintenance of specially adapted systems for the rigorous requirements of the cement industry. These systems are of immense benefit to the kiln operation as well as to the process optimization, but also to the safety- and emission supervision. In other words, these kinds of systems are essential measuring tools for every cement plant.

CEMAT-SCAN, an infrared line-scanner system for fast rotary kiln shell temperature monitoring and the supervision of tyre creep, aids the optimization and economic operation of the kiln and also consistently reduces maintenance and repair costs.

SIEMENS has for many years provided cement producers with systems for temperature measurement on rotary kilns. As a result Siemens has collected enormous experience in this field. Beginning with pyrometer systems on cable rails along the kiln body up to swiveling pyrometers (pyrometers with orthogonal and spiral scanning), Siemens has done it all. These conventional systems generated a temperature profile of the kiln shell only after a few kiln rotations and as such only could react satisfactorily to relatively slow temperature variations. With increased dynamics in modern process operation, this type of scanning was simply not fast enough. These sluggish pyrometer systems with minimal local resolution were superseded by the development of fast line scanners (like Gesotec´s "Millennium-TMCx" infrared line-scanner series). The new shell scanners offer temperature scanning in real time recognizing even single brick failures.

Scanning of the kiln shell in real time requires that already after a single kiln rotation the complete temperature registration and evaluation is done. With the use of Millennium IR-Scanners even "fast" temperature variations of the kiln shell caused by coating-fall or brick breakout can be recognized and interpreted early. Critical situations during kiln firing like the risk to neck due to massive temperature differences between kiln shell and tyre, can also be effectively recognized and countered through changing of the flame control.

A Millennium IR-Scanner reduces unplanned plant shutdowns and shortens plant downtimes. Siemens decided to further develop an industrial system that is able to send the data produced by the IR-Scanner over long distances in rough environments without any loss or reduction in the integrity of information.

The latest innovative CEMAT-SCAN system incorporates the newest generation of Gesotec Millenium IR- Kiln shell scanners and is entirely based on the WINDOWS® NT operating system. This operating platform guarantees easy integration into modern operation and control systems (e.g. CEMAT-CS, see Fig.2). This combination with CEMAT -CS allows the kiln shell temperature measuring system to be integrated into the total production process. The CEMAT system can be easily and cost-effectively expanded and enhanced with specific component add-ons. The system can be easily serviced and modified by plant staff themselves. No specialists are necessary. Access to the temperature data from each connected workstation in the integrated system keeps operator and management well informed with the latest up-to-date and 'true' data.

This PC based system offers a flexible solution with high reliability and economy. The user can reduce the operation costs through lower maintenance coupled with the ease and fast commissioning of the IR-scanner system

The SIEMENS CEMAT-SCAN system provides the kiln operator with concise and informative diagnostic functions: real-time kiln shell temperature profile, extensive data records, production reports, different display modes, refractory- management, tire creep supervision…

In case of the integration with CEMAT -CS, the temperature data are available at each level of the overall control system (operator and/or information level).

GESOTEC was founded in 1981 in Germany by a group of entrepreneurs with the mission to bring cutting-edge infrared- and TV- technology to industry.

Over all the years their main goal was (and today still is) not only to design reliable and effective industrial solutions based on the actual leading edge technology in Opto-electronics, but also to produce such products and complete systems, as well as providing related engineering- and technical services. Two very special fields of such activities can briefly be described as follows:

1. Industrial online systems for non-contact temperature measurement with sophisticated infrared sensors (cameras, line-scanners and spot-meters) for the initial adjustment and the continuous control of product- & process temperatures, mainly in complex manufacturing processes like e.g. the production of cement, steel, glass, paper…
2. PC- based image-processing systems for visual sensors in R&D and general quality control applications…

Rotary kiln operators in port-land cement-, paper-, lime-, phosphate- and other chemical manufacturing facilities all need constant, useful product and/or shell temperature monitoring. Gesotec analyses the total need in each individual process and provides an integrated solution to fit.

Properly positioned for field of view, Gesotec Millenium IR-Scanners offer options to get BASIC, GOOD, BETTER and BEST hot spot detection. A basic solution (Fig.3) would include one Millennium IR-scanner to monitor the entire kiln shell surface every single kiln rotation. Fiber optics are used for noise free, real-time data transfer.

A standard Ethernet data link interfaces the Data Acquisition Controller (Sensor Control Unit) with PC workstations running Gesotec's application software package "KTCem".

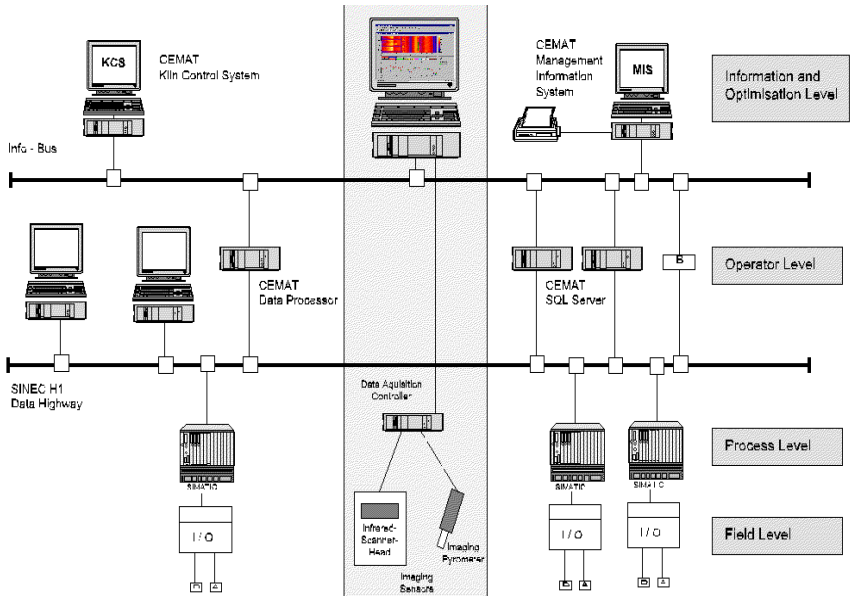

Figure 2
Modern Plant- and Process Control System

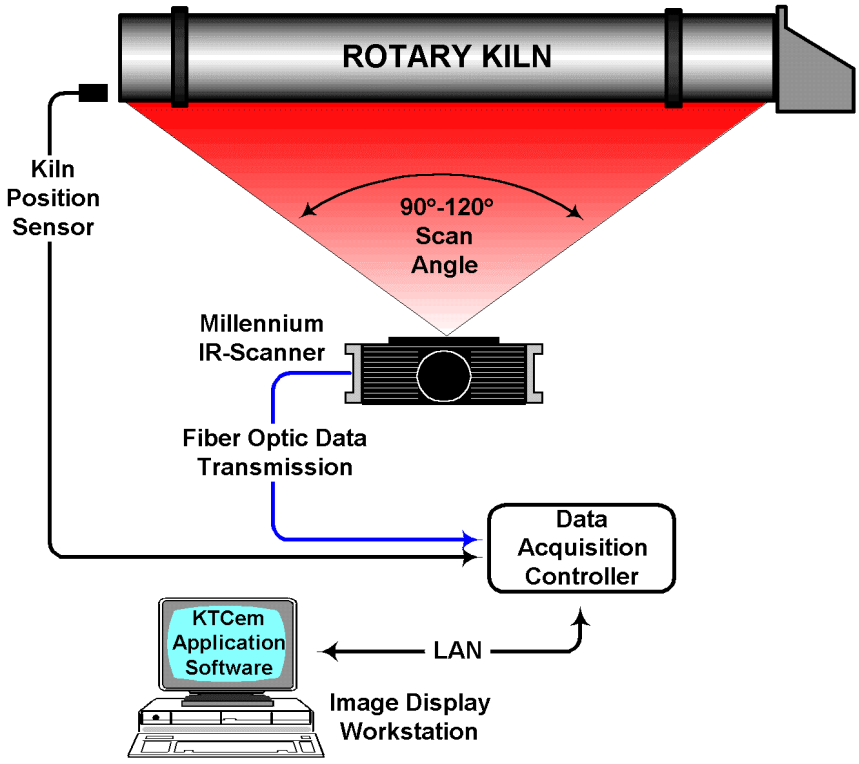

Figure 3
Basic Configuration of a modern Kiln Shell Temperature Monitoring System

Both, hardware and software may be configured to offer custom monitoring modes, alarms and historical data collection.

Pyrometers together with IR-scanners can also be implemented to solve some common real life problems (Fig.4). When building supports, columns or other structures interfere with the scanner's field of view, an infrared "shadow" occurs.

Additional “compensating- pyrometers” seamlessly combine with Millennium IR-scanners to obtain a complete thermal image of the kiln shell without any gap. Up to six external pyrometers may be used with a single IR-scanner.

By placing two scanners on the same kiln, a "stereo" effect may be created (Fig.5). This gives the ability to generate thermal images even when large objects such as walls, or multiple small objects (e.g. building supports) obstruct the field of view.

An additional on-line calibration-pyrometer can also be added-on to overcome the effects of changes in the atmospheric attenuation. Up to four IR-Scanners and six external pyrometers per scanner may be used with a single Data-Acquisition-Controller. Tire creep sensors are easily integrated through the TCEM application software. DOS, Windows 3.11, 95 and NT operating systems are available depending on customer preference.

If monitoring of temperature inside the sinter zone of the rotary kiln is required, clients can use the PYRO-VIPER imaging pyrometer, as well as with the DISCO-3 system, a periscopical clinker cooler camera (Fig.6). From start to finish, pyro-processing in a rotary kiln operation can be monitored and process controls implemented. Integrated into an expert system (e.g. CEMAT-KCS) the imaging pyrometer or clinker cooler scanner is an essential tool for process optimization.

Because of the versatile PC based design, GESOTEC temperature monitoring systems can be easily integrated with LAN's and tied into automation and process control systems (e.g. SIEMENS CEMAT-CS). By adding a modem, remote diagnosis is possible.

In addition to temperature monitoring, Gesotec offers a Refractory Management program and a sophisticated Tire Creep Measurement system. Both run simultaneously with all the temperature monitoring functions in the main TCEM application.

A kiln shell temperature scanning system gives far more information than just nice colour pictures. The advantages of integration of these measuring system are not limited only to the operator personnel but also offer general economies in data handling and evaluation. Temperature data can be selectively evaluated by the integrated system so that each user of the system only receives the data which are important for his task (e.g. CEMAT-MIS Management Information System). The value of these online tire creep- and temperature measurement systems for today’s process integration should be without further questions for any modern cement plant operation…

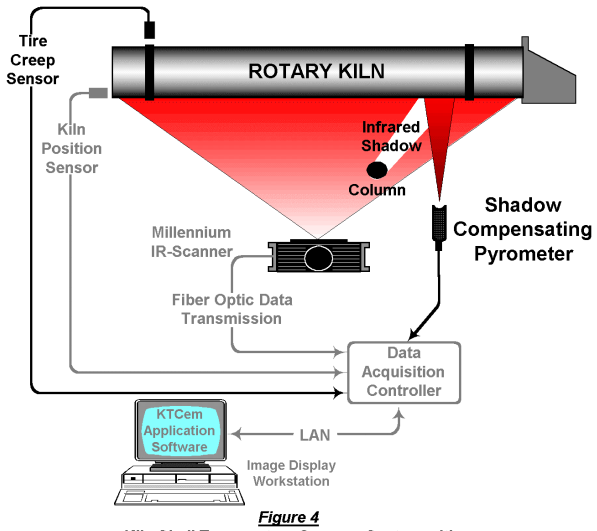

Figure 4
Kiln Shell Temperature Scanner System with Shadow Compensating Pyrometer and Tire Creep Sensor

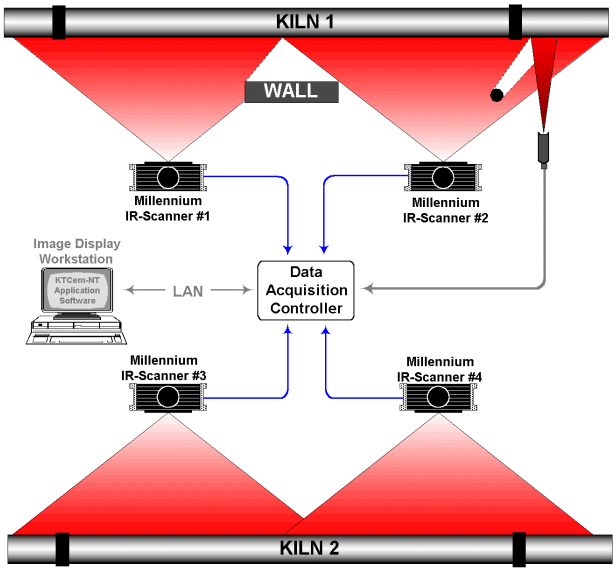

Figure 5
Kiln Shell Temperature Monitor with Multiple IR-Sensors

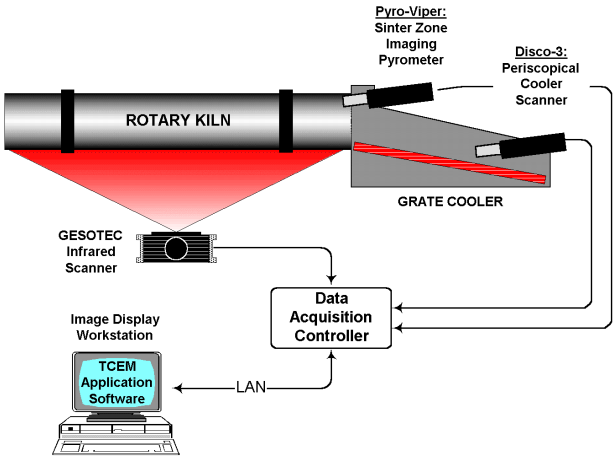

Figure 6
Kiln Temperature Monitoring with Sinter Zone Imaging-Pyrometer and Clinker Cooler 2D-Scanner