ACTIVITIES OF THE MEASURING GROUP

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1. INTRODUCTION

To gain insight into the production process and aspects relating to the environment or occupational health and safety, the measuring group of TCKI carries out various types of measurements. The following paragraphs explain the types of measurements, how they are carried out and for what purpose. The measurements serve as a basis for reports and advice. A number of activities is RvA-accredited by the Dutch Accreditation Council. For further information about measurement methods, planning, and possibilities, please contact the head of the measurement group.

Many different measuring instruments and aids are used to perform work for the ceramics industries. In addition, consumptive materials are removed or turned over to the client, after carrying out the measurements.

Measurements are always carried out under the supervision of a process engineer or consultant from TCKI. For the sake of working effectively, TCKI may consult with the client to see whether the clients themselves can carry out some of the activities. Measuring instruments are not available to clients without a TCKI process engineer or consultant being involved in the project.

Consumptive materials will be charged to clients at cost price. Clients will be charged by the day or the period in use, for measuring instruments and aids, depending on the type. These charges are derived from the purchase price and the average maintenance costs.

2. FLOW MEASUREMENTS

For measuring air and flue-gas output, the TCKI has several pitot's tubes and pressure transmitters. These can be used for manual or continuous measurements and, where necessary, carried out in accordance with ISO 10780. In cases of continuous measurements, the transmitter signal will be recorded. The activity is, if performed according to the ISO 10780, RvA accredited. For measuring fan output (free suction), for example, use can be made of an anemometer (wind mill). The results are processed after the measures have been taken.
Likewise TCKI has a revolution counter to count the rotations from a fan. In combination with the performance characteristic there from the moved amount of air can be estimated.

3. TEMPERATURE MEASUREMENTS

3.1 Temperature profile of tunnel kiln loads

To determine temperature profiles in tunnel kiln loads, use can be made of a data acquisition system (Datapaq). A steel box is installed under the tunnel kiln car. Thermocouples are placed between the products or in the kiln atmosphere, which are then connected to the data acquisition system. One or two data loggers in the box periodically record the temperatures during the completion period. At the end of the measurement the data logger is scanned. There can be a maximum of twenty couples connected simultaneously. If the kiln is not suitable for a data acquisition system (lack of space), use can be made of a Teflon towrope and recorder with memory card.
All data are reported after measuring including all general information.

3.2 Other temperature measurements

Using various types of thermocouples (types T and K), temperature measurements can be carried out at any desired location. These could include the following:

- down draught flame kiln sheet measurements;
- measurements in air and flue-gas ducts;
- measurements in kilns;
- measurements in dryers.

All couples are connected to a recorder with memory card. When the measurements have been completed, the memory card is scanned, elaborated and reported.

4. POWER MEASUREMENTS

With the aid of power measurement equipment, various users or groups of users can be tested for continuity in one or three phases. Using the power meter e.g. power, reactive power, apparent power, voltage, frequency, cosinus phi, peak power and energy consumption can be measured. Several quantities are given per phase or in total. By using counters simultaneously to record user hours, insight is gained into the use per day, week, month or year. Also, there is software available that makes it possible to save all quantities in a computer or on a memory card, to be worked out later in a complete overview.
Besides power measurements, TCKI also has separate measuring instruments for determining power, voltage, current intensity (amperage) and the labour factor (cosinus phi).

5. CLIMATE CHAMBER, DRYING TESTS

To measure the drying behaviour of moulded bricks, TCKI has a climate chamber that can follow a preset temperature and relative humidity curve very accurately. The moulded bricks are placed in the weighing cage on a drying plate, which on request can be a client's own drying plate. The weight loss in combination with the shrinkage and product temperature are registered during the drying process. After conclusion of a drying test, the data are processed and evaluated together with the product.
A new drying test is started on the basis of these results obtained if so desired for the follow-up testing.
Products can be tested in the climate chamber under extreme conditions for their drying behaviour and thus a drying time as short as possible.
The results of the climate chamber tests can be used for drying the products in the practice drying chambers.
If so desired, drying tests with a mobile dryer can first be carried out prior to these practical tests, see the explanation in Chapter 7 for this.

6. DRYER MEASUREMENTS

To understand the drying behaviour of wet products and the dryer characteristic, drying measurements are carried out in tunnel and chamber dryers. The weight loss, shrinkage and temperature of the wet products is measured and recorded at one or two locations (fast and slow drying locations!), as is the relative humidity and temperature of the drying air. When the measurements have been completed, the results are worked out and advice can be given on how the drying curve can be adjusted. Dryer measurements are usually carried out in case of:

- drying textures or product failure;
- a desired shortening of the drying time;
- a desired lowering of energy consumption;
- adjustments or maximisation of the dryer.

In the case of determining energy consumption, the output and the temperature of the outgoing air stream are also measured.
Likewise there is a possibility to build in a registering gas meter to measure the gas consumption from one chamber/tunnel or a dryer in total. If there is a gas meter present to the measure chamber and/or dryer there is a possibility to register the gas consumption with a pulse counter on a recorder.

A mobile dryer for carrying out various trials can be used to obtain insight into the shortest possible drying cycles. Such trials can be used to further investigate and optimize various

parameters such as how the air stream is introduced into the dryer, the distance between the products being dried, the depth of the load, and the change in temperature and relative humidity over time (also refer to chapter 6).

When optimising the operation of the dryer it is also possible to arrange for one drying chamber to dry independently from the PLC control, via a program generator/controller
In order to obtain insight into the shortest possible drying cycles, a mobile experimental dryer can be deployed. This makes it possible to investigate and optimise various aspects including the manner in which air is blown in, distance between products, load depth, and change in temperature and relative humidity over time on the basis of RH/T regulation or a regulation based upon ΔT-psychrometric (T_{dry}-T_{wet}).

7. PILOT DRYER

The focus of the pilot dryer is on the process optimisation of (ceramic) dryers. Process optimisation is based on the following;

- energy saving;
- reduction in drying time;
- quality improvement.

The pilot dryer provides a better insight into the (non)homogeneity of drying processes and energy consumption. Dryers can be optimised on the basis of analyses in the pilot dryer, which can be carried out on the premises of ceramics companies. Practical recommendations to improve the process can also be issued. The drying tests carried out at the company's premises use actual moulded products based on standard support and drying orientation. The results are, therefore, representative and transferable.

By using the pilot dryer all drying principles can be simulated to scale size, including "carra", "rotamix" and giant wheel"" principles and, if necessary, drying principles based for example on vertical air flow. In the event of deviating principles the pilot dryer can be adapted (following consultation) in order to mimic practical applications as close as possible. A total of approximately 400 bricks or 80 roof tiles can be dried, distributed across 6 levels (200 mm distance) and two drying cages. With other product types the drying cages, level distances and/or drying chamber can be adjusted by consultation.

Prior to carrying out measurements in the pilot dryer, drying measurements can be carried out in a drying chamber. This enables monitoring of the drying behaviour of the fastest and slowest drying products. These measurements together with air flow measurements are used to adjust the pilot dryer. Once the basic settings comply with the practical measurements, the optimisation of product quality and/or drying time is started. Upon completion of each measurement sufficient products are available to be fired in the company's existing kilns. Once fired the products are evaluated by TCKI and the manufacturer. This evaluation will establish whether the products meet the final quality requirements.

The advantage of the pilot dryer lies in the fact that drying tests can be carried out independent of the in-house drying process and without affecting the drying production process.

8. ENERGY

8.1. Energy and mass balance sheet

To determine the entire energy management of a (production)plant, output and temperature meters are installed in various main ducts of the air and flue-gas systems of the kiln(s) and dryer(s). The signals are recorded by a recorder memory card. Smaller energy flows are usually measured by hand. All data is processed into an energy balance sheet. During the measuring period, the client usually monitors gas consumption (kiln, dryer, total, etc.) and the start, stop or shifting times of the dryer. All energy data is converted into specific quantities. In plants with a gas meter there is the possibility to register the gas consumption with a pulse counter on a recorder.
Schematic drawings and reports are used to clarify the energy balance sheet.

8.2. IR Camera

TCKI has an infrared camera that can monitor temperatures up to approximately 600° C for detection of heat losses.
These heat images give a good indication of temperature profiles for pipes, kilns, dryers, steam boilers, etc., in order to identify heat leaks.

9. COMPOSITION OF FLOWS

9.1 Instantaneous gas composition

To gain an indicative determination of several gasses, TCKI has a Dräger instrument for determining carbon monoxide (CO), carbon dioxide (CO_2), oxygen (O_2) levels and on request for other gas components. This instrument could be loaned to clients to carry out their own measurements at various locations, at their own pace. The instruments are often used to determine the kiln atmosphere across the length of the heating and firing zone in a kiln. Both types of instruments measure instantaneous values.

9.2 Continuous measurements of gas composition

For the continuous measurement of gas composition, the TCKI has measuring equipment with diverse measuring ranges. This equipment enables measurement of oxygen (O_2), methane (CH_4), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen monoxide (NO) and nitrogen oxides (NO_x). The equipment is placed in a measuring location, including the gas pre-treatment system (filter, cooler, etc.). There is a continuous record kept of the measuring signal on a recorder with memory card. When the measurements have been completed, the data is processed.
A technician of TCKI installs the equipment. Where necessary, measurements are carried out in accordance with NEN, EN or ISO standards.
CO_2 can also be measured in the low range up to 6000 ppm (0.6 vol %). This measuring range is used in detection of flue gas trace components from the kiln to the dryer.

For the situation that the measurements are carried out with the van with emission instrument, the measurement of the current components are RvA accredited with the exception of methane.

9.3 Emission measurements (flue gases)

In the framework of an environmental permit, periodic measuring reports containing the results of the various air emissions from the operation may be desired. Also, information may be required in determining a system for flue-gas cleaning and its dimensioning or operational management.

In the case of flue-gas measurements, the measurements listed below are always measured in triplicate. Also, the oxygen content is measured in order to re-calculate all concentrations to 18 percent oxygen by volume. Flue gas emission measurements are done on the basis of (inter)national standards, as indicated in the Netherlands Air Emission Guidelines (NeR). If necessary, the execution of the measurement will be adjust to meet applicable measurement standards outside the Netherlands.
All measurements are RvA accredited, with the exception of the analysis on metals SO_3 and fine particulate matter.

Dust measurement
For measuring dust emissions, for example, in flue-gas ducts and funnels of dust exhaust systems, TCKI has a Tecora isokinetic dust measurement system available. The system is connected to the duct in which the gas flow is to be measured.
Depending on the diameter, three samples are taken isokinetically at an unspecified number of locations during a shifting or changing period. In the case of the remaining emission points (for example dust exhaust), measurements are taken for half an hour. The mass of the filter(s) that catch the dust is determined before and after sampling. The results are reflected in a report, which can be used for the permit authority.

Fine particulate matter PM 10 and PM 2,5
TCKI has a set of cyclones that can be inserted into a (flue gas) duct so that fine particulate matter can be separated from a constant flow of air.
After rinsing the sampling system, the mass of the filters and grid pots from the cyclones is determined gravimetrically and reported.

Fluoride, chloride and sulphur oxides
Fluorides, chlorides and sulphur oxides are sampled with the aid of bubbler bottles. The (flue) gas is channelled through three wash bottles linked in series, with 200 ml of absorption liquid per bottle. When sampling has been completed, the concentrations of fluoride, chloride and sulphur oxide are determined in the laboratory.

CO, CO_2, NO_2, SO_2, C_xH_y and O_2
TCKI has a measuring van with equipment for emission measurements, by means of which the CO, CO_2, NO_X, C_xH_y and O_2 components can be measured. Flue gasses are channelled across a heated filter (180 °C), a heated pipe line (180 °C) and then channelled through cooling systems before reaching the analysis equipment. All equipment is adjusted and checked before and after measuring.

Other components
In addition to the sampling of F, Cl, and SO_x in bubbler bottles heavy metals (mercury, lead, cadmium), and SO_3 are be sampled in bubbler bottles. The absorbing liquid is adjusted depending on the component.
Sulphur trioxide is a determining factor in the acid dew point of flue gasses and can be important in the operation of specific flue-gas cleaning installations.

The measurements described above can be worked out in more or less detailed combinations.

10. NOISE MEASUREMENTS

10.1 Noise emissions

In the framework of the All-in-one Permit for Physical Aspects (Environment), various measurements are carried out at the sources of noise and at site boundaries. Based on these measurements and on acoustic model calculations, noise pollution can be calculated at specific emission points. Also, based on model calculations, proposals for noise reduction, forecasts for new building projects of production plants and improvement developments can be made.

10.2 Occupational health & safety acoustic

In the framework of the occupational health and safety acoustic, noise measurements are carried out at individual noise sources and at specific workplaces. A hall acoustic is determined from measurements of diffuse reverberations. Based on acoustic model calculations, machine-related noise levels are determined, along with daily exposure calculations for individual employees. In addition, model calculations form the basis for noise reduction and forecasts relating to changes.
In addition to brief OH&S noise measurements at specific work sites, TCKI has noise monitors. This monitor is carried by the appropriate people for one work day (8 hours). After the measurement, the data are processed using specific software.

11. OCCUPATIONAL HEALTH & SAFETY MEASUREMENTS - WORK PLACE ATMOSPHERE

11.1. Occupational dust

For measuring the total and the respirable (fine) dust, quartz contents and ceramic (fibers), TCKI has a set of sampling pumps. The sampling pumps are carried by people, in order to determine the dust levels after the sampling to which they are exposed. During the work day a dust pump sucks air and captures the dust on a filter. The filters are weighed before and after measuring. It is possible to determine the quartz, cristobaliet and tridymite content of the dust captured, using FTIR analysis technique (NIOSH 7602).
The measurement is RvA accredited.

To understand the development of dust concentration during the work day, TCKI also has available a dust meter for continuous determination. The signal from this dust meter is registered by a recorder with memory card. After having been worked out, the measurements are shown in graph form.

In addition, TCKI has sampling pumps that are suitable for the sampling of (ceramic) fibers. After sampling, the gold-coated filters are analyzed for their number and its type of fibers.

11.2. Occupational air

Besides analyzing particle-bound components TCKI has analysis equipment for sampling of ambient gases. These devices are able to analyse various components (CO, CO_2, SO_2, H_2, H_2S, etc.) at low level.