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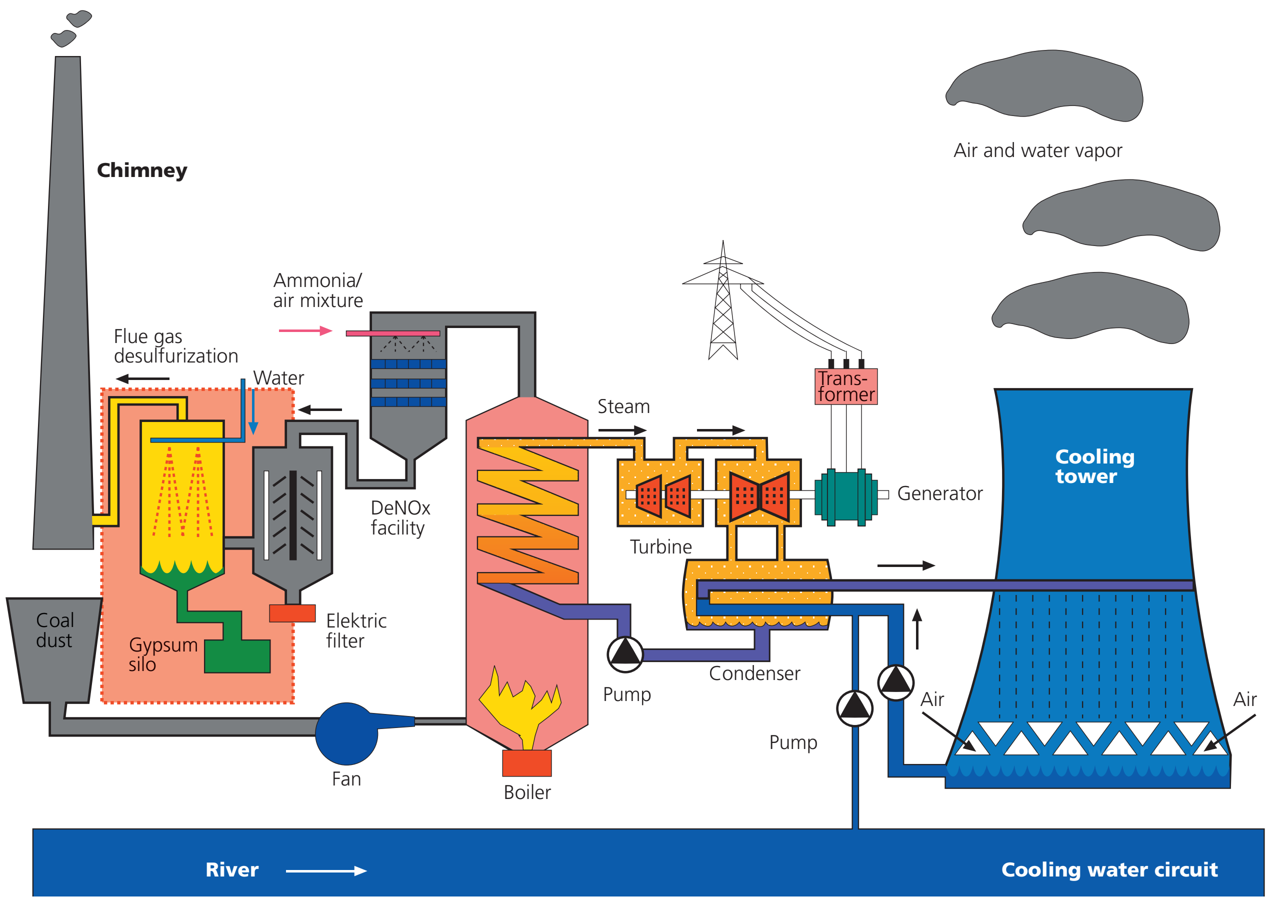
Knick

Application Report

pH Measurements in Flue Gas Cleaning Plants (Gas Scrubbers)

Flue gas desulfurization (FGD) of fossil fuel power plants and waste incineration plants

Procedure

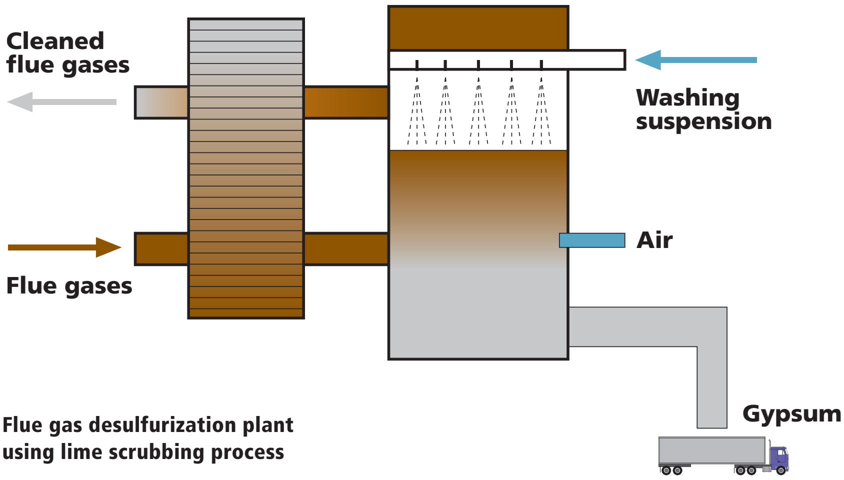


Background

The combustion of organic material such as gas, heavy oil, and coal in power plants, of domestic and industrial waste in waste incineration plants, but also various process control procedures in the chemical industry result in polluted exhaust gases which must not be released into the environment without secondary treatment.

Legal basis

The emission limits for the corrosive gases SO_2, SO_3, NO_X, (HCl, HF) are governed by standard rules which apply throughout the EU. In the USA the Clean Air Act applies. Almost all new-built plants, particularly in China and South-East Asia, use this state-of-the-art technology so that there are almost no new plants without modern flue gas cleaning.



Flue gas desulfurization plant using lime scrubbing process

Procedure

From impurities in the source materials to be combusted mainly sulfur dioxide results. There are several procedures to extract it. In the most cases the most efficiently working so-called "wet procedure" is applied. The sulfur dioxide, which is acidic in solutions, is bound by an alkaline suspension in an absorbtion tower. Mostly a limestone suspension or hydrated lime (milk of lime) are used:

$CaCO_3 + SO_2 \longrightarrow CaSO_3 + CO_2$
Limestone → Calcium sulfite

$CaO + SO_2 \longrightarrow CaSO_3$
Quicklime

$Ca(OH)_2 + SO_2 \longrightarrow CaSO_3 + H_2O$
Calcium hydroxide

Calcium sulfite accumulates in the lower part of the tower, the so-called sludge. By injecting air (forced oxidation) it is converted into gypsum.

$2\ CaSO_3 + O_2 \longrightarrow 2\ CaSO_4$ (gypsum).

The resulting gypsum is dewatered and can then be used as building material. Gypsum from waste incineration plants may be more contaminated and must possibly be disposed of. In that way the SO_2 emissions have been reduced from 1.6 mio t to 120.000 t within 20 years.

Measurement and control problems

The pH value must be measured at 3 points of the flue gas cleaning process.
Typically the flue gas cleaning consists of two separate cleaning steps.

Measuring point 1:
In the pre-scrubber (1st stage) the hot flue gas is cooled by injecting milk of lime. The pH value is only slightly increased (typically between pH 1-2 at 80 °C). Here, the pH must not rise above 2 because only HCl / HF and heavy metals are to be precipitated but SO_2 binding is to occur at the second stage.

Measuring point 2:
In the second stage, the main scrubber, the pH is increased by further addition of lime. SO_2 is bound. Here, the lime milk addition must be controlled by continuous pH measurement. When the pH values are too high, too much lime has been added (increased costs) and the gypsum is polluted by excess calcium hydroxide. When the pH values are too low, the binding of SO_2 is less efficient. The optimum lies between pH 5.5 and 6.0. Higher values lead to soft and greasy calcium sulfite coatings (soft plugging) at slightly reduced efficiency. Lower pH values cause heavy incrustations which are difficult to remove (hard scale formation). Generally, the pH measuring point lies in the backflow circulation line of the calcium sulfite / gypsum sludge.

Measuring point 3:
The excess water remaining after precipitation / thickening of the gypsum must be subjected to a neutralization procedure. For that purpose, sulphuric acid is added to bind the excess lime. Also at this measuring point there are heavy incrustations and deposits.

The challenges to the described pH measuring points in a gas scrubber are:
High content of solids (2-15 %),
Corrosive (particularly in pre-scrubber) and abrasive sludge
Choking deposits leading to coating and incrustations.

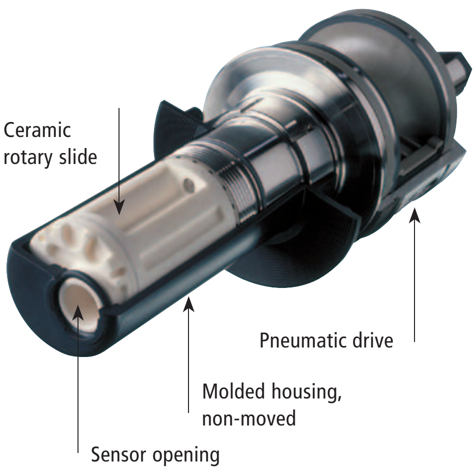
These conditions make the pH measuring points extremely maintenance intensive.
Due to the heavy coatings the pH sensors must often be cleaned. Electrode life is reduced by abrasion and contamination of the reference system. Until today, automation of the cleaning (and calibration) procedure has failed due to the probes and holders used. Metallic ball valve or displacement probes corrode. Due to the extreme incrustations, the movable parts stick together and the measurement fails. Plastic probe holders do not withstand the mechanical and thermal stresses.

Solution:

The Ceramat® WA 150 remote calibration probe together with the Unical® 9000 automatic cleaning and calibration system allows complete automation of this difficult measuring point with maximum availability. The Ceramat® probe consists of a virtually undestructible, ultrahard, superpolished, rotating ceramic part and a corrosion resistant, carbon reinforced, non-moved plastic (PEEK) housing. The ceramic and the rotary movement are not influenced by the incrustations and the static probe housing shows hardly any deposits.

In conjunction with the automatic Unical® controller, the sensor is automatically cleaned and calibrated at regular intervals.
Depending on the sluggishness of the scrubber process, the sensor can stay in the rinsing chamber and just briefly be moved into the process for measurement (e.g. for 10 s every minute) to increase its service life.

Ceramat® WA 150
ceramic sensor lock-gate



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The complete measuring system:

- Highest reliability
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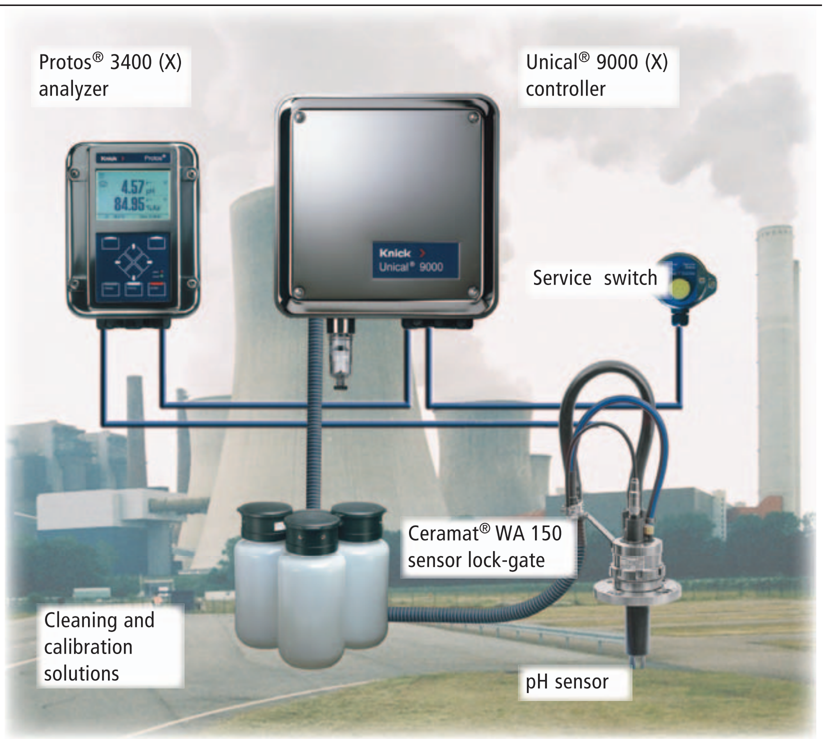

Applied Components

Ceramat® flange DN 50
WA 150 –N0AAA1-000

Unical® 9000-NC301222CN000-000

Protos® 3400C
with Unical module PHU 3400-110

pH combination electrode SE 532/2
(225 mm)

Sensor cable VP ZU 0314

Buffer solutions pH 4,01 ZU 0200 and
pH 7,0 ZU 0201