Industrial Gas Analyzers in Applications Information

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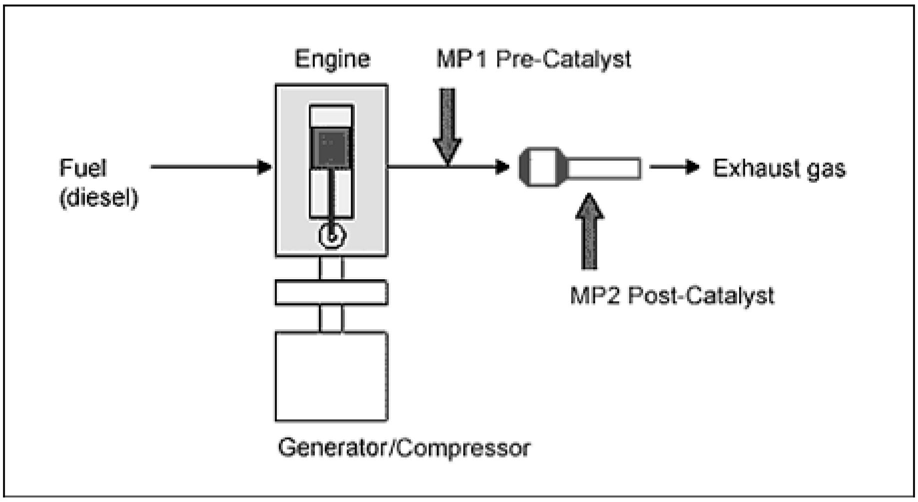
Engine and Diesel Testing

Thousands of internal combustion engines are located throughout the world. They range in size from small emergency generators to massive 16 cylinder diesels powering the largest ocean vessels. Stationary engines are used for generating electricity, compressing natural gas, pumping fluids, used in oil and gas production, used by municipalities for combined heating and power stations, and a myriad of other uses.

Generally speaking, there are three types of stationary engines:
• Spark ignited, 4-stroke, lean burn or rich burn or "clean burns"
• Spark ignited, 2-stroke lean burns, and
• Diesel engines

The exhaust gases contain pollutants such as NOx, SO2, CO, Total Hydrocarbons, soot and particulates. Each engine type has its own particular emission signature. However, engine manufactures and the supporting industries have developed innovative ways of controlling and substantially reducing emissions. Measurements of the exhaust gas are an essential component of engine control and help demonstrate continued air quality improvement.

Use of gas analysis for e.g.
• Measurement during the development process
• Measurements as part of long-term tests
• Measurements as part of certification procedures
• Measurements for state and Federal compliance

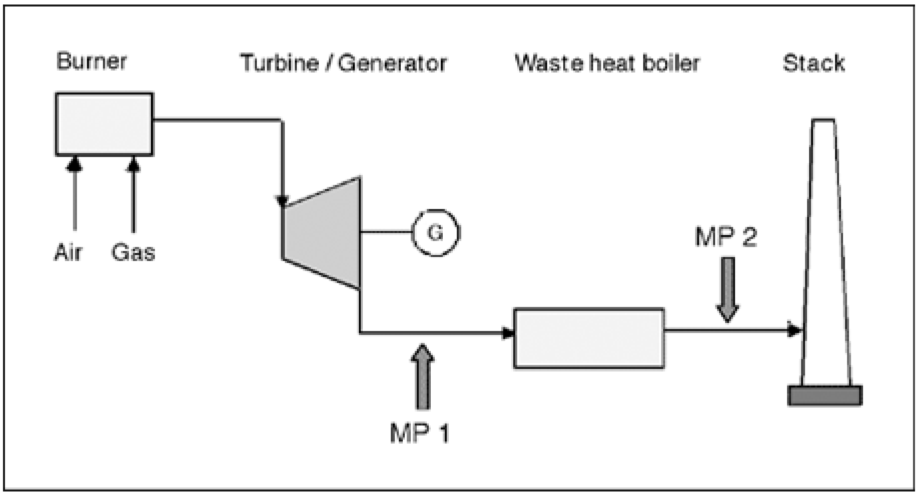


Flow chart of a stationary engine system with measuring point

Gas Turbine Plants

Stationary gas turbines were originally developed as air craft engines and are applied to drive generators. Installations are used to generate peak load electrical power and often, together with a waste heat boiler, to generate heat energy. The flue gas composition is very similar to that of gas fired furnaces. Typically natural gas, landfill gas or biogas is used as fuel.

Use of gas analysis for e.g.
• Monitoring the turbine emission for optimum operation
• Monitoring emission concentrations for compliance with regulations



Process flow chart of a gas turbine plant with measuring points

Measuring point locations and analysis tasks
• MP 1 at the turbine outlet for monitoring the turbine emission (optimum operation)
O_2 = 15..18 %
NO_2 = 0..60 ppm
CO = 0..30 ppm
Temp = 300/400°C
• MP 2 at the stack for emission monitoring (compliance with regulations)
O_2 = 15% (ref value)
NO_2 = <35 ppm
CO = <15 ppm

Hint: A dynamic partial vacuum exists at the measuring point MP 1. The sampling point therefore must be carefully sealed in order to prevent ambient air from being sucked in and cause incorrect measurements.

Magazine : www.dieselgasturbine.com ; http://www.dieselpub.com/

Jenbacher
http://www.ge-energy.com/prod_serv/products/recip_engines/en/index.htm
http://www.ge-energy.com/prod_serv/products/recip_engines/en/contact.htm
UK Clarke energy, user of Gline4000, is servicing Jenbacker.

Caterpiller
http://www.cat.com/cda/layout?m=37532&x=7

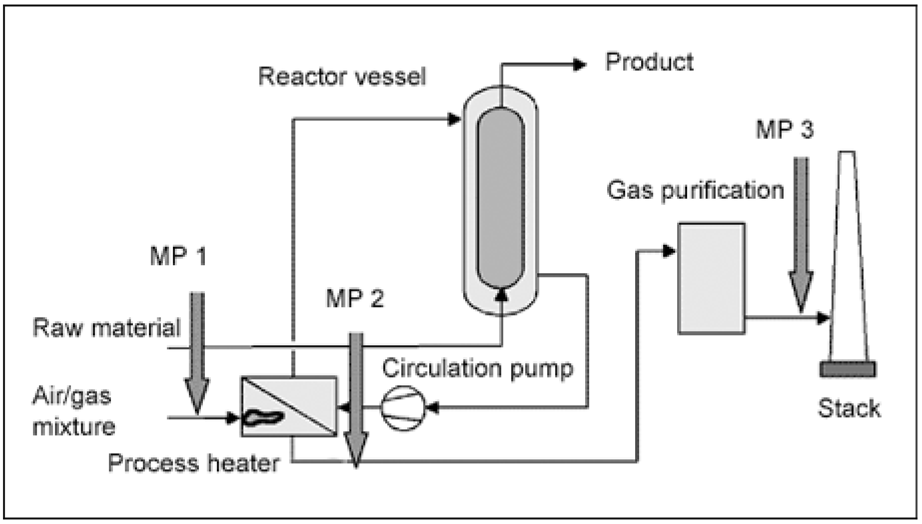
CENTRAX
Ansaldo Energia – Finmeccanica
Cummins power generation
Rolls Royce Engine
GE Nuovo Pignone

SERVICE COMPANIES

Process Heaters and Boilers

High temperatures are required in almost all plants in the chemical and petrochemical industry to produce final or intermediate products from raw materials. In most cases, superheated steam is used for this purpose and is generated by process heaters. The figure below shows such a plant schematic with a process heater that delivers steam to a double-walled reactor vessel where the production process performs at high temperatures.

Use of gas analysis for e.g.
• Optimum adjustment of the burner (Fuel saving and emission reduction)
• Monitoring emission concentrations (compliance with regulations)



Process flow chart of a process heater plant with measuring points

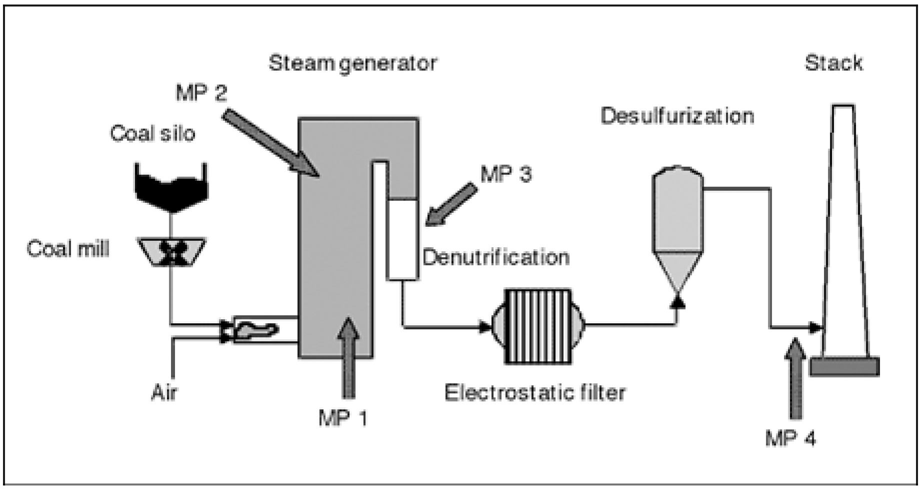
Measuring point locations and analysis tasks
• MP 1 at the burner for fuel composition control
• MP 2 behind the burner for burner optimization (energy cost reduction)
• MP 3 at the stack for emission monitoring (compliance with regulations)

Power Plants

Coal-fired power plants belong to the group of thermal power plants that generate electricity from coal.

The coal is crushed, dried, and ground in a mill. Together with preheated combustion air the powdered coal is blasted into the furnace and burned at temperatures of approximately 1832°F. The furnace is surrounded by the heat exchanger which comprises a tightly packed pipe system with boiler water flowing through. The water is heated up and thus fresh steam is generated with a pressure of approximately 2900 psi to drive a turbine. The flue gases escape from the furnace, pass through different gas scrubbers and are released into the atmosphere through the stack. The steam, after leaving the turbine, is cooled down to water and recharged into the boiler system again.

Use of gas analysis for e.g.
• Optimum adjustment of combustion components (fuel cost reduction, profitability of the plant operation)
• Performance control of SCR's and scrubbers
• Monitoring emission concentrations for compliance with regulations
• Safety of personnel and plant (CO monitoring)
• SCR optimizing – measuring NOx to determine ammonia injection grid performance. • Multiple analyzers can be used simultaneously for profiling ammonia injection rates



Process flow chart of a coal-fired power station with measuring points

Measuring point locations and analysis tasks
• MP 1 at the furnace for controlling constant combustion and air value, identification of CO nests and providing reliable operation
• MP 2 at the furnace outlet for combustion control and optimization (profitability)
• MP 3 at the denitrification plant for performance control
• MP 4 at the stack for emission monitoring (compliance with regulations)

Warning!
For measurements after the electrostatic filter, the sample probe must be grounded to avoid dangerous static electric shocks.

MP1
O_2 = 5..9 %
CO = 10..5000 ppm
Temp = 1000°C

MP2
O_2 = 5..9 %
CO = 10..5000 ppm
CO_2 = 15..18 %
NO_2 = 500..600 ppm
SO_2 = 500..2000 ppm
Temp = 1000°C

Refineries

Refineries (more precisely crude oil refineries) comprise a variety of different processing plants at one site where marketable products such as gasoline, diesel oil, plastics, fibres, detergents etc. are produced from crude oil in several processing steps. The production steps proceed at high temperatures causing the need of numerous firing plants in one refinery.

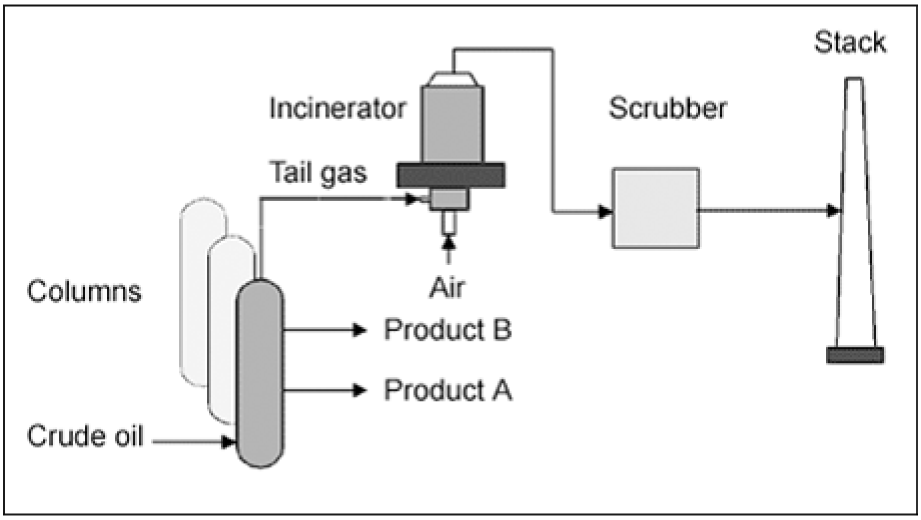
The refining process starts with distillation of crude oil at atmospheric pressure and appr. 662°F, whereby gasoline, gas oil, or kerosine are separated. The residues are either utilized as heavy fuel oil or further processed in a vacuum distillation at 752°F to create lubricating oil or bitumen, for instance.

The great variety of products requested by the market, however, cannot be realized through distillation alone. Special processes are used to transform the crude oil distillates into light hydrocarbons (cracking processes) with following refinement steps (reforming processes). Both processes operate with the use of catalysts at temperatures of 932°F and above. The figure below shows schematically the distillation columns, the discharge of final and intermediate products and the exhaust gas (tail gas) treatment through incineration and purification.

Refineries are emission sources for pollutants such as SO_2, NO_x, H_2S, particulate matter and many hydrocarbons. Emissions result from diffuse as well as concrete sources, e.g. firing plants. Emission reduction is achieved by using appropriate fuels, special firing measures and flue gas purification plants.

Use of gas analysis for e.g.

- Optimum adjustment of the burner (fuel saving and preventive emission control)
- Monitoring the gas purification plant performance
- Monitoring emission concentrations (compliance with regulations)
- Ensuring safety of personell and plants (fire and explosion protection)



Process flow chart of a refinery (without measuring points)

Measuring tasks

Because of the very large variety of different plants in a single refinery complex no specific measuring point locations are mentioned here. Once more, however, it is referred to the large number of firing plants operated in a refinery for steam generation and tail gas incineration, which offer many applications to gas analysis.

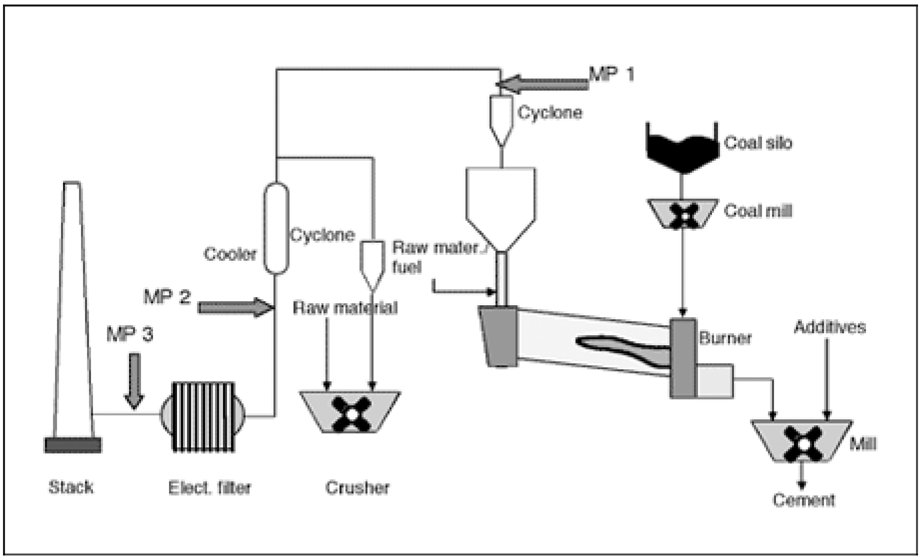
Cement/Lime Production

The material known as cement consists of ground cement clinker mixed with gypsum. It is the end product of a firing process in the cement furnace. Raw materials are limestone (CaCO3) and additives such as clay, ash, or sand. Powdered coal, oil, and waste material (used tires) are utilized as fuel. The major process steps are:

Grinding of the raw materials, drying of the material using hot exhaust gases, heating of the raw meal up to 800°C with removal of CO2, firing in a rotating kiln, cooling, mixing with gypsum, and grinding to cement. The exhaust gases pass through an evaporation cooler and some gas cleaning plants (not shown in the figure below) including an electrostatic filter before they are released to the atmosphere.

Use of gas analysis for e.g.

- Optimization of the evaporation cooler operation
- Protection of the electrostatic filter by monitoring CO
- Control of sampling probe position of the stationary analyzer
- Monitoring emission concentrations for compliance with regulations



Process flow chart of cement production with measuring points

Measuring point locations and analysis tasks

- MP 1 between calcinator and cooler to determine a plant balance
- MP 2 between cooler and filter to determine plant balance and filter efficiency
- MP 3 at the stack for emission monitoring (compliance with regulations)

O_2 = up to 10 %
CO = 100..10000 ppm
CO_2 = 20..40 %

MP1 Temp = 300/400°C

MP2
NOx = up to 1000 ppm
Temp= up to 150°C

Hint:

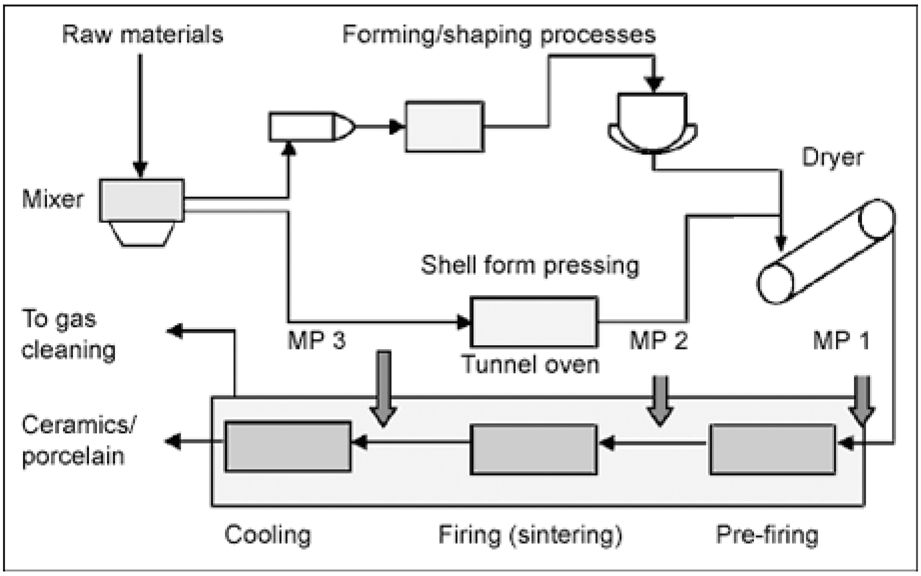
1. High dust loading of raw gas and sometimes of ambient air
2. Very high concentration of CO2, partially outside the measuring range
3. The O2 sensor is, at high O2 concentrations, cross-sensitive against high CO2 concentrations
4. Gas flow measurements are not possible at high dust concentrations and high gas flow velocities
5. The sampling probe must be grounded when mounted at a stack built of bricks!
6. Depending on the kind of fuel also limit values of lead (as dust) as well as of thallium and cadmium may be relevant.

Ceramics/Bricks

The term ceramic describes various kinds of material resp. products made from clay and additives and solidified by firing at high temperatures. The raw materials are Kaolin (a clay of certain composition), quartz (SiO2) and feldspars (a rocky mineral of different silicates). The materials are prepared by grinding, washing, filtering, and mixing, pass then through the shaping processes and are, at the end of the process, fired in a tunnel kiln in several steps: pre-firing at appr. 1652 °F, firing (sintering) at 2552 °F and finally cooling. Colors and glaze are applied either during the sintering phase or in a separate step. Firing temperature and the composition of the oven atmosphere are decisive for the quality (solidity and appearance) of the final product. The exhaust gases of the oven pass through several gas cleaning installations; very often the collected powdered material is recycled to the process.

Use of gas analysis for e.g.

- Optimum adjustment of the burner for fuel saving
- Control of gas composition for securing product quality
- Monitoring the level of drying for process control)
- Monitoring emission concentrations for compliance with regulations



Process flow chart of ceramic production with measuring points

Measuring point locations and analysis tasks

- MP 1-3 in the raw gas between the different firing steps to optimize burner adjustment, to secure high and constant product quality, and to determine the drying level.
- MP 4 (not shown in the figure above) in the clean gas to monitor the performance of the cleaning installations and the emission concentrations (compliance with regulations).

MP1-3
O_2 = 13..16 %
CO = 40..60 ppm
NOx = 30..40 ppm
SO_2 = 700..1300 ppm

MP4
SO_2 = 450..900 ppm

Hint: Aggressive components (HF, HCl) may be present in the exhaust gas. Therefore the use of a heated sampling system is recommended.

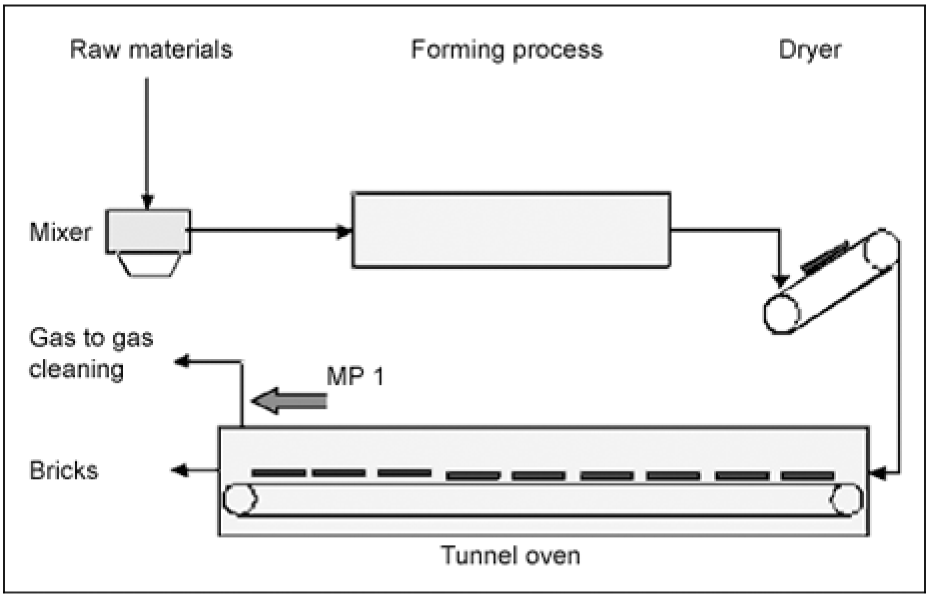
Bricks

Bricks are manufactured from clay that is fired in brick kilns. The raw materials are crushed, mixed and dried to a given level of humidity and then pass through a forming and drying process before the are placed on a car riding through the tunnel oven for firing at 1652-2372 °F.

The flue gases mainly include dust particles but also sulfur and nitrogen oxides or HF may be present.

Use of gas analysis for e.g.

- To perform optimum burner adjustment (fuel saving)
- To ensure product quality
- To determine the level of drying
- To monitor compliance with the emission regulations



Process flow chart of brick production with measuring point

Measuring point locations and analysis tasks

• MP 1 at the tunnel oven for optimum burner adjustment, to ensure high and constant product quality, and to determine the level of drying

• MP 2 (not shown in the figure above) in the clean gas to monitor performance of the cleaning process and the emission concentrations for compliance with the regulations

O_2 = 16%
CO = 1600..1800 ppm
CO_2 = 3..5%