

A short insight into the measurement of a wood gasifier installation in Switzerland



2. Task 33 Workshop “gas measurement and analysis in thermal gasification systems”
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Christoph Baltzer

Head of department of measuring, controlling and retrofitting



Introduction

- What do we do?
 - Some pictures
- Where do we do that?
- Measuring wood gasifier installation
 - Calculations for dust emissions
 - Carbon monoxid and nitrogen oxides
 - Results and consequences
- Questions?



What do we do?

- We are responsible for the execution of the Federal Act on the Protection of the Environment (EPA).
- And there especially for the Ordinance on Air Pollution Control (OPAC) in the Canton Bern.



What do we do?

- We call up
- We measure
- We evaluate measurement reports of
- We carry out negotiations on deadlines for retrofitting
- We issue the necessary limitations until the retrofit of
- . . . many kinds of stationary installations, such as:

Wood- / Oil- or Gas-fired Inst. (1200)



Wood- / Oil- or Gas-fired Inst. (1200)



Galvanising Installations (9)

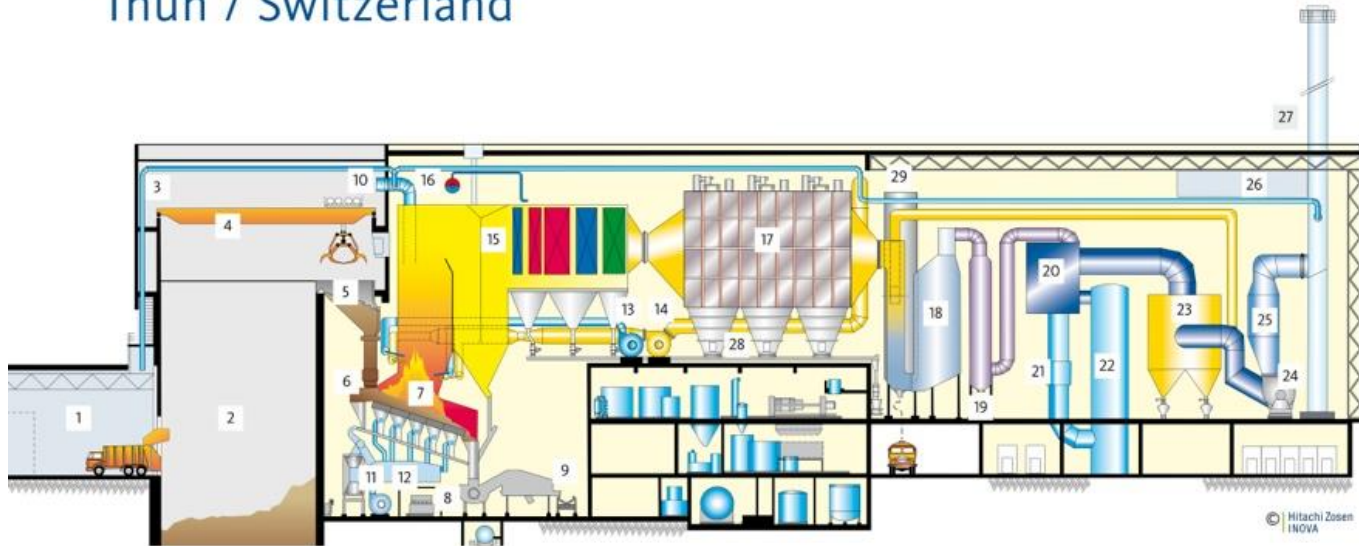


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Municipal Waste Incinerator (4)

Thun / Switzerland



Waste receiving and storage

- 1 Tipping hall
- 2 Waste pit
- 3 Waste pit ventilation
- 4 Waste crane

Combustion and boiler

- 5 Feed hopper
- 6 Ram feeder
- 7 Hitachi Zosen Inova grate
- 8 Ram bottom ash extractor
- 9 Bottom ash handling
- 10 Primary air intake
- 11 Primary air fan
- 12 Primary air distribution
- 13 Secondary air fan
- 14 Flue gas recirculation fan
- 15 Four-pass boiler
- 16 Boiler drum

Flue gas treatment

- 17 Electrostatic precipitator
- 18 SCR DeNOx and catalyzer
- 19 Economiser
- 20 Gas/gas heat exchanger
- 21 Quench
- 22 Wet scrubber
- 23 Fabric filter
- 24 Induced draft fan
- 25 Silencer
- 26 Emissions measurement
- 27 Stack

Residue handling and treatment

- 28 Ash conveying system
- 29 Residue silo

Crematorium (15)



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Coffee-Roasting Installations (15)



Other Installations (300)



Other Installations (300)



Other Installations (300)



Where do we do that?



Where do we do that?



Where do we do that?



Where do we do that?



Measurement of a Wood Gasifier



Measurement of a Wood Gasifier

- Limit values of stationary internal combustion engines (OPAC, appendix 2, number 81) which uses biogas from agriculture
- dust (solids) → 10 mg/m³
(before 01.01.2016: 50 mg/m³)
- nitrogen oxides (NO_x) → 250 mg/m³
(before 01.01.2016: 400 mg/m³)
- carbon monoxide (CO) → 650 mg/m³
(before 01.01.2016: 650 mg/m³)

Measurement of a Wood Gasifier (dust)

- First of all, we calculated the pumping speed:

$$v * \frac{\left(\frac{d}{2}\right)^2 * 10^6 \frac{mm^2}{m^2} * \pi}{1000 \frac{l}{m^3} * 60 \frac{s}{min.}} * \left(\frac{(b+p) * (273^\circ C + T_O) * \left(1 - \left(\frac{f_{Ch}}{f_{Ch(max.)}} - \frac{f_n}{f_{n(max.)}}\right)\right)}{p * (273^\circ C + T_{Ch}) * (273^\circ C)} \right) = \dot{V}_p \text{ [l/min.]}$$

- That means, we measured:
 - E.-velocity, and ambient pressure
 - ambient temp., am. humidity, am. pressure
 - pressure (ch.), temp. (ch.) and the humidity (ch.)
 - we've chosen the diameter of the tube (10mm)

Measurement of a Wood Gasifier (dust)

- $$\frac{v * \left(\frac{d}{2}\right)^2 * \frac{10^6 \text{ mm}^2}{\text{m}^2} * \pi}{1000 \frac{\text{l}}{\text{m}^3} * 60 \frac{\text{s}}{\text{min}}} * \left(\frac{(b+p) * (273 \text{ }^\circ\text{C} + T_O) * \left(1 - \left(\frac{f_{Ch}}{f_{Ch(max.)}} - \frac{f_n}{f_{n(max.)}}\right)\right)}{p * (273 \text{ }^\circ\text{C} + T_{Ch}) * (273 \text{ }^\circ\text{C})} \right) = \dot{V}_p \text{ [l/min.]}$$
- $v = 10 \text{ m/s}$
- $d = 10 \text{ mm}$
- $b = 939 \text{ mbar}$
- $p = -2 \text{ mbar}$
- $T_O = 24 \text{ }^\circ\text{C} / f_n = 5 \text{ g/m}^3 / f_{n(max.)} = 24 \text{ g/m}^3$
- $T_{CH} = 86 \text{ }^\circ\text{C} / f_{Ch} = 153 \text{ g/m}^3 / f_{Ch(max.)} = 286 \text{ g/m}^3$

Measurement of a Wood Gasifier (dust)

$$\begin{aligned}
 & \frac{10m}{s} * \left(\frac{10mm}{2}\right)^2 * \frac{10^6 mm^2}{m^2} * \pi \\
 & \frac{1000 \frac{l}{m^3} * 60 \frac{s}{min}}{1000 \frac{l}{m^3} * 60 \frac{s}{min}} * \\
 & \left(\frac{(939mbar + (-2mbar)) * (273^\circ C + 24^\circ C) * \left(1 - \left(\frac{153g}{m^3} - \frac{5g}{m^3}\right) \frac{24g}{286g}\right)}{939mbar * (273^\circ C + 86^\circ C) * (273^\circ C)} \right) = \frac{26.7l}{min}
 \end{aligned}$$

- The performance of the pump is between 17l/min. up to 40 l/min.
- → Tube-Diameter is ok, isokinetic sampling is warranted.

Measurement of a Wood Gasifier (dust)



Measurement of a Wood Gasifier (dust)



← 27 l/min.

- temperature m. d.
- pressure m. d.
- gas meter
- condenser
- bottle calibration gas (O₂, NO, CO)
- pump

Measurement of a Wood Gasifier (dust)



Measurement of a Wood Gasifier (NO_x)

- To measure nitrogen oxides (NO and NO_2), the air sample is passed through a converter to convert nitrogen dioxide into nitrogen monoxide.
- Because nitrogen dioxide is water-soluble, we need a heated pipe to prevent water condensation and thus too low NO_2 -Values.
- The measurement principle used is chemiluminescence.

Measurement of a Wood Gasifier (NO_x)



Measurement of a Wood Gasifier (CO)

- A nondispersive infrared sensor (or NDIR sensor) is a simple spectroscopic sensor often used as a gas detector.
- We use it to detect CO.



Measurement of a Wood Gasifier (CO and NO_x)



- Datalogger
- NO-Analyser
- CO-Analyser
- Gas Diluter
- Pump

Measurement of a Wood Gasifier (CO and NO_x)

- 3 times 30 minutes each installation.



Results

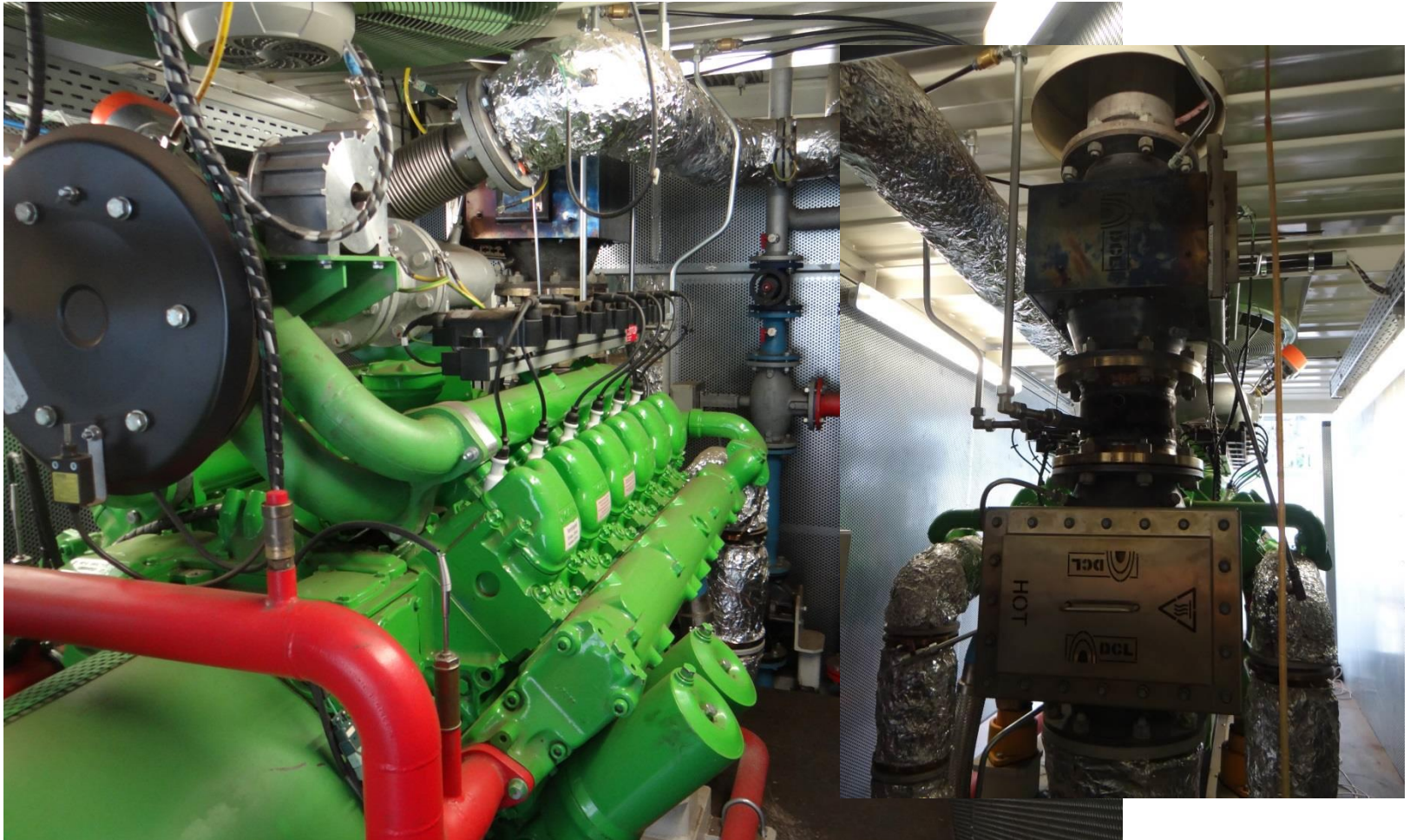
- CGA 1-3
 - Dust (solid): 5 mg/m³ [l.v: 10 mg/m³]
 - CO: 375 mg/m³ [l.v: 650 mg/m³]
 - NO_x: 335 mg/m³ [l.v: 250 mg/m³]
- CGA 1-4
 - Dust (solid): 5 mg/m³ [l.v: 10 mg/m³]
 - CO : 11 mg/m³ [l.v: 650 mg/m³]
 - NO_x : 447 mg/m³ [l.v: 250 mg/m³]

Consequences

- Adjustment of both installations by the manufacturer.
- Another round of measurements by the end of fall.



Measurement of a Wood Gasifier



Measurement of a Wood Gasifier



Measurement of a Wood Gasifier



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Measurement of a Wood Gasifier



Thank you very much for your attention!

- If you have any questions, please do not hesitate to ask.
- christoph.baltzer@vol.be.ch
- +41 31 633 57 99

