

CLEEN MMEA- WP 4.2.2 Comparison emission measurement of particle concentration

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Confidentiality: Confidential

Report's title Comparison emission measurement of particle concentration		
Customer, contact person, address Pegasor Oy Markku Rajala	Order reference	
Project name Comparison emission measurement of particle concentration	Project number/Short name 71091 / CLEEN/MMEA/WP4/2010 -2012/ENE	
Author(s) Harri Puustinen, Olli Antson	Pages 7	
Keywords Particulate concentration	Report identification code VTT-R-08387-12	
Summary This study summarizes the results from the comparison measurement of particles performed at Ekokem Oy Riihimäki waste incineration plant. The participants were VTT, Pegasor Oy and Ekokem Oy.		
Confidentiality	Confidential	
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Distribution Pegasor Oy, Ekokem Oy, MMEA research program		
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1 Introduction

This study summarizes the results from the comparison measurement of particles performed at Ekokem Oy Riihimäki waste incineration plant. The participants were VTT, Pegasor Oy and Ekokem Oy.

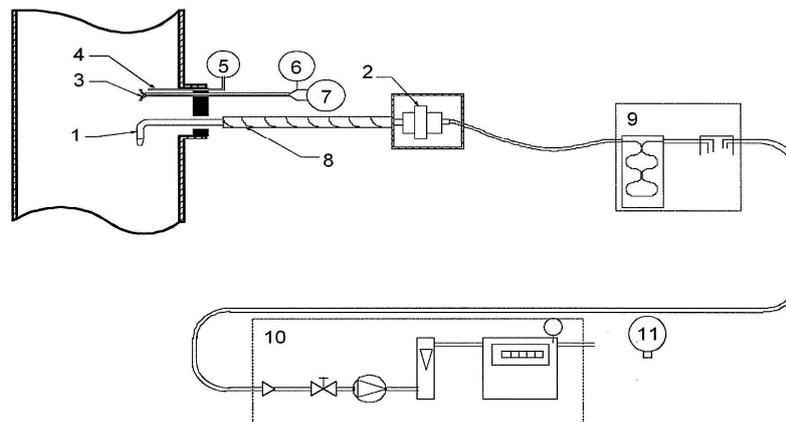
Comparison measurements were performed at the incineration line nr 4 after the textile filter on the 3rd of May in 2012.

2 Objective

The objective of the study was to compare particle concentrations measured by VTT's standard reference method, Pegasor Oy's PPS-1 device and by Ekokem Oy's Sick FEW 200 device.

3 Measurement methods

VTT determined particle concentrations using the European standard reference method based on EN 13284-1 (Determination of low range mass concentration of dust. Part 1: Manual gravimetric method). The measurement principle is shown in Fig. 1.



Key

- | | |
|-------------------------------|--|
| 1 Entry nozzle | 7 Dynamic pressure measurement |
| 2 Filter holder | 8 Suction tube („out-stack“ device) |
| 3 Pitot tube | 9 Cooling and drying system |
| 4 Temperature sensor | 10 Suction unit and gas metering device (see Figure 5) |
| 5 Temperature indicator | 11 Pressure gauge |
| 6 Static pressure measurement | |

Figure 1. Out-Stack-method, standard EN 13284-1

The measurement uncertainty of the standard method is $\pm 2 \text{ mg/m}^3$ (NTP, dry).

Pegasor Oy's PPS-1 sensor determines particle concentrations by charging the particles in plasma and measuring then the leak current of the sensor. The measurement value is determined by multiplying the average current value by a calibration coefficient. The measurement range is $0,01 \text{ mg/m}^3 - 250 \text{ mg/m}^3$. The measurement uncertainty is mainly determined by changes in particle size distribution and changes in sample temperature. These factors were not known in this experiment, and thus a measurement uncertainty value was not available for comparisons.

Ekokem Oy measures particle concentrations from their processes with an optical automated measurement system Sick FEW 200. For this instrument the measurement range is $0 - 100 \text{ mg/m}^3$. The environment permission accepts $\pm 30\%$ measurement uncertainty at the emission limit value 10 mg/m^3 or $\pm 3 \text{ mg/m}^3$. According to the device manufacturer the measurement uncertainty of the device at $0-100 \text{ mg/m}^3$ range is $\pm 2\%$ or $\pm 2 \text{ mg/m}^3$.

4 Measurement results

Table 1 shows the results of the comparison measurements.

Table 1. The results of particle concentrations measured by VTT, Pegasor and Ekokem on 3.5.2012.

Sample	1	2	3
Time 3.5.2012	12:15 – 13:30	14:46 – 15:48	16:10 – 17:15
PM-concentration, NTP, ($p = 101,3 \text{ kPa}$, $t = 0 \text{ }^\circ\text{C}$)			
VTT, dry gas, mg/m^3	2,9	3,3	2,8
Ekokem, dry gas, mg/m^3	2,9	3,1	2,6
VTT, wet gas, mg/m^3	2,4	2,6	2,2
Time 3.5.2012	11:00-11:54	17:26-17:48	
Ekokem, dry gas, mg/m^3	1,9	2,6	
Ekokem, wet gas, mg/m^3	1,4	2,0	
Pegasor, PPS-1, wet gas, mg/m^3 ¹⁾	0,18	0,20	

1) Pegasor PPS-1 gives the result in wet gas, NTP

The trend of the particle concentrations measured by Pegasor PPS-1 is presented in Figure 2.

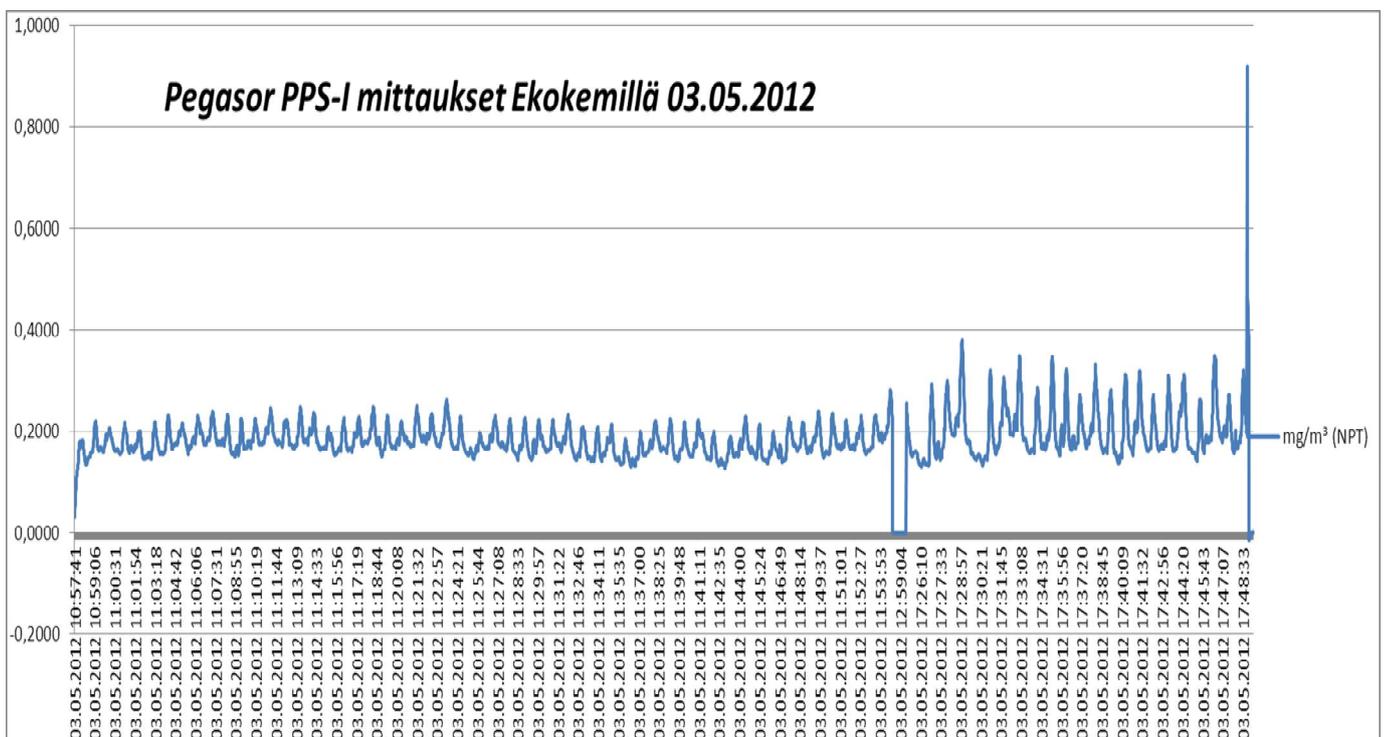


Figure 2. The trend of the particle concentration measured by Pegasor PPS-1 3.5.2012.

Other stack gas parameters measured by VTT are shown in Table 2.

Table 2. Other stack gas parameters in samples 1, 2 and 3 measured by VTT.

Sample		1	2	3
Time 3.5.2012		12:15 – 13:30	14:46 – 15:48	16:10 – 17:15
Components				
O ₂ , dry	%	8,6	8,1	8,6
t	°C	132	132	132
H ₂ O, wet	%	19	21	21
Velocity, wet, in stack	m/s	23	24	22

5 Conclusions

Particle concentration results between VTT and Ekokem Oy are the same within the measurement uncertainty of the standard method ($\pm 2 \text{ mg/m}^3$) and the AMS method ($\pm 2 \text{ mg/m}^3$, data given by the device manufacturer for 0-100 mg/m^3 range). VTT's results were 2,9 mg/m^3 , 3,3 mg/m^3 and 2,8 mg/m^3 and Ekokem Oy's results were 2,9 mg/m^3 , 3,1 mg/m^3 and 2,6 mg/m^3 (NTP, dry).

During VTT's measurements Pegasor Oy's PPS-1 device was erroneously switched off. Therefore, the comparison of VTT's and Pegasor's results is not relevant. However, the PPS-1 data can be compared to Ekokem Oy's AMS results which were measured simultaneously.

The particle concentration results of Pegasor PPS-1 (0,18 mg/m^3 and 0,20 mg/m^3 , NTP, wet) are the same as Ekokem Oy's AMS results within the measurement uncertainty limits of the AMS method (1,4 mg/m^3 and 2,0 mg/m^3 , $\pm 2 \text{ mg/m}^3$, NTP, wet).

The high sensitivity and time-resolution of Pegasor PPS-1 device can be seen in the experimental data. The variation of the current signal has 1-2 minute period which corresponds to the period of the pressure pulse cleaning of the fiber filter unit.

The aim of this study was to compare the results of the standard method to those of the two AMS during one day measurement period. If a calibration study would have been required, then, according to the EN 14181 standard, at least 15 parallel measurements would have been collected during at least three days.