SSSAAP 2008 SPECIAL

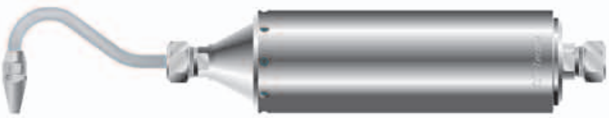
TCR TECORA Today

MSSI: Multi Stage Stack Impactor

TCR Tecora introduces in its Emissions product line a major innovative product: the Multi Stage Stack Impactor.
This new product widen our offering in the applications for dust sampling.
MSSI is designed to facilitate the sampling in industrial stack emission where dust is present in low concentration, there is a large mass emissions and size classification is required. All these conditions are the perfect case for the isokinetic sampling with MSSI impactor.

MSSI is designed to meet the requirements of EN13284-1 and VDI2066 § 10. The European Standard EN13284 specifies a reference method for the measurement of low dust concentration in stack emission with concentrations below 50 mg/m3 standard conditions. This method has been validated with special emphasis around 5 mg/m3 on an average half hour sampling time.

The European Standard is primarily developed and validated for gaseous streams emitted by waste incinerators. More in general, it may be applied to gases emitted from stationary sources, and to higher concentrations.
Evaluation test of MSSI functionality has been performed by "CESI Ricerche", Power generation research centre, on different industrial plants as urban waste incinerator, coal fired power station and gas turbine generator combined cycle with positive results.



Assembled Impactor with nozzle for sampling in horizontal position

Assembled Impactor with nozzle and cone for sampling in vertical position

MSSI components

A typical example of MSSI application is emission with a concentration below the 50mg/m3. For instance, gas turbine power stations, operating with natural gas where dust concentration is low and mass emissions beyond the million cubic meter per hour for power station of 100MW.
Since considered green for their low environmental impact (low NOx and SOx), this class of power generators are growing but, due for the large mass emissions, there is still the requirement to control their emissions.

The emissions limits nowadays in force is about 10 to 50 mg/m3, therefore the accuracy of the current applied method which is almost 0,5mg/m3 is not sufficient. In order to increase of 10 times the measurement accuracy, from 500 µg/m3 to 50 µg/m3, it is necessary to analyse how this value is affected by the adopted method.
The dust measurement is realised with gravimetric systems, summarizing: a given volume of flue gas is sucked through a filter, the dust is captured on the filter and than the filter is weighted in laboratory before and after the sampling test, to evaluate the weight difference.
The accuracy is determined by the error of two parameters:

- Collected dust weight;
- Gas volume;

In order to reduce the weight error, it is recommended to use quartz filters. Quartz filters are lighter and are binding free, because they are manufactured by compression process. This characteristic makes quartz filter, for this application, ideal since the weight of the filter remains stable even when they are exposed at high temperature.

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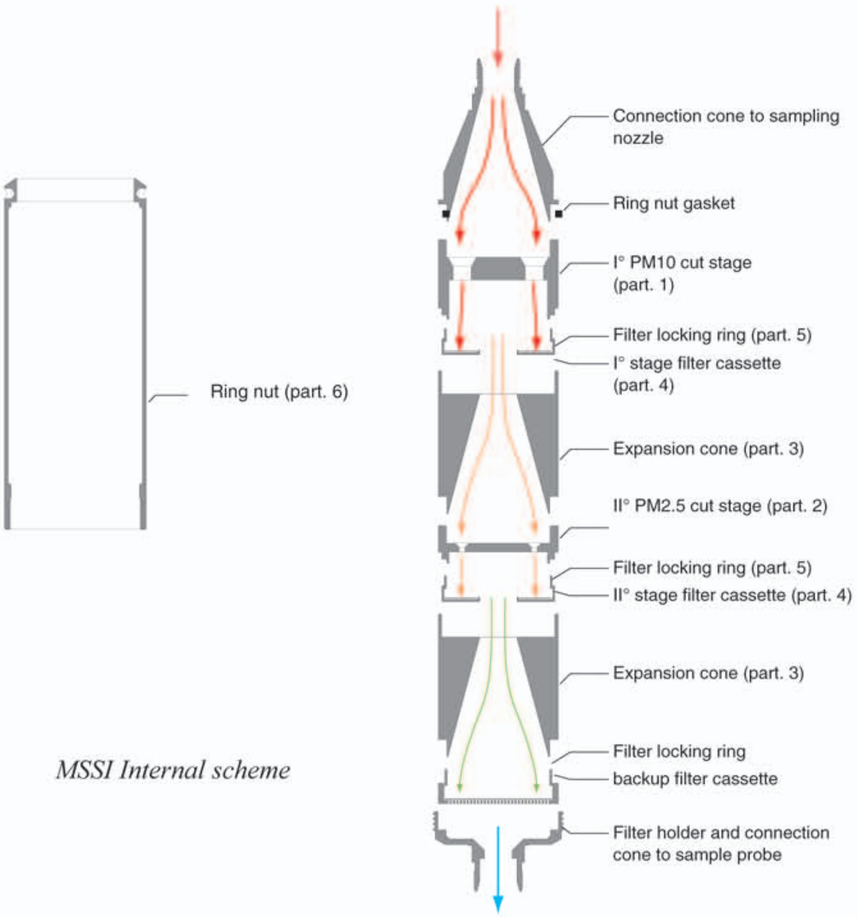
In order to increase the accuracy of the volume and to collect more dust, it is recommended to have a longer duration of the sampling time. In addition, to achieve the objective, it is advised to use an isokinetic automatic sampler like Isostak Basic or Isostak Plus, which allows to sample for long time an accurate volume of gas measured through a dry gas meter and keep control of the isokinetic condition, with minimum operator involvement.
The isokinetic automatic sampler guarantees a volume measurement with an accuracy within 2% and save operation cost due to reduction of operators required to monitor and to manage the test sampling.
In order to understand the nature of the dust, to identify process issues or to optimise the emissions, it is required to make a particles sizing.
Possible particle nature may be the following:
• Earth erosion solids residual in fuel gas;
• Particle originated from plant metals erosion;
• Incombustible;
• Presence of carbon black in case of CH4 combustion.

According to the sampling method available we may consider three approaches:
1. Integrated isokinetic heated probe;
2. PM10 and PM2,5 Cyclones;
3. Sampling with multi stage impactor;
The main differences are the following:
1. The isokinetic probe is a well tested method, but does not allow particle sizing;
2. Cyclons are a well tested method, but part of the sample cannot be collected on the filter and gets lost, and for this reason this method is not ideal.
3. The probe with the multistage impactor MSSI, with low dust concentration, guarantees the maximum collection of dust in different sizing as PM10 and PM2,5.



MSSI Internal scheme

The dust enters the impactor and is accelerated at high speed and hits against the filter membrane due to their inertia. In this way the dust remains bind to the filter to avoid any sample loss in the next analysis process.

MSSI FIELD TEST

According to the official methods, such as EN13284-1 and EPA No 5, three different sampling devices can be used for dust measurement:
- isokinetic probe;
- cyclone;
- multi stage impactor.

As the first two systems are well known, impactor's separation performances have to be demonstrated. Particulate matter is accelerated through the separation nozzles and dust impactors with high impact energy on quartz fibre filter paper, reducing loss of dust. Losses can also be avoided by using expansion cones as transition from a stage to another.

All the samples were provided by CESI Ricerche. They're issued from a sampling campaign which aim was a test field. Dust samples were captured using MSSI. Filters were submitted to SEM analysis in order to have more informations on separation. An E-SEM was used: as it's an environmental SEM, no sample preparation was needed.
Sample's sets to analyze were chosen from the 24h ones. The most homogenous ones were considered (without spots due to manipulations or moisture) and the test was perform on singles spots (for stages I and II) and on 1/8 of filter (for back up filter). Microscopy were done both on secondary and back-scattered electrons. Secondary electrons give information on morphology, back-scattered ones give information on density differences. Those ones were the selected ones to measure particles

matter sizes.

RESULTS

	0–1	1–2	2–2,5
Prova 4 T1	0,00	0,00	0,00
Prova 4 T2 a	0,00	9,65	7,89
Prova 4 T3 a	64,32	28,64	1,88

	2,5–3	3–4	4–5
Prova 4 T1	0,00	0,00	0,00
Prova 4 T2 a	7,89	24,56	14,91
Prova 4 T3 a	1,41	1,88	0,00

	5–6	6–7	7–8
Prova 4 T1	7,14	0,00	0,00
Prova 4 T2 a	14,91	3,51	5,26
Prova 4 T3 a	0,00	0,47	0,00

	8–9	9–10	10–16
Prova 4 T1	14,29	7,14	35,71
Prova 4 T2 a	6,14	2,63	2,63
Prova 4 T3 a	0,00	0,00	1,41

	>16
Prova 4 T1	35,71
Prova 4 T2 a	0,00
Prova 4 T3 a	0,00

Tab 1: Distribution of particulate matter on different stages

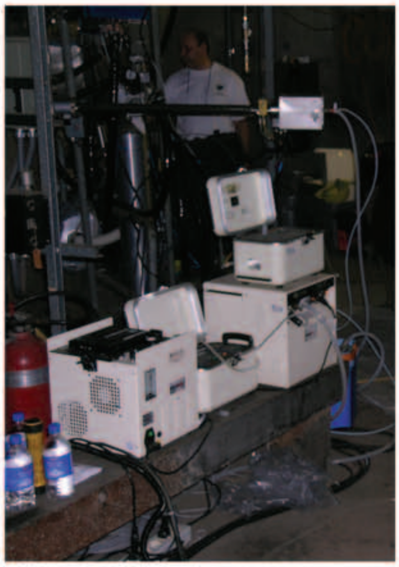
The three different stages show distribution peaks in different size areas. Size categories were selected considering the widest geometric range, according to aerodynamic equivalent diameter. Stage 3 filter (Prova 4 T3 sample) shows a high dust concentration and simultaneously very small size, about 90% shows geometric diameter lower than 2 µm. This is in accordance with expected emission profile of a turbo gas system.
Field data are fitting expected data for the MSSI. The correct separation was obtained by constant flow sampling flow to ensure a correct speed across separation nozzles. The inlet nozzle was chosen after a stack characterisation to determine emission velocity. The inlet selection and the constant flow are the two main parameters for a high efficiency and reliable sampling run.

See pictures on page 4

ARMSTRONG PROJECT: mercury reference test comparison

Have you ever wondered why for mercury stack testing the Americans do it in a different way from Europeans? Indeed in US for reference testing is widely accepted the method called Ontario Hydro Method (OHM) and in Europe the EN 13211. Which one can insure the best and more reliable results in reference measurement?
To this question tried to answer scientists from the Energy Research Center of Lehigh University of Pennsylvania US in cooperation of the scientists of Cesi Ricerche of Milan Italy.

Background. The US Federal Government has adopted a special plan for a drastic reduction of mercury emissions generated in the territory of the United States, mainly by coal fired power stations, called "Clean Air Mercury Rule" (CAMR). CAMR through a substantial investment plan in new technologies for the process removal of mercury in emission and the measurement of the emission, has the objective to reduce the emission of mercury from 11t/y (2006) to 3t/y within the 2020.
By January 1 2009, certified mercury CEMs need to be installed to a large number of coal fired power stations. Following certification, certified mercury CEM should collect 12 months of mercury emissions data. Reporting of data for compliance monitoring would start on January 1, 2010. This gives only one year for mercury CEM installation and certification, and two years until mandatory reporting for emissions compliance.



Isostack plus under test

With the support from the U.S. EPA, EPRI, U.S. electrical utility companies, and
the Italian Ministry of Economic Development, The Institute for Environment and Sustainability of the Joint Research Centre, through CESI Ricerche, and with great help from Allegheny Energy, the ERC organized a field test , what we call here in this report "The Armstrong Project", where the commercially available Hg CEMs and sorbent trap methods were field-tested at Allegheny Energy's Armstrong Power Station and compared to the reference method.
Therefore in July 2006 all involved parties met at Allegheny Power Station to participate the field test. In particular CESI Ricerche used TCR Tecora equipment Isostack Plus with EN13211 sampling train and newly developed MSSI for the dust testing PM2,5 and PM10.
From the final report of Lehigh University we read:
"*In summary, EN-13211 is, in many aspects, similar to the OHM. The main difference is that isokinetic rate is computer-controlled (no operator is needed), and only three impingers are used. These impingers are smaller compared*

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Armstrong project...

to the Smith Greenburg impingers. Also, the sampling volume is smaller and sampling time is shorter compared to the OHM. These features make EN-13211 inexpensive to use."

Moreover, Isostak plus and his accessories proved a great flexibility, because with the same equipment and same arrangement of the sampling train was possible to perform:

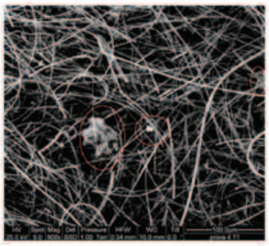
1)the heavy metals

The measured metals included: Arsenic (As), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel, (Ni), Thallium (Tl), Vanadium (V), Antimonium (Sb);

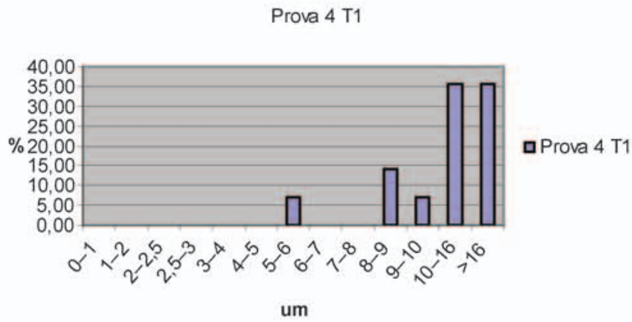
2) with addition of MSSI impactor to the standard probe and few modification to sampling train was possible to perform dust sampling with PM2,5 and PM10 impactors according to EN13284-1.

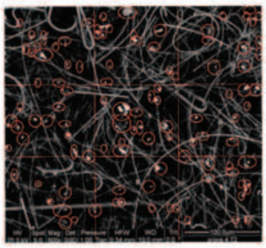
Therefore with Isostak products is required less sampling time, only 45min, less resources only 1 operator per train vs 2 of OHM, less chemical just 150ml and more stable sampling operation due to: less volume and good absorption because of the side stream, isokinetic automatic control and calculation, data logging integrated with computer download facility.

MSSI: Field test

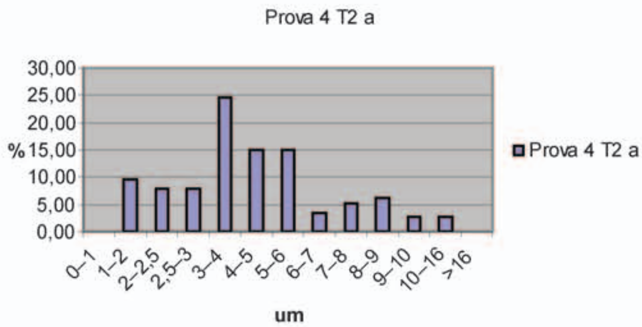


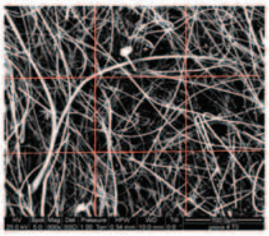
prova 4 T



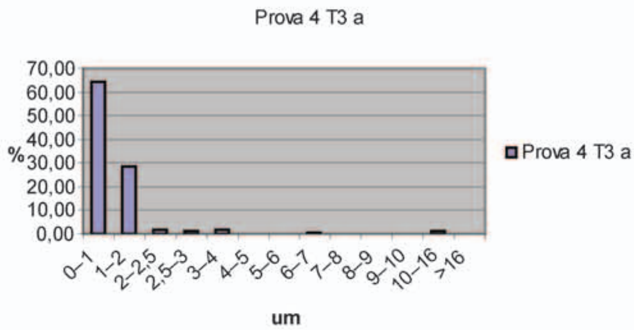


prova 4 T2





prova 4 T3



TCR Tecora was established in Milan in 1974. The company's aim was to design and manufacture technologically advanced instrumentation for air quality and stack emission, based on international standards.

The customers hold a top position for TCR Tecora, which designs its products according to their requirements. Since 1998 TCR Tecora operates with a company's quality system that meets the standard UNI EN ISO 9001:2000 specifically for designing, manufacturing and trading equipment for air quality, emission sampling and monitoring.