www.paulgothe.com service@paulgothe.de

First of all, congratulations for your purchase of our products. Our equipment is manufactured to the VDI, ISO and EN standards and thus offers the possibility of high precision and accuracy measurement of the ingredients in exhaust gases.

Note that this information does not replace manual of each device and no national or international standards for measurement technology.
We refer explicitly to the knowledge of the VDI 2066 and EN 13284-1!

Basically we use for filter devices and suction tubes only G ½ thread. Only the impactor has an input with G ¾ thread. Through this threads you will be able to use the filter devices In-stack (filter device in the duct) or OUT-stack (filter device outside of the duct).

For the suction (drying tower, pump, flow meter, gas meter) we use G ¾ thread with hose fast connectors. With these fast connectors can assemble the parts very quick.

A few tips first:

Please check before using any thread, if there are any chips or dirt in the thread. All threads are smooth running that means, no thread has stiffness in the turning. If a thread does not move easily, please do not use force. Check that the seal is not in the thread and blocked. The seal must place in the back of the thread. All threads are sealed with flat gaskets.

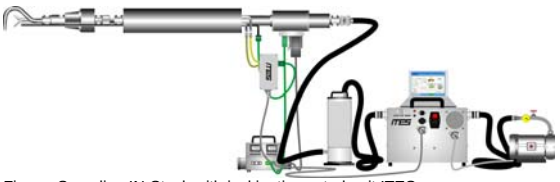

Figure: Sampling IN-Stack with isokinetic control unit ITES

For the dust measurements with the filter head in the duct, the nozzle or the gooseneck nozzle is screwed into the filter head. At the entrance of the suction tube (except for the unheated probe), must be located an adapter, with nut and a drilling to take the exchangeable inner tube. This nut is to align the bent that the orientation of the nozzle can controlled by the direction indicator or power connector at the output of the suction tube.

Figure: Mounting IN-Stack filter

At the exit of the suction tube is connected the hose for the drying tower. One hose connect the output of the drying tower with the input pump (connection with vacuum gauge).
The vacuum gauge on the pump displays the pressure behind the filter. Beware of too high pressure, it can rip the filter. This can happen by heavy dust loading of the filter. In the beginning, should be less than 100 mbar. The measurement should be stopped at a vacuum of more than 500 mbar because it may create a filter rip.
The output of the pump is connected to the pulsation damper and in front of the flow meter. Behind the flow meter is placed the gas meter. Attention, the flow meter indicate incorrect values if it used without pulsation damper, because the flowmeter will be disturbed by the pulsation of the pump.

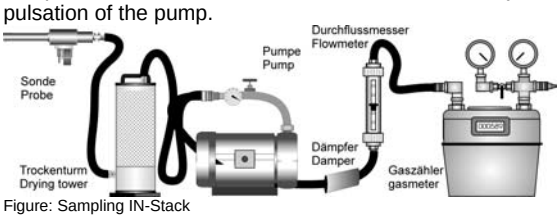

Figure: Sampling IN-Stack

In case the filter is placed behind the suction tube, should it be heated to avoid condensation on the filter. If no standards require a higher temperature, the temperature of the heater should set 20 – 30°C over dew point.

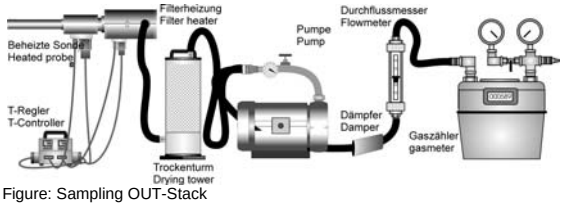

Figure: Sampling OUT-Stack

All parts placed in front of the filter must rinse after the sampling to collect the dust which is in the parts. The rinse solution, in case that the dust is not dissolving, can be simply filtered through a plane filter. This filter can prepare like the standard filter. If this dust amount is negligible, the rinsing must not done the next time at this corresponding measuring point.

Before the filter can be used, it must be free of volatile compounds and balanced. How to prepare the filter, read the information given in the standards.
Short information here:

Pre-sampling conditioning of weighed parts

The measuring filters have to be dried to a constant weight before weighing. The maximum permissible temperature of the filter material shall be taken into account. Loose fibres or remnants from punching shall be removed carefully before the measuring filters are put into the drying oven.
The drying oven should be used without forced air ventilation to avoid dust losses during the drying of the dust-loaded filters. Afterwards the measuring filters shall be cooled to room temperature in a desiccator.
The filter holders of the measuring filters shall be uniquely marked for identification purposes. The scales used for weighing the measuring filters shall meet the requirements of the EN Standard. All readings shall be taken according to a fixed time schedule. Hygroscopic material should be weighed in light weighed closed boxes. After weighing the measuring filters shall be stored proof against dust and damage. In view of the reweighing of the dust loaded filters, weighing and reweighing should be performed with the same scales, if possible. Furthermore, it has to be taken into account that the drying temperature of the loaded filters can be limited due to possible changes of the collected dust. In this case vacuum drying is recommended.
Weighed parts shall be dried in a drying oven for at least 1 h, at a minimum of 180°C. The measuring filters and/or the weighing containers are cooled down to ambient temperature in a desiccator located in the weighing room for at least 8 h. For larger parts e.g. weighing containers up to 12 h may be necessary. If the humidity is controlled and dust is not hygroscopic, the measuring filters and/or the weighing containers may be equilibrated in the weighing room.

Plane filter device

Field of application: < 0 .. 20 mg/m³

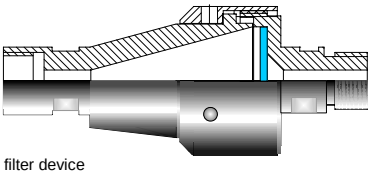

Figure: Plane filter device

The filter holder are cleaned of dust and grease (for example in an ultrasonic bath) and then dried in a drying oven. After being cleaned, the plane filter is put into the filter holder.
For the plane filter holder note the following: The ring for fixing the filter inside the filter holder is not a snap ring. According to studies of the HLUG in Kassel occur through a gap losses. To fix the ring into the holder press these ring a little oval but not too much. The removal of the ring takes place with the supplied hooks. Please avoid tilting of the ring during assembly and disassembly.

Figure: Plane filter holder with fixing ring

Tubular filter with plane filter

Field of application: 10 .. 1000 mg/m³

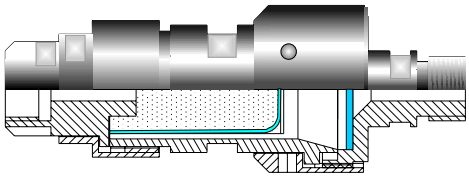

Figure: Tubular filter device with plane filter

The filter holder are cleaned of dust and grease (for example in an ultrasonic bath) and then dried in a drying oven. After being cleaned, the plane filter is put into the filter holder. Then the filter husk is stuffed with quartz wool. The filling quantity is about two thirds of the husk volume. The filling shall consist of coherent wool without any short-fibred flocks and small particles, if possible. It can be put in dry or wet. Then the quartz wool shall be compressed, for example with a wooden ram, so that no through ducts exist any longer after stuffing. After wet stuffing the filters shall be sucked and dried until the weight is constant.
Simple is the use of ready for use glass or quartz fibre thimbles. Their retention rate is defined and corresponds to the VDI and EN specifications.

Tubular filter without plane filter

Field of application: 20 .. 1000 mg/m³

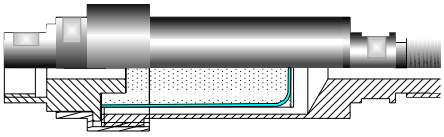

Figure: Simple tubular filter device

Tubular filters without plane filters shall be cleaned and stuffed. In case of dry stuffing the husk filters shall be sucked with dust-free air. This scavenging of the measuring filters removes broken quartz fibres caused during the filling procedure and avoids practically mass losses caused by the suction during the measurement. The volumetric flow should be about 4 m³/h but not less then 1,1-times the sample volumetric flow during the measurement. Scavenging should take at least 10 min.
Simple is the use of ready for use glass or quartz fibre thimbles. Their retention rate is defined and corresponds to the VDI and EN specifications.

Post-sampling treatment of weighed parts

Weighed parts shall be dried after sampling in an oven for at least 1 h at 160 °C. Afterwards they will be equilibrated to ambient temperature. Reweighing of the measuring filters and the control filters left in the laboratory is carried out under the same conditions as the determination of the filter blank values. If a systematic difference between weighing and reweighing of the control filters is identified, this difference shall be taken into account as an average correction for the dust loaded filters. A correction of the dust loaded filters is carried out, if the differences in weighing are greater than 0.2 mg for plane filters or greater than 0.6 mg for husk filters. Such differences are due to little climatic differences in the weighing laboratory on one side and/or different periods for equilibration with time dependent humidity reception of the filters on the other side. Husk filters shall be checked after being reweighed to detect possible measuring errors:

- The dust separated from the sample gas flow is mainly retained in the front section of the quartz wool filling. Traces of dust on the outside of the filter husk or on the inside of the filter casing indicate insufficient sealing. If dust is separated throughout the quartz wool filling, it can be concluded that the packing density is unsatisfactory. The error sources indicated cause a resulting dust content which is too low.

- If there is an increased dust accumulation or a discolouration of the quartz wool just before the perforated bottom, condensate has possibly flown back to the measuring filter during sampling or shortly after. As a consequence of this, the resulting dust content is too high.

Sampling

The sampling should be done at a spot which is free from any turbulence and obstacles. Before the sampling plane should be a straight length of five times of the duct diameter and behind two times.
The gas velocity should not below 3 m/s.

Recommendable is the controlling of the plant operating condition by measuring a parameter like a gas component. It can be quickly detected if the plant works with malfunction.

Well known must be the operating density and the humidity of the gas. The determination of the humidity can be done easily by using the Paul Gothe Psychrometer or by sampling through absorber or bubbler and balance out the weight before and after the sampling. With the Excel-file can calculate the humidity and water content if the weight and the sampling volume are known.

If all parts mounted the leak test can make. Between nozzle and bent are no seal! Please remove the nozzle and close the entry of the bent with a plug. Set the suction vacuum to 300 – 400 mbar by using the by-pass valve from the pump and have a look at the gas meter. After 1 minute should the system be evacuated and the gas meter should indicate no flow. In case of a leak, it must be checked if the leak rate is below 2% of the estimated gas sampling rate. If the leak more as 2 %, the reason must found out.
Small tip: Start at the end: Disconnect the hose from the entrance pump and close the pump. No leak, connect the hose again and close the entrance of the drying tower and so on.

If the leak test passed, the sampling can start.
At first must determine the gas velocity at the sampling points. Calculate the necessary sampling points according VDI or EN Standards. If you know the gas velocity, the nozzle opening can select (see diagram from page 4).

Calculate the suction volume rate and the indication of the flowmeter. If the sampling time on one spot is very short, should regulate the pump to the desired suction rate without the filter before the sampling start. The sampling volume rate through the filter device should be between 1

and 4 m³/h in operating condition filter device and the flow rate must adjust in order to obtain isokinetic sampling within -5% and +15%. The necessary calculation can make with the Excel-file from Paul Gothe GmbH.

Insert the probe with filter (in case of heated probe and filter: start with the heating timely that no cold probe will be in the stack) and at first adjust the nozzle tip with the flow direction. Please wait until the filter device has the duct temperature.
Turn the probe for the sampling against the flow direction and start the pump. Use the bypass valve on the pump to regulate the isokinetic sampling. It will be easier, if a flow-meter will be used. Attention: The displayed value on the flowmeter must be recalculated to operating condition. Details for the calculation can find in the operating manual of the flowmeter.

At the end of the sampling, before you start to unscrew the parts, must cool down the threads. If the threads are too hot to unscrew, therefore please do not exercise force, the threads will be damage. Even after the sampling you must have smooth running threads. If not, is some dirt inside the threads. Check before you use the threads if they are free of dirt. If one thread can not open, please do not exercise force. Try it with much back and forth turning to get more and more thread turns. You will cut a new thread. In case you can detach the parts, don't use this thread a second time. The thread must be revised.

Protect the filter for contamination. Are your fingers clean for the removal of the plane filter holder or filter husk?

In case of high vacuum in the duct, should start the pump before you insert the probe with low sampling flow rate, to avoid backflow through the filter. At the end of the sampling, the pump should continue to be run with low sampling rate until the probe will be outside the stack.

For a small fee you can get an Excel-file for the calculation. This file is intended as a basis for designing your own and is not optimized for all types of measurement task.

And even more: In order to assess how well your measurements are, should take always an empty filter holder to the sampling spot. From the results of the blank samples and a good error analysis, you can calculate the quality of your sampling.

Please run the pump after the sampling additional 10 minutes with dry ambient air to remove any condensate from inside the pump head. Otherwise there is a risk that the carbon blade will be blocked and the pump does not start up the next time. If the pump does not even start, you can try to help the electric motor by turning the fan with a screwdriver. If the fan can turn only extremely difficult, the pump must send to Paul Gothe GmbH.

Sampling with bubbler

If should determine the filter passing elements, bubbler must place behind the filter. There are two methods.
In the direct method the total sampling flow is sucked through the bubbler. The sampling rate is limited to a maximum of 1 m³/h, depending on the bubbler size and the absorber. The isokinetic controlling will take place with one sampling train.
By the bypass method, will take from the main gas flow with a gas distributor one constant flow rate for the bubbler. The isokinetic controlling will be made by the main gas flow which does not pass through the washing bottles. The advantage is that through the filter can sucked a gas volume flow rate up to 4m³/h and the constant bypass flow through the bubbler can be optimized. For each bubbler series must use an extra sampling train. It is advantageous to use the Paul Gothe gas sampler with CP module, so that the flow rate will be constant even with changes in the pressure drop behind the bubbler. The constant sampling flow rate through the bubbler must be considered by the calculation of the isokinetic sampling rate and added to the indication of the flowmeter.

And finally:

At the determination of particles with sizes bigger as 5 µm, the isokinetic sampling is very important. With too low suction rate, particles will fly by the inertia forces inside the nozzle, but not the corresponding gas stream. So you will measure more dust than is actually present in the gas volume. With too high gas sampling (hoover effect) the gas stream from outside the surface of the nozzle will be flow inside the nozzle, but the particles from this gas stream will passed the nozzle and that occur lower results. The error of the sampling will be higher if the suction rate is too low. A little bit higher suction rate will cause less error. But if the ratio of the isokinetic sampling will be more than +15 %, the error is not negligible. In case of wildly fluctuating gas velocity should use the isokinetic control unit ITES, to get measurements with high accurately and reproducibility.

The Paul Gothe team wishes success in the measure-ments!

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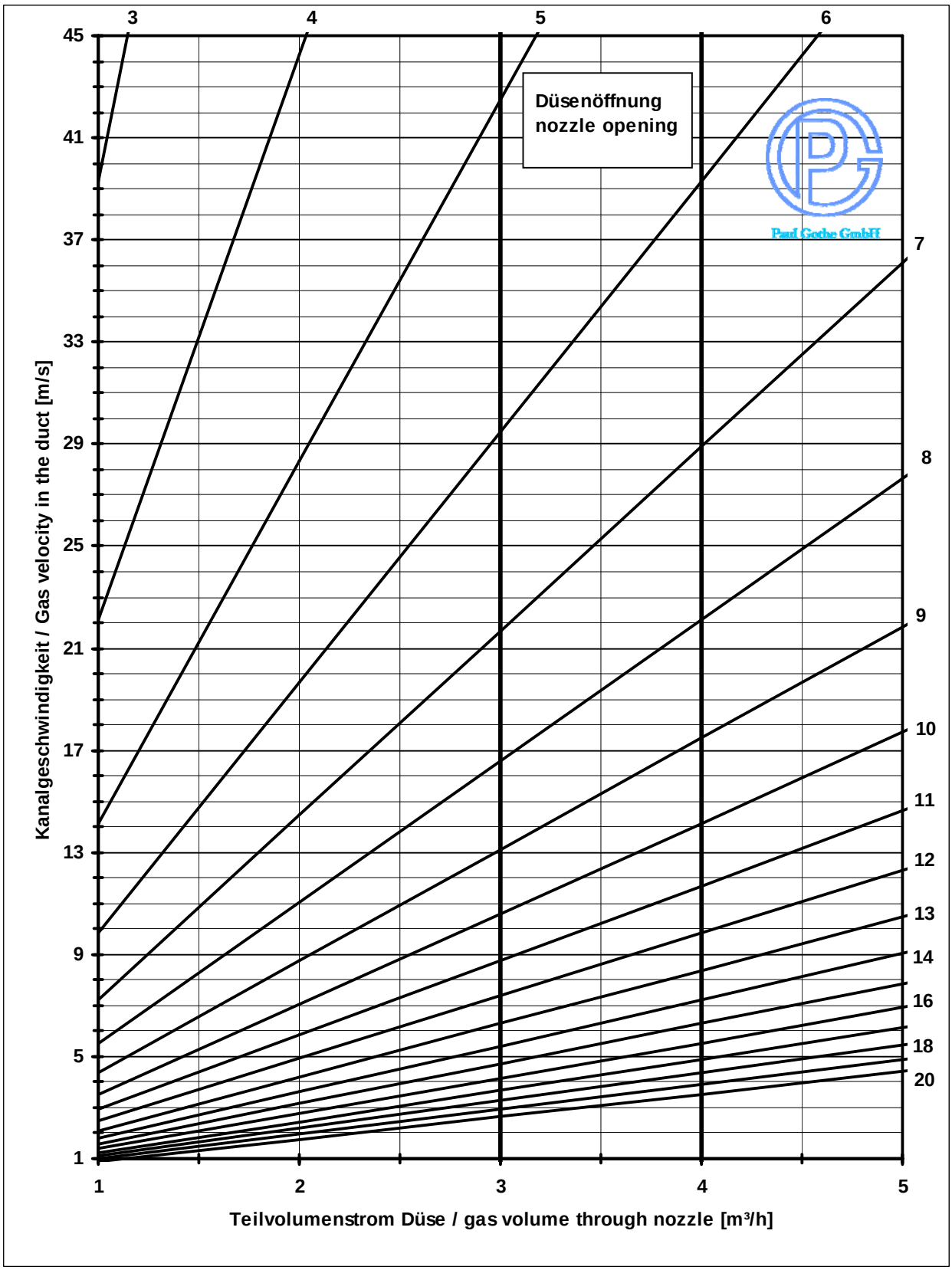

Figure: Diagram nozzle opening as a function of the gas velocity