TRACERTECH
GESELLSCHAFT FÜR SPURENGASTECHNIK MBH

Guidance for Air Change Rate Measurements

Contents of Standard Set

- One 60 ml plastic syringe filled with tracer gas, SF_6 (sulphur hexafluoride) with yellow label and orange or blue cap
- Five 60 ml empty plastic syringes with white labels and red caps for Standard-ACR Set or
  ten empty 60ml plastic syringes for Combi-ACR Set
- protocol form sheet

Some introductory remarks

The reason for an Air Change Rate (ACR) measurement is most often

- The measurement of the infiltration rate of a room or a building to determine the building tightness for assessing the energy consumption due to infiltration losses
- To measure the infiltration rate with a first and the ACR with the mechanical ventilation system ON with the second measurement (Combi Set)
- In combination with an indoor air quality measurement to determine the source strength of a contaminant, to evaluate ventilation strategies to improve the situation and to properly assess the measured concentration w.r.t. ventilation
- To determine the ACR of natural ventilation systems with defined window opening positions at different weather conditions
- To measure the fresh air supply in a naturally ventilated room with a double facade during occupancy and to determine the magnitude of passive night cooling
- To determine the mechanical exhaust volume flow of an exhaust fan (e.g. in a bath or kitchen)
- To evaluate the effectiveness of air supply terminals
- To assess the air exchange in naturally ventilated underground garages

Depending on the nature of the problem the boundary conditions during the measurement have to be properly assessed and controlled before and during the measurement.

Brief Overview about the Measurement

An important prerequisite of an ACR measurement is the complete mixing of the tracer gas with the room air throughout the measurement. The tracer gas is contained in the syringe with the yellow label. Before injection the tracer gas in the syringe is to be diluted according to the volume of the room to not inject too much tracer[1]. After dilution the tracer gas has to be dispersed as evenly as possible throughout the zone. Depending on the magnitude of the estimated air change allow for 5-15 minutes of mixing time in the zone. Then

[1] Too much injected tracer gas would cause a saturation of the GC-analyser during later analysis resulting in extensive more analysis effort; the target concentration of the first sample should be around 30 ppb ±10.

draw a first sample and in time intervals acc. to Table 1 draw the other four samples using the five white label syringes. The quality of the measurement improves with the degree of mixing of the tracer gas with the zone air. One should support the natural mixing process by a fan or by mixing the air with a newspaper or similar means.

Instruction to perform an ACR measurement:

1. Step - PREPARATION

Adjust the boundary conditions for your measurement in the building, e.g. close or open windows, doors, turn on/off fans, dampers etc. and document it on the enclosed protocol sheet.

2. Step – FILL OUT THE PROTOCOL SHEET

Write your name and address on the protocol sheet. Mark the type of building. Enter a zone description and an abbreviation to be documented on each white label syringe. When needed write other details of the measurement down.

3. Step – DETERMINE ZONE VOLUME

Measure or estimate the floor area and the zone volume; note it on the protocol sheet.

4. Step – FILLING OF SYRINGE WITH CORRECT AMOUNT OF TRACER GAS

According to Table 1 determine the amount of tracer gas needed for your zone.

Room volume [m^3]	Amount of tracer gas [ml] with 100% SF_6	Amount of tracer gas [ml] with 20% SF_6
<50	1	5
100	2	10
200	4	20
500	10	50
600	12	60
1000	20	---
3000	60	---

Table 1 shows how much tracer gas is needed for different zone volumes. Please see yellow label what type of injection syringe is used.

Important: Please take the syringe with the yellow label and leave the building, go to the outside and carefully empty the syringe till the exact amount of tracer gas according to Table 1 is reached. Pay attention that not too much tracer gas is injected to the outside. Now you have the correct amount of tracer gas in your syringe. Now pull the piston back to the 50-60 ml scale bar, so that the tracer gas in the syringe is diluted with ambient air which gives you more gas to disperse. Cap the syringe and return to building. Note the volume to what you have emptied the syringe on the protocol sheet. Add the room and ambient temperature as well as the wind speed and date.

If you had stored your Standard- or Combi-Set for a long time at home, take all empty syringes outside and flush them 2 times with ambient air to avoid contamination.

5. Step – EXERCISE THE INJECTION

The next step is to evenly distribute the tracer gas in the zone. To achieve this, use an empty syringe with a white label to exercise with. Remove the red cap and pull the piston up to 60 ml. Now take the syringe, filled with room air, between forefinger and middle finger, put the thumb on top of the piston and start walking through the room(s) by slightly pushing the piston down, see Figure 1. It is easily possible to extend the injection time to 2 minutes. When injecting into a single family house with 1-3 floors, you should have walked through each room. Then the syringe should be empty. In between checks can be done by reading the scale of the syringe and comparing it to the already injected part of the zone volume – after half of the floor area the syringe should also be half emptied.

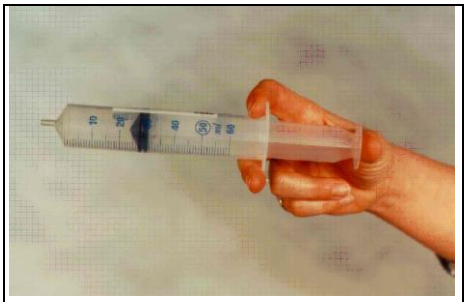

Figure 1: Handling of syringe during injection

When measuring in a single or in multiple rooms on one floor, just repeat your walk-through till the syringe is empty. It is important that the piston is evenly pushed down and that you swing the arm in a circle to achieve a good initial mixing. The longer the injection lasts the better.

6. Step – SAMPLE EXERCISE

It is advantageous to pull the piston upwards using only one arm because this eases to swing the arm in circles – from the floor to the ceiling. For the first inch you can handle the syringe as shown in Figure 2 while slightly pushing the thumb against the outer rim.

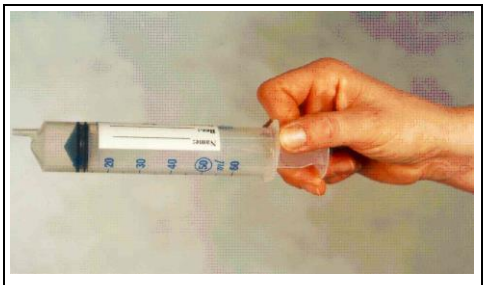

Figure 2: Handling of syringe at the beginning of sampling

Then reach about the piston according to Figure 3 and pull the piston to the 50 to 60 ml marker. Sample taking proceeds similar as the injection by walking through the rooms. The injection as well as the sampling should last 2 minutes. If you think you have a representative sample and the syringe is not completely full, so just stop further pulling the piston and cap the syringe. Your sample should have a minimum of 40 ml for later analysis. Should a sample fail just empty the syringe and try again. After sampling cap the syringe and note the end of the sampling time on the white label.

Figure 3: Handling of syringe to complete sampling

7. Step - INJECTION

After having completed the injection and sampling exercises, please take the capped tracer gas syringe with the yellow label and remove the cap. Inject the tracer gas now as exercised in Step 5. Carefully cap the syringe after injection with the blue cap.

Note the start and end of the time of injection (hour and minute) on the protocol sheet.

>>> Never use an injection syringe for sampling!! <<<

>>> Never use the blue cap for sealing a sample syringe <<<

8. Step – 1ST SAMPLE

For infiltration measurements take the first sample after 15 minutes. At higher ACR start sampling after 5-10 minutes. The higher the ACR the higher the risk of incomplete mixing of tracer gas with the room air. Therefore it is highly recommended to mix the air during the whole measurement by waving with a newspaper or similar means. Take an empty syringe with a white label, remove the cap and do the sampling as outlined in Step 6. The more local volumes your syringe passes the more representative is the measured mean concentration. After sampling cap the syringe and note date, end of sampling time, short name and if necessary a comment. Please also note the end time of sampling on the protocol sheet.

9. Step - 2. TO 5. SAMPLE

According to the estimated ACR take the next sample as shown in ***Table 2***. Don't forget to support tracer gas mixing in the zone.

Estimated ACR [h^{-1}]	Recommended sampling intervals [min]
<0,5	30-40
0,5-1	20-30
1-2	15
2-5	10
5-10	5
über 10	2

Table 2: Determine the sample interval according to the estimated ACR

Tip: A room with a tilted window often gets supply flows of more than 100-150 m³/h. A small room with 30 m³ may then have ACRs of more than n = 5 h^{-1}.

After the 5th sample check whether all syringes are properly labelled and the protocol properly filled out. Put the five sample syringes back in the box and send it back to TRACERTECH for analysis. Please don't send the injection syringe back; please dispose it on your site.

TRACERTECH
GESELLSCHAFT FÜR SPURENGASTECHNIK MBH
Hardtstr. 19
D-88090 Immenstaad a.B.
Tel.: 07545-9411-0
FAX: 07545-9411-29
E-mail: service@tracertech.de
www.tracertech.de

An information about sulphur hexafluoride *(SF_6):* SF_6 is an odourless, non-toxic and non-harmful gas in the concentrations here used. According to VDI 4300, Sheet 7 this method is the only allowed ACR measurement method to be used in occupied buildings. The room concentrations are so low that during 30 years of application no adverse effects have been discovered.

Procedure with Combi - Set

Background:
The Combi-Set enables you to make two ACR measurements after another at different boundary conditions with only one injection. Therefore the Combi-Set consists of one injection syringe and ten syringes for sampling.

Procedure:
Just proceed in the same way as with the Standard-Set. Take your first five samples. After the 5th sample change the boundary conditions of the building or of the ventilation system. Note the time of change and what you have changed on the protocol sheet. Now take the next five samples.

The Combi-Set is often used for the following applications:

1. ACR measurement to quantify the tightness of a building/room with the building envelope closed and then measurement of ACR with e.g. open window or air supply elements.
2. ACR measurement to determine the infiltration rate of a building with building envelope closed and then ACR measurement with ventilation system ON. Often used in low energy houses.
3. ACR measurement of ventilation system, operating in LEVEL1 and afterwards in LEVEL 2.
4. ACR measurement in a room with tilted window (5 cm) and then with 15 cm.
5. Quantification of passive stack ventilation. First measurement with passive stack SEALED, second measurement with passive stack OPEN.

Recommendation:
It is recommended to do the first part of the measurement when the ACR is small. As the measurement lasts longer manual mixing support is even more important. Please also note that the sample intervals may vary according to different estimated ACRs, see Table 2. The Combi Set-should only be used if first ACR is less than 1 h^{-1}.