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INFLUENCE OF FILTERING SYSTEM ON HIGH SOUND INSULATION VENTILATING WINDOWS

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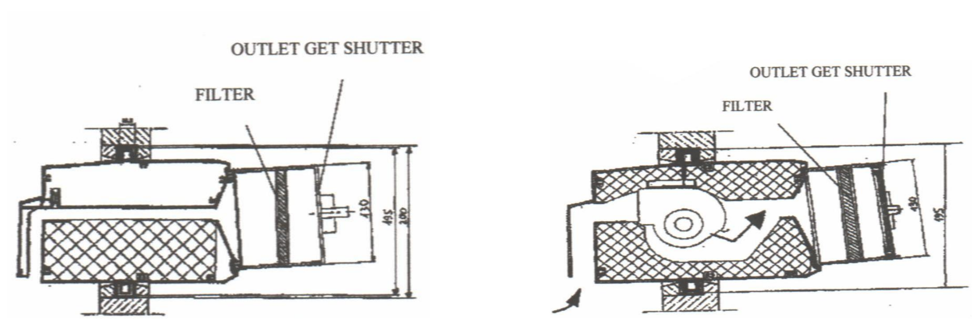
ABSTRACT
A new opportunity to protect buildings against noise pollution is constituted by High Sound Insulation Ventilating Windows (HSIVW), which show good insulation performances and, meanwhile, allow airflow through the window itself. In a previous work, acoustic and airflow performances of the windows have been measured; in the present paper the research is carried out by putting a filter in the aerator of the windows. The filter is necessary to purify the inlet airflow; four different filters, including one with active carbon, have been considered. Experimental investigation shows that the windows equipped with filters still present high sound insulation, with acceptable airflow properties. The airflow through the aerators, in fact, is reduced by filters from 10 to 50%, but is still enough for the ventilation and cooling requirements of the building.

1 - INTRODUCTION
High Sound Insulation Ventilating Windows (HSIVW) represent a recent opportunity to protect urban buildings, especially those close to motorways or high traffic roads, against noise pollution. HSIVW, in fact, show good insulation performances and meanwhile allow airflow through the window itself; such a performance matches summer indoor ventilation and refreshment needs.
In a previous work [1], twelve different samples of HSIVW have been tested to compare acoustic performances with airflow ones; in particular sound reduction index (R) and single number sound reduction index (R_w) have been determined according to ISO 140/3/95 [2], while airflow rates have been evaluated thanks to an original experimental facility [3].
The research was carried out by measuring the influence of different filtering systems, inserted in the aerator of the window, on the acoustic and airflow performances of the window itself. To this aim, the aerators have been modified to allow insertion of the filters (fig. 1).



(a): Without fan. **(b):** With fan.
Figure 1: Aerator sections.

2 - EXPERIMENTAL FACILITIES

The shape and the volume of the UNIPG Lab test room are in agreement with ISO 140/1 requirements [2]. The sample window has been installed on a filler wall which divides the emitting and the receiving room (Fig. 2). R_w measurements have been performed according to ISO 140/3; both acoustic and airflow measurements Lab facilities have been described in a previous work [1].

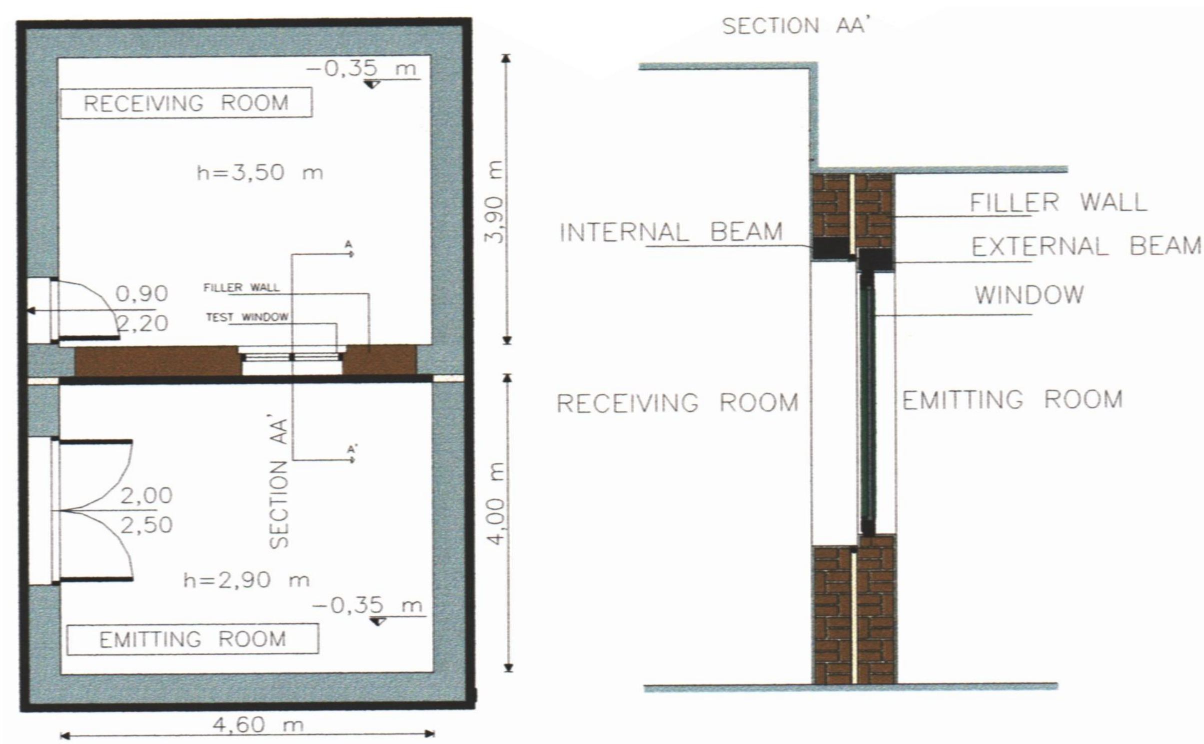


Figure 2: Test room map and filler wall section.

3 - TESTED SAMPLES

Measurements have been carried out with reference to a window with simple frame, sandwich glass thickness of 12-12-9 mm, gas Argon inside the sandwich glass. Acoustic and airflow measurements have been made with both a natural convection aerator (called aerator a, sample 11, N43 [1]), and with a forced ventilated one (called aerator b, sample 12, V40 [1]); four different filters have been considered: filter 1, thickness: 10 mm, weight: 120 g/m^2, ponderal average efficiency: 86%; filter 2, thickness: 20 mm, weight: 200 g/m^2, ponderal average efficiency: 93%; filter 3, black sponge cloth filter, thickness: 20 mm, weight: 1800 g/m^2; filter 4, thickness: 20 mm, weight: 600 g/m^2, average ponderal efficiency: 98%.

4 - MEASUREMENTS RESULTS

Acoustic measurements results are reported in figs. 3 and 4 and in table 1; the condition of the aerator with no filter is compared to the ones with the four different filters. As can be seen, the introduction of all different filters does not produce variations of Rw, while R increases a little at high frequencies, especially with filters 3 and 4.

Airflow rate measurements results are reported in figs. 5, 6, 7 and 8. The airflow rate has been determined for the two aerators and at two different conditions: outlet gate shutter partially opened (50%) and outlet gate shutter completely opened (100%). In this case the introduction of filters produces a significant reduction of airflow rate, which can be summarized as follows:

- filter 1: reduction of 20% in aerator a and of 5-10% in aerator b;
- filter 2: reduction of 20-30% in aerator a and of 10-20% in aerator b;
- filter 3: reduction of 35-45% in aerator a and of 30-40% in aerator b;
- filter 4: reduction of 40-50% in aerator a and of 40-50% in aerator b.

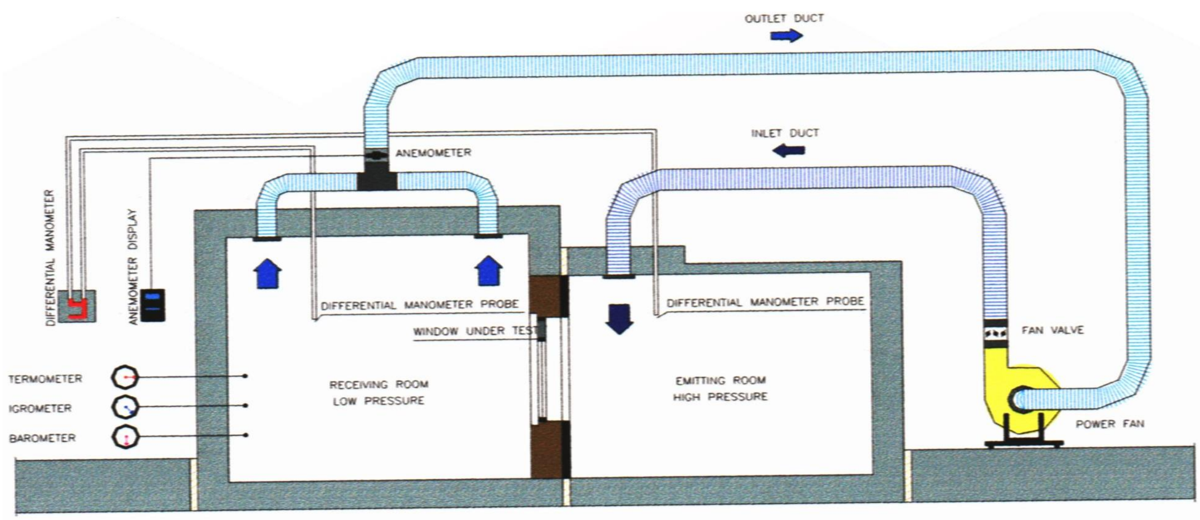


Figure 3: Air flow rate measurement facility.

Even though the reduction is relevant, airflow through the aerators is still high enough to satisfy ventilation requirements and to contribute to the building summer cooling [4].

Frequency (Hz)	**R (dB) for aerator a without fan**					**R (dB) for aerator b with fan**				
	No filter	**Filter 1**	**Filter 2**	**Filter 3**	**Filter 4**	**No filter**	**Filter 1**	**Filter 2**	**Filter 3**	**Filter 4**
100	18,1	16,7	17,1	16,5	18,1	14,0	13,2	13,1	13,4	12,9
125	21,8	21,9	22,3	22,4	21,8	18,2	15,5	16,1	15,6	15,9
160	21,0	20,6	21,5	21,0	21,0	13,4	12,2	12,0	12,6	13,3
200	27,2	26,2	27,3	27,3	27,2	17,5	16,5	16,9	17,0	17,7
250	26,8	26,5	27,2	27,3	26,8	19,3	19,5	19,1	19,9	20,2
315	31,1	31,4	31,6	31,7	31,1	25,3	25,1	24,5	24,7	25,0
400	29,7	29,1	29,0	29,2	29,7	24,7	23,6	23,9	23,3	24,2
500	27,8	27,5	27,8	27,8	27,8	25,0	24,1	24,5	24,3	25,0
630	24,4	24,0	24,0	24,0	24,4	23,9	23,1	22,7	22,5	23,2
800	25,5	25,2	25,6	25,3	25,5	24,7	24,2	24,0	23,9	24,3
1000	29,2	29,6	29,5	29,1	29,2	27,9	27,8	27,6	27,3	28,0
1250	33,7	33,4	33,2	33,2	33,7	31,2	30,9	31,0	30,9	31,5
1600	36,5	36,3	36,7	36,7	36,5	31,8	32,8	32,9	33,5	33,8
2000	40,5	39,9	39,9	40,1	40,5	34,0	33,7	34,2	34,8	35,0
2500	41,5	40,8	41,3	41,5	41,5	36,4	36,1	36,3	37,4	37,6
3150	43,8	43,3	43,5	43,9	43,8	39,9	40,0	40,5	42,0	41,8
4000	43,2	43,0	43,0	42,9	43,2	40,0	40,7	41,0	41,8	41,7
5000	43,8	43,0	43,3	43,3	43,8	41,1	41,4	42,3	42,6	42,3
R_w	32	32	32	32	32	28	28	28	28	28

Table 1: R (dB) and R_W (dB) data for the two aerators, with the four different filters.

5 - CONCLUSIONS

An experimental investigation on a HSIVW sample, with two different aerators, has been carried out in order to evaluate the influence of different filtering systems on acoustic and airflow performances. The results show that the HSIVW sample with all different aerators and filters has still good sound insulation properties ($R_w \approx 30$ dB) and acceptable ventilation performances. HSIVW are therefore a possible solution for urban noise pollution healing, especially in those cases where other noise protection systems (barriers, buffles) cannot be installed because of relative noise source-receiving point position or because of other economic or territorial constraints.

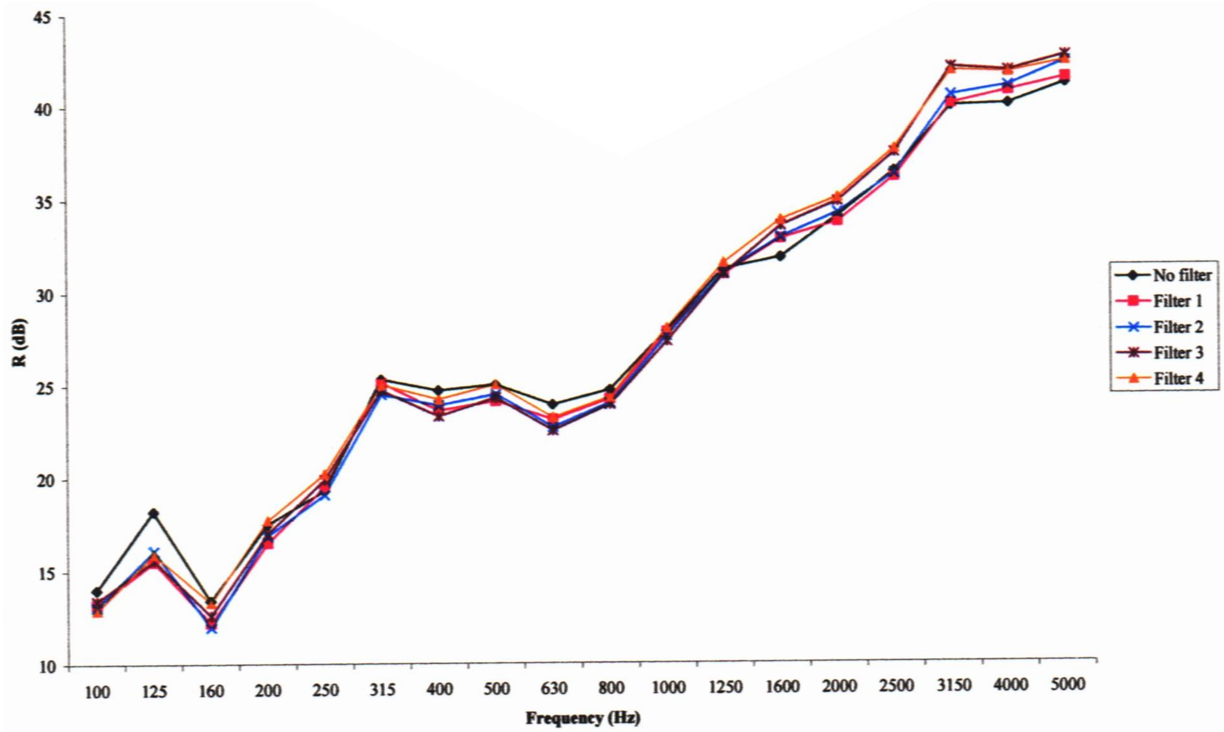


Figure 4: R data for aerator Renson 40V, with the different filters.

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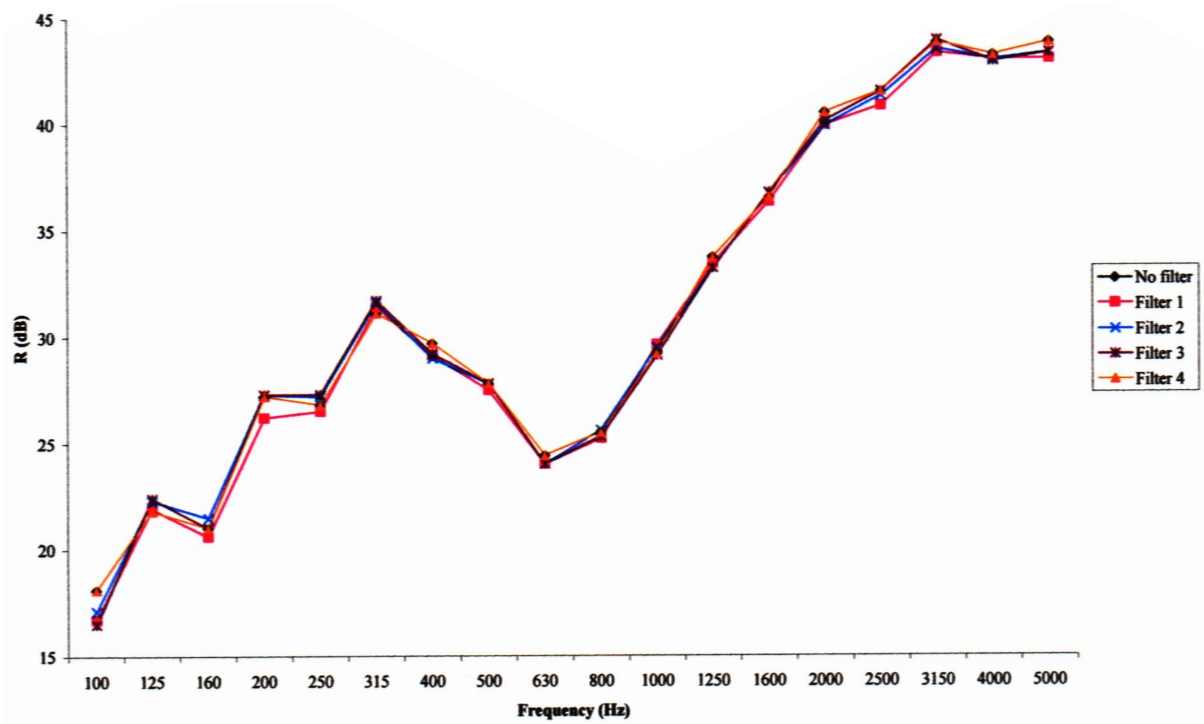

Figure 5: R data for aerator Renson 43, with the different filters.

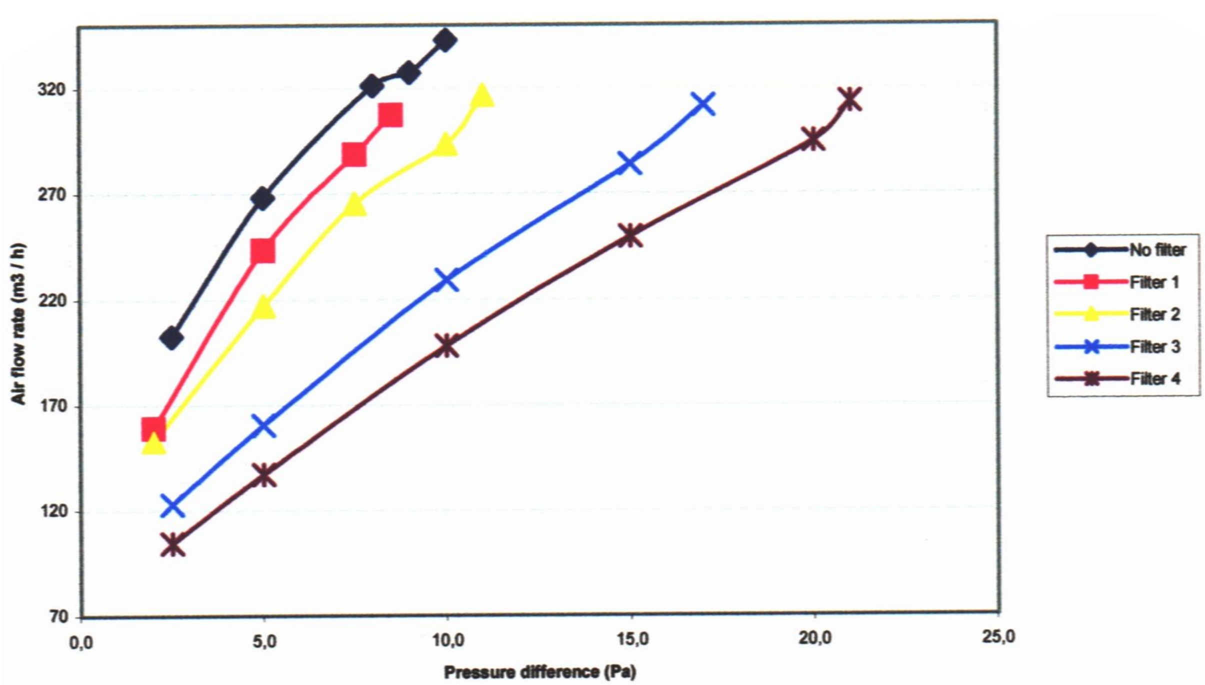

Figure 6: Air flow rate vs. difference of pressure, aerator Renson 40V, outlet gate shutter completely opened (100%).

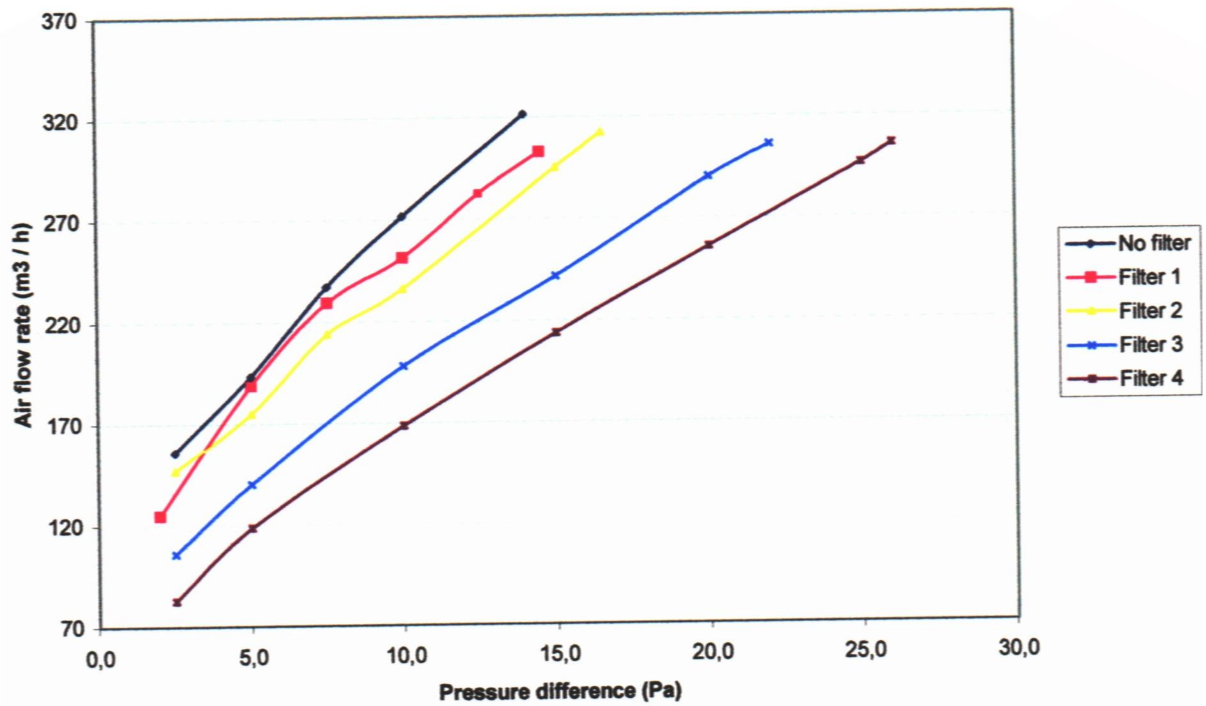

Figure 7: Air flow rate vs. difference of pressure, aerator Renson 40V, outlet gate shutter partially opened (50%).

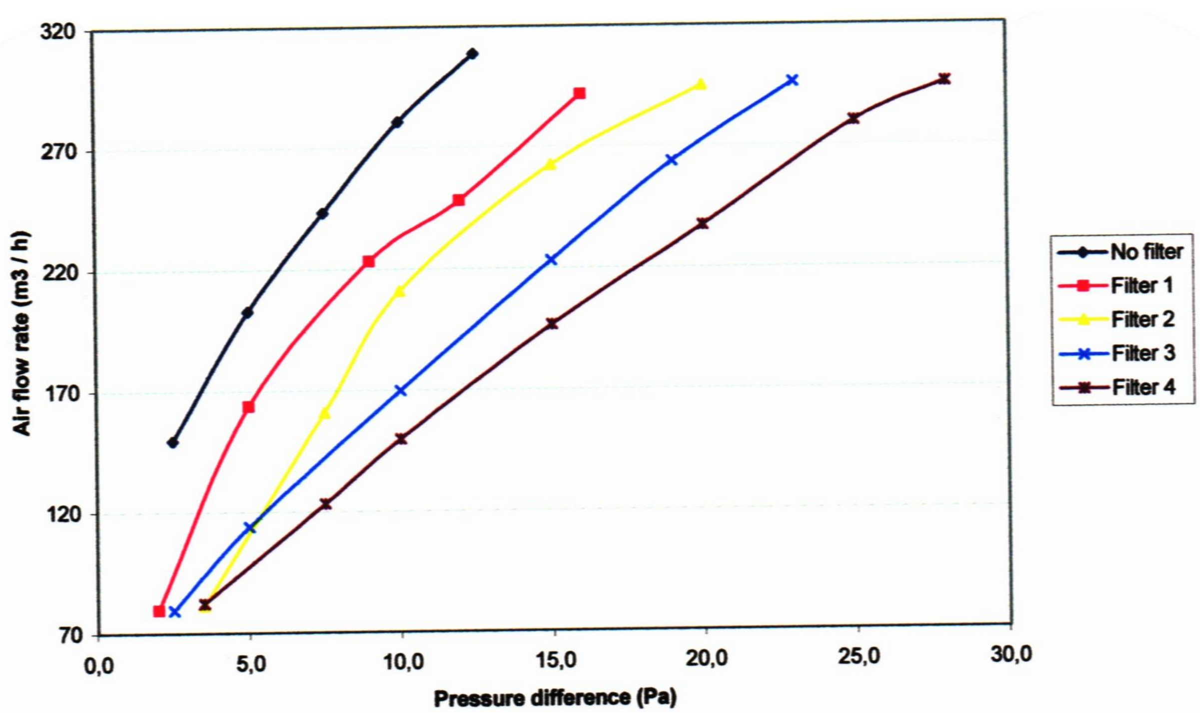

Figure 8: Air flow rate vs. difference of pressure, aerator Renson 43, outlet gate shutter completely opened (100%).

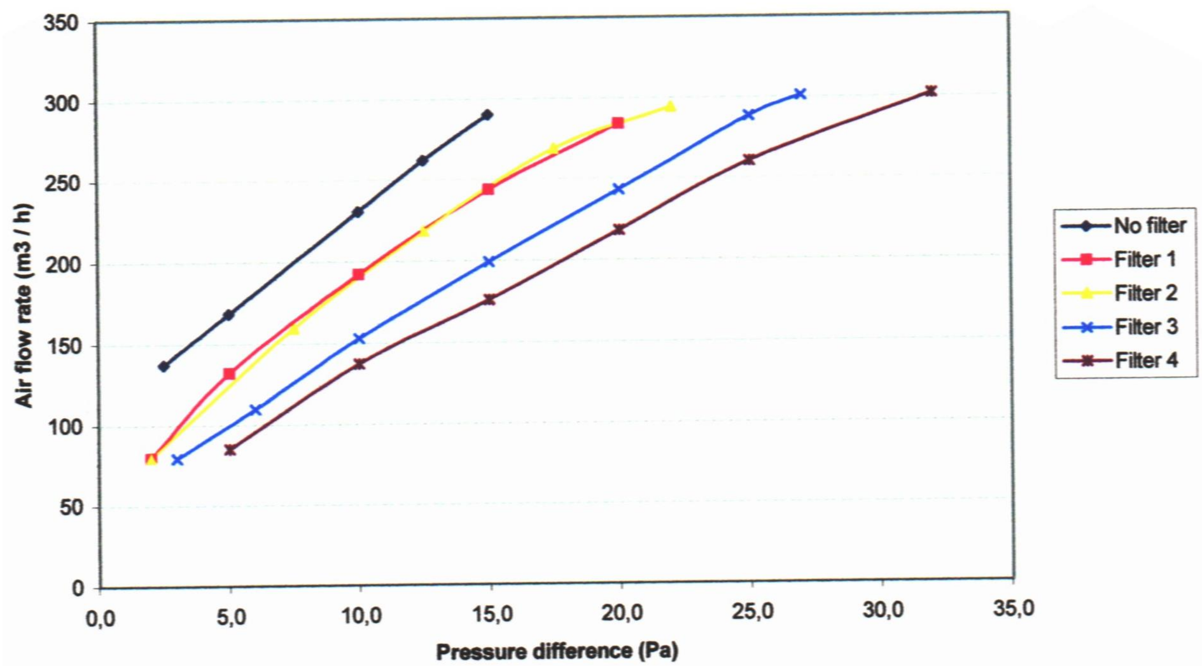

Figure 9: Air flow rate vs. difference of pressure, aerator Renson 43, outlet gate shutter partially opened (50%).