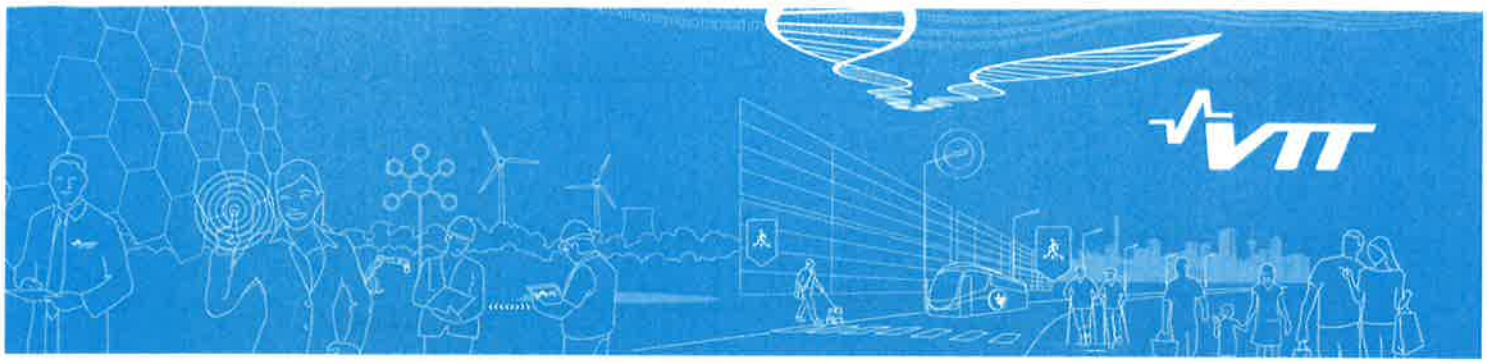

CUSTOMER REPORT

VTT-CR-02736-15/EN | 11.8.2015

The Filtration Efficiency of the Filter Materials

Authors: Inga Mattila, Matti Niemeläinen

Confidentiality: Confidential

Report's title

The filtration efficiency of the filter materials

Customer, contact person, address	**Order reference**
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Project name	**Project number/Short name**
Measurements of filter materials	102651

Summary

The purpose of the commission was to determine air flow and filtration efficiency of filter materials for replacement air valves and window filters. The initial filtration efficiency of the materials was compared to the classification of air filters.

The measurement system followed the principles of air filter test standard EN 779. The initial filtration efficiency was measured with DEHS (di-ethyl-hexyl-sebacate) test aerosol. The efficiency was determined by measuring particle concentrations alternately from the air downstream of the filter material and from the unfiltered air of the reference line. The flow rate through the filter material was determined so that it corresponded to 7 l/s stream of air through a whole replacement air valve.

Based on the results one can say that the initial efficiency of the filter materials 1 (Filtrete GSB 70) and 2 (Filtrete GSU 60) fulfil the filtration efficiency requirements of the F7 class filter.

Tampere 11.8.2015

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1. Description and objectives

The aim of this study was to determine the air flow and initial filtration efficiency of some filter materials of the replacement air valves and window filters. The measurements were performed by utilizing the flow-through method. The purpose was to clarify how the initial filtration efficiency of the materials corresponds to the classification of the filters. The assignment was made to the filter materials (table 1) delivered by the customer to VTT Technical Research Centre of Finland on August 8th 2014.

Table 1. Filter materials.

1.	Filtrete GSB 70 (Velco valve's old filter model VS-100)
2.	Filtrete GSU 60 (Velco valve's 2015 filter model)
3.	Filtrete SU (alternative model)
4.	Filtrete DDU (alternative model)
5.	Filtrete GS (alternative model)
6.	Replacement air valve, filter A
7.	Replacement air valve, filter B (1)
8.	Replacement air valve, alternative filter B (2)

2. Methods / realisation

The measurements were made between 9.9 and 12.9.2014 at VTT's air filtration laboratory. The test system followed the principles of air filter test standard EN 779. The initial pressure drop and filtration efficiency of the materials were determined from a planar, circular (diameter 160 mm) samples. Filter material samples were placed to an adapter presented in Figure 1.

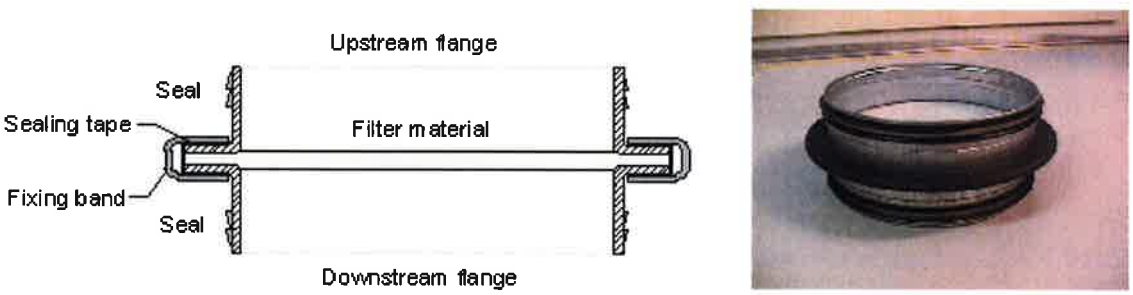


Figure 1. Filter material adapter.

The pressure drop of the filter samples was measured so that it corresponded to a 7 l/s flow rate through a whole replacement air valve. Air flow through the material was measured with a Venturi tube and the pressure drop with a micromanometer DPM TT 470S.

The filtration efficiency was performed by utilizing the flow-through method (figure 2). The initial efficiency was measured with DEHS (di-ethyl-hexyl-sebacate) test aerosol generated with a pneumatic aerosol nebulizer. The test aerosol was mixed into HEPA filtered supply air. The efficiency was determined by measuring particle concentrations alternately from the test line (filtered air) and from the reference line (unfiltered air). The particle size distributions were determined with an optical particle size analyzer PMS LAS-X2 in the size range of 0.1 - 1 µm.

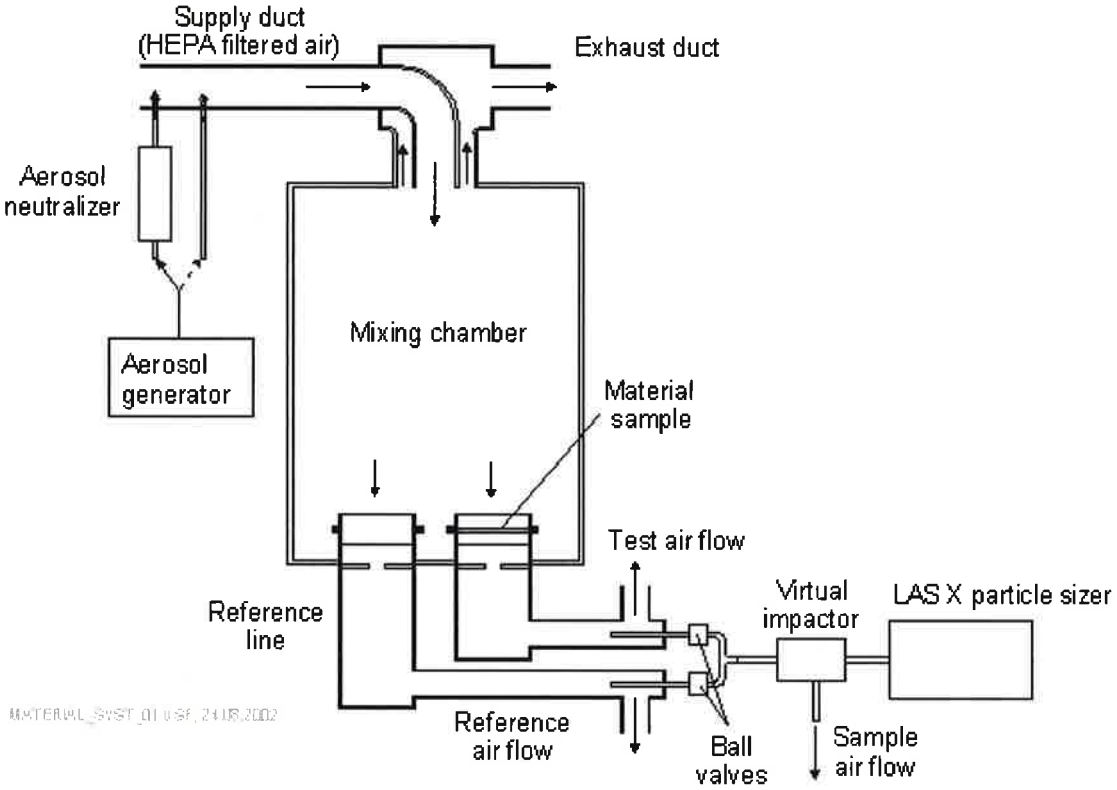


Figure 2. Principle of the test system.

In this study neither the dust capacity nor the discharged efficiency of the materials was determined.

3. Results

The pressure drops, used flow rates and calculated areas of the filters manufactured from the tested materials are shown in the table 2. Initial filtration efficiency is shown in Table 3 and in the pictures in Appendix 1. The test results are valid only to the tested samples.

Table 2. Flow rate and pressure drop of the materials and calculated filter areas.

Material	**Calculated area of a filter manufactured from the material [cm^2]**	**Flow rate [cm/s]**	**Pressure drop [Pa]**
Filtrete GSB 70	888	7,9	3,8
Filtrete GSU 60	888	7,9	4,2
Filtrete SU	201	35	26,9
Filtrete DDU	201	35	18,8
Filtrete GS	201	35	19,6
Replacement air valve, filter A	201	35	1,0
Replacement air valve, filter B (1)	229	30,6	13,1
Replacement air valve, alternative filter B (2)	229	30,6	0,8

Table 3. The initial filtration efficiency as a function of the particle size range (Dp).

Dp (µm)	**Filtration efficiency [%]**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Filtrete					**Replacement air valve**		
	GSB 70	**GSU 60**	**SU**	**DDU**	**GS**	**A**	**B1**	**B2**
0,094	38,3	41,6	36,5	34,4	35,3	0,0	8,0	0,0
0,101	36,9	39,0	25,2	30,0	23,9	2,9	4,7	0,0
0,109	37,8	44,7	33,5	34,6	27,9	5,6	5,8	0,0
0,118	38,5	43,3	35,6	35,2	30,3	3,9	5,3	0,0
0,128	41,5	45,9	36,2	37,0	32,4	1,5	2,2	0,0
0,138	43,6	51,8	41,6	39,7	35,6	8,5	3,6	0,0
0,149	46,1	49,8	38,0	41,2	36,1	5,7	4,5	0,0
0,161	46,3	52,7	44,4	42,6	37,1	3,6	1,9	0,0
0,174	52,2	54,9	46,2	42,9	39,0	5,4	1,0	1,1
0,188	52,4	59,4	47,3	46,9	40,9	8,3	0,4	1,7
0,203	54,4	58,9	51,5	47,8	44,2	5,4	0,1	0,0
0,220	58,1	64,1	52,5	52,5	45,1	5,9	0,4	0,0
0,238	58,0	66,2	55,3	52,2	50,7	7,9	1,6	0,0
0,257	62,2	65,9	57,5	54,4	49,3	10,2	3,1	0,2
0,278	64,2	68,9	58,6	58,1	50,5	8,3	0,0	0,0
0,300	65,5	70,5	61,2	58,2	53,3	9,6	4,5	4,9
0,324	66,7	73,1	62,4	60,4	58,1	10,2	1,8	0,0
0,350	68,5	75,3	66,1	60,8	58,5	8,9	0,4	0,0
0,379	71,0	76,1	68,0	63,5	62,3	12,1	1,1	2,2
0,409	75,5	79,0	72,1	68,1	64,0	13,5	1,7	0,0
0,442	74,7	81,2	73,4	72,6	68,6	16,6	2,2	3,0
0,478	76,5	81,8	76,1	71,1	67,3	5,4	2,4	0,0
0,517	77,0	83,3	75,9	73,3	70,8	8,6	4,9	0,1
0,558	79,6	83,5	76,6	73,3	71,7	7,2	0,9	0,0
0,604	81,6	85,9	81,8	76,2	73,0	8,6	0,3	0,0
0,652	81,1	85,3	82,5	80,0	75,7	8,8	4,0	0,0
0,705	80,4	87,6	81,1	79,7	78,3	13,9	3,2	1,1
0,762	84,0	91,1	83,9	81,7	78,3	10,7	0,0	1,4
0,823	85,4	88,9	85,1	81,0	79,7	21,4	2,4	0,9
0,890	85,4	90,1	84,4	82,2	82,5	4,1	0,0	0,0
0,962	88,0	91,3	88,8	87,0	83,9	13,1	2,3	0,0
1,000	92,6	95,2	94,8	92,4	90,3	17,2	6,8	3,6

4. Summary

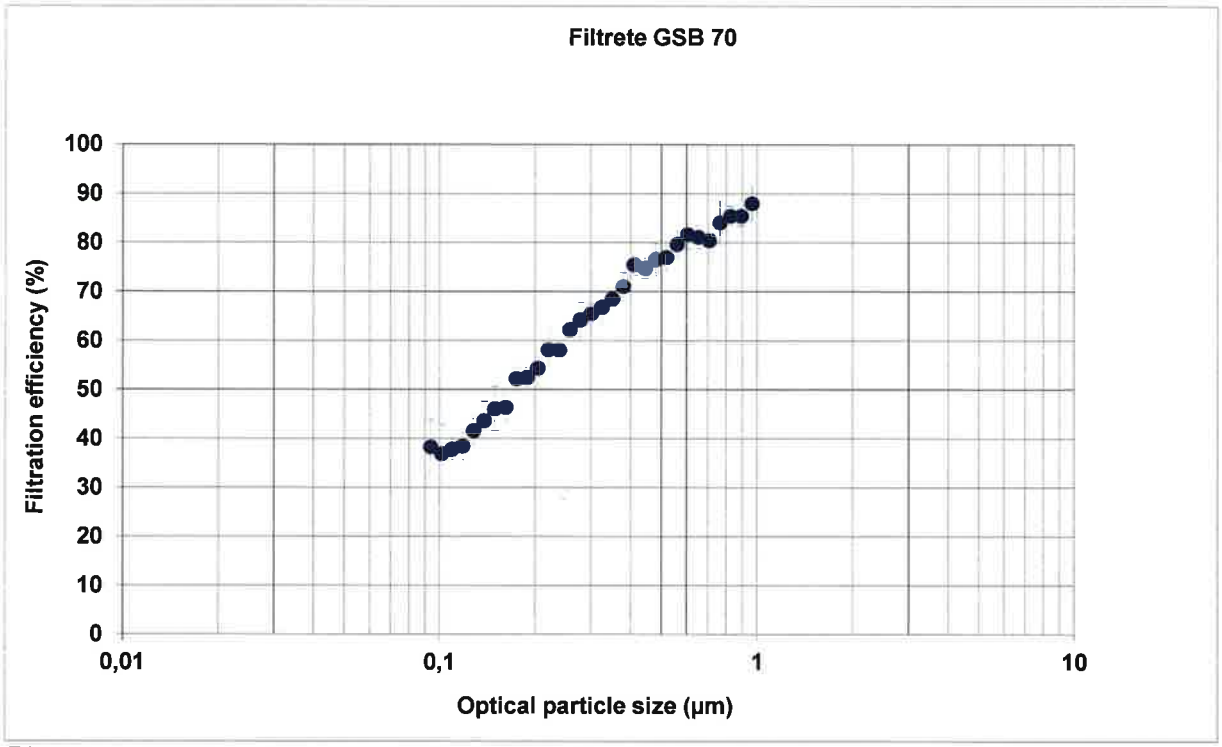
The summary of the results of the pressure drop and the initial filtration efficiency of the filter materials are shown in Table 4.

Table 4. The summary of the results.

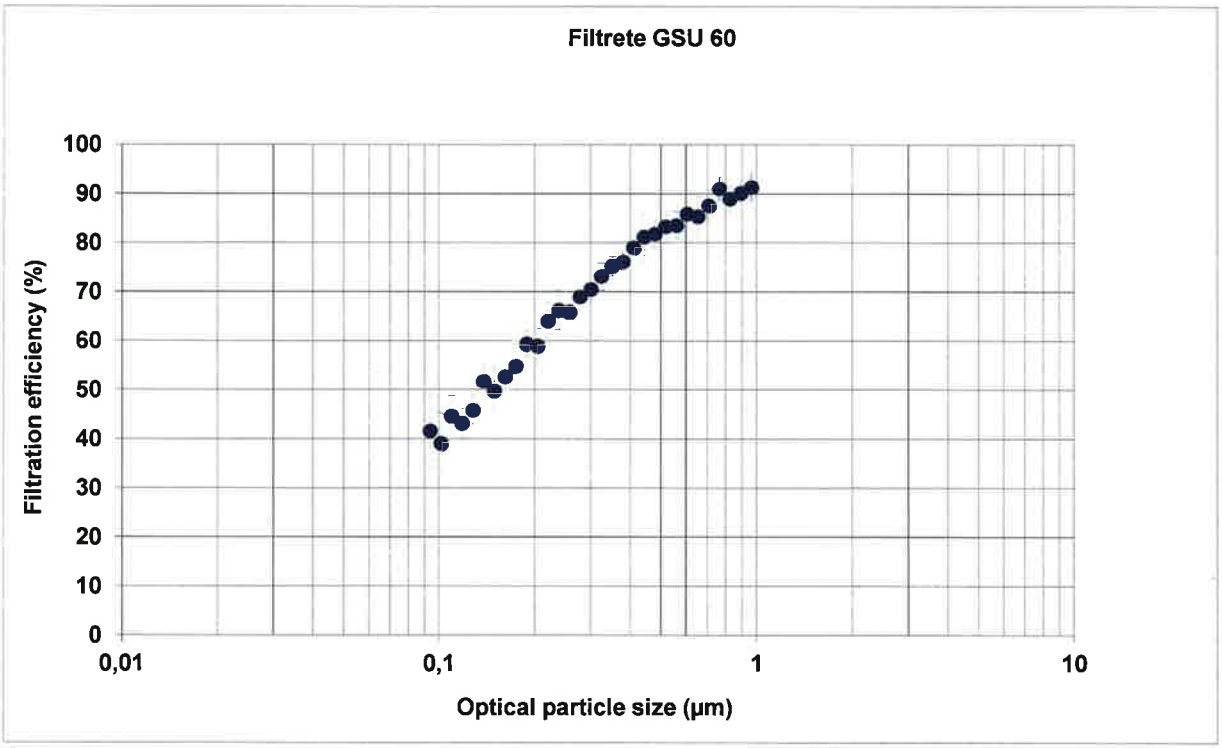
Material	**Pressure drop [Pa]**	**Range of the efficiency [%]**
1. Filtrete GSB 70	3,8	36,9 – 92,6
2. Filtrete GSU 60	4,2	39,0 – 95,2
3. Filtrete SU	26,9	25,2 – 94,8
4. Filtrete DDU	18,8	30,0 – 92,4
5. Filtrete GS	19,6	23,9 – 90,3
6. Replacement air valve, filter A	1,0	0,0 – 21,4
7. Replacement air valve, filter B (1)	13,1	0,0 – 8,0
8. Replacement air valve, alternative filter B (2)	0,8	0,0 – 4,9

Based on the results one can say that the initial efficiency of the filter materials 1 (Filtrete GSB 70) and 2 (Filtrete GSU 60) fulfil the filtration efficiency requirements of the F7 class filter.

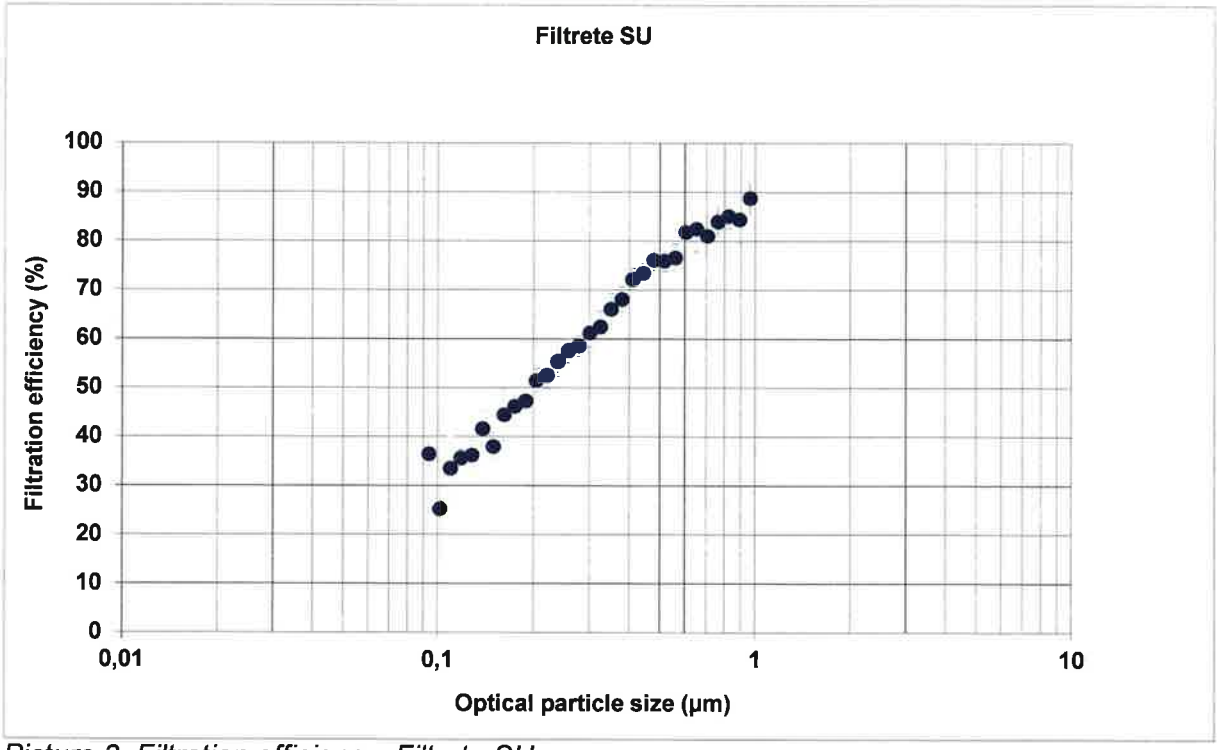
Appendix 1.



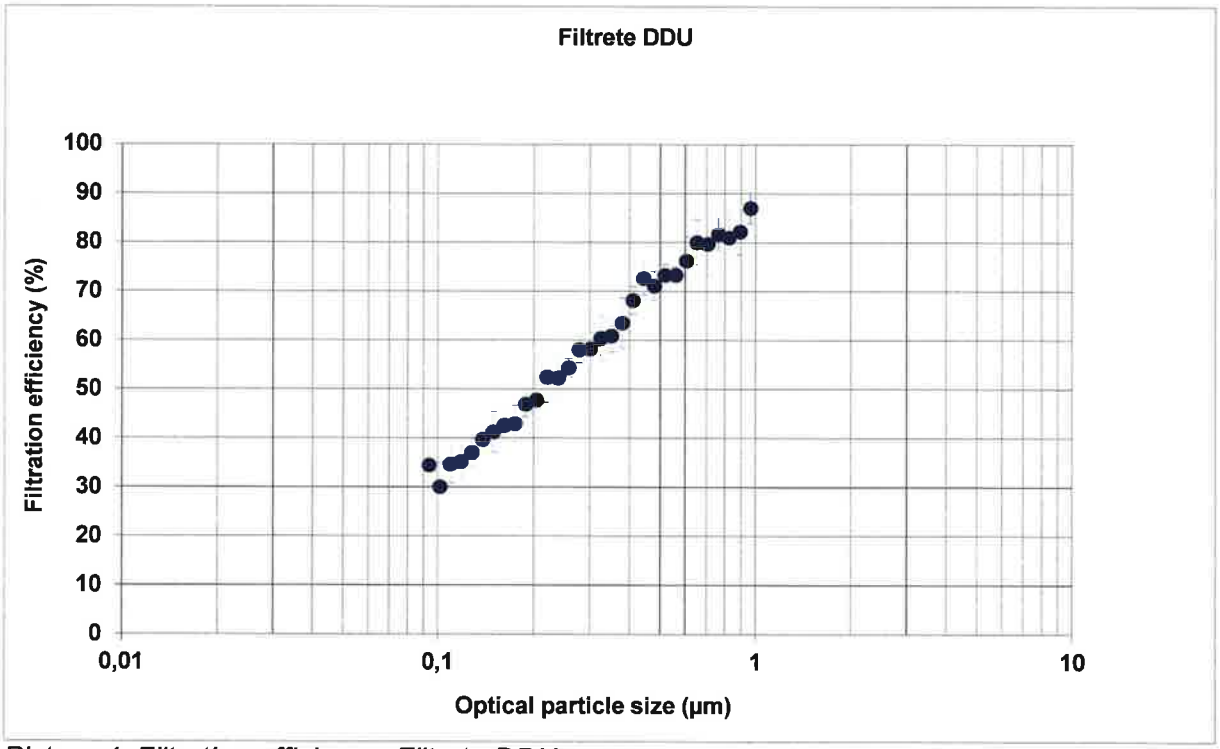
Picture 1. Filtration efficiency, Filtrete GSB 70.



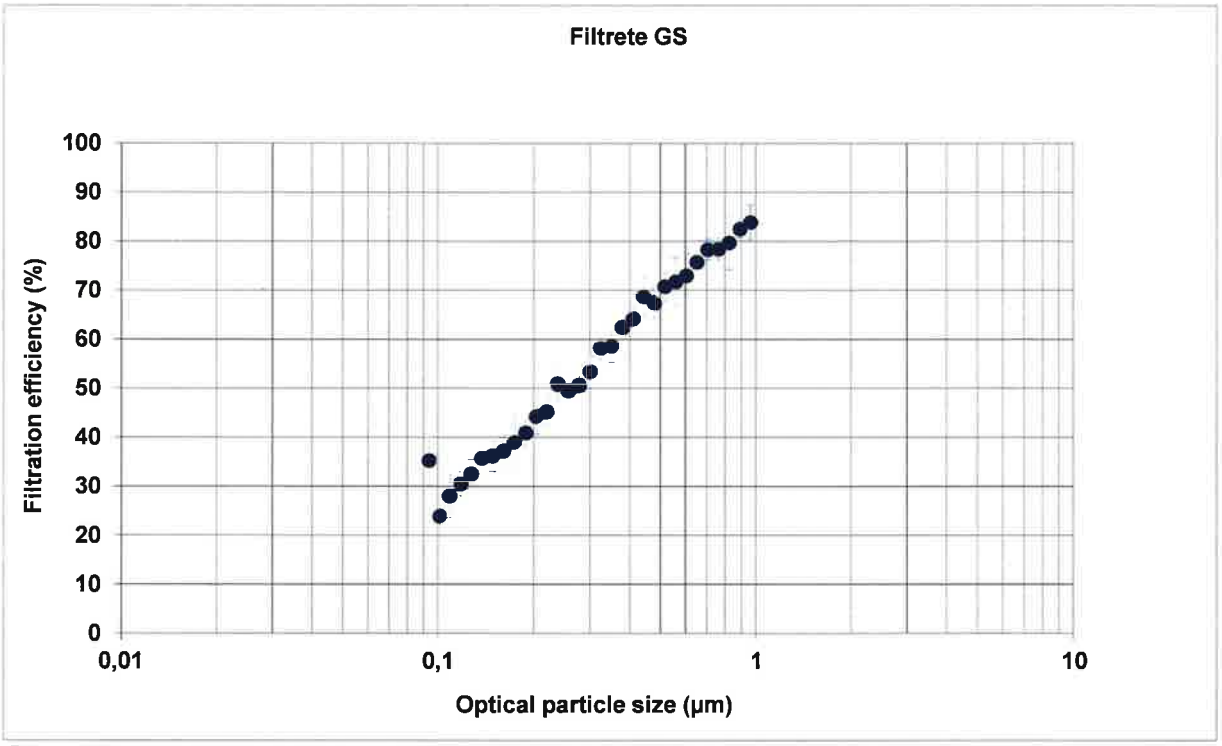
Picture 2. Filtration efficiency, Filtrete GSU 60.



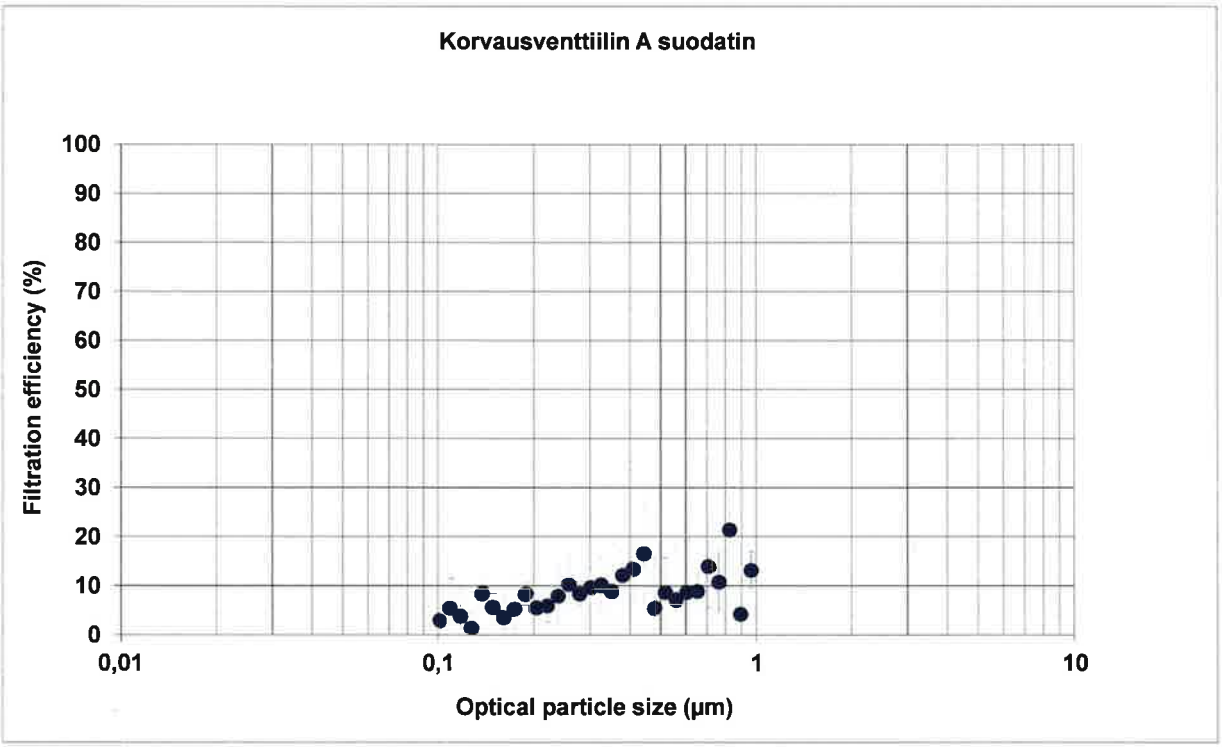
Picture 3. Filtration efficiency, Filtrete SU.



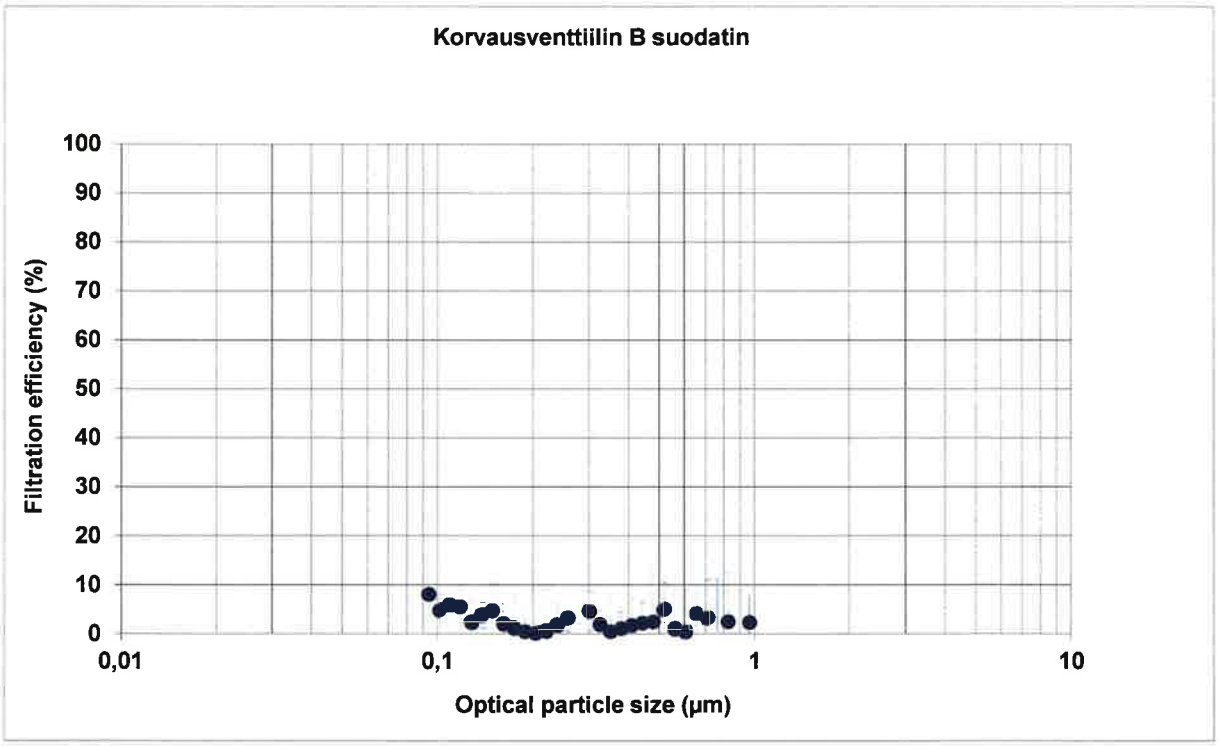
Picture 4. Filtration efficiency, Filtrete DDU.



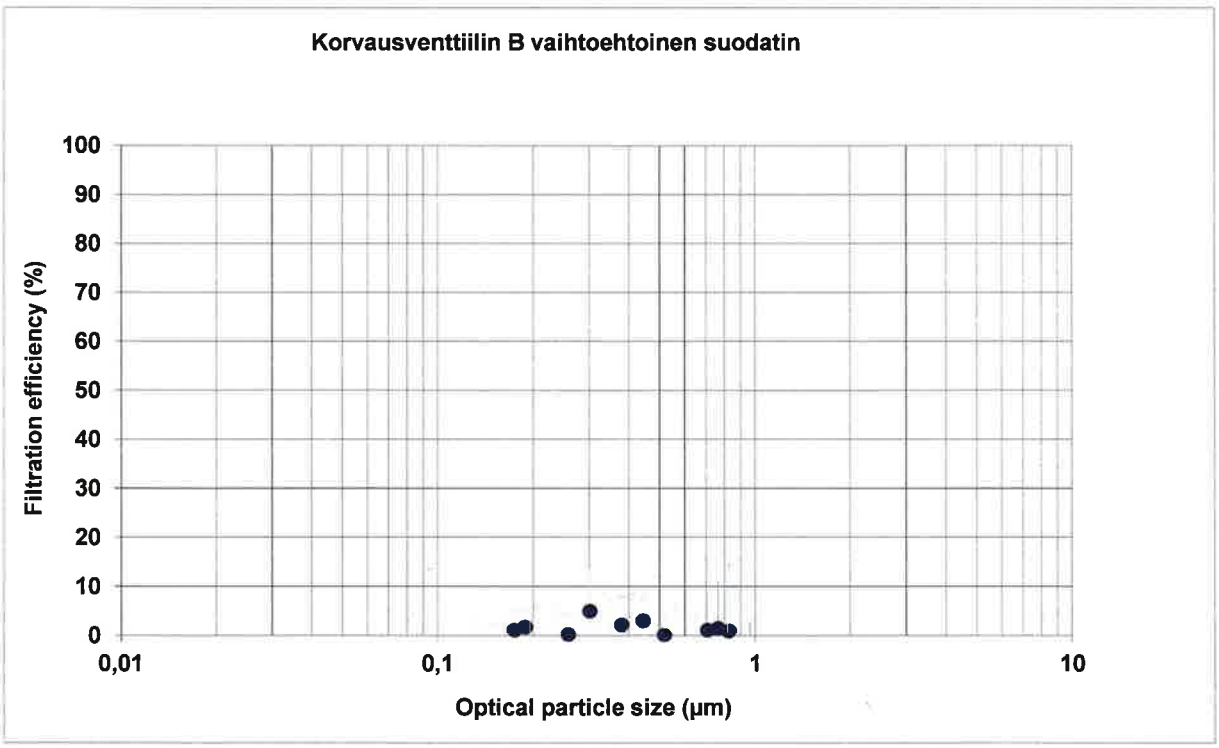
Picture 5. Filtration efficiency, Filtrete GS.



Picture 6. Filtration efficiency, Replacement air valve, filter A.



Picture 7. Filtration efficiency, Replacement air valve, filter B (1).



Picture 8. Filtration efficiency, Replacement air valve, alternative filter B (2).