NatureWorks
Stage 1

IFTS tests organized before a Notary

TEST REPORT N. RA_2020_00006470

Filtration efficiency and retention capacity test according to NF P 90-319 § 4 with derogations
Domestic swimming pools — Filtration groups and systems — Test method for evaluating the filtration efficiency, the retention capacity and the mechanical resistance

§ 4 Measure of filtration efficiency and retention capacity

Sample ref. Stage 1 (1)

CUSTOMER IDENTIFICATION	
Company	**NATURE WORKS TECNOLOGIAS**
Address	C/ Tabarca nº 16, 03580 ALICANTE, SPAIN
Contact	**Mr Guillermo GIL VENEZIANI**
Purchase order nb	PO acc. to DEV_00005868.01

IFTS REFERENCES	
Purchase order nb	ARC_00005973
IFTS Order n.	AFF_00004971
Quotation n.	DEV_00005868.01

Written by
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Validated and signed by
Test Manager

REVISION TABLE			
Date	*Version*	*Reason for revision*	*Revision Description*
30/11/2020	RA_2020_00006470	Initial release	

1 - SCOPE

NATURE WORKS TECNOLOGIAS has requested IFTS (Institut de la Filtration et des Techniques Séparatives) as per purchase order number PO acc. to DEV_00005868.01 to evaluate the performance of a specified number of samples according to NF P 90-319 §4 with derogations - Domestic swimming pools - Filtration groups and systems - Test method for evaluating the filtration efficiency, the retention capacity and the mechanical resistance §4 : Filtration efficiency and retention capacity.

The data contained in the following paragraphs establishes the report of the test performed on the sample identified in paragraph 2 of this document. A separate test report is issued for any other test requested as per the purchase order.
This test has been performed with qualified personnel using thoroughly selected equipements in order to comply with test conditions summarized in paragraph 3 of this document. IFTS is accredited by the COFRAC to carry out tests and perform modular activities dealt with by the ISO/IEC 17025.

2 - TEST SAMPLE

Sample ref.	*IFTS ref.*
Stage 1 (1)	ECH_00036252

Sample ref. : Stage 1 (1)
supplied by NATURE WORKS TECNOLOGIAS

3- TEST CONDITIONS

3.1 Determination of the filtration efficiency and the retention capacity

The following test conditions have been applied :

- Standard : NF P 90-319 §4 with derogations*
- Multipass circulation of contaminant
- Test liquid : Filtered water
- Temperature : 23°C
- Contaminant : specified according to ISO 12103-1 A4 (ISO CTD)
- Flow velocity : 20 m3/h.m²
- Test flow rate : 0,37 m3/h
- Test volume : 41,9 L
- Counting sizes : 1, 2, 5, 10, 20, 30, 40, 50 µm

- Test concentrations : Counting step : 5 mg/L
  Clogging step : 50 mg/L
- On line particle counting

- Test end criteria
  - Final ΔP - Initial ΔP = 500 hPa or
  - Maximal test duration as specified by the customer reached or
  - Upstream pressure

** Derogation in term of fluid circulation (IFTS's pump instead of customer's pump in order to maintain constant flow rate)*

3.2 Test rig

The main pump of the test circuit is installed upstream the tested filter
- Column size H=205 cm ; d=15,4 cm ; Ω=0,0186m²
- Filtration's beds sizes :
  - No support layer
  - Stage 1 (1) : H=100 cm
- Backwash procedure :
  - 1 cycle of 5 minutes at 30 $m^3/h.m^2$
  - 1 cycle of 5 minutes at 72,8 $m^3/h.m^2$ (30% of bed expansion)

Fig 1. : Picture of test rig

4- TEST RESULTS

4.1 Test end criteria

	Test end criteria	Actual value	End criteria
Final ΔP - Initial ΔP (hPa)	500	4	No
Test duration (min)	≥ 360	392,0	Yes
Upstream pressure (hPa)	3000	2100	No

4.2 Filtration performances

Retention capacity at Final ΔP (g)	Filtration ratio 80% (µm)	Filtration efficiency 45µm (%)	Comments
83,0	11,12	99,83	/

The global filtration rating and the global filtration efficiency are calculated based on total counting data relative to all the test duration at 5 mg/L.

4.3 Filtration performances

TEST IDENTIFICATION

Test date : 25/11/2020	Operator : BRD	IFTS Number : ECH_00036252

FILTER IDENTIFICATION

Sample ref. : Stage 1 (1)	Tool ref. : IFTS Column (height : 205 cm ; diameter : 15,4 cm)

OPERATING CONDITIONS

Test fluid — *Type :* Microfiltered water — *Temperature (°C) :* 23,1

Initial cleanliness level — *Upstream :* 280,7 > 1 µm/mL — *Downstream :* 198,1 > 1 µm/mL

Test contaminant — *Type :* ISO 12103-1 A4 (ISO CTD) — *Batch n. :* 14151C

Fluid circuit

Period	Filter test		Contaminant injection				Particle counting			
	Initial flow rate (L/min)	6,2	Flow rate (L/h)	Concentration (mg/L)			Counter	Sensor	Flow rate (mL/min)	Volume (mL)
	Volume (L)	41,91		Initial	Final	Average				
Counting	Concentration (mg/L)	4,9	10,0	194,0	172,0	183,0	PAMAS 2132	Waterviewer	25	25
Clogging		52,9	10,0	1921,0	2022,0	1971,5				

Test parameters evolution (Fig. 5)

TEST RESULTS

Differential pressure at test flow rate

ΔP column (hPa) : < 2

Filtering media (hPa) : 45

Clean assy (hPa) : 45

Final filtering media ΔP (hPa) : 49

- **Filtration term: Pressure Drop**
- **Technical term: Filtering media (hPa)**
- **Calculation: Inlet - Outlet pressure**
- **Value: 45 hPa**

Table 1 : Clogging curve (Fig. 4)

Period n.	1		2		3		4		5	
Concentration (mg/L)	-	4,9	52,9	4,9	52,9	4,9	52,9	4,9	52,9	4,9
Test duration (min)	0	29	90	119	180	212	270	300	365	392
Differential pressure (hPa)	45	45	46	47	48	46	47	48	46	49
Injected mass (g)	0	0,885	20,63	21,51	41,26	42,53	61,29	62,51	83,27	-

Total injected mass : 83,3 g

Final test concentration (CF 1) : 7,53 mg/L

Non-retained mass : 0,32 g

Retention capacity : 83,0 g

- **Filtration term: Filtration Performance**
- **Technical term: Retention Capacity (%)**
- **Calculation: Retained mass (83,0 g) / Injected mass (83,3 g) = 0,9964 x 100%**
- **Value: 99,64 %**

Raw counting results (Fig. 1-2-3)

Table 2 : Average filtration ratio and efficiency vs. Test period

Cumulative counts (#/mL)

Particle size (µm) / *Counting period*		*> 1 µm*	*R10 E%*	*> 2 µm*	*R11 E%*	*> 5 µm*	*R12 E%*	*> 10 µm*	*R13 E%*	*> 20 µm*	*R14 E%*	*> 30 µm*	*R15 E%*	*> 40 µm*	*R16 E%*	*> 50 µm*	*R17 E%*
Upstream initial counts		280,7		148,3		14,56		2,096		0,136		0,016		0		0	
1	*Upstream*	20484	2,503	12734	2,84	2732	4,726	307,2	12,43	32,2	83,75	8,298	622,3	2,431	1094	0,822	∞
	Downstream	8184	60,05	4484	64,79	578,1	78,84	24,72	91,95	0,384	98,81	0,013	99,84	0,002	99,91	0	100
2	*Upstream*	29686	1,943	18958	2,068	4060	2,772	435,8	5,117	46,17	22,94	12,25	132,2	3,524	418,5	1,301	∞
	Downstream	15278	48,53	9168	51,64	1465	63,92	85,16	80,46	2,013	95,64	0,093	99,24	0,008	99,76	0	100
3	*Upstream*	26758	1,836	17678	1,926	4173	2,439	478,4	4,256	50,96	16,14	13,36	78,82	3,855	1012	1,291	∞
	Downstream	14573	45,54	9180	48,07	1711	59	112,4	76,5	3,158	93,8	0,17	98,73	0,004	99,9	0	100
4	*Upstream*	28464	1,833	19067	1,892	4620	2,243	501,7	3,414	49,03	10,32	12,3	47,68	3,58	162,7	1,234	154,3
	Downstream	15527	45,45	10075	47,16	2060	55,42	147	70,7	4,752	90,31	0,258	97,9	0,022	99,39	0,008	99,35
5	*Upstream*	23966	2,356	16105	2,412	4189	2,774	541,5	4,05	57,89	11,45	14,72	38,74	4,469	223,4	1,631	734
	Downstream	10173	57,55	6678	58,54	1510	63,96	133,7	75,31	5,056	91,27	0,38	97,42	0,02	99,55	0,002	99,86
Average	*Upstream*	25872	2,03	16908	2,136	3955	2,7	452,9	4,502	47,25	15,38	12,19	66,7	3,572	316,4	1,256	614,3
	Downstream	12747	50,73	7917	53,18	1465	62,97	100,6	77,79	3,073	93,5	0,183	98,5	0,011	99,68	0,002	99,84

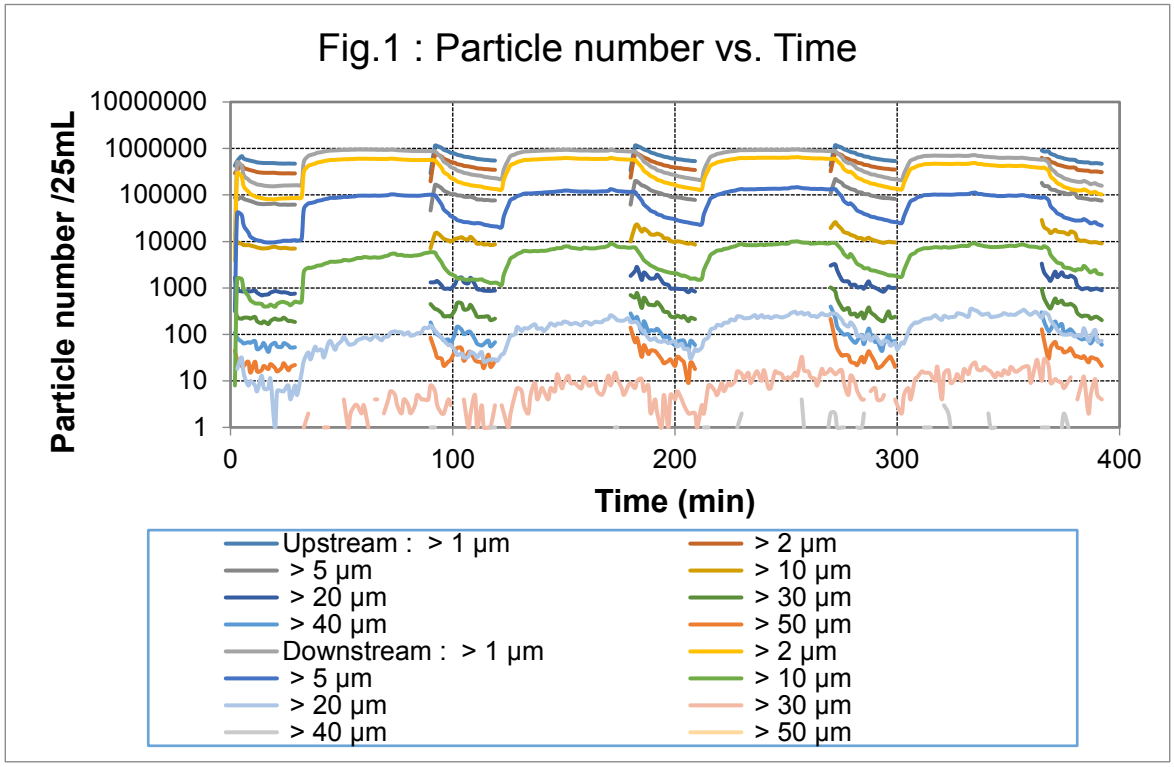
Fig.1 : Particle number vs. Time
Particle number /25mL
10000000
1000000
100000
10000
1000
100
10
1
0
100
200
300
400
Time (min)
Upstream : > 1 µm
> 2 µm
> 5 µm
> 10 µm
> 20 µm
> 30 µm
> 40 µm
> 50 µm
Downstream : > 1 µm
> 2 µm
> 5 µm
> 10 µm
> 20 µm
> 30 µm
> 40 µm
> 50 µm

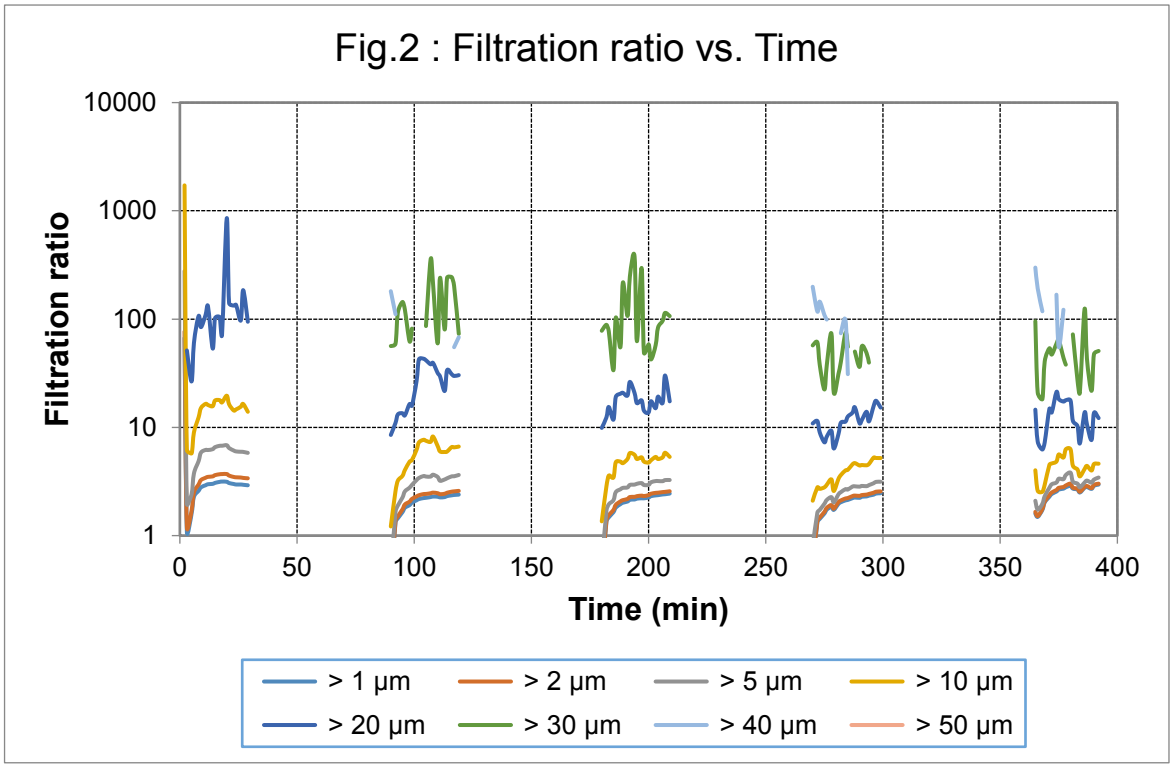
Fig.2 : Filtration ratio vs. Time
Filtration ratio
10000
1000
100
10
1
0
50
100
150
200
250
300
350
400
Time (min)
> 1 µm
> 2 µm
> 5 µm
> 10 µm
> 20 µm
> 30 µm
> 40 µm
> 50 µm

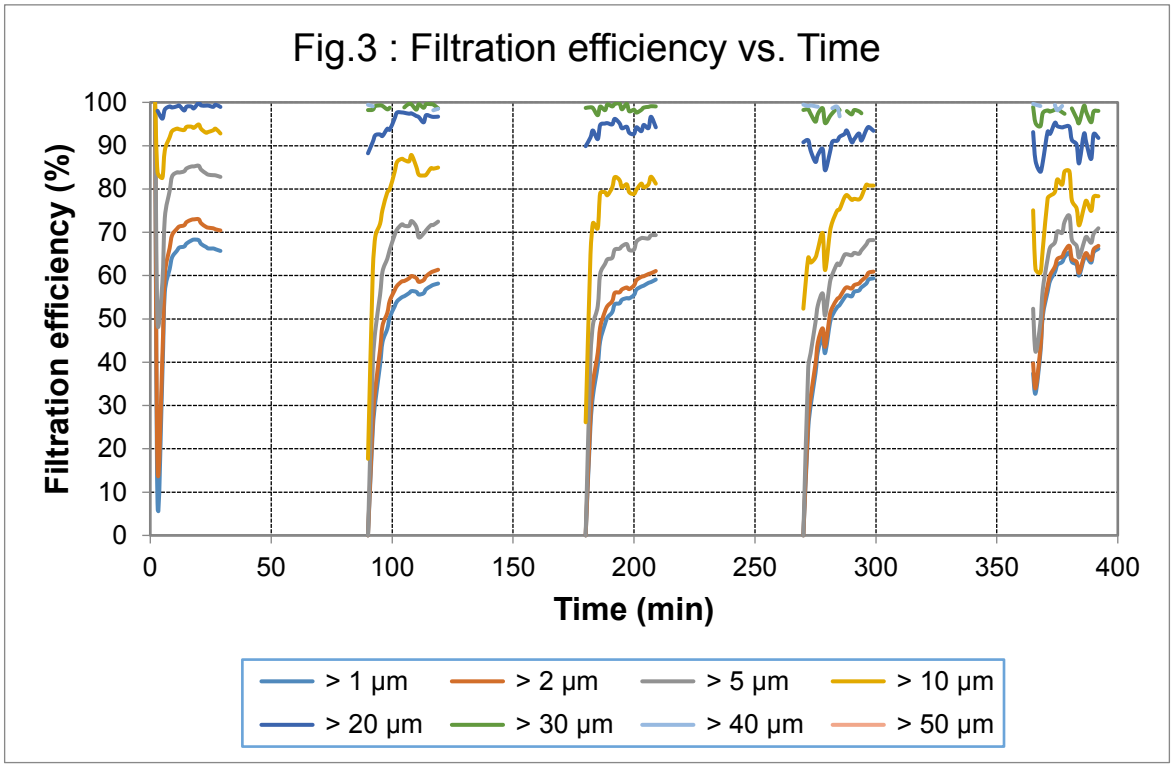
Fig.3 : Filtration efficiency vs. Time
Filtration efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
Time (min)
> 1 µm
> 2 µm
> 5 µm
> 10 µm
> 20 µm
> 30 µm
> 40 µm
> 50 µm

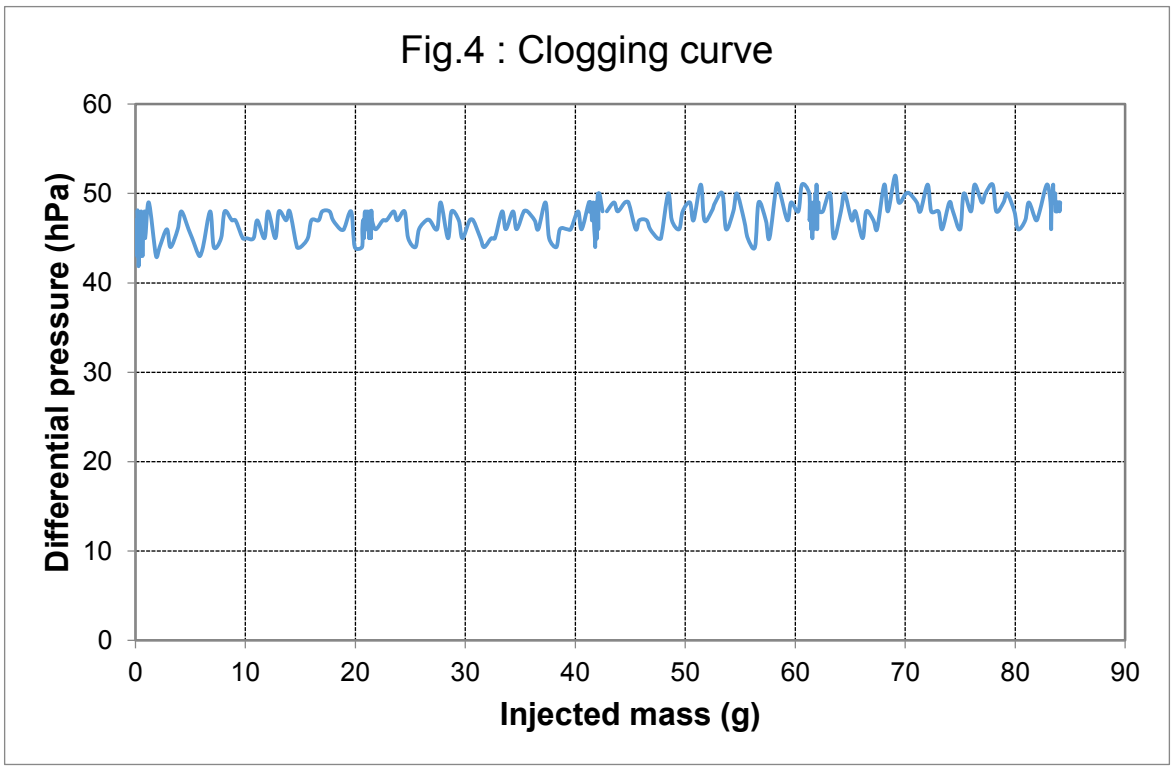
Fig.4 : Clogging curve
Differential pressure (hPa)
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
Injected mass (g)

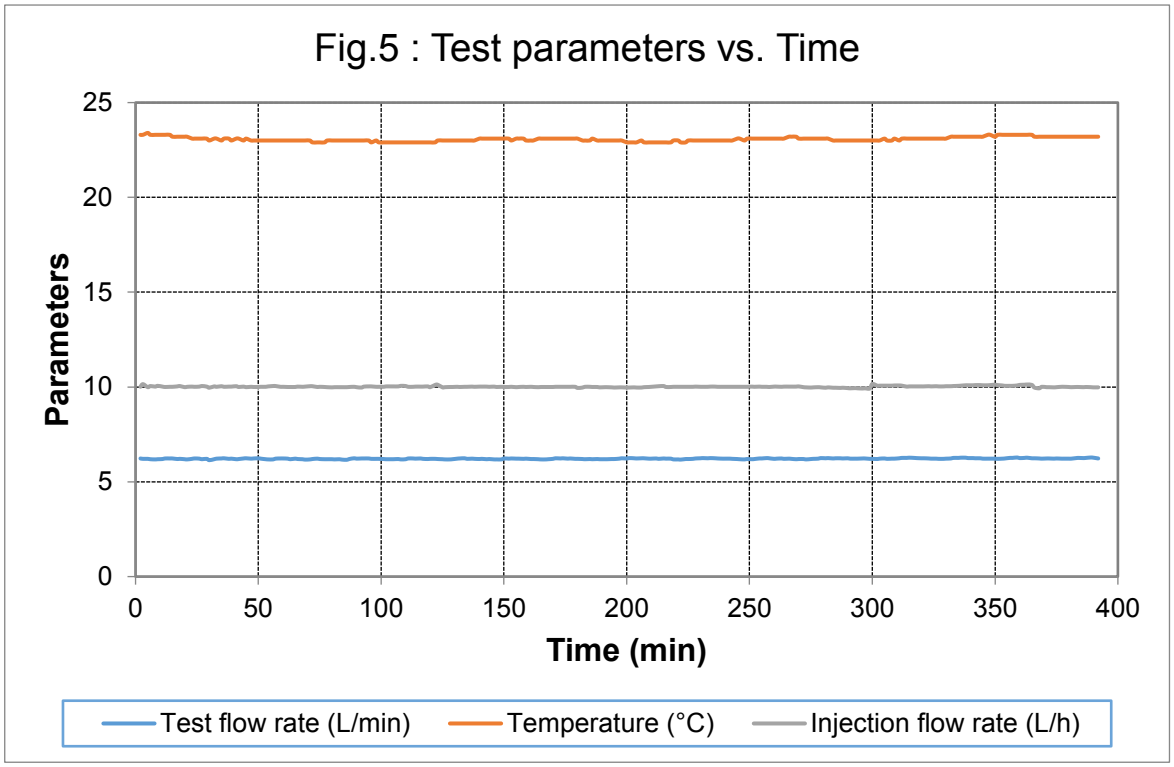
Fig.5 : Test parameters vs. Time
Parameters
25
20
15
10
5
0
0
50
100
150
200
250
300
350
400
Time (min)
Test flow rate (L/min)
Temperature (°C)
Injection flow rate (L/h)

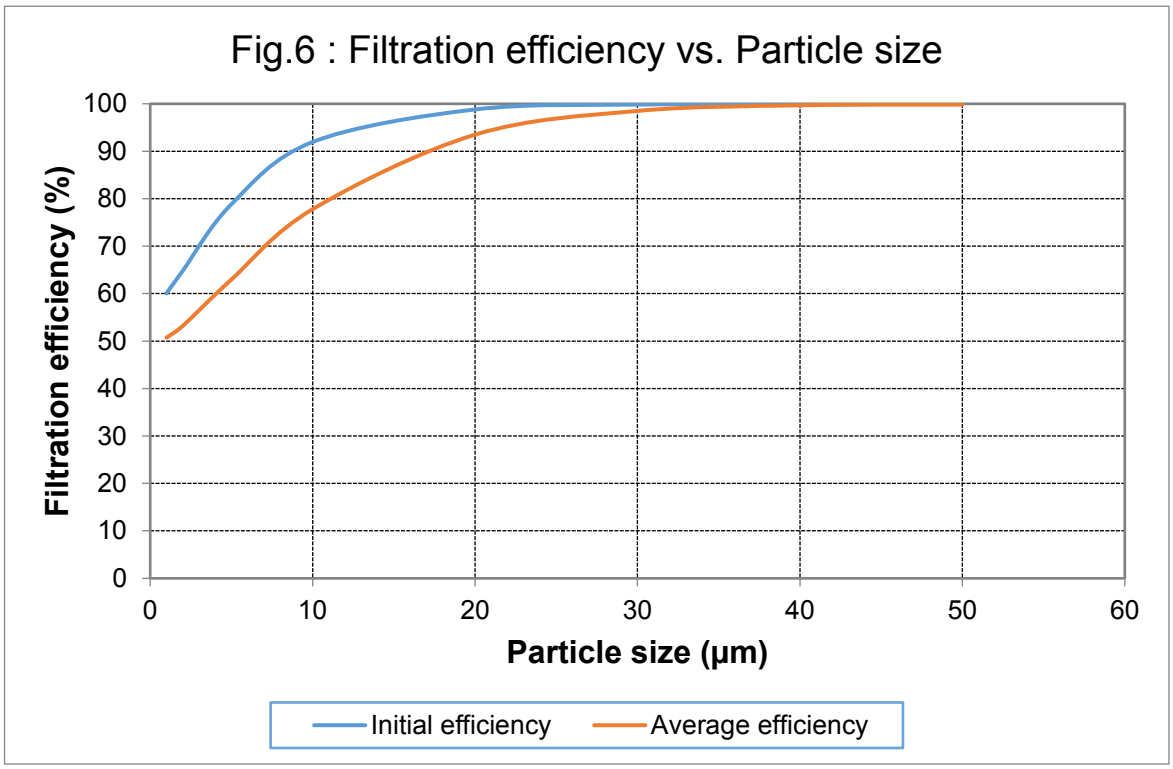
Fig.6 : Filtration efficiency vs. Particle size
Filtration efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
Particle size (µm)
Initial efficiency
Average efficiency