

Automated Weighing of PM Filters: Impact of Equilibration Duration

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Abstract - This study aims to present results from the repeated measurements of unloaded PM filter mass using the robotic weighing system RB 2.4Y.F, (Radwag, Poland) and to select the most appropriate equilibration time. The criteria for filter equilibration used in this study followed the PN-EN 12341:2024 standard. For that purpose filters of different types (quartz-QF, glass-GF, nylon-N, Teflon-PTFE, and polycarbonate-PC) were equilibrated in a controlled atmosphere, and weighed in replicates for nearly two weeks in the case of quartz fibre filters and for over a month in case of other filters to check the effect of conditioning time on filters mass deviations. This study aimed to compare mass deviations among filters along with increasing conditioning time and, consequently, determine the choice among acceptable filters based on mass stabilization criteria. As a standard, 9 successive filter weighing cycles were performed, except for quartz filters for which 3 weighing cycles were carried out. Based on the obtained results, the average mass of the unloaded quartz filters remains stable throughout the conditioning time while maintaining constant relative humidity ($50 \pm 5\%$) and air temperature ($20 \pm 1^\circ\text{C}$). Similar results were observed in the case of glass fibre filters. The weight of Teflon and polycarbonate filters stabilized much longer (in the 4th and 6th weighing cycles, respectively), and it was higher by more than 1 mg than the initial weighing. The reason for the longer stabilization time compared to quartz or glass fibre filters was most likely the absorption of electrostatic charges on the surface of Teflon and polycarbonate filters, caused by the ineffective operation of the deionization gate.

Keywords: automatic weighing, gravimetric, balance, PM filters, non-exposed filters, blank filters

1. Introduction

The variability of filter mass before exposure is a critical factor in precise measurements, particularly in contexts such as environmental monitoring or industrial hygiene, where particulate matter is assessed. When using weighing methods, both manual and automatic, the type of filter can significantly influence this variability due to several factors, including material composition, hygroscopic properties, filter pore size and surface texture, and static charge [1]. Environmental conditions during weighing can also significantly impact mass results. Quartz fibre filters, commonly used in the environmental monitoring of air pollution by particulate matter (PM), are known for their stability at high temperatures and resistance to chemical reactions. These filters exhibit minimal mass change due to environmental conditions, thus offering low pre-exposure variability. Similarly, glass fibre filters are stable in terms of mass variability before exposure due to their non-hygroscopic nature. However, they can be fragile and prone to shedding fibres, which can affect mass measurement. During weighing, tiny particles may fall off quartz or glass fibres, leading to a decreased measured mass, thereby introducing variability and potential inaccuracies in the measurement [2].

The balance might indicate a lower mass than the actual initial mass of the filter. Shed fibres can also accumulate on the balance pan or surrounding areas, potentially interfering with the calibration and operation of the balance. This contamination can lead to inconsistent mass readings over time, as the balance may measure the mass of both the shed fibres and the filter itself. PTFE (Polytetrafluoroethylene) filters are chemically inert and resistant to most chemicals. They also have low hygroscopic properties, which help maintain a consistent mass before exposure. In contrast, nylon and polypropylene filters, although rarely used, are more hydrophilic and can absorb moisture from the air, potentially leading to higher variability in pre-exposure mass. Cellulose-based filters can show significant mass variability due to changes in ambient humidity. This issue is less pronounced with hydrophobic filters like PTFE [3].

Filters with larger pore sizes or rougher surfaces may trap more aerosol particles, leading to variability in mass [4]. Smooth, fine-pored filters typically exhibit less variability before exposure due to humidity changes, but the influence of electrical charge can increase this variability. Some filters, particularly synthetic ones, can accumulate static charge, which can attract or repel particulate matter (PM) particles, thus affecting mass measurements. Anti-static treatments or handling in controlled environments can mitigate this issue. The uniformity of filter production also plays a critical role; high-quality, consistently manufactured filters exhibit less mass variability. Any irregularities in thickness, composition, or treatment during manufacturing can contribute to mass differences. The user's goals in sampling determine the relative importance of various filter characteristics (e.g., cost, ease of handling, physical and chemical characteristics) and, consequently, determine the choice among acceptable filters [5]. Additionally, certain types of filters may not be suitable for use with some samplers. For instance, high-volume samplers can mechanically damage PTFE or nylon filters due to large volumes of air. Under heavy loading conditions (high mass concentrations), the rapid increase in filter flow resistance can exceed the capability of the sampler's flow control device, potentially blocking airflow and stopping the air sampler.

The specifications given by PN-EN 12341:2024 [6] standard are minimum requirements to ensure the acceptability of the filter medium for the measurement of PM_{2.5} or PM₁₀ mass concentrations. Other filter evaluation criteria should be considered to meet individual sampling and analysis objectives. Even automatic weighing methods do not guarantee stabilization in filter mass in the environmental conditions (e.g., temperature, humidity, air currents) in the weighing chamber. Filters with materials sensitive to these conditions will show more variability [7]. Automatic weighing methods, using microbalances, provide high precision and repeatability, however, the type of filter can influence the effectiveness of this method [8]. Automatic balances with high sensitivity can detect even minor mass changes due to environmental factors or handling. The procedures involved in automatic weighing (e.g., calibration, stabilization time, handling) must account for the specific properties of the filter type to minimize variability [9].

The filter type used significantly influences filter mass variability before exposure. Factors such as material composition, hygroscopic properties, surface texture, static charge, manufacturing consistency, and environmental conditions all play crucial roles. Understanding these influences helps select appropriate filters and optimize weighing protocols to ensure accurate and consistent mass measurements.

2. Methods

The methodology in this study includes repeated measurements of the mass of filters before exposure to assess the impact of conditioning time on filter mass deviations. Characteristic of filter types used in this study is presented in Table 1 and include quartz fiber, glass fiber, polyamide, Teflon, and polycarbonate filters. As standard, 9 consecutive weighing cycles of filters were performed before exposure, except for quartz filters, for which 3 weighing cycles were carried out. Each weighing cycle contains two single mass measurements, with a time interval of 12 hours (by the conditions specified in the PN-EN 12341:2024 standard). Basic information regarding individual weighing cycles is presented in Table 2.

Table 1: Characteristics of Whatman® filters used in measurements.

No.	Filter material	Product no.	Product name	Production date	Pore size [µm]	Purity	Thickness [µm]	Particle retention efficiency [%]
1.	Quartz fiber	1851-047	QMA 4.7CM 100/PK	Feb 2020	2.2	QMA	450	98
2.	Glass fibre	1820-047	GF/A 4.7CM 100/PK	Jan 2020	1.6	GF/A	220	98
3.	Nylon membrane (polyamide membrane)	10414012	NL 16	Nd.	0.2	Pure polyamide	110	Nd.
4.	PTFE (polytetrafluoroethylene)	7592-104	PM2.5 PTFE W/PP RING 50/PK	Nd.	2	-	30-50	99.7
5.	Polycarbonate membrane	7060-4702	Cyclopore™ Polycarbonate	Jun 2019	0.2	Cyclopore PC	7-20	Nd.

*nd. No data

Before conditioning, the filters were placed in open, clean Petri dishes, described with consecutive numbers from 1 to n and a letter identifying the filter type (QF - quartz fiber; GF - glass fiber; N - nylon; PTFE - polytetrafluoroethylene; PC - polycarbonate). The method of placing filters from the package into dishes was randomized. Each filter was visually inspected to record information about any filter losses, dirt, etc. Then, the filters from the dishes were transferred to the robotic system warehouse. The method of placing filters from the package into dishes was randomized. Each filter was visually inspected to record information about any filter losses, dirt, etc. Then, the filters from the dishes were transferred to the rotary warehouse of the RB 2.4Y.F robotic system and equilibrated under the conditions specified in the PN-EN 12341:2024 standard (Fig. 1). All filter transfer operations were performed using stainless steel tweezers and wearing powder-free gloves. After 48 hours of conditioning, the first mass measurement of the filters was performed, and the next mass measurement was performed after another 12 hours. To assess the effect of conditioning time on the filter mass difference, the measurements were continued in the following cycles:

- 48 hours of conditioning (measurement 3),
- 12 hours of conditioning (measurement 4) and so on.

The number of cycles for quartz filters was 3, for other types of filters 9, and the number of weightings was twice the number of cycles (6 for quartz filters and 18 for the others).

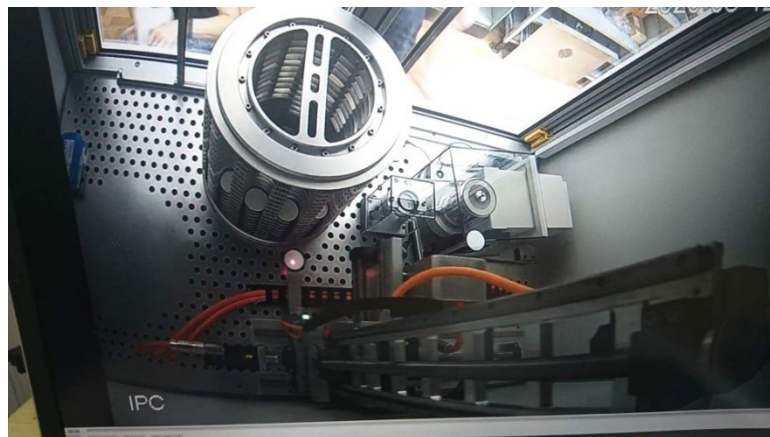


Fig 1: The chamber of the RB 2.4Y.F weighing robot, on the left rotary warehouse magazine, and the right – microbalance and ionization system are located just in front of the microbalance chamber.

The automated filter mass measurement process in the RB 2.4Y.F robotic system was operated using the RMCS filter software. In addition to recording measurements, it enables real-time viewing of the RB 2.4Y.F robot's operation, as well as control to start/stop the filter weighing process. Each weighing session was preceded by checking the correctness of the scale's readings. This control was carried out by checking the precision and drift of the scale by weighing a mass standard (taken from the reference warehouse) with a mass similar to the weight of the weighed filters and by checking the stability of climatic conditions in the chamber by weighing two "blank" – nonexposed filters. If the drift of the balance indication differed by more than 10 μg compared to the mass of the reference standard, then the system operating parameters were verified again until stable indications were obtained. The filters were placed in the cassettes of the weighing machine's magazine using stainless steel tweezers. Before starting the conditioning process, the correct loading of the cassettes was verified - a correctly placed cassette adheres to the entire surface of the target warehouse. Filters were identified by item numbers in the filter target magazine. The program included parameters for orders regarding filter mass measurements before and after exposure, including: assigning a research station to the order, selecting the storage levels at which the filters were placed, ionization activation/deactivation, conditioning time, and the temperature/humidity and pressure to prevail during weighing. The RMCS program also allows to importation of data (including temperature/humidity conditions) prevailing at the research station directly into the RMCS measurement sheets and links them to a specific filter.

Non-exposed filters were conditioned for a minimum of 48 hours before weighing. Weighing was repeated after another 12 hours to verify the stability of the filter mass. If the filter mass during subsequent weighing processes was greater than 40 µg, the appropriate filters were weighed in the third pass. The mass of the non-exposed filter (averaged) was calculated as the average of two separate measurements (m_1 , m_2) according to formula (1):

$$M_{averaged} = (m_1 + m_2 / 2) \quad (1)$$

Before weighing, each filter was subjected to neutralization of the uncompensated electric charge thanks to the ionization system located just in front of the microbalance chamber. This procedure guaranteed to obtain a stable mass of filters after the conditioning process. The system of the RB 2.4Y.F robotic filter weighing system ensured regulation of climatic conditions during equilibration in the following ranges: 20-22°C ± 0.5°C (average 1h); humidity 45-50% ± 2.5% (average 1h); dew point: 7.7-11.1°C ± 1°C. The uncertainty (at 95% confidence level) for the temperature sensor was ≤ 0.2K and for the humidity sensor ≤ 2%. To prevent dust from the environment from entering the chamber, the RB 2.4Y.F is equipped with a HEPA filter that purifies the air before feeding it into the device's chamber. The air conditioning system controlled the airflow inside the chamber, ensuring stable operating conditions, and allowing automatic control and adjustment of temperature through heating and cooling. The convection unit controlled the required relative humidity.

The PN-EN 12341:2024 standard specifies a minimum filter conditioning time of ≥ 48 hours before PM sampling. No commercially available procedure is ideal in all respects for all filter media. Therefore 12341:2024 standard suggests testing filters for one month before sampling to see if there is a significant effect upon the mass of filters conditioned under 19 °C - 21 °C and 45%-50% RH.

Table 2: Basic information on unloaded filter weight measurements using the automatic weighing system RB 2.4 Y.F. (Radwag, Poland).

No. of cycle	No. of single weighing in the cycle	Date of measurement	Starting the measurement*	Measurement completion*	Type of filter
1	1-1	16.08	11:00	17:00	QF, GF, N, PTFE, PC
	1-2	16/17.08	23:00	5:00	
2	2-1	19.08	12:00	18:00	QF, GF, N, PTFE, PC
	2-2	20.08	24:00	6:00	
3	3-1	27.08	9:00	15:00	QF, GF, N, PTFE, PC
	3-2	27/28.08	21:00	3:00	
4	4-1	30.08	9:00	13:00	GF, N, PTFE, PC
	4-2	30/31.08	21:00	1:00	
5	5-1	2.09	6:30	10:30	GF, N, PTFE, PC
	5-2	2.09	18:30	22:30	
6	6-1	9.09	7:00	11:00	GF, N, PTFE, PC
	6-2	9.09	19:00	23:00	
7	7-1	12.09	7:30	11:30	GF, N, PTFE, PC
	7-2	12.09	19:30	23:30	
8	8-1	16.09	6:30	10:30	GF, N, PTFE, PC
	8-2	16.09	18:30	22:30	
9	9-1	19.09	12:30	16:30	GF, N, PTFE, PC
	9-2	20.09	0:30	4:30	

* rounded to 30 min. Filters markings: QF – quartz filters; GF – glass filters; N – nylon filters; PTFE – Teflon filters; PC – polycarbonate filters

Statistical analysis was performed using MS Excel (Microsoft) and Statistica 13.0 (StatSoft). It included: a) rejection of extreme and outlier values that could distort the results of the statistical analysis - based on the analysis of box-and-whisker plots (range of non-outliers); b) determining descriptive statistics for filter mass measurements before exposure; c) graphical presentation of the results of statistical analysis, including examination of the normality of distributions; d) examining the significance of differences between filter mass measurements before exposure in subsequent weighing cycles.

3. Results and discussion

Table 3 presents basic statistics for the filter conditioning conditions prevailing in the weighing machine - a series of continuous measurements of relative humidity [%] and air temperature [°C], calculated for a 1-hour data set. This information was obtained from the "Environmental Conditions" report generated by the RMCS program for a given period (August 14 - September 20, 2020). Detailed data on individual weighing cycles, including average conditioning conditions of the filters before exposure, are listed in Table 2. It was found that the humidity and temperature conditions throughout the entire period of measurements can be considered stable, which is also visible by analyzing the graphs of the series of hourly values of the considered parameters (Figures 2 and 3). Any possible fluctuations were generally within the limits permitted by the PN-EN 12341:2024 standard, with a slight exception for the air temperature at the very beginning of the measurement campaign. This could have been influenced by operational activities related to placing the filters in the rotating warehouse. Considering only weighing cycles, the average values of relative humidity were in the range of 48.0 – 48.1%, air temperature: 19.52 – 19.59°C, and pressure: 977.6 – 991.9 hPa (Table 4). Due to the stability of the above-mentioned parameters, it can be concluded that they will not significantly affect the variability of the filter mass before exposure. However, the filter conditioning time will play a decisive role.

Table 3: Descriptive statistics of a series of continuous measurements of relative humidity [%] and air temperature [°C] - based on 1-hour average values during the measurement campaign (August 14 - September 20, 2020).

Parameter	Average	SD	Minimum	Maximum
Humidity [%]	48.3	0.3	46.8	52.3
Temp. [°C]	19.4	0.1	18.5	20.1

Note: average hourly humidity and temperature values were obtained from the "Environmental Conditions" report generated by the program for a given period

Table 4: Filter equilibration conditions before exposure in individual weighing cycles.

No. of weighing cycle	Starting date	Conditioning time [min]	Humidity [%]	Temperature [°C]	Pressure [hPa]
1	16-17.08.2020	3600	48.1	19.59	984.1
2	19-20.08.2020	7980	48.1	19.58	981.4
3	27-28.08.2020	19350	48.1	19.58	983.0
4	30-31.08.2020	23670	48.1	19.56	977.6
5	02.09.2020	27840	48.1	19.56	987.2
6	09.09.2020	37950	48.0	19.56	991.3
7	12.09.2020	42300	48.0	19.55	991.7
8	16.09.2020	43680	48.0	19.54	988.4
9	19-20.09.2020	45480	48.1	19.52	991.9
Average			48.1	19.56	986.3
Standard deviation			0.1	0.02	5.1
Minimum			48.0	19.52	977.6
Maximum			48.1	19.59	991.9

* data obtained from RMCS reports generated by the program for individual weighing cycle.

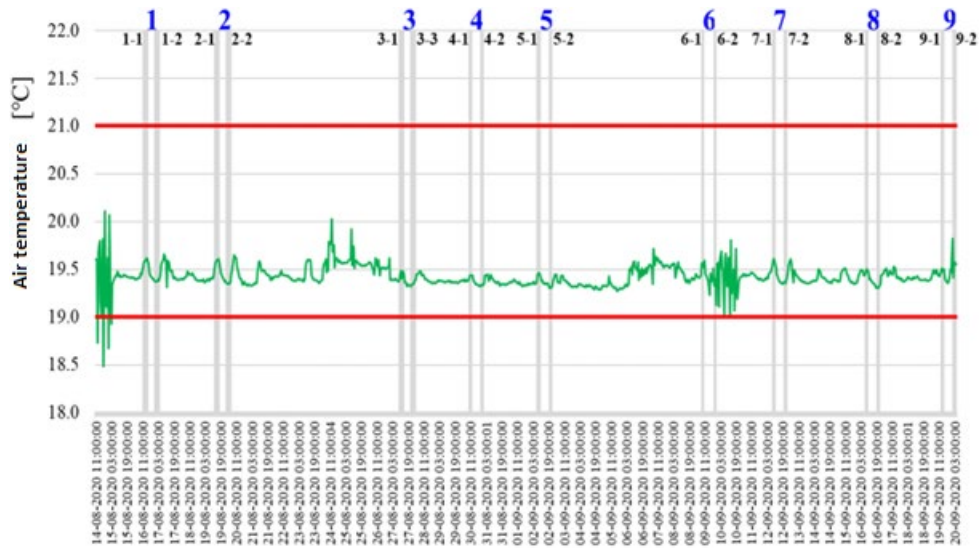


Fig 2: The series of average hourly air temperature values [°C] throughout the entire period of filter mass measurements before exposure, distinguishing individual weighing cycles and single weighing (based on the "Environmental Conditions" report generated by the program for the period under consideration. Single measurements of filter mass before exposure are highlighted in gray; the number of individual weighing cycles is marked in blue; the red line indicates the limits of the permissible variability of air temperature (by the requirements of the PN-EN 12341:2024 standard).

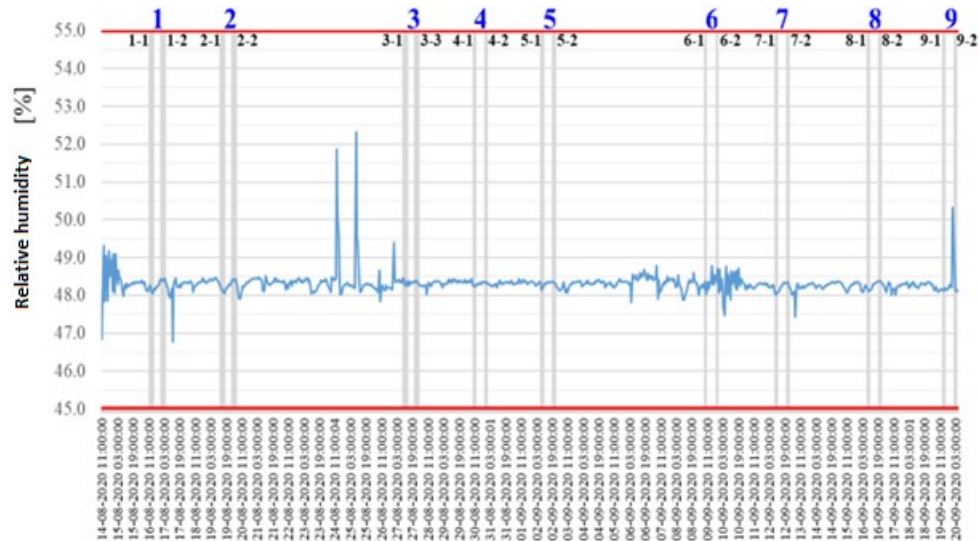


Fig 3: The course of a series of average hourly relative humidity values [%] throughout filter mass measurements before exposure, distinguishing individual weighing cycles and single weighing (based on the "Environmental Conditions" report generated by the program for the period under consideration. Single measurements of filter mass before exposure are highlighted in gray; the number of individual weighing cycles is marked in blue; the red line indicates the limits of the permissible variability of air temperature (by the requirements of the PN-EN 12341:2024 standard).

Table 5: Change in the mass of filters before exposure in individual weighing cycles against the background of the conditions prevailing in the weighing warehouse of the RB 2.4Y.F robotic system.

No. of weighing cycle	t [h]	RH [%]	T [°C]	P [hPa]	M _{average} [mg]	m ₁ -m ₂ [mg]	Δm [mg]
QUARTZ FILTERS							

1	60	48.1	19.59	984.1	147.230	0.003 (1)	0.000
2	133	48.1	19.58	981.4	147.246	0.018 (1)	-0.016
3	322.5	48.1	19.58	983.0	147.263	0.002	-0.024
GLASS FILTERS							
1	60	48.1	19.59	984.1	92.021	0.001	0.000
2	133	48.1	19.58	981.4	92.028	0.001	-0.008
3	322.5	48.1	19.58	983.0	92.036	0.001	-0.016
4	394.5	48.1	19.56	977.6	92.040	0.001	-0.019
5	464	48.1	19.56	987.2	92.042	0.001	-0.021
6	632.5	48.0	19.56	991.3	92.047	0.002	-0.026
7	705	48.0	19.55	991.7	92.048	0.001	-0.028
8	728	48.0	19.54	988.4	92.049	0.001	-0.029
9	758	48.1	19.52	991.9	92.051	0.001	-0.030
NYLON FILTERS							
1	60	48.1	19.59	984.1	77.673	0.106 (19)	0.000
2	133	48.1	19.58	981.4	77.609	0.009	0.065
3	322.5	48.1	19.58	983.0	77.631	0.006	0.042
4	394.5	48.1	19.56	977.6	77.639	0.011	0.034
5	464	48.1	19.56	987.2	77.649	0.008	0.024
6	632.5	48.0	19.56	991.3	77.658	0.008	0.015
7	705	48.0	19.55	991.7	77.664	0.008	0.010
8	728	48.0	19.54	988.4	77.669	0.007	0.004
9	758	48.1	19.52	991.9	77.674	0.008	-0.001
PTFE FILTERS							
1	60	48.1	19.59	984.1	137.882	0.436 (29)	0.000
2	133	48.1	19.58	981.4	137.160	0.145 (21)	0.722
3	322.5	48.1	19.58	983.0	136.691	0.050 (9)	1.191
4	394.5	48.1	19.56	977.6	136.652	0.034 (7)	1.230
5	464	48.1	19.56	987.2	136.656	0.025 (4)	1.227
6	632.5	48.0	19.56	991.3	136.643	0.015 (1)	1.240
7	705	48.0	19.55	991.7	136.638	0.010 (2)	1.245
8	728	48.0	19.54	988.4	136.644	0.024 (4)	1.238
9	758	48.1	19.52	991.9	136.658	0.011 (1)	1.224
POLYCARBONATE FILTERS							
1	60	48.1	19.59	984.1	36.239	0.197 (23)	0.000
2	133	48.1	19.58	981.4	35.746	0.078 (16)	0.493
3	322.5	48.1	19.58	983.0	35.321	0.029 (5)	0.918
4	394.5	48.1	19.56	977.6	35.250	0.015 (3)	0.989
5	464	48.1	19.56	987.2	35.216	0.007 (2)	1.023
6	632.5	48.0	19.56	991.3	35.183	0.004	1.056
7	705	48.0	19.55	991.7	35.178	0.003	1.061
8	728	48.0	19.54	988.4	35.175	0.004	1.064
9	758	48.1	19.52	991.9	35.177	0.004	1.062

Note: N – weighing cycle number; t – conditioning time; RH – relative humidity; T – temperature; P – pressure; m_{av} – the average mass of filters before exposure; |m₁-m₂| – the average mass difference between individual weighing’s (absolute value); Δm = (m₁-m_n) – average change in the mass of filters before exposure in subsequent weighing cycles (n); The number of measurements in which the difference in filter masses between the first and repeated weighing was greater than 40 μg (0.040 mg) is marked in red.

Table 5 presents information on the variability of the mass of filters before exposure, separately for 5 types of filters - quartz, glass, nylon, Teflon, and polycarbonate. Here, attention should be paid to the mass differences between individual weighing’s |m₁-m₂| in each weighing cycle, which, by the conditions of the 12341:2024 standard, should not exceed 0.040 mg (40 μg). This requirement was fully met only in the case of glass filters. Concerning quartz and nylon filters, single deviations were noted in the initial weighing cycles. However, significant discrepancies were observed when weighing clean

Teflon and polycarbonate filters, and the number of cases that did not meet the requirements of the PN-EN 12341:2014 standard regarding the permissible weight difference decreased with the increase in the filter conditioning time.

Apart from the difference between individual mass measurements in a given weighing cycle, an important aspect of filter mass measurements before exposure is also the issue of the change in filter mass after the standard conditioning period. This information is summarized in Table 5 and graphically presented in Figure 4. Analysis of the graph shows clear differences between different types of filters. In the case of quartz and glass filters, the variability of the filter mass indication was observed with the passage of conditioning time, up to -0.024 mg (quartz filters) and -0.030 mg (glass filters), and the probable cause of this variability was the evaporation of moisture from the filter surface.

The mass of the nylon filters stabilized slightly longer, with a significant increase in the 2nd weighing cycle (0.065 mg), followed by a gradual decrease in mass until reaching a value of -0.001 mg in the last weighing cycle. A different situation was observed for Teflon and polycarbonate filters, with a relatively large increase in mass in the 2nd and 3rd weighing cycles. The mass of these filters stabilized approximately around the 4th (Teflon filters) and 6th weighing cycle, although it should be noted that it was higher by over 1 mg compared to the initial weighing. The cause was most likely the ineffective removal of electrostatic charges on the surface of Teflon and cellulose filters by the deionization gate.

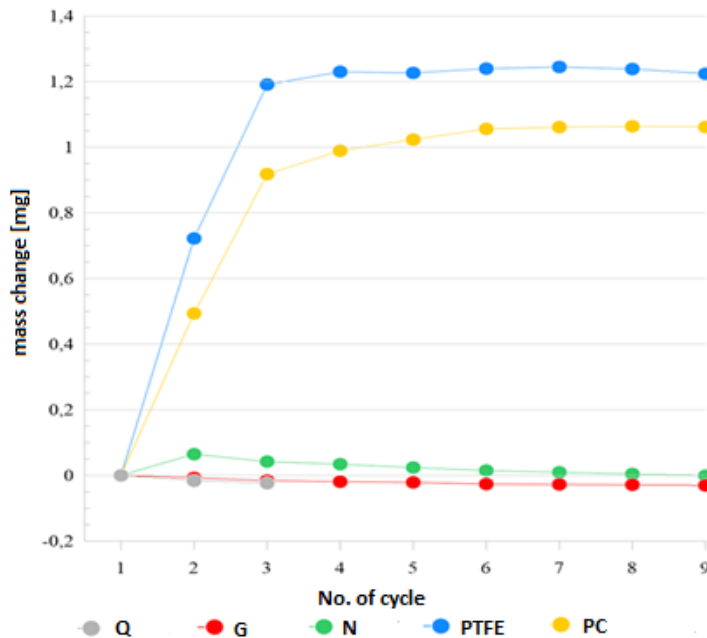


Fig. 4: Average change in the mass of filters before exposure, to the initial weighing, in subsequent weighing cycles for various types of filters.

The research carried out allowed for the development of a set of substantive and practical guidelines for conducting gravimetric measurements using an automatic weighing system and the influence of environmental conditions of the weighing machine and the type of filter material used on filter mass measurements. It was found that the RB 2.4Y.F Filter Robot assembly allows for maintaining stable conditions of relative humidity and air temperature, the fluctuations of which do not exceed the range permitted by the requirements of the PN-EN 12341:2024 standard ($50 \pm 5\%$; $20 \pm 1^\circ\text{C}$).

During the weighing process, the values of these parameters should be controlled, which is possible thanks to the report on environmental conditions generated by the program for a given measurement period. The occurrence of deviations in temperature and humidity values beyond the range allowed by the standard is usually related to operational activities such as placing filters in the filter storage room, which should be recorded in the weighing report.

Due to the stability of temperature and humidity conditions, it should be assumed that the filter conditioning time will have a decisive impact on the variability of the filter mass before exposure, and this impact will also depend on the type of filter material used. By the requirements of the PN-EN 12341:2024 standard, unloaded filters should be

conditioned in a weighing machine, under constant temperature and humidity conditions, for a minimum of 48 hours, and then weighed twice, with a 12-hour interval.

Attention should be paid to the differences in mass between individual weightings, which, according to the requirements of the PN-EN 12341:2024 standard, should not exceed 0.040 mg (40 µg). In the course of the research, this requirement was fully met only in the case of glass fiber filters (Whatman GF/A filters) and, excluding individual deviations, also for quartz fiber filters (Whatman QM-A filters).

However, significant deviations were observed in filters made of nylon (Whatman, NL 16), Teflon (Whatman, PM2.5 PTFE W/PP RING) and polycarbonate (Cyclopore™ Polycarbonate). In such cases, it is recommended to check the operation of the antistatic ionizer and carry out subsequent weighing cycles to verify the mass of the filters, paying particular attention to the change in the mass of the filter with the initial weighing.

The tests carried out as part of the first stage of the work showed that the mass of quartz and glass filters remains stable over the conditioning time, while maintaining constant conditions of relative humidity (50±5%) and air temperature (20±1°C). The mass of Teflon and polycarbonate filters stabilized much longer (in the 4th and 6th weighing cycle, respectively), although it was higher by over 1 mg compared to the initial weighing. The cause was most likely the absorption of electrostatic charges on the surface of Teflon and cellulose filters, caused by the ineffective operation of the deionization gate.

4. Conclusion

1. The RB 2.4Y.F Filter Robot Assembly ensures stable air temperature and relative humidity values specified in the standard (20 ± 1)°C and (50 ± 5)% RH throughout the entire conditioning and weighing period.
2. The mass of quartz, glass, and nylon filters remains stable over the conditioning time, while maintaining constant conditions of relative humidity (50±5%) and air temperature (20±1°C).
3. The mass of Teflon and polycarbonate filters stabilizes over time after conditioning in constant relative humidity conditions (50±5%) and air temperature (20±1°C). These filters achieve stable mass readings in the 3rd and 6th weighing cycle, respectively for Teflon and polycarbonate filters, i.e. after 2 and 4 weeks from the start of the stabilization process.
4. Unloaded quartz and glass filters should be conditioned in the weighing room for at least 48 hours before weighing.

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