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WEIGHING ACCURACY TEST ON POWDER WEIGHING BALANCE ENCLOSURE

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Medicines that we take are often compounded from small quantities of active ingredient(s), typically less than 5% of the total weight fraction. The inactive ingredients typically count for more than 95% of the finished dosage form of the medicine. Only a small quantity of the active ingredient(s) is typically required due to high potency. However, due to the high potency aspect of some active ingredients, an accidental release in the manufacturing or laboratory environment resulting in operator respiratory or contact exposure can have potentially harmful or lethal consequences.

To protect operators a number of engineering controls and personal protective solutions are available. One such engineering control is the Esco PowderMax™ cabinet. The Esco PowderMax™ cabinet is designed to provide operator protection by using airflow to capture and draw away any harmful airborne powders away from the operator's respiratory zone. However this relatively high airflow can influence the performance of highly sensitive analytical balances if the equipment is not correctly designed to mitigate airflow factors. In addition, the stability of the work surface is critical, to ensure accurate and repeatable weighing.

The operator protection of Esco PowderMax™ cabinet was successfully validated using ASHRAE 110 test procedure by Invent UK and surrogate testing using naproxen sodium powder. The purpose of this study is to verify the stability of the work surface ensure accurate and repeatable powder weight readouts using a sensitive micro balance placed in the work zone of the Esco PowderMax™ cabinet.

The micro balance used for this test is the Mettler-Toledo™ XP56 which is an extremely sensitive, accurate, and advanced micro balance. This balance has a readability of 0.000001 gram (1 microgram, lighter than a strand of human hair). The balance is fitted with outer and inner weighing chambers to significantly reduce the effect of airflow around the balance. Moreover, the outer and inner chamber doors are electronically operated using infra-red proximity sensors. Therefore, there is no need for the operator's hands to touch any part of the balance during the weighing process.. This hands-off feature improves the operator protection, and the balance stability.

A set of robotically-calibrated weights were used for this measurement, (20 gram and 5 gram, with the accuracy of ± 0.000020 gram). The weights used are made from polished vacuum melted steel. This manufacturing process significantly reduces undesired trace elements, removes dissolved gases, and improves oxide cleanliness, to achieve the highest material purity. To further improve accuracy, the weights were placed on the balance using tweezers, and never touched by hand.

The test was performed with Esco PowderMax™ cabinet, with the standard phenolic resin work surface and Mobicart™ stand. The blower was set to nominal inflow of 0.50 m/s (100 fpm), as well as at reduced inflow of 0.40 m/s (80 fpm) and 0.30 m/s (60 fpm), and with the cabinet turned off. A calibrated Shortridge flow hood was used to measure the inflow velocity to the cabinet. The test set-up is illustrated in the following photographs:

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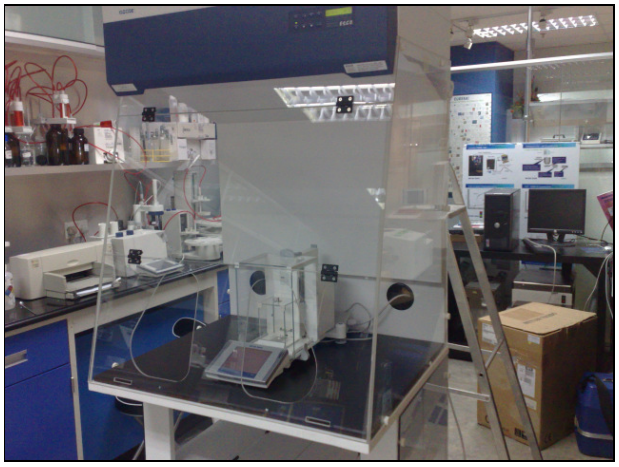

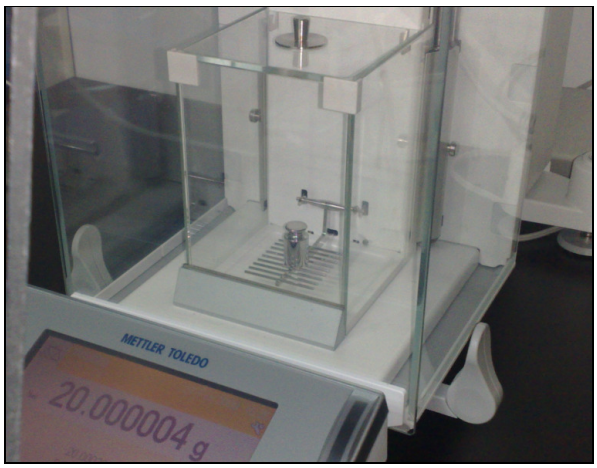

Experiment Data

The test results for the four different scenarios and two different weights are as described below:

I=0.50m/s(100fpm)	Weight (g)	
Measurement #	20	5
1	20.000010	5.000011
2	20.000016	5.000025
3	20.000019	5.000013
4	20.000013	5.000014
5	20.000021	5.000013
Average	20.000016	5.000015
Standard Deviation	0.000004	0.000006
% RSD	0.000022	0.000112

I=0.40 m/s (80 fpm)	Weight (g)	
Measurement #	20	5
1	20.000027	5.000016
2	20.000026	5.000020
3	20.000030	5.000019
4	20.000030	5.000019
5	20.000031	5.000018
Average	20.000029	5.000018
Standard Deviation	0.000002	0.000002
% RSD	0.000011	0.000030

I=0.30m/s (60 fpm)	Weight (g)	
Measurement #	20	5
1	20.000011	5.000022
2	20.000013	5.000020
3	20.000019	5.000021
4	20.000021	5.000024
5	20.000020	5.000017
Average	20.000017	5.000021
Standard Deviation	0.000004	0.000003
% RSD	0.000022	0.000052

I=0 m/s (0 fpm)	Weight (g)	
Measurement #	20	5
1	20.000019	5.000016
2	20.000019	5.000008
3	20.000019	5.000011
4	20.000016	5.000008
5	20.000015	5.000008
Average	20.000018	5.000010
Standard Deviation	0.000002	0.000003
% RSD	0.000010	0.000070

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To further investigate the weighing stability with a very light weight (0.5 gram), an additional test was performed using a pentagon wire weight (shown below), at the nominal 0.50 m/s (100 fpm) inflow velocity, with the data described in the table to the right below:

I=0.50m/s(100fpm)	Weight (g)
Measurement #	0.5
1	0.500039
2	0.500013
3	0.500017
4	0.500019
5	0.500014
Average	0.500020
Standard Deviation	0.000011
% RSD	0.002133

Data Analysis

1. The standard deviation of all weight measurements in an Esco PowderMax™1 is extremely low. As a benchmark comparison, the comparison of standard deviation against the leading brand Brand "L" powder weighing enclosure at same 0.50 m/s (100 fpm) inflow velocity, is as below:

	Esco PowderMax™ 1	Brand "L"	Cabinet
Std Deviation for 20 gram	0.000003	0.0679	Std Deviation for 100 gram
Std Deviation for 5 gram	0.000002	0.0239	Std Deviation for 50 gram
Std Deviation for 0.5 gram	0.000001	0.0524	Std Deviation for 5 gram

2. Lowering the inflow velocity, even turning off the fan, results in a very small weighing accuracy improvement, and it is practically negligible. The work surface is placed on top of Mobicart™, but not in direct contact with the PowderMax™ body. Therefore, the fan vibration from the PowderMax™ body is not directly transmitted to the work surface, resulting in a more stable weighing condition.

3. Esco PowderMax™ 1 provides a very stable work surface, that when used on measuring a very light 0.5 gram weight, yields an impressively repeatable 0.000001 standard deviation, with the blower running at nominal 0.50 m/s (100 fpm) inflow velocity.

Conclusion

The Esco PowderMax™1 cabinet at nominal airflow can provide a stable work condition for the sensitive powder weighing work, with extremely low standard deviation that in the range of 0.000001 to 0.000011 for weighing 20g, 5g, and even 0.5g objects.

References

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