Disposable garments

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Really an alternative to washable textile cleanroom garments?

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Again and again the question is raised whether it makes sense to use so-called disposable garments in routine cleanroom operation. For a variety of reasons, it seems appropriate to use these instead of textile (washable) cleanroom garments. Statements by manufacturers of disposable garments regarding the cleanroom suitability of their materials that are not specified in more detail make it more difficult for the end user to decide. The following explanations help to better understand the differences between these two garment alternatives.

Walking simulation in the Body-Box with reusable garments

Walking simulation in the Body-Box with disposable garments

In an article published at the end of 2005 on the subject of disposable garments for cleanroom use *(Einwegbekleidung für den Reinraumeinsatz)*, the impression was conveyed that there was a strong technical case for using the garments of a well-known manufacturer in cleanroom class ISO 5 (in accordance with ISO 14644-1) without restrictions. [Author's note: this impression is given by almost all manufacturers of disposable garments]. However, if you take a closer look at this point, i.e. the area of application in the air cleanliness classes ISO 5 or 6, you will soon come across an essential detail which at least limits the unquestioned use of this type of garments without hesitation. This was the reason to check in Dastex' own test cleanroom, a „Body-Box", to what extent disposable garments are generally suitable for cleanroom use, especially with regard to particle release.

The holistic approach of the „Body-Box" test gives a very good impression of how many particles a test person with a defined garment system releases over a certain time interval. Before entering of the test person, the test cabin (Body-Box) reaches the cleanroom class ISO 3 / ISO 4. In other words, almost all particles measured after entering of the test person must come from this person and/or his/her clothing. With this test setup, it is therefore relatively easy to determine results relevant to practice and make statements. The Body-Box test method is described in more detail in ReinRaumTechnik 2/2004 (GIT-Verlag, by now Wiley-VCH Verlag).

The manufacturer's information on particle retention capacity suggests that certain types of disposable garments could be used without hesitation in cleanrooms. However, in German-speaking countries, for reasons of cost, only uncleaned disposable garments are usually used, i.e. all particles deposited on the garments during the production process are carried into the controlled area and can be released there. In this context it must be pointed out that disposable garments cannot be cleaned in the usual cleanroom laundries with aqueous media, but must be prepared under special conditions. Another option that does not seem to make much sense is to pack uncleaned disposable garments under more or less clean conditions. Improved packaging does not remove the basic contaminants on a garment.

Since the particle emission between different persons can vary very widely, the different test series were carried out with a single person. It was ensured that in all test series comparable undergarments (jogging suits) were worn under the garments to be tested. The gloves, the shoes (under the respective overboots) and the mouth protection system were also uniform. Only the garments were varied accordingly. Four different disposable materials and typical cleanroom garments made of washable fabric were tested: all of them were not pre-cleaned. In addition, one set of cleanroom garments made of the same washable fabric and one set of disposable garments, both pre-decontaminated. The material of the decontaminated disposable garments is comparable to one of the first four test samples. The sets of disposable garments consisted of coveralls with integrated, i.e. sewn-on hood and overboots. The reusable garments consisted of overalls and full protection hood (separately) and also overboots.

During the test series, comparable conditions prevailed in the Body-Box. Temperatures fluctuated slightly around 23 °C, the relative

The following garment variants were tested in detail:

1. sample material ➡ Disposable garments of a well-known international manufacturer – not pre-cleaned (= not washed/decontaminated before packaging) –
2. sample material ➡ Disposable garments as sample material 1 – pre-cleaned –
3. sample material ➡ Disposable garments of a material that is almost identical to sample material 1 according to the manufacturer's statements – not pre-cleaned –
4. sample material ➡ Disposable garments from Asia, according to manufacturer's statement comparable in technical properties to sample material 1 – not pre-cleaned –
5. sample material ➡ Disposable garments from another well-known international manufacturer packed under controlled conditions – not pre-cleaned –
6. sample material ➡ Reusable garments as typically used in class ISO 5 cleanrooms – not pre-cleaned –
7. sample material ➡ Reusable garments as typically used in class ISO 5 cleanrooms – pre-cleaned –

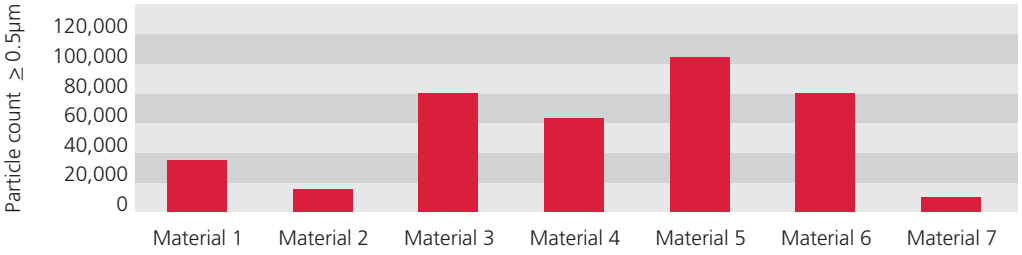

Chart 1: Measurement results (average values) of emitted particles ≥ 0.5 µm of different garment systems when standing in the Body-Box with a total measurement duration of 10 min.

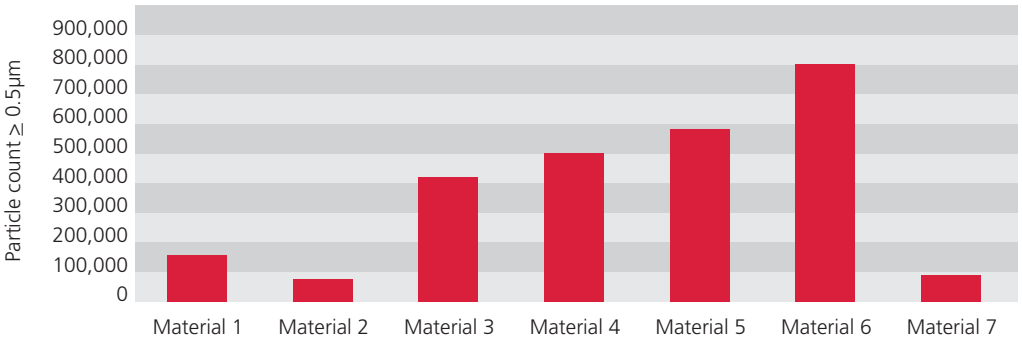

Chart 2: Measurement results (average values) of emitted particles ≥ 0.5 µm of different garment systems when walking in the Body-Box with a total measurement duration of 10 min.

Tip:
Materials 1 – 5 = disposable garment systems
Materials 6 – 7 = reusable garment systems

humidity was between 42% and 44% and the air velocity was constant at 0.3 m/sec. Two particle counters of the same manufacturer and type were used in these studies. This doubled the sample volume from 28.3 l/min to 56.6 l/min and thus increased the measuring accuracy.

Before starting the actual measurements, the Body-Box runs in idle mode, i.e. without a test person, to ensure that ISO Class 3 / ISO Class 4 are observed before the actual series of measurements. Then the test person with the garments to be studied enters the Body-Box and stays there for about 10 minutes without any measurement. This ensures that possible particles that have been locked in when entering the cabin are not taken into account. In addition, the test person can acclimatise. The test person then carries out the prescribed movement program, which in this case lasted for 20 minutes and consisted of the following: standing for 5 minutes, walking for 5 minutes, standing for 5 minutes and walking for another 5 minutes. The particle counters recorded the emitted particles per minute. This means that an exercise program of 20 minutes resulted in 20 measurements (10 minutes meaning 10 measurements when standing and 10 minutes meaning 10 measurements when walking). From these results, average values were calculated, which are shown in chart 1 (standing) and chart 2 (walking). For these studies only the particles ≥ 0.5 µm were analysed.

The results of these studies are very clear. Only the sample materials 2 and 7 show acceptable values. All other samples gave off a multiple of contaminations during the test series. It is not surprising that only the pre-cleaned samples scored correspondingly well, but are the end users being made aware of this problem? In the case of reusable garments, usually yes. Before the first use, it is pre-cleaned up to three times in order to remove both contaminations from the garment making process and the usual chemical residues from the weaving process. This is usually not the case with disposable garments. On the one hand, because there is no pre-cleaned disposable garments available from many suppliers and, on the other hand, because the product becomes so expensive due to the very complex pre-cleaning process that many customers reject it for cost reasons.

A simple calculation illustrates this problem:

- Disposable overall pre-cleaned: acquisition costs approx. 6,– €/piece
- Reusable overall: acquisition costs approx. 50,– €/piece
- Cleaning costs per reusable overall: approx. 3,– €/piece

The single-use overall is worn (contrary to the meaning „SINGLE-USE") for a whole day and then disposed of. The reusable overall is also worn for one day and then goes to the laundry. After only one month (i.e. 20 cycles) the break-even point (in favour of the reusable garments) is reached. Reusable garments can, however, be used for far more than 100 wearing cycles, depending on the stress-time factor!

Apart from the obvious differences between pre-cleaned and „untreated" garment systems, the results for the various tested disposable materials are also very interesting. Sample material 1 scored significantly better than samples 3, 4 and 5, which illustrates very clearly the extreme differences that can exist between single-use coveralls and single-use coveralls. In these studies, simple polypropylene coveralls were deliberately not tested, as it was assumed that their particle loads would have been many times higher. Rather, only disposable garments were tested that could be used in a cleanroom, if necessary, due to the base materials from which the coveralls were made. The fact that sample material 3 performed so much worse than sample 1 is a little surprising, because according to the manufacturer's statement, sample 3 is supposed to be an almost identical copy of material 1. The measured values speak against this. The results for sample 5 show that packaging under controlled conditions can by no means replace professional decontamination.

Conclusion

Certainly there are special areas of application in which the use of cleanroom suitable disposable garments still makes sense. It is important, however, that in critical areas (starting with class ISO 6 and better) care should be taken to ensure that disposable garments have been pre-cleaned accordingly. Only pre-cleaned disposable garments are qualitatively (in terms of particle emission) comparable to cleaned reusable garments.
There are considerable qualitative (in terms of particle emission) differences between the various disposable garment systems on the market, which a user should definitely consider more closely and adapt to his requirements before using them in his cleanroom.

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