



The Esco Group of Companies

PUBLICATION

TECHNICAL PAPER

The KI-Discus Test

AUTHOR: LIN XIANG QIAN
DATE: October 2002

Worldwide Headquarters
Esco Micro Pte Ltd
21 Changi South Street 1, Singapore 486 777
Tel: +65 6542 0833 Fax: +65 6542 6920
Email: lab@escoglobal.com ; WWW: <http://www.escoglobal.com>

SECTION A: INTRODUCTION, AND OPERATOR PROTECTION FACTORS

The KI discus test is defined in the European Standard for microbiological safety cabinets, EN12469:2000 as a test method for validating the operator protection capabilities of the cabinet.

Before we go into detail about the KI discus test, let us first examine the different factors that influence the operator protection capabilities of any microbiological safety cabinet:

1. Directional air flow - in any Class I or Class II safety cabinet an air curtain flowing from the laboratory into the front of the cabinet always exists in order to prevent biological hazards from escaping from inside the work zone of the cabinet where these hazards may be manipulated.

The performance test related to this aspect is the air flow smoke pattern test, during which the manufacturer ensures that air is flowing inward (into the cabinet from the laboratory) at all positions in the work access opening without any reflux or backflow. This test is a qualitative test.

2. Controlled air velocity - in any Class I or Class II safety cabinet the velocity of the air curtain flowing from the laboratory into the front of the cabinet (the "inflow") must be of a controlled magnitude. Excessive inflow velocity can result in undesirable turbulence that can cause contaminated matter to be "swept" out of the cabinet workzone (through the open front of the cabinet). On the other hand, an inflow velocity which is too low will not be able to sufficiently prevent particles from escaping the interior of the cabinet (i.e. the particles could escape the interior of the cabinet easily with very low "escape velocity").

Each safety cabinet operates within a performance envelope that is determined by the manufacturer by extensive testing. The inflow velocity of the cabinet must fall within this performance envelope (velocity range) in order for the cabinet to deliver optimum protection for the operator.

The physical performance test related to this aspect is the inflow velocity measurement test during which the inflow velocity is measured and reported quantitatively (typically in metres per second or feet per minute).

3. Exhaust filtration - clearly since there is an air curtain entering the front of the safety cabinet, by conservation, some air must also exit the system. In all safety cabinets this exhaust airflow is filtered through high efficiency HEPA / ULPA filters. These filters collect practically all particulate matter in the exhaust air stream on the filter media, therefore preventing any biological hazards from escaping into the laboratory.

The performance test related to this aspect is the exhaust HEPA filter leak test. During this test the filtration system is "challenged" by a test aerosol (the test aerosol is generated using an aerosol generator placed in the air stream before the exhaust filter). The concentration of test aerosol before the filter, and after the filter, is measured and compared (this involves "scanning" the entire exhaust face of the filter at a very slow rate passing the probe above the filter face). The percentage of aerosol that passes through the filter in other words the penetration, is then reported.

The above 3 factors work together in tandem. When one or more factors are compromised the entire safety performance of the cabinet is also degraded. For example a cabinet may have perfect exhaust filtration, but if the directional air flow of the cabinet is compromised and there is turbulence, biological hazards may very well be leaking out from the interior of the cabinet through the work access opening.

SECTION B: THE 4TH TEST, OR MICROBIOLOGICAL OPERATOR PROTECTION TEST

Since the 1970s when the first major international standards for biological safety cabinets, such as the NSF49 (USA), were published, the industry also adopted a final / additional test method to

validate the operator protection of the cabinet. This test method is known as the microbiological method for validating operator protection, or sometimes simply the "operator protection" test. This 4th test method supplements the above 3 methods in the following ways:

1. The microbiological operator protection test uses actual microbes. Since a safety cabinet is built for manipulating microbes, this provides a very realistic test taking into account other factors which cannot be measured using test methods 1 - 3 above.
2. Assuming the exhaust filters are leak free, the microbiological test measures, to a large extent, the leakage of microbes escaping the interior of the work zone through the work access opening of the cabinet. Since every Class I / Class II has an open front, there is bound to be some "leakage" of microbes during operation through this route. No test except the microbiological operator protection test measures this aspect. (The air flow smoke pattern test, on the other hand, is purely qualitatively whereas the microbiological operator protection test is quantitative).
3. The microbiological operator protection test supplements and complements the other 3 methods and is the most complex and demanding test. Since it provides a quantitative indication of the operator protection level of the cabinet, it can also be used by the manufacturer as a type-test to determine the optimal inflow air velocity of the cabinet design.

The microbiological operator protection test method involves the generation of a bacterial aerosol (containing millions of miniscule particles of bacteria) INSIDE the work zone of the cabinet, while air samplers are operated outside the cabinet. The positions of the nebuliser (the device generating the bacterial aerosol) as well as the air samplers, in addition to the duration of the test are defined strictly in the standards.

The downside of the microbiological operator protection test method is that results take days to obtain and preparation for the test is extremely complex requiring highly trained personnel and special equipment. Consequently it is impractical for use a field-test for a cabinet installed in a laboratory in the real world.

SECTION C: THE KI DISCUS TEST

As an alternative to the microbiological operator protection test method the European Standard EN12469:2000 recognizes the KI discus test. Unlike the microbiological operator protection test, the KI discus test is rapid (results can be obtained within 15 minutes of beginning the actual test) and portable - therefore making it extremely useful as a field-test.

The principle of the KI discus test is similar to that of the microbiological operator protection tests. In the KI discus test a "spinning disc" apparatus aerosolizes KI (potassium iodide) solution into very small fine particles. The spinning disc rotates at a very high speed (thousands of rpm) and liquid is continuously deposited onto its surface by a peristaltic pump, discharging millions of fine particles inside the work zone of the cabinet.

At the same time, a metal cylinder is introduced into the cabinet, simulating the airflow disturbance caused by an arm of the operator, while air samplers are collecting air from outside the cabinet. Again, the duration of the test as well as the positioning of the apparatus are strictly defined in the standard.

The air samplers draw air through special filter paper, which, at the end of the test, is immersed in palladium chloride solution. Any potassium iodide particles which escaped through the front of the cabinet during the test show up on the filter paper as small brown dots, which are then examined and counted using a magnifying glass.

The KI discus test shows excellent correlation with the microbiological test method for operator protection. In addition to being a more rapid substitute test method for the microbiological operator protection test in the research laboratory, the KI discus test is also extremely useful for

validating the actual containment performance in-situ of the biological safety cabinet, a point which is examined in the next section.

SECTION D: THE NEED FOR IN-SITE KI DISCUS TESTING

What many users sometimes do not realise is that the performance of the safety cabinet depends greatly on the nature of the installation as well as proper positioning of the cabinet in the laboratory. For example, the inflow air velocity from the laboratory into the cabinet is often of a very low magnitude (around 0.5m/s for example) and this can easily be disrupted by airflow turbulence in the room, for example, an air-conditioning outlet / diffuser.

A safety cabinet may meet all performance criteria in the manufacturer's laboratory after production, as well as in the testing lab of the independent certification agency, but may very well fail to deliver adequate protection on-site when it is actually installed. (It is important to understand that testing conditions in the manufacturer's laboratory as well as the laboratory of the certification agency, are ideal test conditions which sometimes do not correlate with real-world conditions).

As we have covered above, the KI discus test (like the microbiological test for operator protection) is a containment tests. A safety cabinet can also pass all the other 3 performance tests (air flow smoke pattern, inflow velocity, and filter integrity) but fail the containment test.

This simple fact, when combined with variables caused by real-world conditions (installation and positioning of the cabinet) create a dangerous combination - the user may feel completely safe if the cabinet has been certified by a local certification company for air flow smoke pattern, filter integrity and inflow velocity etc. (these are very basic / common tests), but he or she may still not be adequately protected because of other factors, such as external airflow disturbances.

The only way to be sure there are no external airflow disturbances is to conduct an on-site containment testing (note, other containment tests for related containment equipment such as the ASHRAE 110 test for fume hoods DO NOT show a correlation with the microbiological test method and are hence unacceptable, in fact the KI discus test is steadily gaining industry acceptance as a more sensitive test compared to the conventional SF6 tracer gas test for fume hoods) individually, for every safety cabinet installed.

Clearly then with the microbiological test method an impracticality, the only alternative is the KI discus test.

The KI discus test not only serves as "confirmation" that the first 3 basic tests (airflow smoke patterns, inflow velocity, filter integrity) have been properly performed, but also validates containment of the cabinet (which the 3 tests do not validate directly and / or quantitatively) AND takes into account possible ambient airflow disturbances, to deliver an overall performance "grade" in terms of operator protection, of the cabinet.

SECTION E: KI DISCUS SERVICES

Despite the rapidity of the test method, the KI discus test requires considerable investments in personnel and equipment. Esco is proud to be the only company in Southeast Asia equipped to perform this test, under Esco Biotech Certification (our service division) for customers of our microbiological safety cabinets.

In fact, feedback from many local Singaporean customers indicate that our ability to perform the KI discus test (in addition of course to the high quality of our products as well as independent certification) is often a key factor in their decision to choose only Esco biological safety cabinets.

The effects of exposure to biological hazards are often insidious and symptoms may not manifest themselves for years. Thus for your safety and protection, remember to ensure that your cabinet

is KI discus tested at least once a year (or in the event of cabinet relocation, filter changing, or other mechanical / electrical service).