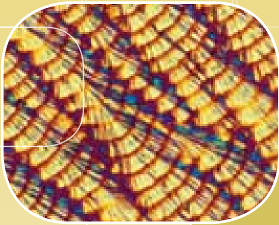

A Guide to Ductless Fume Hoods

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INTRODUCTION

A ductless fume hood is a device which recirculates filtered air from a hood or enclosure directly back into the working environment. These hoods are unique in that the contaminated air is not vented to the outside through a system of ducts, unlike conventional fume hoods. The objective of the filtration system is to reduce the levels of solids, gaseous or vapor constituent to that below the acceptable limit at the exhaust of the ductless fume hood.

Safety to laboratory personnel is provided by conventional ducted fume hood by drawing air across a front opening in the hood at a controlled rate, therefore preventing toxic vapours generated during the experiments from escaping into the general laboratory environment. Air is then exhausted via a fan system to the outside of the laboratory, usually via an outlet mounted on the roof of the building. When released to the external atmosphere in this manner, chemical fumes and vapors, which would have otherwise been toxic in the enclosed environment of the laboratory, are diluted many times over and have an insignificant effect on the environment.

Ductless fume hoods are quickly becoming a viable alternative to conventional fume hoods. Unlike conventional fume hoods, these hoods filter out chemical fumes and recycle air directly back to the laboratory. Personnel protection is provided in a manner similar to conventional fume hoods by drawing air at a controlled rate across a front opening into the hood. Ductless fume hoods have many advantages over conventional fume hoods:

In most uncontrolled situations, fume hoods remain the equipment of choice for ventilating hazardous airborne materials from the laboratory. But there are situations when installing a ducted hood is impractical or has undesirable consequences because of any of the following:

- Flexibility in placement of the ducted fume hood is limited. Laboratories located in the center or bottom of a several story building may not have a ducting option.
- Some laboratories are "air-starved" and the make-up air available is insufficient to accommodate a ducted fume hood.
- Loss of conditioned air results in a less energy efficient heating and cooling system, increasing costs.
- The initial expense for ductwork and installation is significant.
- Portability is essential.

Esco's Ascent™ Max Ductless Fume Hoods have been independently certified by Invent-UK, Ltd as fully compliant to the latest safety and performance requirements of the US Standard ANSI/ASHRAE Standard 110-1995 and British Standard BS 7258 standards. In addition, the Ascent™ Max ductless hoods have been successfully tested to the requirements of the following international standards (by Invent-UK, Ltd):

- European Standard EN 14175-3 (for containment)
- French Standard AFNOR NF X 15-203 (for containment)
- French Standard AFNOR NF X 15-211 (for filter retention capacity)
- British Standard BS 7989 (for filter efficiency and retention capacity)

Esco Ductless Fume Hoods are available with a wide range of Activated filter options, various optional accessories as well as in different configurations designed to meet the needs of every laboratory worker.

ADVANTAGES OF A DUCTLESS FUME HOOD

- They protect the environment since toxic fumes are not released to the environment unlike in conventional fume hoods. Activated Carbon filters retain / neutralize pollutants eliminating harmful discharge to the environment.
- Fully installed systems ready to operate are available at a lower cost than bulky conventional fume hoods. Ductless fume hood can be placed on a bench and connected to an electrical supply. No external ducting, building work or changes to heating and ventilation systems.
- An expensive ducting and external blower system that is often difficult to maintain is not required.
- They are mobile and can be relocated easily to meet your changing needs; perfect for schools and education institutes. Hood may be easily re-positioned or filters changed to suit new requirements at anytime.
- They allow energy savings since air which is costly to air-conditioning or heat is not removed from the laboratory. Recirculatory airflow eliminates the need for laboratory make-up air and integration into ventilation system controls.

NANOCARB™ ACTIVATED CARBON FILTRATION

Esco's ductless fume hoods incorporate a state-of-the-art vapour phase Nanocarb™ activated carbon filter system, which is the primary filtration component in removing all chemical fumes from within the hood before air is recirculated back to the laboratory.

Activated Carbon includes a wide range of amorphous carbon-based materials prepared to exhibit a high degree of porosity and an extended interparticulate surface area. These qualities impart activated carbon with excellent adsorbent characteristics that make carbon very useful for a wide variety of processes, including filtration, purification, deodorization, decolorization, purification and separation.

The effectiveness of activated carbon as an adsorbent is attributed to its unique properties, including "large surface area, a high degree of surface reactivity, universal adsorption effect, and favorable pore size. Powdered activated carbon was first produced commercially in Europe in the early 19th century, using wood as a raw material. This carbon found widespread use in the sugar industry. In the United States, the first production of activated carbon used black ash as the source, after it was accidentally discovered that the ash was very effective in decolorizing liquids. Activated carbon has since been used extensively for this purpose in many industries.

The first documented use of activated carbon in a large scale water treatment application was in 19th-century England, where it was used to remove undesirable odours and tastes from drinking water. Use in the United States for similar purposes closely followed. In recent years, the use of activated carbon for the removal of priority organic pollutants has become very common. Today, hundreds of brands of activated carbon are manufactured for a large variety of purposes.

Wood (at 130,000 tons/year) is by far the most common source of activated carbon, followed closely by coal (100,000 tons); coconut shell (35,000 tons) and peat (35,000 tons) are also used in large quantities, but they are more expensive and less readily available.

A. Production of Activated Carbon

Activated carbon is produced from a wide variety of carbon-rich raw materials, including wood, coal, peat, coconut shells, nut shells, bones and fruit stones. New materials are currently under investigation as sources for activated carbon.

1. Chemical Activation

This technique is generally used for the activation of peat and wood based raw materials. The raw material is impregnated with a strong dehydrating agent; typically phosphoric acid or zinc chloride mixed into a paste and then heated to temperatures of 500 °C - 800 °C to activate the carbon. The resultant activated carbon is washed, dried and ground to powder.

2. Steam Activation

This technique is generally used for the activation of coal and coconut shell raw material, which is usually processed in a carbonised form. Activation is carried out at temperatures of 800 °C - 1100 °C in the presence of steam.

B. Main Cause of Physical Adsorption

London Dispersion Forces:

- It is a type of Van der Waals' force.
- Intermolecular interaction exists between all molecules (both polar and nonpolar), but is extremely short ranged.
- It is responsible for condensation of most gases to liquid and physical adsorption on activated carbon.
- Characteristic Properties of London Forces:
- Nonspecific - existing between all molecules.
- Temperature Independence from -273 °C to 1000 °C
- Additive - The sum of all interactions
- Short ranged - The magnitude of the interaction is sensitive to the separation of the molecules.

These characteristics make London dispersion forces analogous to gravitational forces, but short ranged.

The adsorption process takes place in steps:

- Macro transport: The movement of organic material through the macro-pore system of the active carbon (macro-pore >50nm)
- Micro transport: The movement of organic material through the meso-pore and micro-pore system of the active carbon (micro-pore <2nm; meso-pore 2-50nm)
- Sorption: The physical attachment of organic material on the surface of active carbon in the meso-pores and micro-pores of the active carbon.

C. Four Step Mechanism for Adsorption Kinetics

- Bulk or Interparticle Diffusion Step
- Boundary Layer or Film Diffusion Step
- Interaparticle or Pore Diffusion Step
- Surface Diffusion or Rate of Chemical Reaction Step on Surface

D. Adsorption Parameters of Activated Carbon

- Particle Size: Smaller particles provide quicker rates of adsorption.
- Temperature: Lower temperatures increase adsorption capacity except in the case of viscous liquids.
- Concentration of Adsorbate: Adsorption capacity is proportional to concentration of adsorbate.
- pH: Adsorption capacity increases under pH conditions, which decrease the solubility of the adsorbate (normally lower pH).
- Contact Time: Sufficient contact time is required to reach adsorption equilibrium and to maximize adsorption efficiency.
- Nonspecific: existing between all molecules.
- Temperature Independence from -273 °C to 1000 °C
- Additive: The sum of all interactions
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These characteristics make London dispersion forces analogous to gravitational forces, but short ranged.

ESCO'S DUCTLESS FUME HOOD APPLICATIONS

Some of the suitable applications for a ductless fume hood;

- PCR operations
- Slide staining operations
- Drum decanting
- Robotics Enclosures
- Graphic arts preparation
- Powder weighing and dispensing
- Solvent bonding, welding or decanting

The use of ductless fume hoods should be avoided in applications involving:

- Chemicals with a very low IDLH Biotoxins or Biological organisms such as virus or bacteria.
- Processes with high contamination outputs such as evaporative reduction of solvent baths.
- Mineral acid digestions or other high acid level emitters.
- Applications where chemicals or product of reactions are unknown.
- Applications requiring very high internal hood temperature.

Selecting the proper enclosure for any given situation requires consultation with technical specialists qualified to evaluate the various options available.

DUCTLESS FUME HOODS TESTING

ASHRAE 110 test is a method of testing the performance of Laboratory Fume Hoods; it can be adapted for testing and certification of ductless fume cabinets. Ductless Fume Hoods are self contained devices which incorporate their own air moving devices, filters, seals, lights, monitors and alarms and all associated controls. They generally do not interact with the laboratory's exhaust system, as the laboratory fume hoods. There are three test procedures incorporated in the 110 test; the first is the face velocity grid test, the second is the flow visualization or smoke test and the third is the tracer gas containment test.

Esco Ductless Fume Hoods have been tested and developed at Esco's in-house ASHRAE testing laboratory at our Research and Development facilities using performance tests according to the ASHRAE Standard requirements. Esco's ductless fume hoods incorporate a state-of-the-art vapour-phase activated carbon filter system, which is the primary filtration component in removing all chemical fumes from within the hood before air is recirculated back to the laboratory.

At Esco's factory, every ductless fume hood produced is rigorously tested to the requirements of two major international standards: Filter efficiency tests according to BS 7989:2001 and Containment tests according to ASHRAE 110-1995.

Class II ANSI / ASHRAE 110-1995 Containment Tests

1. Flow Visualization - Local Smoke Visualization, Gross Smoke Visualization
2. Face Velocity Measurement- Cross Draft Velocity
3. Tracer Gas Test- Static Tracer Gas Test, Surface Scan Test, Sash Movement Effect

BS 7989:2001 Filter Efficiency and Capacity Test Gaseous phase filter test for capacity and efficiency using propan-2-ol according to British Standard 7989:2001. The purpose of this test is to ensure that a recirculating ductless fume hood is capable of meeting the filter capacity requirements specified in 8.5.2 of the BS 7989:2001 Standard

Acceptance Criteria:

The filter, when challenged continuously at 800 ppm (+/-50 ppm) of propan-2-ol, shall maintain the concentration of propan-2-ol in the exhaust stream at below 40 ppm throughout the period of evaporation of 1 litre of propan-2-ol and below 400 ppm throughout the period of evaporation from 1 litre to 2 litres of propan-2-ol.

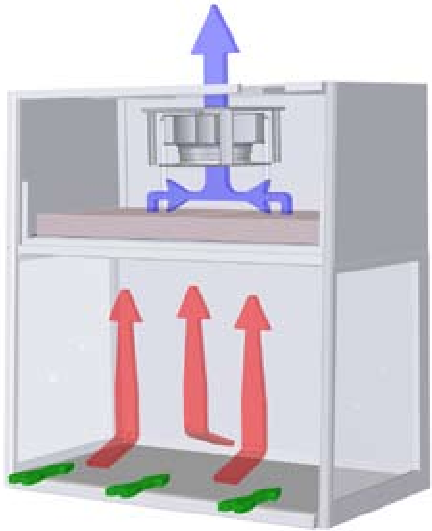
DUCTLESS FUME CABINETS - SAFETY PRECAUTIONS

- The ductless fume hood should not be used for laboratory work in which chemicals of different types are used repeatedly. For example, the operator should not use the ductless fume hood for acid emitting processes where hydrocarbon type filters are installed. The ductless fume hood should not be specified or used for unknown chemicals or to contain byproducts of reactions for which the characteristics are not known.
- The ductless fume hood should not be used for multiple chemical processes where two or more chemicals could combine in the filter and cause reactions with toxic, exothermic or explosive properties. The chemicals may react later when the second chemical is adsorbed even if the chemicals are not present in the ductless fume hood base at the same time.
- The ductless fume hood should not be used with certain types of chemicals, virus or bacterial emissions, high concentration acid emissions or processes with very high levels of chemical emissions such that the filter life would be very short. For such types of applications, standard fume hoods, glove boxes, biohazard cabinets should be used.
- Extreme caution should be taken when working with ignition sources inside a ductless fume hood. Ignition sources such as electrical connections; controllers and open flame can be used inside a ductless fume hood as long as there are no operations involving flammable or explosive vapors. If possible, ignition sources should remain outside the hood at all times.
- Ductless fume hood are potential locations for fires and explosions due to the types of experiments conducted in these hoods. The location of the ductless fume cabinets should be within the laboratory so that in the event of a fire or explosion within the fume hood, exit from the laboratory would not be difficult.
- Ductless fume hood should be located away from high traffic lanes within the laboratory because personnel walking past the sash opening may disrupt the flow of air into the hood and cause turbulence, drawing fumes into the laboratory.
- Safety devices such as drench showers, eye wash stations, fire extinguishers, first aid kits and fire blankets should be located convenient to the fume hood operating personnel and proper instructions should be posted as to their use and function.

PROPER WORKING PROCEDURE

- The operator should work at least six inches beyond the plane of the sash. The farther the operator is from the ductless fume hood, it is better.
- The contaminants and equipment above the surface of the hood should be elevated so as to enable flow beneath and around the obstructions.
- The motions in the lab should be kept to a minimum while working in the ductless fume hood. Substantial cross drafts can be generated due to the traffic past the hood.
- The operator should attempt to slowly approach and withdraw from the ductless fume hood. The opening and closing of the sash should be done slowly.
- The operator should make sure that the head and upper body remains outside the plane of the hood opening at all times.
- The ductless fume hood sash should be kept shut when not working in the hood.
- There should be minimum movement inside the ductless fume hood as well as in the front.
- The saturation of the filter should be checked regularly, at least once every 60 hours of use.

AIRFLOW PATTERN IN ESCO DUCTLESS FUME HOODS



ULPA-filtered air
Unfiltered/ Potentially contaminated air
Room air/ Inflow air

Airflow System Inside The Ascent Max Ductless Fume Hoods

Ductless fume hoods provide operator and environment protection from toxic vapours, gases and fumes.

- The inflow moves from the ambient environment into the work zone through the hood front opening, with an average velocity of 0.5 m/s or 100 fpm. Additional inflow air taken through the AutoPurge™ perforations at the back of the work zone prevents fume accumulation for better operator protection. Negative pressure is created in the hood's work zone, which ensures operator protection.
- The inflow flushes the entire work zone of the hood; within the main chamber of the hood, negative pressure (relative to the ambient environment) is maintained in order to ensure that no chemical fumes or vapours escape the work zone.
- Air is taken through a pre-filter and an activated carbon filter mounted in the interior; The pre-filter is in-built with the activated carbon filter, which helps prolong carbon filter life by removing large particulates before the they enter the carbon filter. The carbon filter removes all fumes from the exhaust air stream; filtered clean air is exhausted directly back to the room from the top of the hood.
- The ductless fume hood can be remotely exhausted to the external atmosphere via an airtight hard ducting system (optional), the hood provides protection for the operator from volatile toxic chemicals used in trace amounts, which normally would not be removed by the exhaust ULPA filter.

SALIENT FEATURES OF ESCO'S DUCTLESS FUME HOODS

(Left to Right) Esco Ascent™ Max Ductless Fume Hood and Esco Ascent™ Opti Ductless Fume Hood

A. Ergonomic Features

Extremely low noise (less than 56dBA) and vibration levels due to proprietary construction and mounting technology. Sloped front design minimizes glare in the viewscreen and improves user comfort during extended operations. Service fixture provisions are offset and staggered for easier reach and access to service fixtures. Standard Esco hood comes with two factory-prepared service fixture provisions on each side wall of the hood. Esco Retrofit Kit™ system allows for convenient on-site installation of electrical outlets and service fixtures. Provisions for these items are pre-fitted at our factory on standard models. Large, spacious work zone and high internal work ceiling (765mm / 30.1") accommodate many laboratory procedures and instruments. Tempered transparent glass sides are suitable for demonstrations and benchtop operations in the classroom. (Optional transparent glass back wall is available for maximum visibility into the work zone during demonstrations).

B. Safety and Maintenance Features

Auto-Purge™ slots at the back of the work zone improve containment and operator protection by preventing the accumulation of fumes in the work zone. All hood service and filter replacement can be carried out from the front allowing the hood to be placed against walls in the laboratory to save space. Front service panel opens up easily for immediate access for all maintenance functions. Designed to meet the general safety requirements of the IEC 61010-1 / EN 61010-1 / UL 61010A-1 / CSA C22.2 No. 1010.1-92. Hood is shipped fully-assembled; simply plug the unit into a power source for operation - no local installation is required; 10 international plug types are available.

C. Construction Features

Industrial-grade main body and dress panels constructed from electrogalvanised steel is durable. All-metal frame is reinforced, welded and expertly gasketed, thus ensuring an airtight carcass for better safety to the operator and the environment. The unique electrolytic zinc coating on the steel provides an additional barrier of protection against corrosion and rust as compared to conventional uncoated cold-rolled steels in order to maximize the service life of the hood. All parts are finished in a specially selected, abrasion resistant thermoset powder coating process that is both environmentally friendly (compared to conventional paints) as well as resistant to common disinfecting chemicals. Permanently lubricated direct drive centrifugal blower(s); energy efficient external rotor type design reduces operating costs; industry exclusive backward-curve motorised impeller design guarantees better airflow uniformity, lower noise and lower overall energy consumption. Built-in solid state variable speed controller(s) (infinitely adjustable from zero to the maximum setting) with built-in RFI and noise filters is superior to conventional "step" controllers. Chemical and abrasion resistant stainless steel work surface will never chip. Lip at front edge of the work surface contains spills in the work zone. Curved front edge minimizes airflow turbulence and improves user comfort.

D. NANOCARB™ Filter Features

Nanocarb™ activated carbon filter(s) are factory installed and tested for efficiency according to British Standard BS 7989. Small Filter ID window behind the front panel allows the user to easily identify the type of filter they are using. Unique diffusion technology (US patent pending) with white epoxy powder-coated filter diffuser constructed of electro-galvanised steel is installed in the work zone ceiling below the filter. The diffuser ensures a uniform adsorption of the fumes across the filter surface, preventing filter degradation at concentrated points and prolonging the filter life span. Pre-filter is built-in with the main carbon filter, which means there are no separate pre-filters to replace. Improved filter clamping design (no bolts are used) allows easier filter removal while maintaining uniform clamping over the entire filter surface to prevent leaks. Optional secondary exhaust back-up filter may be installed to ensure a higher level of filtration. When installed, the hood complies with the requirements of ANSI/AIHA Z9.5- 2003.

E. Operational Features

True airflow velocity (for inflow velocity) sensing technology, with temperature compensation for improved sensor accuracy. (Air-velocity can be displayed in either fpm or m/s). Continuous digital display of inflow velocity on the front LCD for constant monitoring. Configurable post-purge cycle ensures all residue contaminants are purged out of the cabinet work zone before the hood is deactivated. Intelligent diagnostics of hardware problems with error message reports. All hood operating parameters can be customised and configured based on the requirements of the user. Built-in 24hr clock and experiment timer display for monitoring the duration of experiments and processes. Ambient temperature display both in Celsius and Fahrenheit.

F. Security Features

Fail-safe control system equipped with a watchdog timer ensures the cabinet safety is not compromised even if the electronics hardware fails. In case of failure, the control will automatically reset the system and restore the hood to safe settings. An Admin PIN can be set by the laboratory supervisor to restrict access to all menu functions. A Fan PIN feature allows the supervisor to restrict access to fan control, thereby preventing usage of the hood by unauthorized personnel.

G. Safety Features

Audible and visual alarms for low and /or high airflow, unsafe sash positions. High temp alarm for monitoring of emergency conditions like a fire in the cabinet, due to chemical reactions. Sash alarm is activated and the light is automatically cut off when the sash is lower or higher than standard operation height, in order to restrict the user's operation, thus enhance safety.

H. Maintenance Features

Blower hour meter to help the user monitor total cabinet usage, and thus gauge the life span of the carbon filter / pre-filter. Every 60 hours, the control system reminds the user to test the exhaust concentration with gas detection tube to see whether the filter is saturated. Airflow calibration can be done easily using the microprocessor control on the front panel of the hood. The special maintenance mode for servicing purposes allows for by-pass of the hood presets and complete control over the hood's functions. All system interlocks are disabled, and all raw inputs and outputs can be viewed for troubleshooting purposes.

I. FILTRACHECK™ Chemical Advisory Service

Ductless fume hoods offer many advantages over conventional ducted enclosures such as mobility, no installation costs and energy savings. However, they are only suitable primarily for lighter or fixed chemical applications. The complex nature of any chemical laboratory today means that thousands of chemicals in almost infinite permutations can be used in a chemical hood or enclosure. How can you be sure that a ductless hood will offer the right level of protection and how often your filters need to be changed?

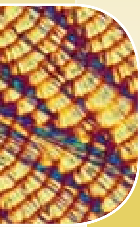
Esco's FiltraCheck™ Chemical Advisory Service is a free chemical assessment service dedicated to advising current and potential users of Esco ductless fume hood on the right hood and filter for their application. FiltraCheck™ is conveniently available online and can be completed by means of a simple online form. Just tell us how you plan to be using your ductless fume hood (including information on chemicals, quantities and type of experiment) and we will do the rest!

At Esco, your safety means the world to us. Esco FiltraCheck™ is supported by our dedicated in-house test laboratory, trained experts on carbon adsorption technology, and external consultants from independent organizations and the world's leading carbon suppliers. Our in-house computer simulations can be used to estimate carbon adsorption capacity, efficiency and simulate competitive adsorption scenarios where multiple types of chemicals may be used.

In our Invent-UK recognized laboratory, we can run almost any type of chemical application using combinations or single compounds to validate your application to actual, empirical test data. Our laboratory performs tests primarily in accordance with the chemical adsorption test methods specified in world standards such as the French Standard AFNOR NF X 15-211 and British Standard BS 7989:2001. Our test capabilities have also been independent validated and recognized by Invent-UK, an independent organization specializing in the field of chemical containment technology. An optional follow-up reminder service is also available from FiltraCheck™ to remind you when your filters need to be changed.

Since 1978, Esco has emerged as a leader in the development of controlled environment, laboratory and cleanroom equipment solutions. Products sold in more than 100 countries include biological safety cabinets, fume hoods, ductless fume hoods, laminar flow clean benches, animal containment workstations, cytotoxic cabinets, hospital pharmacy isolators, and PCR cabinets and instrumentation. With the most extensive product line in the industry, Esco has passed more tests, in more languages, for more certifications, throughout more countries than any biosafety cabinet manufacturer in the world. Esco remains dedicated to delivering innovative solutions for the clinical, life science, research and industrial laboratory community. www.escoglobal.com.

NSF / ANSI 49 Biological Safety Cabinets • Animal Containment Workstations • Fume Hoods • Clean Benches



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Esco Technologies, Inc. • 2940 Turnpike Drive, Units 15-16 • Hatboro, PA 19040, USA
Toll-Free USA and Canada 888-375-ESCO • Tel 215-441-9661 • Fax 215-441-9660
us.escoglobal.com • usa@escoglobal.com

Esco Micro Pte. Ltd. • 21 Changi South Street 1 • Singapore 486 777
Tel +65 6542 0833 • Fax +65 6542 6920 • mail@escoglobal.com
www.escoglobal.com

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