

Handling, Installation and Burn-off Procedure for HEPA Filters

It is highly recommended that this whole document be read carefully before handling filters.

Definitions

HEPA Filter = High Efficiency Particulate Air Filter. High means 99.97% or higher. The efficiency is a measure of how effectively the filter traps particles. It is calculated by dividing the number of particles trapped by the total number impinging on the filter. Fewer than 3 in 10,000 are allowed through a filter, if it is to be rated as HEPA grade. Typically the paper passes fewer than 1 in 10,000. None of these is larger than 5 microns, unless there is a leak in the filter.

Media = filter paper which traps particles from the air flowing through it. It is made of boro-silicate glass fibers and binder. It is not a strong paper when new, and is extremely fragile after burn-off.

Binder = A substance used to bond the glass fibers together that gives some structural strength to the media. The binder is a normal part of HEPA filter manufacturing.

Separators = Components which hold the media pleats apart and channel the airflow. They are typically corrugated aluminum foil, but string, lines of glue, and other schemes have been used.

DOP = Dioctyl Phthalate - An oily liquid (plasticizer) used to produce aerosol droplets of .3 micron size ("hot DOP" for filter efficiency measurements) 2 to 4 micron size ("cold DOP" to test filters for leaks)

Burn-Off = A high temperature process for removing the binder from the filter. It should be continued long enough to remove the smoke and odor from the oven. Manual cleaning of the oven is usually required afterwards.

Shedding = The filter behavior characterized by higher levels of particles downstream during changing temperature. Faster temperature changes result in larger particle counts. This is a typical characteristic of filters after the binder has been burned off of the media.

Pleat = The fold in the media at each face of the filter. The pleating gives the filter a large media surface area.

Packaging and Shipping

Packaging varies among filter manufacturers. Normally HEPA filters are packaged in internally strengthened cardboard boxes. The filters are packaged with the separators vertical - running from the top to the bottom of the package. The package should be clearly marked with a vertical arrow and a THIS SIDE UP label.

Typically, all the HEPA filters required for an oven will be banded together on a single pallet for shipment, with plywood sheets protecting the paper faces either in each carton or on the whole pallet.

CAUTION: When receiving a shipment of HEPA filters, make sure that they have been shipped with pleats oriented vertically. In horizontal shipment, normal road vibration and jarring may cause the filter media to sag. Any rough handling can cause subtle damage to the filter. **This damage is quite difficult to see but will show up as leaks. Damage of this sort will typically make the filter unsuitable for oven use.**

Handling and Storage

Minimize unnecessary handling. HEPA filters should be handled like very fragile glass. They should never be dropped or jarred. Any filter dropped, whether or not in the carton, should be re-examined for damage as described under Inspection. Filters should remain in their crates and shipping cartons until installation.

When handling a filter, it is recommended that the unit be tilted up on one corner, and picked up by the two adjacent corners (diagonal from each other).

Always maintain the filter in the proper vertical position, as marked on the container, during storage.

- For installation, the filters should be unloaded at a point which will minimize physical handling, and then should be unpacked as follows.

Unpacking

Remove the crate from around the carton(s) - as close to the oven as possible. Use extreme caution when removing the filter from its carton. The filter should not be dropped or jarred.

Be sure the area is large enough and clear of obstacles which may damage the filter. Carefully remove the sealing tape from the top of the carton.

- Open and fold back the top flaps of the carton.
- Gently invert the filter box to place the exposed top of the filter on a flat surface, preferably the floor.
- Pull the carton up, off of the filter.
- Carefully remove the plastic bag from the filter.

CAUTION:

Attempting to remove the filter from the carton by grasping the filter frame can result in irreparable damage, when fingers puncture the delicate filter media.

Inspection

Use a strong lamp to examine the exposed areas of the filter to assure that no breaks, cracks or pinholes are evident. A less intense light, such as a flashlight, can be used in a darkened room.

- Look for visible defects with the light projected along the full length of each channel created by the separators. All separators should be even and uniform. Separators which are compressed at one edge indicate significant shock to the filter, which probably damaged the media. Translucent spots in the media may or may not indicate holes or cracks.
- Small breaks or cracks in the media usually show up on the surface edges of the filter pleats, but are often not detected readily. Even though they are small, they are important. If the filter unit is installed this way, the cracks get bigger, because of the air movement.
- After examining each channel, the inspector should carefully examine the adhesive seal around the filter face, to be sure that the seal is complete and unbroken. It should stick tightly to both the frame and the media. Also check the media at the edge of the adhesive. Hairline cracks, dimpled or fuzzy paper at or within 1/2 inch of the joint are clues to hidden damage to the filter.
- After a thorough scrutiny of both filter faces, the corner joints of the frame should be checked for adhesive sealing and tightness. The gasket around the edge of the frame should be inspected for tight abutment or mating of strips and good physical condition. Gasket strips should also be examined for full adhesion to the frame.

HEPA Filter Replacement

HEPA filters should be replaced when they no longer perform the required function. Some of the more common reasons are:

- Excessive resistance, or pressure drop, across the filter unit. The resistance of a HEPA filter increases as it loads up with particles. The airflow through the oven is reduced as the filter static pressure increases. This slows the rate at which heat is delivered to the product. Individual processes vary, but usually the HEPA filters should be changed if the initial static drop across the filter increases by 1 inch of water. For example, if a new filter has an initial static drop of 1.3 inches of water, it should be changed when the static increases to 2.3. Record the new filter pressure drop for later comparison.
- Loss of efficiency (leakage), determined from particle counts made downstream of the filter unit.
- Visible damage to, or rupture of the paper in a filter (which may result in reduced pressure drop across the filter).

Installation

Anyone installing HEPA filters must be aware of the high-efficiency performance required. Moreover, they should know that the filter pack within each frame is delicate, and must not be damaged during installation. Also, each filter must be installed so that unfiltered air will not leak past. The surface to which a filter is mounted should be true, clean, smooth, flat, free of weld splatter, and sufficiently rigid to fully compress the gasket (typically to about half its new or uncompressed height).

The following procedure is recommended.

- Carefully remove filter from shipping carton, following the procedure described under Unpacking.

CAUTION: Unpack one filter at a time, as and where each is to be installed.

- Carefully inspect both faces of the filter unit for cracks in the filter medium, damage to the separators and for separation of the adhesive between the filter pack and the frame, as described in Inspection. See that the gasket is cemented firmly to the frame and that the gasket pieces are butted or mated tightly at the joints.
- **Vertical Filter Mounting:** Always install the filter with pleats oriented vertically. A spacer of the appropriate thickness across the bottom two hold-down rods may help locate the filter while the fastening hardware is attached.

CAUTION: If installed in the wrong orientation, the pleats in the filter will form shelves which collect entrapped materials. The accumulated weight of the materials may lead to early failure of the filter.

- **Horizontal Filter Mounting:** If the airflow has a consistent direction turning into the filter, the filter should be oriented to minimize turbulence. That is, the separators should run in the direction that the air approaches the filter. They should not run across the air stream where the air would be turning over a sharp edge.
- Locate the filter evenly over the opening. Use extreme care in this step. Get help if necessary. Keep fingers out of filter media and separators.
- Compression nuts should be successively tightened to equalize the pressure on the filter. The gasket should be compressed evenly, and equally, to approximately half its free height. When the hold-down nut is 3/8-16 NC thread (as is usually the case on Despatch ovens), this is 2 to 3 rotations after contact. This is a torque of approximately 4 to 12 foot pounds. Record the torque for comparison with later values.
- Record the pressure drop across each group of new filters at ambient temperature for later comparison in case of plugging.

CAUTION: Fresh air, oven, and exhaust filters are frequently the same size. Make sure that a filter to be installed in an oven or exhaust is rated for the temperature. The filters typically have red elastic

adhesive between the filter media and the frame for temperatures up to 260°C / 500°F, and a compressed fiber pad for hotter use.

Burn-Off of Binder

The burn-off process will take place in any piece of equipment where a new HEPA filter is used at temperatures above 150°C / 300°F. There will be smoke, possibly a pungent odor, and a residue on interior surfaces. This is a result of oxidation of the binder, and the evaporation/decomposition of any challenge agents. One of the media manufacturers says that most of the binder will leave the filter after running at a temperature of 260°C / 500°F for eight (8) to 48 (forty-eight) hours. After eight hours 4.2% of the total media weight is lost, and 4.8% after 48 hours. Approximately .1% will be lost after that. Check the oven for particles or the exhaust for smoke and odor to determine that the burn-off is finished.

When the filter media has the binder burned out, it becomes very fragile. After that, a filter may not stand up to normal handling, and especially shipping. Do not expect HEPA performance if HEPA filters are handled after binder burn-off.

Significant advantage in paper strength and shedding characteristics is obtained for some filters if some of the binder is left on the media (burn-off done below 220°C / 428°F, and the lower, the better). However, the burn-off should be done at or above the maximum process temperature. If the binder is burned off below 260°C / 500°F, it is wise to remember that additional smoke will be given off when an oven is heated over this maximum process temperature.

Select a location for this process where the smoke and odor generated will be ventilated with the least amount of interruption and inconvenience. Ideally this will be in the final location for the oven. However, it may be a receiving dock, some well ventilated space or even outside if the weather is acceptable. If this location is a very clean area, then special attention must be given to an exhaust hook-up that will capture the smoke and odor.

The following procedure is recommended:

- Locate the equipment exhaust opening where chamber air is being expelled.

If the oven filter is to be burned off in a clean area, be sure to handle the equipment exhaust appropriately. If the equipment is large and the exhaust stack is a permanent service connection, it should be connected before the burn-off process is run. If the equipment is small with no permanent exhaust duct required, arrange a temporary connection out of the clean area, that will handle the maximum temperature of the equipment. Direct the smoke and odor outside, or to a highly ventilated area.

- Filters for below 260°C / 500°F: Set the temperature control at the maximum process temperature.

Filters for above 260°C / 500°F: To maximize the life of the filter, set the control to ramp the oven temperature at 1 degree C (1.8 degree F) per minute or slower. Program a 3 hour soak at 75°C / 167°F, a 3.5 hour soak at 105°C / 220°F, and a 1 hour soak at the chamber maximum temperature plus 5 to 10 degrees C (9 to 18°F) during the first heating ramp. The filter should not be cooled faster than 1 degree C per minute. The limited ramp rate and soaks will cure the ceramic adhesive in these filters for maximum strength, during the first cycle. After the first heating, the soaks can be removed from the program. **See figure 1.**

- Start the Fan(s) after making the electrical power connections.
- Energize the equipment heater.
- Burn off the filter until the downstream air is clean enough for the process.

Typical High Temperature Filter Burn-off Temperature Profile

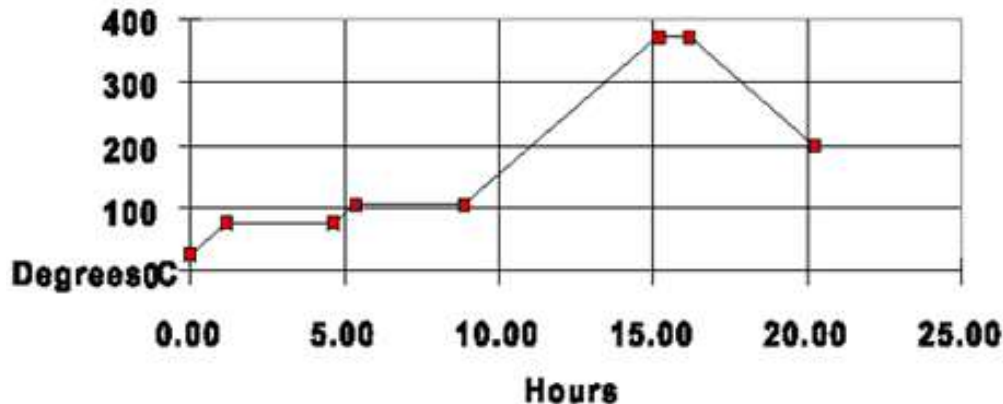


Figure #1

Use enough fresh air or purge nitrogen to remove the smoke, while still being able to achieve and maintain the necessary temperature.

The completion of the burn-off period should be based on the particle level in the oven. Laminated media will take longer than the standard HEPA media to burn off to a particular cleanliness level, at the same temperature. Both types of media will burn off faster at higher temperature. Neither has a clearly defined end to the burn off process, and will continue to clean up during oven operation. The laminated media generally will clean up to a lower particle level than the standard media. Filters for below 260°C / 500°F: Normally clean up within 72 hours at 500°F. Filters for above 260°C / 500°F: Normally clean up within 24 hours at 750°F.

If it is necessary to move the equipment after the burn-off process (which is not recommended), considerable care should be used. The binder which gives strength to new filters is now gone and the media is very fragile. Any handling of either the filter alone or the equipment with the filter installed is strongly discouraged. The media may crack or tear (leak).

For best clean oven processing, it is recommended that the oven be thoroughly cleaned after the burn-off period and at regular intervals thereafter.

The filter hold-down nuts should be checked after burn-off and tightened again, if necessary. For best results, this step should also be repeated on a regular basis. Most oven gaskets are known to take a set, and thus require tightening after heating.

Testing

The filters are frequently checked for leakage after installation. **DOP** and similar challenge agents are **not recommended** for use in ovens, because of their behavior at elevated temperature.

Testing varies widely among different companies. However, it should be noted that efficiency testing of the recirculation filters is not required. It is generally sufficient that the filter be able to maintain the required cleanliness class of the oven. This would be done after the burn-off of the binder. One way to check the particle level, in an oven at elevated temperature, is to pull samples of the air out through a heat exchanger to a particle counter. Another is to determine a correlation between settling rate onto

monitor wafers at ambient temperature. Then monitor wafers are used in the oven through the oven cycle. Contact the factory for further information.

We hope you will find this information useful. THANK YOU for contacting us and allowing us to be a service to you. Please contact us at 1-800-473-7373 if you have any questions.

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