A filtration system for a ventilation hood includes a first filter configured to be mounted within the ventilation hood. The first filter includes an air inlet, and air outlet, and a grease outlet. The filtration system also includes at least one second filter, attached to the first filter, and operatively located downstream of the first filter.
Particle Collection Efficiency for Streivor Inc.
Cartridge and Woven Metal Filters

Particle Collection Efficiency, %

Particle Diameter, μm

Fig. 6A

Particle Collection Efficiency for Streivor Inc.
Cartridge and Fiber Filters

Particle Collection Efficiency, %

Particle Diameter, μm

Fig. 6B
MULTI-STAGE HOOD FILTER SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims priority to, and the benefit of, U.S. Provisional application 61/438,226, filed Jan. 31, 2011, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] The present invention relates generally to exhaust hoods, and, more particularly, to multi-stage filters for use with such hoods.

[0003] In a typical restaurant kitchen, a plurality of cooking units are lined up side by side in a row under a common exhaust hood. The cooking units may include, for example, ranges, griddles, fryers, and broilers. They all produce air laden with grease, smoke, fumes, moisture, and heat in varying amounts and temperatures. The air is drawn in to the exhaust hood, where it is filtered. One known filtration system is disclosed in U.S. Pat. No. 6,394,083 to Lamberton, the disclosure of which is hereby incorporated by reference.

[0004] Commercial exhaust hoods manufactured to be installed in the U.S. must comply with certain codes, such as the National Fire Protection Association (NFPA) Standard 96. This standard requires that all hoods installed over cooking equipment that creates grease as an effluent during the cooking process include grease filters that are individually listed in accordance with Underwriters Laboratories (UL) Standard 1046, or as components of UL 710 listed hoods. This standard requires grease filters to be able to prevent the spread of fire from the downstream portion of the filter to at least 18 inches upstream of the filter.

BRIEF SUMMARY

[0005] Embodiments disclosed herein provide a filtration system for a ventilation hood, which includes a first, or “primary” filter configured to be mounted within the ventilation hood, including an air inlet, and air outlet, and a grease outlet. The primary filter is configured to drain grease through the grease outlet and out of the ventilation hood. The system also includes at least one second, or “secondary” filter configured to be attached to the primary filter, operatively located downstream of the first filter.

[0006] The first filter may be, for example, a cartridge filter, and may be particularly effective as a fire barrier. The second filter may be, for example, woven metal, such as corrugated stainless steel. Alternatively, the second filter may be fiber. The system may further include a perforated sheet configured to be mounted within the ventilation hood downstream of the second filter. The system may also include a filter housing, configured to removably receive the first and second filters. The housing may further house the perforated sheet. The filtration system may further include a third filter configured to be mounted to the first or the second filter, at a location downstream of the second filter.

[0007] Some embodiments of the invention also provide a ventilation hood, housing the above-described system.

[0008] For a further understanding of the nature and advantages of the invention, reference should be made to the following description taken in conjunction with the accompanying figures. It is to be expressly understood, however, that each of the figures is provided for the purpose of illustration and description only and is not intended as a definition of the limits of the embodiments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a schematic cross-sectional view of a first exemplary embodiment.

[0010] FIG. 2 is a schematic cross-sectional view of a second exemplary embodiment.

[0011] FIG. 3 is a schematic cross-sectional view of a third exemplary embodiment.

[0012] FIG. 4 is a schematic cross-sectional view of a fourth exemplary embodiment.

[0013] FIG. 5 is a schematic cross-sectional view of a known cartridge filter.

[0014] FIGS. 6A-6C are graphs showing particle collection efficiency vs. particle size for the embodiments illustrated in FIGS. 1-3, respectively.

[0015] FIG. 6D is a graph showing particle collection efficiency vs. particle size according to the embodiment illustrated in FIG. 5.

[0016] FIG. 6E is a graph showing particle collection efficiency vs. particle size for a known filter setup, not shown in the drawings.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0017] Exemplary embodiments of the invention provide a filtration system for a ventilation hood including a first, or “primary” filter, which drains grease to a grease drain, and at least one second, or “secondary” filter located downstream of the first filter.

[0018] The terms “primary,” “secondary,” and “tertiary,” as used herein, refer to the relative placement of the filters within the ventilation hood. The secondary filter is positioned downstream of the primary filter, i.e. between the air outlet of the primary filter and the air outlet of the ventilation hood. Therefore, the air is filtered first by the primary filter, second by the secondary filter, and, in some embodiments, third by the tertiary filter. These terms are used throughout the specification to refer only to the relative positions of the filters within the ventilation hood. The “secondary” filter should not be construed as being subordinate to or less relevant than the “primary” filter, but only as being located in a second position. Likewise, the “tertiary” filter should not be construed as being subordinate to or less relevant than the “primary” or “secondary” filters, but only as being located in a third position.

[0019] As mentioned above, in some embodiments, the primary filter drains grease to a grease drain. One example of a filter for a ventilation hood that drains grease to a grease drain is the adjustable ventilator cartridge filter disclosed in U.S. Pat. No. 6,394,083 to Lamberton (the inventor of the present application), and shown in FIG. 5. A ventilation hood is disposed above one or more cooking units (not shown). The ventilation hood employs a fan (not shown) to remove the polluted air and exhaust it out of the kitchen, as generally indicated by the curved arrows. A cartridge filter is disposed in the upper rear portion of the ventilator to regulate the air flow through the hood. As seen in FIG. 5, the air enters the cartridge filter from one side and exits the filter on the other side in a controlled manner. It is noted that other arrangements are possible. A grease drain is disposed below the cartridge filter. The cartridge filter desirably has a substan-
entially open and unobstructed bottom so that grease does not accumulate inside the cartridge filter, but flows to the grease drain. In the embodiment illustrated in FIG. 5, the cartridge filter is inclined by about 45°, but other arrangements are possible.

[0020] The polluted air enters the filter at the topmost arrow and encounters two immediate direction changes forced by the configuration of the walls of the filter. These immediate direction changes start the segmenting of the heavier pollutants from the lighter air. The air flow then enters a high velocity corridor at the second arrow. The entire flow is sped up and then goes through a drastic turn of direction of about 180° at the third arrow. The high rate of air speed and the sudden change in direction facilitate grease extraction. The separated heavier pollutants are unable to follow the lighter air flow around the sudden change of direction at the third arrow. Thus the momentum of the grease carries it to the bottom of the cartridge filter where it impinges with the hood, and then drains into the grease trough provided in the ventilation hood.

[0021] Another example of a filter for a ventilation hood that drains grease to a grease drain is a bubble-type filter, such as that disclosed in U.S. Pat. No. 3,910,782 to Struble et al., the disclosure of which is hereby incorporated by reference.

[0022] Other grease-draining filters are within the scope of the appended claims.

[0023] The inventor of both U.S. Pat. No. 6,394,083 and the instant application has noted that the cartridge filter of U.S. Pat. No. 6,394,083 and FIG. 5 is very effective at preventing fires from traveling from the downstream portion of the filter to the upstream portion, as is required by UL Standard 1046. The grease that is filtered by the cartridge filter is drained rather than being stored inside the filter. In other words, the cartridge filter is an example of a “non-loading” filter, in that the grease does not load up within it. Therefore, if a fire enters the filter, there is very little grease inside of the filter to serve as fuel. The shape of the cartridge filter is also such that a flame cannot travel through the entire filter.

[0024] However, referring also to FIG. 6D, the filter of U.S. Pat. No. 6,394,083 and FIG. 5 is satisfactory at filtering out grease with a particle size of greater than about 5 µm, but less effective with smaller particles.

[0025] Therefore, embodiments of the present invention further include a second disposable or permanent filter, located downstream of the first filter, the second filter being permanently or removably attached to the first filter.

[0026] A recent change in the UL 1046 standard now allows for testing of so-called “multi-stage” filters. Materials that cannot and could not pass the fire safety requirement of the standard individually may be utilized if the filter assembly as a whole can pass the test. Less flame-retardant portions of the multi-stage filter must be attached to more flame-retardant portions so a user cannot erroneously install only the less flame-retardant portions.

[0027] Embodiments of the present invention thus provide a filtration system with both a primary and a secondary filter, where the primary filter is a very effective fire barrier, and the secondary filter is a very effective grease filter. The resulting combination provides superior performance in both respects. Because the primary filter is very effective as a fire barrier, the secondary filter is protected from potential fire damage. This allows the secondary filter to be made of materials that were previously considered unsuitable for use in a such a filtration system. This also allows the secondary filter to be a “loading” filter, i.e. to store the grease that has been filtered out within the filter. Embodiments of the present invention provide a primary filter that both blocks fire from spreading to the secondary filter, as well as filtering out many of the larger grease particles, which would otherwise load the secondary filter with a large amount of grease, leading to an increased risk of fire spreading, or even clog the secondary filter.

[0028] In some embodiments, the secondary filter is made, in whole or in part, of woven metal. The fineness or coarseness of the weave, size of the fiber, and material can be selected by a person of ordinary skill in the art based on the teachings herein to advantageously filter any desired particle size. For example and without limitation, the secondary filter may be stainless steel filter as manufactured by Smith, such as that disclosed in http://www.nationalfilter.sales.com/product.php?id=smith_filter_3020sn&product=100554&category=192 and http://www.netsupply.com/files/products/stainlessmesh.pdf, both provided as Appendix A, the disclosure of both of which is hereby incorporated by reference. Such an exemplary filter includes seven layers of corrugated stainless steel. Filter elements are processed from stainless steel sheets, expanded to 0.032 strand. Frames are made from stainless steel, no less than 0.024 thickness, joined with stainless steel rivets.

[0029] In other embodiments, the secondary filter is made, in whole or in part, of fibers, such as natural, synthetic, and/or hybrid fibers, with or without a stabilizer frame, such as, for example and without limitation, the filter disclosed in U.S. Patent Publication 2010/0071324 to Alexander et al., the disclosure of which is hereby incorporated by reference. In some embodiments, the secondary filter is made, in whole or in part, of wool fiber, such as, for example and without limitation, the filter disclosed in U.S. Pat. No. 6,293,983 to More, the disclosure of which is hereby incorporated by reference.

[0030] Other filters are within the scope of the appended claims.

[0031] FIG. 1 shows a first exemplary embodiment, in which the primary filter is a cartridge filter and the secondary filter is a woven metal filter. The secondary filter is attached to the primary filter at its downstream end, between the air outlet of the primary filter and the air outlet of the ventilation hood. In some embodiments, the secondary filter is attached to the primary filter in a modular form so that both filters can be removed together by a user for cleaning and/or disposal. The filters may be permanently or removably attached to one another. For example, the secondary filter may be disposable while the primary filter is not, or the secondary filter may desirably be disposed of more often than the primary filter. In these instances, the user can disconnect the two filters from one another to reuse one and dispose of the other.

[0032] In use, polluted air enters the primary filter, and many of the particles, such as those of a particular particle size, exit the ventilation hood through the grease drain, while others remain in the air. The less-polluted air then enters the secondary filter, where further particles become lodged in the secondary filter. The clean air then exits the ventilation hood.

[0033] FIG. 2 shows a second exemplary embodiment, in which the primary filter is a cartridge filter and the secondary filter is a fiber filter. The secondary filter is mounted to the primary filter at its downstream end, between the air outlet of the primary filter and the air outlet of the ventilation hood. As discussed above with reference to FIG. 1, the secondary filter may be permanently or removably attached to the primary filter.
Also illustrated in FIG. 2 is a sheet of perforated material, such as metal, immediately downstream of the fiber filter. This sheet may have a cross-section substantially identical in shape and size to the fiber filter, to act as a backing for the filter. It may be approximately 0.5 mm thick and made, for example, of stainless steel. The perforations may take any number or configuration that can be selected by a person of ordinary skill in the art based on the teachings herein, and may take up, for example, approximately 60% of the total cross-sectional area of the sheet. The percent open of the perforated sheet can be selected so as to enable efficient flow resistance behavior for the multi-stage filter system, to allow for enhanced grease capture while not adversely impacting the flow resistance of the multi-stage filter system.

In some embodiments, this perforated sheet provides resistance to the gaseous air flowing through the fiber filter, creating an additional static pressure drop across the fiber filter. This distributes the air flow more evenly throughout the filter, thus improving the grease extraction efficiency.

FIG. 3 shows a third exemplary embodiment, in which the primary filter is a cartridge filter and the secondary filter is a woven metal filter. This embodiment further includes a tertiary, fiber filter and associated perforated sheet. The secondary filter is attached to the primary filter at its downstream end, between the air outlet of the primary filter and the air outlet of the ventilation hood. The tertiary filter is also attached to the filter assembly, downstream of the secondary filter. As discussed above, the secondary and tertiary filters may be permanently or removably attached to the primary filter in modular form.

In use, polluted air enters the primary filter, where it is first filtered. The less-polluted air then enters the secondary filter, where it is further filtered. The still less-polluted air then enters the tertiary filter, where it is still further filtered. The clean air then flows through the perforated sheet and exits the ventilation hood.

While FIG. 3 shows the primary filter as a cartridge filter, the secondary filter as woven metal, and the tertiary filter as a fiber filter, other numbers and arrangements of filters are within the scope of the appended claims.

FIG. 4 shows a fourth exemplary embodiment, in which the primary filter is a baffle filter and the secondary filter is a fiber filter, with associated perforated sheet. The secondary filter is mounted within the ventilation hood downstream of the primary filter, between the air outlet of the primary filter and the air outlet of the ventilation hood. As discussed above, the secondary filter may be permanently or removably attached to the primary filter.

In use, polluted air enters the primary filter, where it is first filtered, and the less-polluted air then enters the secondary filter, where it is further filtered. The clean air then flows through the perforated sheet and exits the ventilation hood.

Particle collection efficiency for several exemplary embodiments is illustrated in FIG. 6. FIGS. 6A-6C show particle collection efficiency for the embodiments illustrated in FIG. 1-3, respectively. FIG. 6D shows particle collection efficiency for the prior art embodiment illustrated in FIG. 5. FIG. 6E shows particle collection efficiency for a known multi-stage filter, which utilizes a baffle filter as the primary filter, and a packed bed of porous ceramic media as the secondary filter.

As can easily be seen by comparing these Figures to one another, the embodiment of FIGS. 1 and 6A far surpasses the filter of FIGS. 5 and 6D at particle sizes of 2.5 μm and greater, and is comparable to the filter of FIG. 6E at particle sizes of 5 μm and greater. The embodiment of FIGS. 2 and 6B far surpasses the filter of FIGS. 5 and 6D at all particle sizes, far surpasses the filter of FIG. 6E at particle sizes between 1 and 3 μm, and is comparable the filter of FIG. 6E at particle sizes of 3 μm and greater. The embodiment of FIGS. 3 and 6C far surpasses the filter of FIGS. 5 and 6D at all particle sizes, far surpasses the filter of FIG. 6E at particle sizes between 1 and 2 μm, and is comparable to the filter of FIG. 6E at particle sizes of 2 μm and greater.

It should be clear from the foregoing that embodiments described herein provide superior filter systems that are very effective both at removing grease and at preventing fires. It should also be noted that some embodiments create much less static pressure than other devices attempting to achieve similar grease extinction levels. This requires less energy to remove more grease from the airstream.


As will be understood by those skilled in the art, the present invention may be embodied in other specific forms without departing from the essential characteristics thereof. Many other embodiments are possible without deviating from the spirit and scope of the invention. These other embodiments are intended to be included within the scope of the present invention, which is set forth in the following claims.

What is claimed is:
1. A filtration system for a ventilation hood, comprising: a cartridge filter configured to be mounted within the ventilation hood, comprising an air inlet, an air outlet, and a grease outlet, the cartridge filter being configured to drain grease through the grease outlet and out of the ventilation hood; and an additional filter configured to be mounted within the ventilation hood, operatively disposed downstream of the cartridge filter.
2. The filtration system of claim 1, wherein the cartridge filter is effective as a fire barrier.
3. The filtration system of claim 1, wherein the additional filter comprises a member selected from the group consisting of a woven metal, a corrugated metal, and a fiber.
4. The filtration system of claim 1, wherein the additional filter comprises a fiber, the system further comprising a perforated sheet configured to be mounted within the ventilation hood at a location downstream of the additional filter.

5. The filtration system of claim 4, further comprising a filter housing, configured to removably receive the filters, and comprising the perforated sheet.

6. The filtration system of claim 1, further comprising a third filter configured to be mounted within the ventilation hood, at a location downstream of the additional filter.

7. The filtration system of claim 1, wherein the filters are configured to be attached to one another.

8. A filtration system for a ventilation hood, comprising:
   a housing configured to be mounted within the ventilation hood,
   a cartridge filter configured to be mounted within the housing, comprising an air inlet, an air outlet, and a grease outlet, the cartridge filter being configured to drain grease through the grease outlet and out of the ventilation hood; and
   an additional filter configured to be mounted within the housing at a location downstream of the cartridge filter.

9. A ventilation hood, comprising:
   a cartridge filter mounted within the ventilation hood, comprising an air inlet, an air outlet, and a grease outlet, the cartridge filter being configured to drain grease through the grease outlet and out of the ventilation hood; and
   an additional filter mounted within the ventilation hood at a location downstream of the cartridge filter.

10. A filtration system for a ventilation hood, comprising:
    a first filter configured to be mounted within the ventilation hood, wherein the first filter is effective at filtering particles of a first particle size and less effective at filtering particles of a second particle size; and
    a second filter configured to be mounted within the ventilation hood, operatively disposed downstream of the first filter, wherein the second filter is effective at filtering particles of the second particle size;
    wherein at least one of the filters is effective as a fire barrier.

11. The filtration system of claim 10, wherein the first filter is effective at filtering large particles, and is effective as a fire barrier, and wherein the second filter is effective at filtering relatively smaller particles.

12. The filtration system of claim 11, wherein the first filter is effective at filtering particles of approximately 5 μm and larger, and less effective at filtering particles smaller than approximately 5 μm.

13. The filtration system of claim 11, wherein the second filter is not effective as a fire barrier.

14. The filtration system of claim 10, wherein the first filter comprises a cartridge filter.

15. The filtration system of claim 10, wherein the second filter comprises a member selected from the group consisting of a woven metal, a corrugated metal, and a fiber.

16. The filtration system of claim 10, wherein the second filter comprises a fiber, the system further comprising a perforated sheet configured to be mounted within the ventilation hood at a location downstream of the second filter.

17. The filtration system of claim 16, further comprising a filter housing, configured to removably receive the first and second filters, and comprising the perforated sheet.

18. The filtration system of claim 10, further comprising a third filter configured to be mounted within the ventilation hood, at a location downstream of the second filter.

19. A filtration system for a ventilation hood, comprising:
    a first filter configured to be mounted within the ventilation hood, comprising an air inlet, an air outlet, and a grease outlet, the first filter being configured to drain grease through the grease outlet and out of the ventilation hood; and
    a second filter configured to be mounted within the ventilation hood, operatively disposed downstream of the first filter.

20. The filtration system of claim 19, wherein the first filter is effective as a fire barrier.

21. The filtration system of claim 19, wherein the first filter comprises a cartridge filter.

22. The filtration system of claim 19, wherein the first filter comprises a baffle filter.