ABSTRACT

In an exemplary embodiment, this system is found within a kitchen hood, such as those found in restaurants, used to remove excess cooking heat and grease. Building fire safety and sanitation codes mandate routine hood maintenance to maintain fire safety, operator comfort and workplace sanitation. Conventional maintenance can be very messy, time consuming and quite expensive. In an exemplary embodiment, the hood is fabricated to incorporate an integral heat exchanger which further creates a trough housing a grease extraction device. The exchanger and trough are located in such a manner that collected heat and/or grease may be removed from the exhaust air stream and further fabricated to permit automatic and/or semi automatic cleaning of both devices and trough. This invention improves fire safety and sanitation, saves time and reduces maintenance costs. Cleaning is achieved using less energy and keeps the heat exchanger at peak efficiency to further enhance energy savings.
LINEAL SLOT VENTILATOR WITH INTERNAL CLEANING SYSTEM AND ADJUSTABLE BAFFLE

[0001] This application claims the priority benefit of U.S. Provisional Application No. 60/938,612, filed May 17, 2007, which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] 1. Field of the Invention

[0003] An exemplary embodiment of the invention relates generally to kitchen ventilation systems. Some exemplary embodiments of the invention may be useful in other applications. The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) provides definitions and guidelines for Commercial Kitchen Ventilation (CKV) in Chapter 31 of its Applications handbook. This chapter, entitled "Kitchen Ventilation," identifies hoods by Type and Style. Based on ASHRAE's definitions an exemplary embodiment of this invention can be identified as either a Type 1 or Type II hood construction, though its primary intended use may be as a Type I hood "used for collecting and removing grease and smoke". This hood may include grease removal devices such as baffle filters or removable extractors, or both. It may be designed to accept a fixed pipe fire suppression system. An exemplary embodiment of this invention can be used over cooking appliances such as ranges, fryers, griddles and broilers that produce smoke or grease-laden vapors.

[0004] 2. Description of Known Art

[0005] ASHRAE describes the grease removal devices for Type I hoods as 1) Baffle filters; 2) Removable extractors; and 3) Stationary extractors. Stationary extractors are used in water wash hoods and are not removables.

[0006] Stationary extractors are cleaned by spraying detergent and 180° F. hot water through a fixed pipe system that is connected to the hood, typically remote but always separate, water and detergent control panel to the piping manifold connection at the hood. The piping manifold then extends into and throughout the hood extraction chamber and terminates at multiple individual spray nozzles that are precisely located, sized and directed to spray all internal components that may come in contact with grease. These systems may also include pumps and/or other flow control devices to facilitate or direct water flow. Due to their complex nature, water wash systems add considerable expense to the hood. Water wash hoods typically cost 2 to 3 times more than identical hoods that do not have these cleaning systems. In addition, the mechanical and electrical complexities of the cleaning systems require sophisticated maintenance not typically available at the restaurant level. Water wash system nozzles also need routine maintenance to prevent them from clogging with grease, as well as a sophisticated siphoning system that injects detergent into the hot water (180°) line. The detergent must then be sprayed through the pipe and nozzle system. The detergent cycle is followed by a hot water rinse. A major national restaurant end-user of water wash hoods reported that its most recent survey found that the majority of its water wash systems were turned off or not functioning due to lack of, or improper, maintenance.

[0007] Due primarily to lower cost and less complicated maintenance conventional baffle filters and removable extractors are the most prevalent methods of grease removal found in kitchen hoods today. They are designed to be removed from the hood for cleaning. ASHRAE recommends the grease removal devices be cleaned "at least daily." A case-study field trial of an exemplary embodiment was conducted by the applicant and end-user to compare the manual daily cleaning of the extractors versus the daily soak-in-place cleaning system described herein. The trial involved (1) 10' long backshelf hood with removable extractors installed over (1) 36" gas griddle and (2) 36" gas under fired char broilers in a heavy-use fast-casual restaurant. The manual extractor cleaning process includes removing the extractors from the hood and soaking the extractors in a pot sink with a degreasing chemical solution for one hour to loosen the heavy grease. After soaking, the extractors are rinsed and then run individually through the kitchen dishwashing machine. The extractors are then re-installed in the hood. Due to the amount of grease from the extractors the dishwasher must be drained, cleaned and refilled and pot sinks must be cleaned. This process requires at least one employee and one manager's oversight and consumes 4 man-hours nightly. The amount of water used in the process may be calculated as follows. Although industry standard in size, the extractors require two 24"x24"x18" deep pot sinks to soak all of the devices simultaneously. At 0.1337 cu.ft. per gallon, the pot sinks require 88 gallons (44 gallons x 2) of hot water. The dishmachine is a conventional, small conveyor type, typical in many restaurants, with a wash tank capacity of 23 gallons and a rinse volume of 2 Gallons Per Minute. Assuming a 60 second rinse for each device and a total of six devices, the dishmachine will consume an additional 35 gallons of hot water. For this single 10' hood, this daily cleaning consumes 132 gallons water or more plus the energy to heat the water, the labor to remove and install the devices and the time required to clean the pot sinks and dishwasher.

[0008] This example also helps explain why hood grease removal devices are one of the last items cleaned at the end of the each night. The mess created during cleaning, the cost in time water and cleaners, and the last system cleaned also often leads to neglected cleaning. The neglect increases fire hazard, decreases sanitation and can lead to equipment malfunction and component damage. In many restaurants the daily handling, cleaning and/or abuse of baffle filters and/or extractors causes the devices to become damaged. This damage most often reduces the devices grease removal efficiency which decreases fire safety and of course reduces the useable life of the device.

[0009] Food service operators including those operating restaurants are faced with two first-cost hood grease removal decisions. Decision 1 is to increase the cost of the hood substantially by purchasing a hood with stationary extractor and automatic wash system, including the control panel, and sign on to the commitment for expensive more complex life-long maintenance. Maintenance that requires a trained technician not restaurant employees. Decision 2 involves a lower first cost and selects baffle filters or removable extractors that in many operations must be removed, cleaned and reinstalled each day. This cleaning not only shortens the life and effectiveness of the devices but also requires employees and managers who are typically ready to leave the restaurant at the end of their shift to stay in the restaurant long after customers and other employees have left the restaurant. Again this nightly maintenance requires additional time, cleaners, water and the associated expenses.
Regarding heat recovery, in 1996 the Canadian Gas Research Institute published its “Technology Review of Commercial Food Service Equipment”. According to the study, which evaluated facilities and equipment throughout Canada, “Of significance to this study’s objective, are the relative low efficiencies (e.g., 10-50%) for standard gas appliances under full load conditions. . . . Part load efficiencies for most appliances can easily be as low as half the full load cooking energy efficiencies . . . (e.g., 5-10% for gas appliances . . .).” Even though efficiency improvements have been made, commercial gas cooking appliances continue to waste large quantities of energy by generating heat that is not used in the cooking process and is instead exhausted through the kitchen hood and discharged to the atmosphere. Heat recovery in kitchen hood systems has therefore understandably been attempted in commercial kitchens due to this high energy use and low appliance efficiency. Various plate type exchangers and other air to air devices have been and continue to be used. Unfortunately grease is an excellent insulator and as grease collects on heat recovery devices their efficiency decreases. To maintain efficiency these devices require cleaning systems and routine use of these systems. These systems like the afore described stationary extractor cleaning systems require a separate fixed pipe detergent and hot water system and the associated water, water heating and detergent expenses. Like the stationary extractors cleaning systems these heat recovery systems also require technical support and expensive routine maintenance. The devices typically use aluminum or other light gauge material plates to maximize heat transfer and due to their construction are required to be located away from the hot cooking appliances in duct systems and are most often located on the roof or exterior of the building. Located further from the hood the devices see lower temperature but virtually the same grease loading. The cost to purchase, the lower heat content of exhaust air, cleaning and maintenance costs have greatly reduced the use of these energy saving devices.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an exemplary embodiment of the present invention in a vertical section through a commercial cooking hood and further includes a cooking appliance, exhaust duct and exhaust blower for aid in description of operation.

FIG. 2 shows an exemplary embodiment with airflow through the device indicated by arrows. FIG. 2 also shows the heat recovery chambers in this exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENT(S)

Considering the foregoing, an exemplary embodiment of the invention may provide an uncomplicated yet effective soak-in-place cleaning system for kitchen hood grease removal or heat recovery devices that has a lower first-cost, high reliability, is energy efficient and requires low-tech lower-cost maintenance.

U.S. Pat. No. 5,205,279 describes a Lineal Slot Ventilation System (LSVS) that includes an improved method of manually cleaning filter elements while they are in place within the hood. This method involves an external water source and nozzle to spray the filters and baffle and then removing and rotating them to achieve thorough cleaning. This method also requires the person cleaning the hood to access the lower chambers and baffles to complete effective cleaning. Although this is easier and more effective than removing devices for soaking and dishwasher cleaning, it still involves labor and time and requires management oversight at the restaurant to assure continued routine maintenance.

An exemplary embodiment of the invention improves and expands the cleaning feature of the aforementioned LSVS by creating a semi-automatic or automatic method of cleaning the grease removal devices and/or collection trough and/or air conduit and/or heat recovery components in the locations where they are installed in the hood during normal operation of the exhaust hood and cooking process. The components are not removed, relocated or reinstalled for cleaning.

FIG. 1 indicates an exemplary embodiment in the vertical cross section of the backshelf hood 2. The grease removal device 10 may be designed to extract grease from a column of air as it travels up through the vertical grease removal device which is located in the upper portion of trough 4. Trough 4 creates a conduit for exhaust air and is located in the lower portion of hood 2. Grease removal device 10 installs beneath the fill line 17. Exhaust air travels over the cooking appliance 1 and into the full length linear induction slot 3. The baffle 5 directs the exhaust air down into the trough and then, upon reaching the bottom of the baffle, turns 180 degrees up into the grease removal device 10 and then into the upper plenum 13 of hood 2. Trough 4 pitches from one end horizontally towards the opposite or lowest or drain end of the trough. The lowest end of the trough includes a drain connection 6 which is piped through a drain line 8 to the floor drain 9 and includes a shut-off valve 7. The trough further may include a water line connection 11 and water supply shut-off valve 12. In this exemplary embodiment, the operator may at the end of the cooking cycle turn off the exhaust blower 16, close drain valve 7 and then place a detergent into trough 4 through induction slot 3. Hot water shut-off valve 12 is then opened allowing water to fill the trough to fill line 17 at which time shut-off valve is closed. The valve system and fill line location transform the air carrying conduits created within the trough into a soak tank where all submerged components are fully exposed to the cleaning agents. All areas of the air conduit, baffle, trough and grease removal device are submerged and begin the soak clean process. The soaking process may continue until the next cooking process begins at which time the operator simply opens drain valve 7 and allows the trough to empty into floor drain 9, which is connected to the building grease trap which is located beneath the floor but is not shown in FIG. 1. The grease removal device may consist of one or more individual extractors that extend the full length of the hood in trough 4 and each may be constructed using horizontal baffles 18 which extend the full length of each extractor 10. Baffles 18 may pitch downwardly toward the bottom of the trough 4. For example, using linear slots within the extractor may make it possible to reduce the width of the extractor units and thereby relocate the units beneath the lower edge of the induction slot 3. Further interior grease extraction baffles 18 shown in FIG. 1 allow draining of collected grease from baffles towards the bottom of the trough 4 and further allow draining of soak system to carry grease from top of baffles into trough. Other variations are possible in other exemplary embodiments of the invention. For example this system can be made fully automatic simply by making the drain and fill valves solenoid valves and adding a...
simple start/stop timer. The timer may close the drain valve and actuate a relay that opens the water valve. A float may be added in the trough and said float may hold the water valve closed until the water is drained. In an exemplary embodiment the timer opens the drain valve when the set soak time has lapsed. When the water is drained, the float may reset itself such that it is ready to begin the next cycle. A cleaning solution may be added manually or through any of the several simple automatic dispenser systems that add chemicals to the dishmachine during wash and rinse cycles or are used to dispense solutions into pot sinks and other restaurant cleaning systems. Dispensing of the chemicals may be controlled by a timer. In addition a recirculating pump may be added to generate turbulence in the soak tank and thereby reduce the soak time required when using an automatic cleaning system.

[0017] Case-study field tests of the manual soak-in-place cleaning systems have also been conducted in the heavy-use char broiling application described in the preceding Description of Known Art paragraph 0005. For example the field tests demonstrate that the heavy broiling 10' hood required only 2 oz. of degreaser and 37 gallons of hot water provide complete nightly cleaning of the complete hood lower chamber including trough, baffle and grease extractors. The restaurant staff confirms the manual operation of an exemplary embodiment is considerably easier to use and more effective than their previous methods. This method was performed by a manager due to its simplicity and required 15-minutes at night to add cleaning agent and fill the trough with hot water and 5-minutes each morning to drain the system. The process of draining the hood interior soak tank proved that 37-gallons of water were adequate to create sufficient head pressure at the drain and within the tank to carry away heavy grease deposits and leave the tank and components virtually free of collected grease. Twenty-minutes each day represent a savings of 3.6 man hours saved each day. This exemplary embodiment also provided a considerable reduction in water used for nightly maintenance. Thirty-seven gallons versus 132 gallons or a daily savings of 95 gallons of water plus the associated reduction in energy required to heat the water, and a considerable reduction in the amount of degreaser used. Additionally, this submersion soak-in-place method proved to provide a more thorough cleaning of the grease removal devices, trough, baffle and all submerged surfaces than the previous manual cleaning methods described above. This greatly reduced the amount of grease that may be in the hood at any given time, which as grease can add fuel to a cooking fire reduces fire hazards. Whether manual or automatic, the management of the routine nightly maintenance is greatly reduced or even eliminated.

[0018] In an exemplary embodiment of this invention, a simple manual water supply and drain valve may replace multiple nozzles and water piping that would be required to achieve this level of cleaning using a stationary extractor water wash hood. An exemplary embodiment of this invention is also technically simple and may be serviced by a basic level technician doing normal restaurant appliance service.

[0019] Also, an exemplary embodiment of this invention may be used as an internal energy recovery system to improve grease extraction and enhance fire safety and save energy.

[0020] The field test study cited in the preceding Description of Known Art paragraph 0005 and also in the paragraph 0015 cleaning case study is also used here as an energy example here. In this example, the 10' backshelf hood covers three cooking appliances including (1) 36" griddle with a 128,000 BTU input and (2) 36" char broilers with a combined 210,000 BTU input. The exhaust airflow for this hood is 2,440 CFM. This combined input of 338,000 BTU can raise the temperature of 2,440 CFM by 127.6°F. Assuming room air entering the hood system at 72°F and 95% part-load (non-cooking) efficiency, the air that enters the hood in FIG. 2 induction slot 3 can be raised to 193°F. Cooking flare-ups can periodically raise the temperature of the air entering the hood induction slot to more than 400°F. At these temperatures, there is considerable opportunity for energy recovery; however, the air is contaminated with grease and not suitable for conventional heat recovery methods such as heat pipes or light gauge aluminum air to air heat exchangers. A unique design of an exemplary embodiment of this invention may utilize the area 19 behind the cooking appliances as a path of travel for the exhaust air. An exemplary embodiment may also place the induction slot 3 very close to the cooking surface 20. With conventional canopies or backshelf hoods, a much larger area separates the cooking surface and the exposed filter or extractor. As the effluent rises and mixes with room air, it quickly reduces the temperature and, in typical applications, has cooled to 150 degrees or less, thus decreasing the effectiveness of remote energy recovery devices. To capitalize on the proximity of the hood to the cooking surface and maximize energy transfer, an exemplary embodiment of this invention may include water conduits 21 formed into the trough walls, base and internal baffle. Other suitable configurations may be possible in other exemplary embodiments. In the 10' hood example cited above, this could provide more than 73 square feet of available transfer area. As the heat transfer takes place, the temperature of the exhaust airstream is reduced and the water temperature increased. The water may then be piped to be carried off to remote coils during cold weather to preheat outdoor air or year round for preheating of hot water systems. Also as the temperature is reduced; the vapor can begin the process of condensing into larger particles. Some condensing will occur as the airflow contacts the cooler surfaces of the water-carrying structure. The increase in particle size will increase the grease removal efficiency of the grease extractors. The surfaces of the water carrying conduits located on the interior of the trough 4 will be cooled by the water they transport and will have grease condense on their surfaces. The soak-in-place cleaning system that is used to remove the grease for fire safety and sanitation purposes will also clean the heat recovery surfaces each cleaning cycle. A separate cleaning system for heat recovery is not required, no additional energy is required to heat cleaning water and no additional cleaning agents are required. An exemplary embodiment soak-in-place cleaning system combined with an exemplary embodiment for heat recovery place the heat recovery mechanism as close as possible to the heat source thus maximizing the opportunity for heat recovery without any additional energy being required for cleaning to maintain efficiency.

[0021] Any embodiment of the present invention may include any of the optional or preferred features of the other embodiments of the present invention. The exemplary embodiments herein disclosed are not intended to be exhaustive or to unnecessarily limit the scope of the invention. The exemplary embodiments were chosen and described in order to explain some of the principles of the present invention so that others skilled in the art may practice the invention. Having shown and described exemplary embodiments of the present invention, those skilled in the art will realize that...
many variations and modifications may be made to affect the described invention. Many of those variations and modifications will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.

What is claimed is:

1) A system for cleaning kitchen hood grease removal and/or other devices by submersion and/or soaking without removal from the hood or position in which they are installed for normal operation, said system comprised of:
   a. A linear air induction slot located above the grease removal devices.
   b. A full length trough that creates a conduit for airflow from the induction slot to the grease removal devices.
   c. A tapered bottom of the full length trough that enhances natural drainage of grease and cleaning agents by creating a pitch to a drain device.
   d. A full length baffle that diverts exhaust airflow from the induction slot down into the trough and then up into the grease removal device.
   e. A drain that communicates between the pitched bottom of the trough and a floor drain.
   f. A connection to a grease trap through the hood drain for removal of collected grease.
   g. A valve to close the hood drain.
   h. A fill trough fill line to set a level required for soak in place cleaning of all components and surfaces.
   i. The design of the interior components that permits installation beneath the fill line and maintains airflow and grease removal functions.
   j. A method of introducing cleaning agents through the induction slot.
   k. A method of using gravity and pressure of water head to drain grease deposits from a soaking chamber within a kitchen hood.

2) A kitchen hood grease extraction device that may be installed within a kitchen hood and is designed to be soaked cleaned without removal and further designed to drain collected grease vertically down within the holding device or air stream conduit comprised of:
   a. One or more individual grease removal devices to be installed within the trough of the hood.
   b. Grease removal devices that include downwardly pitched horizontal baffles designed to drain grease and wash water or cleaning agents into bottom of the trough.
   c. Individual grease removal devices that may be removed from the hood for replacement of inspection.
   d. A mounting system for grease removal devices that permits installation and support of grease removal devices without the use of tools.

3) A heat exchanger that is integral within kitchen hoods and forms portions of the hood body creating an air stream conduit and/or holding device for grease extraction and/or cleaning systems and is comprised of:
   a. Interior chambers in grease hood airflow trough that extend the full length of the hood induction slot and transport heat recovery fluids.
   b. Interior chambers in grease hood airflow trough that extend the full length of the hood exhaust trough and transport heat recovery fluids.
   c. Interior chambers that extend horizontally and/or vertically within the hood and transport heat recovery fluids.
   d. Interior chambers that are designed to carry a heat recovery fluid such as air, water or other fluid.
   e. Interior chambers in a grease hood that are connected to a supply source of heat recovery fluids.
   f. Interior chambers in a grease hood that are connected to an outlet or outlets to remove the heat recovery fluid after it has been exposed to the heated exhaust airflow.
   g. Chambers that include at least one wall in direct contact with exhaust airflow into or through the ventilator.
   h. Chambers that include at least one wall designed to be an integral portion of the hood structure.
   i. Chambers that are designed to be installed as close as possible to the cooking heat source.
   j. Chambers that are designed and constructed of stainless steel or other materials that may withstand the heat of cooking.
   k. Chambers that are designed and constructed of stainless steel or other materials that may withstand open flame or actual cooking flare-ups, or grease fire without adding to the fire or decreasing fire safety.
   l. Chambers that are designed and constructed of stainless steel or other materials that may withstand exposure to grease fire without adding to the fire or decreasing fire safety.

4) The system of claim 1 that further includes automatic water fill system.

5) The system of claim 1 that further includes an automatic drain system.

6) The system of claim 1 that further includes an automatic cleaning agent dispensing system.

7) The system of claim that further includes a recirculating pump to induce turbulence and decrease soak time.

8) The system of claim 1 where vertical extraction devices remove grease from airflow and drain grease into lower trough.

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