[54] METHOD AND APPARATUS FOR TREATING DISHWASHER DISCHARGE

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[56] References Cited

UNITED STATES PATENTS
3,598,131 8/1971 Weihe, Jr.................. 134/107
3,144,872 8/1964 Kearney.................. 134/104 X
3,266,502 8/1966 Copeland................. 134/107 X

FOREIGN PATENTS OR APPLICATIONS
712,150 10/1941 Germany.................. 134/107

[57] ABSTRACT

In a dishwasher of the type in which racks of dishes are carried through a series of washing and rinsing stations, the hot, moisture laden air emitted by the dishwasher is directed over a series of cooling coils to both cool the air and remove by condensation a substantial portion of the moisture. The cooled, dried air is then exhausted to ambience. Relatively cool tap water is utilized in the cooling coils with the water passing from the coils to the first stage of the dishwasher for use in washing dishes. A valve regulates water flow to the cooling coils and is controlled by the same switch which actuates the final rinse stage of the dishwasher so that additional cooling capacity is gained during the final rinse stage. An adjustable opening is also provided for admitting ambient air into the apparatus for mixture with the air from the cooling section to prevent a build-up of condensate in the sections of the apparatus downstream of the cooling section.

24 Claims, 6 Drawing Figures
METHOD AND APPARATUS FOR TREATING DISHWASHER DISCHARGE

BACKGROUND OF THE INVENTION

Dishwashers, particularly those of the commercial type designed to handle high volumes of dishes on a more or less continuous basis, tend to generate considerable amounts of hot, moisture laden air which must be removed from the dishwasher area to ensure the health and comfort of personnel in that area and to prevent damage and deterioration to the physical facilities themselves. In one form of dishwasher of this type dirty dishes are stacked in racks which are moved by a conveyor through several stages in the dishwasher, each stage being separated by flexible dividers so that the racks of dishes deflect the dividers as they pass from one stage to the other. For purposes of illustration the invention and its background will be described in conjunction with a dishwasher of the type shown in U.S. Pat. No. 3,267,944. It will be apparent, however, that the invention is also applicable to other types of dishwashers, as shown for example in U.S. Pat. Nos. 2,644,473 and 2,884,935.

Generally, the first stage will be a prewash or scrubbing stage, wherein the larger food particles are removed, followed by a power wash for effecting a complete cleaning of the utensils contained in the rack. The power wash is then followed by a power rinse and this in turn may be followed by a final rinse. The temperatures in the dishwasher will generally increase from one stage to another with the initial stage having a temperature of approximately 115°F and the final rinse stage having a temperature of approximately 180°F.

In the first three stages the washing and rinsing water is recirculated through appropriate screening mechanism, while in the last stage a supply of fresh, hot water is utilized. To economize on the amount of fresh water used in the final rinse stage a switch is usually provided at this point which is actuated by the entry of dishes, or a dish rack, into the final rinse stage to energize the final rinse nozzles. Additionally, because of the relatively higher temperatures at this stage of the dishwasher and because the racks of dishes are ejected from this stage out of the dishwasher, the emission of hot, moisture laden air from the dishwasher is usually greatest at this point.

While it is possible to operate a dishwasher of this type without making provision for the disposal of the hot moisture laden air emitted by the washer, as a practical matter some attempt is usually made to ameliorate this problem. Probably the most common approach is to provide a collection hood adjacent the exit end of the dishwasher to collect the hot steamy air and direct it by means of appropriate ductwork from the dishwasher area to a point outside of the building. This, of course, usually necessitates alteration of the physical structure in which the dishwasher is located. Additionally, there are problems of damage to the ductwork by corrosion and the collection of moisture within the ductwork adjacent bends therein and the entrance thereto.

More recently, attempts have been made to accommodate the hot steamy air from a dishwasher by passing this discharge through filters and directing a counterflow of cold water in opposition to the flow of the dishwasher discharge to, in effect, scrub the dishwasher discharge of moisture and cool it. Another system which has been used involves the installation over both the entrance and exit ends of the dishwasher of collection hoods which then direct the discharge from both ends of the dishwasher through horizontal ducts containing cooling coils extending the full length of the dishwasher to a central point from whence the discharge is exhausted from the system.

Obviously, it is desirable to provide a system for removing moisture from dishwasher discharge while cooling the discharge, and preferably this system should be readily adaptable to existing installations with a minimum of expense and alteration of existing equipment or building construction. Also, it is desirable that such a system should require as little maintenance as possible while yet efficiently performing its desired function. It will also be seen that because space is usually at a premium in installations where such dishwashers will be utilized, it is highly desirable that such units be as compact as possible.

SUMMARY OF THE INVENTION

The present invention provides a system for treating the hot steamy discharge from dishwashers, particularly of the commercial type, which is extremely efficient and utilizes compact equipment requiring relatively little maintenance.

Apparatus in accordance with the present invention includes a heat exchanger which is positioned adjacent the exit end of the dishwasher through which is directed the hot steamy discharge from the dishwasher. Upon entering the heat exchanger the discharge passes vertically upwardly over a series of cooling coils to both cool the discharge and reduce the moisture content thereof by condensation. The cooled, dried air is then drawn through a connecting chamber and into a pumping chamber, where a centrifugal blower directs the air downwardly by means of a scrolled baffle to a plenum chamber from which the cooled, dried air is exhausted to the ambience.

It has been found that by providing a flow of additional air into the connecting chamber to mix with the air from the heat exchanger, condensation within the connecting chamber, the pumping chamber and the plenum chamber can be eliminated. Thus, the air exiting from the heat exchanger will be at a lower temperature than the ambient air in the dishwasher room and it will also be at approximately 100 percent relative humidity. It will be seen that under these conditions there will be a marked tendency for moisture to condense from the air coming from the heat exchanger upon even the smallest decrease in temperature. However, by mixing some of the warmer, ambient air with the saturated air from the heat exchanger, the temperature of the mixture will be greater than the temperature of the air from the heat exchanger. This increase in temperature, of course, results in an increase in the dew point of the mixture, or, stated another way, in a decrease in the relative humidity of the mixture. Therefore, an opening is provided into the connecting chamber, adjustable in area, to provide the necessary flow to prevent condensation in those portions of the apparatus downstream of the heat exchanger. As a practical matter mixture or ambient air with the cooler saturated air from the heat exchanger will result in a lowering of the relative humidity of the mixture to approximately 80 percent.
Tap water is used as the cooling medium flowing through the cooling coils of the heat exchanger and the outlet from the cooling coils is directed back to the dishwasher to supply make-up water thereto. The now heated coolant, as well as the warm condensate which is also preferably directed back to the dishwasher, not only supply some of the dishwasher water but lessen the heat that would ordinarily be required.

The inlet to the cooling coils is controlled by a first, pressure responsive valve which provides a substantially continuous flow of cool water through the cooling coils whenever the dishwasher is in operation, with such valve being conveniently controlled by the main switch for the dishwasher itself. A second valve is utilized to provide an additional flow of cooling water through the cooling coils and this valve is preferably controlled by the same switch which controls the final rinse nozzles, this switch being actuated by the passage of articles into the final rinse stage as noted above.

Thus, actuation of the final rinse nozzles which, as noted above is responsible for the greatest emission of hot, moisture laden air, also increases the cooling capacity of the heat exchange section by increasing the flow of cooling water through the cooling coils thereof. Therefore, in addition to the economies effected by utilizing the cooling water and condensate in the dishwasher, further economies are effected by limiting the maximum flow of cooling water to only those times when the final rinse stage of the dishwasher is in operation.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-sectional view through a dishwasher and apparatus for treating a discharge therefrom;

FIG. 2 is an enlarged view of a portion of the apparatus of FIG. 1;

FIG. 3 is a perspective view of the discharge treating apparatus per se;

FIG. 4 is a somewhat schematic showing of the cooling water flow system and the control therefor;

FIG. 5 is a cross-sectional view taken on line 5—5 of FIG. 2; and

FIG. 6 is a cross-section view taken on line 6—6 of FIG. 2.

As noted above, for purposes of illustration a dishwasher of the type shown in U.S. Pat. No. 3,269,944 will be described although it will be apparent that the present invention finds utility in other types of dishwashers, as shown for example in U.S. Pat. Nos. 2,644,473 and 2,884,935, as well.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. 1 of the drawings a dishwasher is shown which includes a housing, referenced in its entirety by the numeral 10, divided into sections 12, 14 and 16 by the flexible dividers 18. Dividers 18, of conventional construction, may each comprise a series of narrow strips which serve to segregate each of the sections from each other but which are readily deflected by the passage of dish racks through the dishwasher machine. In this regard it will be noted that conveyor means, indicated somewhat diagrammatically at 20, serve to convey the racks 22, each of which contains the plurality of dishes 24, through the dishwasher in a stepwise manner.

As the racks enter the section 12, the overhead nozzles 26 and the lower nozzles 28 scrub from the dishes, etc., carried by the racks 22 any large food particles which remain after a preliminary scraping by dishwasher personnel. Water from the nozzles 26 and 28 collects in the sump 30 from which it is recirculated back to the nozzles for reuse. A screen member 32 is positioned between the dish rack and the sump to collect any food particles or the like which are scrubbed from the dishes by the nozzles and an outlet 34 continuously bleeds water from the sump 30 to prevent an excessive buildup of solid particles in this sump.

From the initial prewash stage 12 the dishes next pass into a power washing section 14 similar in all respects to the section 12 except for the temperature of the washing water, which is somewhat higher, and the fact that liquid from the sump 36 of the section 14 is directed back to the sump 30, as indicated somewhat schematically at 38. From the section 14 the dishes are conveyed into the section 16 where a third set of overhead nozzles 26 and stationary nozzles 28 provide a power rinse of water somewhat higher in temperature than in the previous two stages.

Section 16 is also provided with a sump 38 from which liquid is recirculated to the nozzles 26 and 28 and from which liquid is bled back into the sump 36 by means of the connecting line 42. In addition to containing the third or power rinse stage, section 16 also incorporates a final rinse stage wherein a supply of fresh hot water is ejected from the nozzles 44 and 46 onto the racks and their contents just prior to their being conveyed from the dishwasher. As noted above, the temperatures of the washing and rinsing water increase from one end of the dishwasher to the other with the temperature in the first of prewash stage being approximately 115°F. and that in the final rinse stage being approximately 180°F.

A switch, indicated somewhat schematically at 48, is provided in the final stage and is actuated by contact with a rack of dishes to actuate the final rinse nozzles 44 and 46. Since the final rinse nozzles utilize fresh, rather than recirculated water, actuating these nozzles only when articles are passing thereby effects considerable savings in heat and water.

Much of the structure described above is conventional in construction and is merely set forth for purposes of illustration to indicate one environment in which the present invention may be used. For example, the dishwasher may be of the single or double tank type and not use a system of reverse drainage. Regardless of the specific dishwasher construction, however, in accordance with the present invention a hood 50 is mounted adjacent the exit from the dishwasher for collecting a substantial portion of the hot, steamy air discharged from the final stage of the dishwasher.

Hood 50 directs this discharge upwardly over a series of vertically arranged coils which constitute a heat exchanger 52 surrounded by an enclosure 54. Extending continuously with respect to the enclosure 54, as best seen in FIG. 2, 5, and 6, are a pumping chamber 56 and a plenum chamber 58. The pumping chamber 56 and the enclosure 54 are interconnected by a connecting chamber 60 extending between the upper ends of the heat exchanger and the pumping chamber and placing them in fluid communication.

A top wall 62 of the connecting chamber 60 has means defining an opening 64 therethrough, the open
area of which may be controlled by a circular plate member 66 attached by means of a bolt or the like 68 to the top wall of the chamber. A motor 70 is mounted in the plenum chamber with the shaft thereof extending through the wall 72 separating the plenum chamber 58 and the pumping chamber 56 to drive a centrifugal blower 74 mounted in the pumping chamber.

Also mounted within the pumping chamber 56 is a scroll 76 extending spirally about the centrifugal blower 74 and terminating adjacent an opening 78 formed through the wall 72 and interconnecting the chambers 56 and 58. Power to the motor 70 may conveniently be by means of a line 80 leading into a junction box 82 with the input to the junction box being indicated at 84 and controlled by any suitable means. In this regard control of a motor 70 might be tied in with the master switch for the dishwasher so that the blower is automatically actuated when the dishwasher is turned on.

With reference to FIGS. 1, 2 and 4, it will be seen that a pipe 86, connected to any convenient source of water such as a supply tap, leads to a T-connection 88 which in turn leads to parallel branch lines 90 and 92, the flow through which is controlled by solenoid actuated valves 94 and 96, respectively. Lines 90 and 92 are rejoined at a T-connection 98 which feeds a cool water inlet 100 to the cooling coils of the heat exchanger 52.

At the lower end of the heat exchanger an outlet 102 extends downwardly and, as seen in FIG. 1, feeds into the sump 30 of the initial stage of the dishwasher. It will also be noted from FIGS. 1 and 2 that a collecting tray 104 is positioned immediately beneath the heat exchanger in the hood 50. Additionally, the plenum chamber 58 is provided with a plurality of louvered outlets 105 placing the interior of the plenum chamber 58 in communication with ambience.

In operation, the dishwasher is activated by means, such as a switch 106, to cause the washing nozzles in each of the sections 12, 14 and 16 to be energized and the conveyors 20 to begin moving racks of dishes and the like through the dishwasher. Conveniently the control for the motor 70 and the valve 96 can also be tied into the master switch 106 for the dishwasher so that activating the dishwasher causes the centrifugal blower to begin drawing air through the system and allows a flow of cool tap water through the lines 86, 92 and 100 to the heat exchanger.

As the racks and/or dishes move through the various sections of the dishwasher the dishes, utensils, etc. carried by the racks are subjected to washing operations which may be of the type described above for purposes of illustration, although, as noted previously, the construction and operation of the dishwasher per se may be simplified considerably and still use the present invention for treating the discharge therefrom. Regardless of the specific dishwasher, used, however, a switch will usually be provided, actuated by passage of the dishes to energize a rinsing stage. Thus, in the dishwasher described for purpose of illustration, the racks of dishes contact the switch 48 which actuates the final rinse nozzles 44 and 46 to spray the contents of the racks with high temperature rinse water.

The hot moisture laden air which escapes the dishwasher from the downstream end thereof, particularly as the last divider 18 is pushed aside by the passage of the rack of dishes therethrough, is drawn partly by convection and to a great extent through the influence of the centrifugal blower 74, into the hood 50. From the hood 50 the hot moisture laden air is drawn vertically upward over the vertically arranged cooling coils of the heat exchanger 52 in generally countercurrent flow to the downward passage of cool tap water through the cooling coils.

By arranging the coils vertically the condensate is allowed to drain better. Also there is a purging action caused by the downward flow of condensate. Thus, any impurities which collect on the coils, particularly the lowermost coils which are contacted first by the discharge from the washer, tend to be washed off by the condensate flow downwardly over the vertically arranged coils.

As noted above, actuation of the switch 48 also opens the valve 94 to supplement the flow which continuously feeds the inlet 100 through the valve 96. This supplemental flow then increases the cooling capacity of the heat exchanger at the time of peak load, i.e., when the last and hottest rinse stage is in operation. As the cooled discharge exits the heat exchanger 52 it is drawn through the connecting chamber 60 and thence downwardly into the center of the centrifugal blower 74.

From the blower 74, as indicated by the arrows in FIGS. 5 and 6 of the drawings, the discharge is directed in a somewhat spiral path by the scroll 76 to the openings 78 and thence, downwardly into the plenum chamber 58 from which it is exhausted through the louvered openings 105 into ambience. Since the air has been significantly cooled in passing through the heat exchanger and this cooling also has the effect of removing moisture by condensation, the cooled, dried discharge may then be directed back into the room in which the dishwasher is operating.

Since section 12 is the first section in a dishwasher of the type described above, the buildup of solid particles in the sump 30 thereof tends to be somewhat more rapid than the succeeding sections. Therefore, to reduce the solids content of this section the outlet from the heat exchanger is directed back into the sump 30. Since the water flowing from the heat exchanger has been heated by the passage of the hot discharge over the coils of the heat exchanger the heat requirements for raising this water to the proper temperature for the stage 12 are considerably less than if tap water was fed directly into this stage. Condensate which collects in the heat exchanger will collect in the condensate tray 104 and it may also be directed back into the dishwasher in any convenient manner.

Despite the fact that a considerable portion of the moisture carried by the discharge from the dishwasher is removed in the heat exchanger 52 there is still sufficient moisture in the discharge after leaving the heat exchanger to cause some collection thereof by condensation in the pumping and plenum chambers. It has been found, however, that by providing a source of additional air into the system the tendency for condensate to collect in the pumping and plenum chambers is eliminated. Thus, as noted above the mixing of warmer ambient air with the saturated air from the heat exchanger lowers the relative humidity of the mixture and decreases the amount of condensation otherwise experienced in the chambers 56 and 58. Therefore, the opening 64 is provided in the top wall 62 of the connecting chamber 60 and the effective open area of the opening 64 is adjusted with the cover 66 to give the minimum
flow necessary to prevent the buildup of condensate in the chambers 56 and 58.

From the above it will be apparent that the present invention provides a system for treating the hot, moisture laden discharge from the dishwasher which permits the return of the discharge directly in the room in which the dishwasher is located without deleterious effect on the personnel in the area or the condition of the surrounding equipment.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention.

What is claimed is:

1. Apparatus for treating the discharge of hot steamy air from a dishwasher to reduce the temperature and moisture content thereof comprising:
   a. a heat exchanger including coil means,
   b. means for directing a cooling liquid through said coil means,
   c. means for drawing the discharge of hot steamy air from a dishwasher through said heat exchanger to cool said discharge and remove moisture therefrom,
   d. means downstream of said heat exchanger for admitting to said apparatus additional air for mixing with said discharge to form a mixture thereof, and
   e. means for directing said mixture to ambience.

2. The apparatus of claim 1 further comprising:
   a. means for directing cooling liquid from said coils to a dishwasher for use as a washing liquid.

3. The apparatus of claim 1 wherein said means for directing cooling liquid through said coil means comprises:
   a. first valve means for selectively admitting a continuous flow of said cooling liquid to said coil means, and
   b. second valve means for admitting additional cooling liquid to said coil means in response to a control signal received from a dishwasher with which said apparatus is associated.

4. The apparatus of claim 1 further comprising:
   a. means for collecting condensate from said heat exchanger and directing said condensate to a dishwasher.

5. Apparatus for treating the discharge of hot steamy air from a dishwasher to reduce the temperature and moisture content thereof comprising:
   a. a heat exchanger including cooling means,
   b. means defining an axially extending enclosure surrounding said heat exchanger,
   c. a pumping chamber extending contiguously to said enclosure,
   d. a connecting chamber interconnecting an end of said enclosure to an end of said pumping chamber,
   e. means in said pumping chamber for drawing the discharge of hot steamy air from a dishwasher through said heat exchanger, said connecting chamber and said pumping chamber,
   f. means defining an opening from said pumping chamber, and
   g. means for admitting to said apparatus a selected flow of additional air for mixture with the discharge of air from a dishwasher.

6. The apparatus of claim 5 wherein said means for admitting additional air comprises:
   a. means defining an opening into said apparatus downstream of said heat exchanger, and
   b. means for controlling the open area of said opening.

7. The apparatus of claim 5 wherein:
   a. said cooling means includes coil means for carrying a cooling liquid through said heat exchanger,
   b. means for admitting a continuous flow of cooling liquid to said coil means, and
   c. means for admitting an additional flow of cooling liquid to said coil means.

8. The apparatus of claim 7 further comprising:
   a. means for controlling the admission of said additional flow of cooling liquid in response to the energization of a cycle in a dishwasher with which said apparatus is associated.

9. The apparatus of claim 5 wherein:
   a. said cooling means includes coil means for carrying cooling water through said heat exchanger, and
   b. means for directing said water from said coil means for use in a dishwasher with which said apparatus is associated.

10. Apparatus for treating the discharge of hot steamy air from a dishwasher to reduce the temperature and moisture content thereof comprising:
    a. a dishwasher having initial and final stages,
    b. a heat exchanger including cooling means positioned adjacent said dishwasher,
    c. means for directing the discharge of hot steamy air from said final stage through said heat exchanger,
    d. means for mixing additional air with said discharge to form a mixture thereof, and
    e. means for exhausting said mixture from said apparatus.

11. The apparatus of claim 10 further comprising:
    a. means for directing cool water through said cooling means, and
    b. means for directing said water from said cooling means to said dishwasher for use therein in washing.

12. The apparatus of claim 11 wherein said means for directing said water to said dishwasher further comprises:
    a. means for directing said water to said initial stage of said dishwasher.

13. The apparatus of claim 10 further comprising:
    a. means for directing a continuous flow of cooling liquid to said cooling means, and
    b. means for directing an additional flow of cooling liquid to said cooling means.

14. The apparatus of claim 13 further comprising:
    a. valve means controlling said additional flow of cooling liquid, and
    b. switch means in said dishwasher controlling said valve means.

15. The apparatus of claim 10 further comprising:
    a. means for directing condensed moisture from said heat exchanger to said dishwasher.

16. Apparatus for treating the discharge of hot steamy air from a dishwasher to reduce the temperature and moisture content thereof comprising:
    a. a heat exchanger including coil means,
    b. first valve means for selectively admitting a continuous flow of cooling liquid to said coil means,
c. second valve means for admitting additional cooling liquid to said coil means in response to a control signal received from a dishwasher with which said apparatus is associated, and
d. means for drawing the discharge of hot steamy air from a dishwasher through said heat exchanger to cool said discharge and remove moisture therefrom.

17. The apparatus of claim 16 further comprising:
a. means for directing said cooling liquid from said coils to a dishwasher for use as a washing liquid.

18. The apparatus of claim 16 further comprising:
a. means for collecting condensate from said heat exchanger and directing said condensate to a dishwasher.

19. Apparatus for treating the discharge of hot steamy air from a dishwasher to reduce the temperature and moisture content thereof comprising:
a. a dishwasher having initial and final stages,
b. a heat exchanger including cooling means positioned adjacent said dishwasher,
c. means for directing a continuous flow of cooling liquid to said cooling means,
d. means for directing an additional flow of cooling liquid to said cooling means in response to a control signal received from said dishwasher, and
e. means for directing the discharge of hot steamy air from said final stage through said heat exchanger.

20. The apparatus of claim 19 further comprising:
a. means for directing said cooling liquid from said cooling means to said dishwasher for use therein in washing.

21. The apparatus of claim 20 wherein said means for directing said water to said dishwasher further comprises:
a. means for directing said water to said initial stage of said dishwasher.

22. The apparatus of claim 19 further comprising:
a. valve means controlling said additional flow of cooling liquid, and
b. switch means in said dishwasher controlling said valve means.

23. The apparatus of claim 19 further comprising:
a. means for directing condensed moisture from said heat exchanger to said dishwasher.

24. Apparatus for treating the discharge of hot steamy air from a dishwasher to reduce the temperature and moisture content thereof comprising:
a. a heat exchanger including a vertically arranged stack of spaced cooling coils,