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MANUFACTURE OF VINEGAR

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INVENTOR

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This invention relates to a process and apparatus for the manufacture of vinegar in comparatively large types of vinegar generators by the so-called continuous circulation method.

One object of this invention is to provide for the systematic elimination, by cooling the infusion mash, of the thermal disturbances arising with such large generators. A further object is the provision of various refinements which otherwise improve the production and yield and facilitate supervision.

It is a feature of the invention that the reaction in the lower portion of the generator is assisted by the development of a higher temperature than obtains in the upper portion of the generator. This is a distinct departure from processes hitherto used in which the temperature in the lower portion of the generator is so low as to materially reduce or eliminate reaction at this point. Furthermore, the lower temperature at the upper portion of the generator reduces loss of alcohol and vinegar by evaporation, thus effecting economy and rendering the apparatus less objectionable to the community in which it is located.

The present process is particularly adapted for application to generators of large capacity. The known processes of vinegar fermentation limit the size of the generator since it is found that a considerable increase in size results in a comparatively small increase only in the production capacity, so that the increased cost of the large generators renders them unsatisfactory for commercial operation.

Thus, whereas the capacity of generators heretofore constructed have been limited in general to 500–1000 gals., generators built to operate in accordance with the teachings of the present invention and having a capacity of over 1,000 gals. are found to be extremely efficient from a commercial standpoint, and may be increased in capacity to 15,000 gals. and more.

The accompanying drawing illustrates one form of the apparatus diagrammatically in elevation.

1 is a vinegar generator in the lower part of which a grid 2 is mounted. Below the latter is a collecting space 3 for the alcoholic liquid or mash to be converted into vinegar, whilst above the same rests a filling material 4 composed of vinegar chips or shavings, corncobs and the like. 5 indicates one of the air inlets.

A continuously working pump 9 draws mash from the collecting space 3 and forces it through a flow-control valve 11 into a cooler 12. Cooling water enters the cooler by a pipe 13 and leaves at 14. The cooled mash passes through a pipe 15 into a sparger wheel 16 which is mounted in the upper part of the vinegar generator 1 and is rotated in known manner by the reaction caused by liquid flowing therefrom.

This sparger-wheel is of novel construction inasmuch that all the arms do not, as is otherwise usual, commence to discharge liquid simultaneously. On the contrary at first, so long as the flow of liquid entering is relatively weak, the discharge of liquid takes place from a single arm 16. Only when the rate of flow exceeds a certain limit, does a siphon 17 commence to supply a second arm 16. This arrangement ensures a perfect distribution of the infusion liquid at both the practical minimum and maximum rates of flow. The number of sparger arms may be increased as desired.

About 2000 calories per litre of alcohol are liberated in the oxidation of the mash flowing down through the chip filling 4. This would cause immediate overheating of the filling and serious interference with the fermentation of the vinegar. Consequently provision must be made for the withdrawal of the heat evolved. This is performed in
the cooler 12, referred to above, through which the mash must pass in its continuous circulation.

Investigation of the continuous method of vinegar-fermentation has shown that control of the infusion temperature is not alone sufficient for the attainment of maximum yields any more than control of the rate of infusion alone. Rather must these two factors be appropriately co-ordinated. The regulation of the infusion temperature and rate of infusion by hand would however necessitate considerable supervision of the working of the generator. To avoid this, thermal regulating devices, depending upon the expansion of liquids, the automatic closure of electrical contacts or like principles are provided in the upper and lower parts of the generator filling. An upper thermal regulator 18 acts through an operative connection upon a valve 19 in the cooling water-pipe 13. A lower thermal regulator 20 controls, also through an operative connection, a valve 21 in the mash pipe. The regulator 18 controls the infusion temperature. If this temperature is lower than the optimum value, said regulator closes the water valve 19, but if the infusion temperature becomes too high said regulator opens the valve 19 and brings about cooling of the mash.

With the fermentation proceeding properly, the generator filling exhibits its maximum temperature in the lowermost third; since this temperature cannot be exceeded without impairing the fermentation of the vinegar, the thermal regulator 20 is provided in this lowermost zone. Said regulator however, does not directly control the infusion temperature but the rate of infusion, the regulating valve 21 in the mash-pipe being opened if the temperature in the lowermost zone of the filling rises too high. When this happens the mash flowing through the valve 11 is augmented through the valve 21. Nevertheless the temperature of the uppermost zone of the filling is not raised because, on increasing the rate of infusion and thereby increasing the infusion temperature, the regulator 18 at once opens the cooling water valve 19 to a greater extent and re-establishes the set optimum temperature. If an attempt were made to compensate for too high a temperature in the lowermost chip zone by reducing the infusion temperature while maintaining the rate of infusion constant, under-cooling of the upper chip-zone would result and consequently weakening of the vinegar fermentation in said zone.

Because the infusion temperature remains constant, it is possible to control the progress of the acidification areometrically. As the finished vinegar has a higher specific gravity than the alcoholic mash and as, normally, vinegar of the same final strength is always produced and also the extract contents of the vinegar scarcely varies in regular manufacture, consequently, the temperature remaining constant, the conditions necessary for areometric indication of the progress of the acidification are fulfilled. An areometer or hydrometer 22 arranged in the infusion pipe 15 rises in the liquid as the acidification progresses and on the attainment of an adjustable maximum, that is when the acidification is finished, closes an electrical contact, calling attention by a bell signal, light signal or the like to the necessity for recharging the generator with mash.

The oxidation air enters the generator through the pipes 5 arranged below the grid 2, flows upwardly through the filling 4 and leaves the apparatus through a large regulating valve 23. The valuable alcohol and acid vapours contained in said air as it leaves may be separated in known manner by spraying with atomized water, this being performed in condensers 24, 24', any number of which may be arranged in series, cooled by cold water atomized under pressure from nozzle 25. The used air leaves the condensers through a waste-air pipe 27 and a head piece 28 mounted thereon. The cooling of the circulated hot mash may also be performed elsewhere than in the external cooler 12, for instance by a cooler arranged in the collecting space 3, this arrangement, however, gives a less efficient utilization of the water. Furthermore, the temperature control need not be performed by thermal regulators in the generator-filling. Such devices may also be arranged, but with less effect, at other points; for example, in the regulating valve 21. The pump delivery pipe 15 and the regulator 20 in the pump suction pipe between 3 and 9.

When bringing a cold vinegar-generator not yet in fermentation into operation, the cooler 12 may serve for heating up the infusion liquid. For this purpose a device for warming the water, such as a boiler, gas furnace or the like, is arranged in the water pipe 13, the cooler 12 thereby becoming a preheater.

From the foregoing it will be appreciated that the regulation both of the heat exchange unit or temperature control device and the flow control means forms an essential feature of the invention and makes it possible to economically operate a generator by continuous recirculation of the mash therethrough as distinguished from an arrangement in which the mash is passed once through the generator and the finished product immediately obtained. In the claims appended to the specification this dual regulation is described by the term "independent" in order to make it quite clear that it is not the intention to cover an arrangement in which a flow control device only is used and in which the variation of flow would probably result in an
20 incidental change in the temperature. It will be appreciated, however, from the specification that separate means are provided for regulating the temperature, such as a cooler, and for regulating the infusion of liquid, such as a flow control valve, and that these regulating devices are not ordinarily adjusted in any definite and predetermined relation. Thus the regulation of the heat exchange unit and the regulation of the rate of flow may be separately effected and to this extent the control of the two devices may be described as independent.

I claim:

1. The process of manufacturing vinegar in a generator, comprising circulating and recirculating an infusion liquid through the generator filling, regulating the temperature of the liquid thus circulated, and independently controlling the rate of temperature regulation and the rate of circulation of the liquid in accordance with the conditions of temperature within the generator.

2. The process of manufacturing vinegar in a generator, comprising circulating and recirculating an infusion liquid through the generator filling, regulating the temperature of the liquid thus circulated, and independently controlling the rate of temperature regulation and the rate of circulation of the liquid in accordance with the temperatures in the vicinity of the inflow and outflow zones respectively of the filling.

3. A process of manufacturing vinegar in a generator, comprising circulating and recirculating an infusion liquid through the generator filling, cooling the liquid thus circulated with a fluid refrigerant, and controlling the rate of said cooling by independently varying the cooling effect of the refrigerant and the rate of circulation of the infusion liquid in accordance with temperature conditions within the generator.

4. A process of manufacturing vinegar in a generator, comprising circulating and recirculating a mash through the generator filling, cooling the mash thus circulated with a fluid refrigerant, controlling the rate of said cooling by varying the cooling effect of the refrigerant in accordance with variation in the temperature in the vicinity of the inflow zone of the filling and controlling the rate of circulation of the infusion liquid in accordance with the temperature in the outflow zone of the filling.

5. Apparatus for manufacturing vinegar by the recirculation process, comprising the combination with a generator, of a cooler means affording a fluid path forming with said generator and said cooler a complete circuit, control means associated with said cooler for varying the cooling effect thereof, control means in the circuit for varying the rate of flow therein, and heat responsive devices associated with the generator and operatively connected with said control means, whereby the rate of flow in the circuit and the rate of heat exchange in the cooler may be regulated in accordance with temperature conditions in the generator.

6. Apparatus for manufacturing vinegar by the recirculation process, comprising the combination with a generator, of a cooler means affording a fluid path forming with said generator and said cooler a complete circuit, control means associated with said cooler for varying the cooling effect thereof, control means in the circuit for varying the rate of flow therein, a thermal regulating means associated with the inflow end of the generator and operatively connected with said first named control means, and a second thermal regulating means associated with the outflow end of the generator and operatively connected with said second named control means.

7. Apparatus for manufacturing vinegar by the recirculation process, comprising the combination with a generator, a circulation pump and a cooler employing a fluid refrigerant connected to form a closed circuit, control means for said cooler for varying the cooling effect thereof by regulating the rate of flow of the refrigerant, a thermal regulating means associated with the inflow end of the generator and operatively connected with said control means, flow-control means in said circuit for varying the rate of flow therein, and thermal regulating means associated with the outflow end of the generator and operatively connected with said flow control means.

8. Apparatus for manufacturing vinegar by the recirculation process, comprising the combination with a generator, of a fluid passage for withdrawing the mash from the lower portion of the generator and reintroducing the mash in the upper portion of the generator, a device operable for controlling the rate of flow of the mash, a heat exchange device for varying the temperature of the mash independently of the operation of said first named device, and a rotary distributing device in the upper portion of the generator connected with said fluid passage, said distributing device comprising a plurality of arms having delivering openings therein, whereby discharge of mash from said distributing device effects rotation thereof, and means for delivering mash from said passage to an increased number of said arms as the rate of flow of mash is increased.

9. Apparatus for manufacturing vinegar by the recirculation process, comprising the combination with a generator, of a fluid passage for withdrawing the mash from the lower portion of the generator and reintroducing the mash in the upper portion of the generator, a device operable for controlling the rate of flow of the mash, a heat exchange device for varying the cooling effect thereof, control means in the circuit for varying the rate of flow therein, and heat responsive devices associated with the generator and operatively connected with said control means, whereby the rate of flow in the circuit and the rate of heat exchange in the cooler may be regulated in accordance with temperature conditions in the generator.
device for varying the temperature of the mash independently of the operation of said first named device, and a rotary distributing device in the upper portion of the generator connected with said fluid passage, said distributing device comprising a plurality of arms having delivery openings therein, whereby discharge of mash from said distributing device effects rotation thereof, and means for delivering mash from said passage to an increased number of said arms as the rate of flow of mash is increased, said last named means including overflow delivery passages associated with the respective arms.

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