UNITED STATES PATENT OFFICE

2,012,668

CONCENTRATION OF LIQUORS IN MULTIPLE EFFECT AND APPARATUS THEREFOR

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Application January 18, 1934, Serial No. 707,227
In Great Britain January 19, 1933

5 Claims. (Cl. 159—20)

This invention relates to an improved method for the thickening or concentration of trade liquors, and to the construction of plant in which this may be accomplished.

6. A principal object of the invention is to render a method more efficient and continuous, and to make the construction of the plant less expensive particularly by the saving of the wet air pump which has been usual to employ in such a plant and which is of considerable size, being both costly as regards instalment and maintenance, owing to the difficulty of maintaining the said air pump efficient when dealing with condensate, including acid or other chemical contents which cause deterioration of the working surfaces.

The principle used according to this method is that by passing the liquor to be concentrated through a series of low temperature heating and separating units from which the final vapour is removed from a cooled condenser, a draught through the interconnecting series is obtained; by means of an independent steam injector or injectors, one of which in communication with the condenser is applied to the last heater unit, the heat of the steam is moderated by the air and the non-condensable gas entrained from the cooled condenser, and at the same time the draught through the system is maintained by the heater in the condenser assisted by the action of the injected steam.

The accompanying drawing, Fig. 1, illustrates a plant with two large heaters and two small heaters, the heaters being in series and each being provided with a circulating or vapour separator. This figure is to some extent diagrammatical in order to elucidate the working of a complete plant.

Fig. 2 shows in detail the connection between the condenser D and the heater D and the air vessel 21.

Fig. 3 is a detail view of the injector V2.

Fig. 4 is a section view of the connection between the heater A and the heater B; and

Fig. 5 shows a pair of heaters arranged in parallel.

Described shortly, liquor is supplied from a vat 1 to the first heater A, and passes through the tubes thereof in the form of liquor and vapour.

The vapour on reaching the first separator B being separated from the liquor which is thus concentrated and the concentrated liquor deposited at the bottom of the separator, from which part runs back through the heater and a part passes on to the next heater through the tubes of which it rises, while the vapour and/or air also containing moisture passes by a pipe 8 from the first separator to the space outside the tubes of the second heater, B. There being no specific heat supplied to this second heater B which is at a reduced pressure condensation of the vapour would take place on the outside of the tubes 25 so as to heat the tubes to a lesser degree than those in the first heater, but sufficient to again cause evaporation of the liquor within the tubes, the condensate running down to the lower tube plate, and being carried away by a pipe 9 therefrom.

The same process is repeated through the further heaters, say a third and a fourth; from the final separator attached to the fourth heater, the concentrated liquor is drawn off by a pump and delivered to a tank, while the hot vapour and air pass through the condenser on the lower tube plate of which the condensate, which is mostly waste water, collects, while the air and non-condensable vapour having now reached a cool temperature is delivered by entrainment with the steam; the air and non-condensable vapour undergoes a final cooling in condenser J and is returned through the pipe 14 being entrained with the steam through the injector V3 to the heating space of the last heater D. This delivery serves to create a suction through the whole plant including the condenser at the same time that the heat and the steam operating the injector is moderated in the heating of the last heater. A delivery pipe from this last heater carries the air back to the steam stream of an injector supplying heat to the first heater, being again useful in moderating the heat supplied thereto.

Liquor is supplied from a vat or other container 1 through a cock 4a to a pipe 1 leading to the base 3 of the first tubular heater A and rises in tubes 4, where it is heated by steam from injectors V1 and V3 supplied with steam from a suitable source, such as waste exhaust steam, for example from an engine if available at 25 lbs. pressure per square inch, or a higher pressure steam. The heated liquor is evaporated and the liquor mixed with vapour passes up through the tubes 4 and the collector head A1 to the first separator E wherein the vapour is separated off from the liquor by reducing the temperature and pressure and the concentrated liquor deposited, a part of which returns to the base 3 of the first heater A through a pipe 5 and the remainder passes on to the base of the second heater B over a pipe 1. The hot vapour and air separated off in the first
Separator E flows through a pipe 8 to the tubes of the second heater B and by heat exchange the concentrated liquor in the tubes of the second heater B is evaporated at a lower temperature and passed into the second separator F for further separation of vapour from liquor; the air and vapour applied to the second heater B condensing on the tubes thereof so as to create a vacuum in the previous heater and the condensate running down the tubes, collecting on the lower tube plate 4a from which it is withdrawn into a pipe 5, by suction from a condenser J hereafter referred to.

Further concentration of the liquor at a gradually reduced temperature and pressure is obtained by continuing the process through to the third heater C and separator G and finally to the fourth heater D and separator H, from which the liquor in highly concentrated form is withdrawn through a pipe 10 by a pump P, driven by an engine-driven pulley K, and is delivered over a pipe 11 to a tank 12.

Heating of the last heater D is effected primarily by a steam injector V2 supplied with steam at a suitable temperature and pressure in accordance with the conditions to prevail in the last stage, the injector being connected to an air-expansion vessel 13 connected by a pipe 14 to the tubular condenser J through the tubes of which flows cooling water from a high level supply tank 15. The vapour and gases resulting from the separation in the fourth separator H are delivered over a pipe 16 to the condenser J, wherein the condensate collects on the lower tube plate, and the air and non-condensable gases pass to the steam stream from the injector V2 through the vent pipe 14, and entrain with the steam into the heating space of the last heater D.

By this entrainment, suction or vacuum is created and maintained in the condenser and through the whole plant and at the same time the steam being delivered to the last heater D is tempered or moderated to suit the low temperature conditions of the last stage.

The injector V3 of the first heater A is connected by a pipe 17 to the fourth heater D, so that the air and other non-condensable gases mainly originating from the heater J are entrained with the steam stream passing from the injector V3 and thereby tempers and modifies this steam according to the required condition in the first stage. Similarly the injector V1 is connected by a pipe 18 to the pipe 8 leading from the separator E to the heater B, so that the steam passing from the injector V1 entrains with it part of the vapour in the pipe 8 and is also moderated. Thus very effective control of the heat applied to the heater A is obtained, the condensate and air accumulating in the heater A being discharged to atmosphere through a steam trap 19 by means of the slight pressure resulting from the steam introduced into the heating space of the heater A by the injectors V1 and V3. This pressure in the heater A may be as low as 1½ lbs. per square inch, the steam expanding down to the pressure which may be measured by the pressure gauge P.

The condensate collecting on the lower tube plate 4a of the heating chambers of the heaters B, C and D is withdrawn by suction from the condenser J over the pipes 9, passing through air vessels 20, 21, which in regulating the flow of the condensate ensure effective de-aeration of the intermediate and final heaters and provide a means of utilizing the heat of the condensate as it passes through the tube chambers of the heaters over the tube plate 4a.

Continuous withdrawal of the condensate from the condenser J is effected over a pipe 22 by a so-called tail pump P1 driven from the engine-driven pulley K, both pumps P and P1 being of small power.

With regard to the operation of the separators E, F, G and H suction is formed therein by connection of pipes 9 with the condenser and by the heat exchange between the liquor passing through the tubes of the next heater and the vapour surrounding the said tubes to make a suitable vacuum and temperature gauges PTG being provided at the top of each separator.

Preferably the average temperature of the first separator A will be about 220° F. at a vacuum of about 5½" h and will gradually decrease from separator to separator to 125° F. at a vacuum of about 26", or according to the liquor being treated.

According to the invention there is thus provided a process of thickening or concentrating liquors, which is continuous and is effected at low temperatures, preferably below atmospheric boiling point and gradually reduced throughout the stages of the process; a point which is particularly advantageous in preserving the quality and colour of the liquors.

Moreover by utilizing the steam both for heating and creating the suction throughout the plant gives a considerable saving in expense; a four heater plant having a 2400 square feet heating surface will give an evaporative output of about 800 gallons per hour and a steam consumption approximating 2000 lbs. per hour when concentrating acid bleached glue liquor from about 5% to 50% of glue in water; and the driving power saved will approximate to 6 B. H. P.

The apparatus and method according to the invention is applicable for concentrating trade liquors, such as milk, whey, gelatine, glue, lactic acid, tannic extract, apple, lemon, grape and tomato juices, vitamins, sugar, waste sulphite pulp cooking liquor, and liquors of a colloidal nature including slaughterhouse blood for conversion into valuable adhesive.

Fig. 5 shows an arrangement of heaters in parallel (i.e., with parallel temperatures). Referring to the drawings the heater M is illustrated as the heater A of Fig. 1 and is connected as regards its inter-tubular space with a steam trap 26a by means of a pipe 16a, while the heater N corresponds to the heater D of Fig. 1 and is connected in similar fashion to the condenser J, except that the pipe 34 from the injector V2 is carried up through the base of the vapor separator H to near its outlet to the pipe 16.

The Injector V3 is connected as before with the first heater M and the pipe 33 connects it as in the larger plant with the outlet of the inter-tubular space of the heater N. The pipes 26 and 26 apply steam as before and the liquor is supplied by the tank 1 introduced through the pipe A5.

In operation the heater M is used for pre-heating the weak liquor, while the heater N in connection with the vapour separator H is used for liquor boiling and is connected as before with the condenser J and its evacuating accessories. As shown in Fig. 5 the moderated heating is done by the steam ejector V2 and the ejector V1 is dispensed with in view of there being only two heaters in the plant.

The ejector V2 is connected to the condenser J through the expansion air vessel 13 in order to
produce the vacuum suction through the plant, whilst the air exhaustion from the steam chamber N is operated by injector V3.

The relatively small amount of steam flowing through the latter injectors and condenses whilst passing through the preheating in M, with the air along with the condensate water escaping through the pipe 19 to a steam trap 20a. Working in this way 23" of vacuum can easily be contained in the condenser J and at the liquor boiling point, whilst a vacuum of about 14" is maintained in the steam chamber of the heater M.

The other connections to the condenser are the same as in the plant shown in Fig. 1.

The relative sizes of the heaters described in these drawings is not material; although some are shown smaller than the others, they may be all of the same size.

I claim:

1. The combination in a liquor concentrating plant of a plurality of heaters, each having a tubular liquid compartment and a heating space surrounding same, an injector supplying steam to the heating space of the first heater, a vapour separator connected to the liquid compartment of the last heater, a cooling condenser, an injector supplying steam to the heating space of the last heater, an air expansion vessel in communication with the said separator and with the vapour space of the said condenser, a passage connecting the said air expansion vessel through the heater units for the removal from the latter of the condensate, a pipe connection from the last heater to the first heater including a supplemental steam injector, a steam trap, and a pipe connection from the first heater to the said steam trap.

2. A liquor concentrating plant having in combination a series of heaters, each having a tubular liquid compartment and a heating space surrounding same, an injector supplying steam to the heating space of the last heater, a separator connected to the liquid compartment of each heater, a liquid conduit leading from the vapour space of each separator to the liquid space of the succeeding heater and a vapour conduit leading from the vapour space of each separator to the heating space of the succeeding heater, a cooling condenser, the vapour space of the latter communicating at one point with the vapour separator of the last heater of the series, and at another point with the said injector, means for conducting the air vapour contents of the last heater space to the first heater unit, a pump for the removal of the concentrated liquor from the final vapour separator and for pumping it to a receiving tank, and a steam trap for withdrawing the condensate from the condenser, whereby the process of concentration is rendered continuous.

3. In combination in a liquor concentrating plant a series of tubular heaters, a vapour separator connected by a collector with the tube space of each heater, a tubular passage leading from the top of each separator to the space surrounding the tubes of a succeeding heater, a tubular cooling condenser, a passage connecting its interspaces with the last vapour separator, a water supply to the condenser tubes, an air expansion vessel in communication with the inter-tubular space of the condenser, a steam injector in a communicating passage between the said expansion vessel and the inter-tubular space of the last heater, a pipe connecting the said spaces with the interspaces of the first heater, passages connecting each vapour separator with a collecting space communicating with the tubular space of two adjoining heaters, means for removing the concentrated liquor from the final separator, and means for withdrawing the condensate from the condenser.

4. In combination in a liquor concentrating plant a series of tubular heaters, a vapour separator connected by a collector with the tube space of each heater, a tubular passage leading from the top of each separator to the space surrounding the tubes of a succeeding heater, a tubular cooling condenser, a passage connecting its interspaces with the last vapour separator, a water supply to the condenser tubes, an air expansion vessel in communication with the inter-tubular space of the condenser, a steam injector in a communicating passage between the said expansion vessel and the inter-tubular space of the last heater, a pipe connecting the said spaces with the interspaces of the first heater, passages connecting each vapour separator with a collecting space communicating with the tubular space of two adjoining heaters, means for removing the concentrated liquor from the final separator, and means for withdrawing the condensate from the condenser.

5. In combination in a liquor concentrating plant a pair of heaters, each having a tubular liquid compartment and a heating space surrounding same, an injector supplying steam to the heating space of the second heater, a vapour separator connected to the liquid compartment of the second heater for circulating flow, an air expansion vessel, a cooling condenser, the vapour space of the latter communicating at one point with the vapour separator of the second heater and at another point with the said air expansion vessel, a passage communicating between the air expansion vessel and the said injector, a passage communicating between the said injector and the vapour space of the vapour separator, a passage including a second steam injector connecting the inter-tubular space of the first heater with the inter-tubular space of the second heater, a liquid passage between the two heaters, a connecting passage from the inter-tubular space of the condenser through the air vessel to the condensate collecting space of the second heater, a steam trap in communication with the inter-tubular space of the first heater, and means for removing the concentrated liquor from the said vapour separator and the condensate from the said condenser respectively.

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