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METHOD IN EVAPORATION OF WASTE LIQUOR DISCHARGED FROM CONTINUOUSLY OPERATING CELLULOSE DIGESTER OR BOILER

Filed Aug. 9, 1966 Sheet 1 of 2

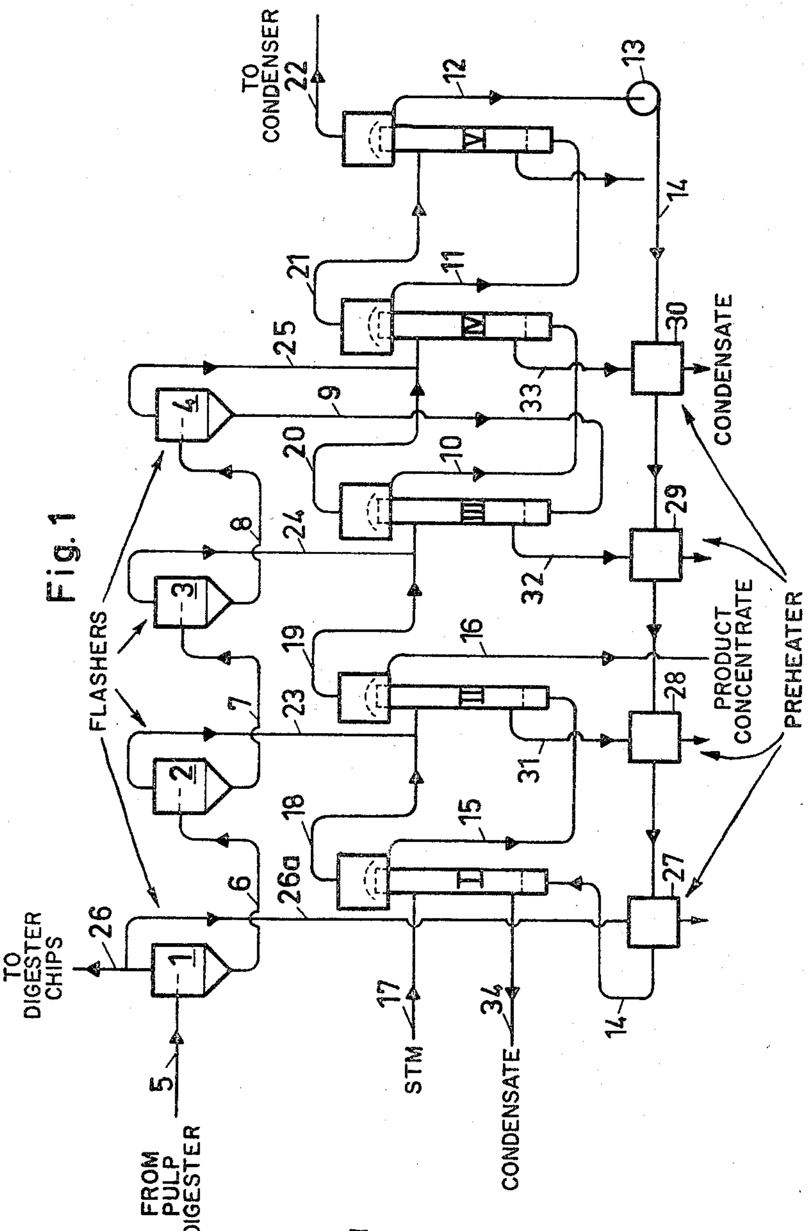

Fig. 1

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Fig. 2

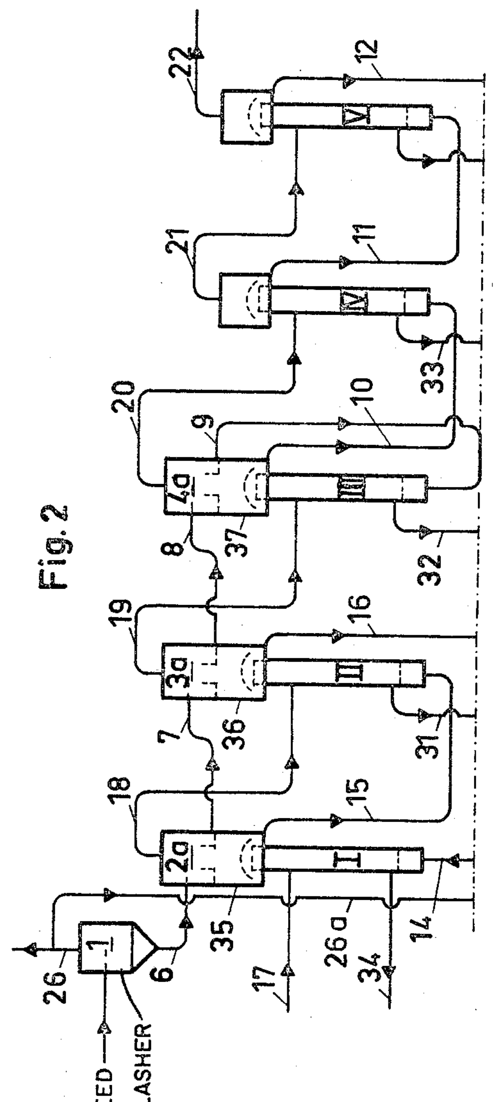
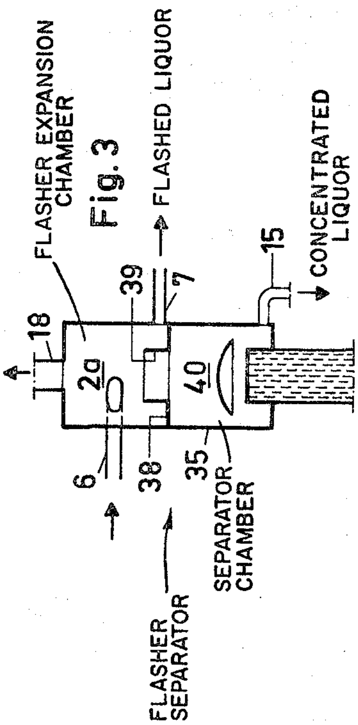


Fig. 3



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METHOD IN EVAPORATION OF WASTE LIQUOR DISCHARGED FROM CONTINUOUSLY OPERATING CELLULOSE DIGESTER OR BOILER

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U.S. Cl. 159—47 1 Claim
Int. Cl. B01d *1/26*

ABSTRACT OF THE DISCLOSURE

The method relates to evaporation of waste liquor or lye discharged from a continuously operating cellulose digester or boiler which operates at high pressure and at high temperature, i.e. the liquor being in the state in which it leaves the digester after completion of the pulping process. More particularly the method relates to the case, in which the liquor after pre-evaporation according to the flash-expansion principle will be evaporated further in an indirect evaporator of multiple effect type.

According to a known method for this purpose, the liquor, which for example can be obtained at a pressure of about 8 atmospheres superatmospheric pressure and at a temperature of about 170° C., will first be subjected to a preliminary evaporation by reduction of the pressure in two successive expansion stages, to the effect that in the first stage liquor vapor of a temperature of about 140° C. suitable for alkalinization of the digester chips will be obtained and utilized for this purpose. In the second expansion stage, from which the liquor or lye will be drawn off and stored in a tank for subsequent final evaporation, the pressure will be reduced further, so that the lye will get a temperature of for example about 100° C., which is considered to be a suitable temperature for storage as well as a suitable supply temperature for the final evaporation process, the lye vapor produced, having a corresponding temperature, being withdrawn through a condensor. The final evaporation process is effected in an indirect multiple stage evaporator, which in its first stage is heated by freshly generated steam and in each one of its subsequent stages is heated by lye vapor from an immediately preceding heating stage.

In the first place the invention aims at effecting such cooperation between the pre-evaporation of the multiple expansion stage type and subsequent evaporation stages, that all vapor liberated in the pre-evaporation during the expansion stages following upon the first stage of evaporation will be utilized as heating vapor during subsequent evaporating operations in a most efficient manner in order to reduce the need for freshly generated steam, while the vapor from the first evaporation stage can be utilized separately, for example for the alkalinization mentioned and/or for other purpose.

The invention is primarily characterized by the fact that the lye vapor or liquor vapor formed is conducted as an additional heating vapor from each expansion stage, with the exception of the first one, to the said heating stage according to the rule: from the second expansion stage to the second heating stage etc. in turn to the extent that there are any further expansion stages and

heating stages, the last expansion stage, which supplies the pre-evaporated liquor to some of the heating stages of the multiple evaporator except the last one being adapted to supply additional heating vapor to the next following heating stage.

The invention will be more particularly disclosed with reference to the accompanying drawings; in which

FIGS. 1 and 2 respectively each illustrate in the form of a flow diagram a modification of an evaporation installation for performing the method according to the invention, and

FIG. 3 illustrates part of the installation according to FIG. 2.

Identical parts in the different figures are provided with the same reference characters. All figures are schematic and are only intended to serve as examples without restricting influence.

In FIG. 1 the liquor from the digester (not shown in the figure) flows through the intake conduit **5** and the connecting conduits **6**, **7**, **8** and **9** and through expansion vessels **1**, **2**, **3** and **4** in the sequence now stated.

I, II, III, IV and V are the different heating stages of an indirect multiple stage evaporator of substantially conventional design, through the liquor chambers of which the liquor flows from the last expansion vessel **4** in the sequence III, IV, V, I and II through the connecting conduits **9**, **10**, **11** and **12**, the circulation pump **13**, the connecting conduits **14** and **15**, and the discharge conduit **16**. Stage I will hereby be fed with freshly generated vapor or steam as heating medium through conduit **17**, while the subsequent stages II, III, IV and V are supplied with liquor vapor as heating medium from the immediately next preceding stage through the vapor conduits **18**, **19**, **20** and **21** respectively; the liquor vapor from stage V being withdrawn to a condenser (not shown in the figure) through the conduit **22**. As known, such an evaporator, the pressures in said conduits and the chambers communicating therewith will fall from one conduit to the next conduit in the sequence stated. Due to the fact, that the vapor chambers of the expansion vessels **2**, **3** and **4** communicate with said vapor conduits **18**, **19** and **20** respectively, through conduits **23**, **24** and **25**, respectively, corresponding differences will be maintained between the pressures in these vessels. The same result will be obtained, if the expansion vessels communicate directly with a chamber, communicating with the vapor conduits stated, for example the expansion vessel with the vapor heating chamber in stage II through conduit **23** or with the liquor vapor chamber of stage I etc.

As a result the hot liquor from the digester, on passing through the expansion vessels will supply vapor under stepwise reduction of pressure, this vapor serving as additional heating vapor and being discharged from the expansion stages **2**, **3** and **4** through the conduits **23**, **24** and **25** respectively, to the heating stage II, to the heating stage III, and to the heating stage IV, whereby the liquor thus pre-evaporated will be conducted through the connecting conduit **9** to the liquor chamber or space of heating stage III at least approximately at the pressure and temperature conditions prevailing in that chamber.

By a suitable degree of throttling in the liquor conduit **6** from the expansion vessel **1** the fall of pressure in the first expansion stage will be limited, so that the vapor there produced which is conducted through the conduit **26** to be utilized for the heat treatment of the digester chips, will get a sufficiently high temperature. Any excess of such vapor for this purpose is conveyed through the branch conduit **26***a* as a heating medium to a preheater **27** for the liquor conveyed through the conduit **14.** In this conduit also additional preheaters **28, 29** and **30** are arranged which are heated by condensate from the heating stages II, III and IV through conduits **31, 32** and **33** respectively. From a pure heating technics standpoint, one could of course imagine alternatively to convey such excess vapor as an additional heating vapor to heating stage I, for example to the fresh steam-conduit **17,** but in this case the discharged condensate of the fresh steam, which should be utilized as feed water, would be contaminated. In this connection it should be pointed out that the expression "fresh-steam" should be understood as relating to the vapor, which yields a condensate of sufficient purity for this purpose, disregarded from the fact from what source it is delivered, for example directly from a steam generator or in the form of drawn off steam from a turbine or any other installation.

In such an installation according to the invention the steam consumption will be about 150 kilos per 1000 kilos evaporated water, while a conventional 5-stage evaporator consumes approximately 250 kilos of steam for the same amount of evaporation. If combined with pre-evaporation in two stages of expansion and condensation of the thereby produced vapor in accordance with the known method indicated above, only a very modest improvement can be obtained, viz. about 220 kilos per 1000 kilos of evaporated water. Thus, the improvement of the steam economy achieved by means of the invention is important.

The installation according to FIG. 2 differs from that according to FIG. 1 only insofar as the expansion vessels **2, 3** and **4** according to FIG. 1 have been replaced by expansion chambers **2***a*, **3***a* and **4***a* in the steam and liquid separators **35, 36** and **37** respectively of the heating stages I, II and III, most clearly illustrated in FIG. 3, so that the previously used steam conduits **23, 24** and **25** could be omitted.

By means of an intermediary bottom **38** with steam piping **39** the separator, for example **35** in the heating stage I, is separated into a separator chamber **40** below the bottom and the expansion chamber **2***a* above the same. In the separator chamber vapor and liquor from the liquor and vapor mixture produced during the heating stage are separated from each other, the liquor being withdrawn through the conduit **15** and the vapor being discharged through the vapor piping **39**, the expansion chamber **2***a* and the conduit **18** to the next heating stage II. The liquor from the first expansion stage is introduced tangentially into the expansion chamber through the conduit **6**, so as to be separated by the centrifugal force from the thereby produced vapor, and collected at the bottom **38** about the vapor piping **39**, from where it is discharged through the conduit **7** to the next expansion chamber **3***a*. The vapor produced is simultaneously mixed with the through-flowing vapor from the separator chamber, and will be entrained to the next heating stage II as additional heating vapor. The processes are analogical in the two subsequent stages **3***a*, II and **4***a*, III.

By this arrangement it will be evident that the apparatus required for performing the invention will not be substantially more complicated nor substantially more expensive than a conventional indirect multiple stage evaporator of the same evaporation capacity. This is of course a substantial advantage, although it should be understood, that the great gain in steam economy would permit considerable investments in installations without substantially reducing the practical value of this gain.

The liquid flow direction III—IV—V—I—II illustrated, is most frequently used in 5-stage evaporators, in first line because the liquor, on account of its viscosity increasing with the increasing concentration, preferably should be finally evaporated at a high temperature, which however should not be permitted to rise above about

100° C., that is to say the highest temperature at which the liquor can be storaged at atmospheric pressure. Such a temperature of the liquor will generally be found in stage II, which in consequence then should constitute the final stage, whereby the aforesaid liquor flow conduction will be the most convenient one. It is a generally accepted requirement, that the liquor should be fed to a multiple stage evaporator at a temperature, which at least not substantially is lower than the digesting temperature in the heating stage to which it is supplied. Thus, the pre-evaporated liquor, fed to the heating stage III, should have a temperature in the proximity of the digesting temperature in this stage, which it will acquire in the last expansion vessel **4** because the latter, which supplies additional vapor to the next following heating stage IV, thereby also is subjected to a pressure approximately equal to the pressure prevailing in the liquor chamber of the heating stage III.

By such a liquor flow in a 5-stage evaporator one can thus, as illustrated, while satisfying the aforesaid requirement, utilize four expansion stages within the scope of this invention.

The number may be increased to five, if stage IV is permitted to constitute a supplying step, resulting in still further reduction of the steam consumption. A further increase of the number of stages does not result in any additional advantage, because an arrangement wherein stage V is a feeding step and a further expansion stage is included would cause that the vapor from the latter stage would flow to the discharge **22** directly. On the other hand, moving the intake to a stage operating at a higher temperature, would cause a reduction of the number of such expansion stages, for example to three stages on feeding in at stage II, whereby obviously also another heating stage has to constitute the final step.

Nor is the invention restricted to the case in which the vapor from the first expansion stage to some extent is utilized for steaming the chips but this vapor can also be used for other purposes. In sulphate digestion the vapor will for example contain turpentine, which should be recuperated. Then the vapor may conveniently be conducted in its entirety to a so called turpentine condenser. In this case the preheater **27** may possibly serve such purpose.

With the guidance of the examples illustrated and described any one skilled in the art will be able to adapt the invention to any other number of heating steps and different types of liquor flow.

What I claim is:

1. A method in evaporation of waste liquor supplied at high pressure and high temperature from continuously operating cellulose digester or boiler, wherein said liquor is first pre-evaporated and cooled by being passed through a plurality of successive flash expansion stages from which the liquor vapor thereby released is discharged and from the last said flash expansion stage of which the pre-evaporated and cooled liquor is thereafter passed to an indirect multiple effect evaporator where it is further evaporated, each effect having a heating-evaporating stage and a vapor separating stage and the number of effects is the same as the number of expansion stages and in which the first heating-evaporating stage is heated by fresh steam and each one of the succeeding heating-evaporating stages is heated by liquor vapor from the next preceding vapor-separating stage, wherein the improvement comprises in combination the steps of passing from each of said flash expansion stages with the exception of the first one the liquor vapor there released as additional heating vapor to a corresponding one of said heating stages according to the rule: from the second expansion stage to the second heating stage from the third flash expansion stage to the third heating stage and continuing correspondingly until ultimately from the *n*th flash expansion stage to the *n*th heating stage and passing the pre-evaporated liquor from said *n*th flash expansion stage to the (n–1) heating stage where "n" is the number of the flash expansion stages and heating stages respectively.

References Cited

UNITED STATES PATENTS

2,544,885	3/1951	Jacoby et al.	159—17 X
2,651,356	9/1953	Sadtler	159—20
3,021,265	2/1962	Sadtler et al.	159—20 X

FOREIGN PATENTS

709,044 8/1931 France.

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