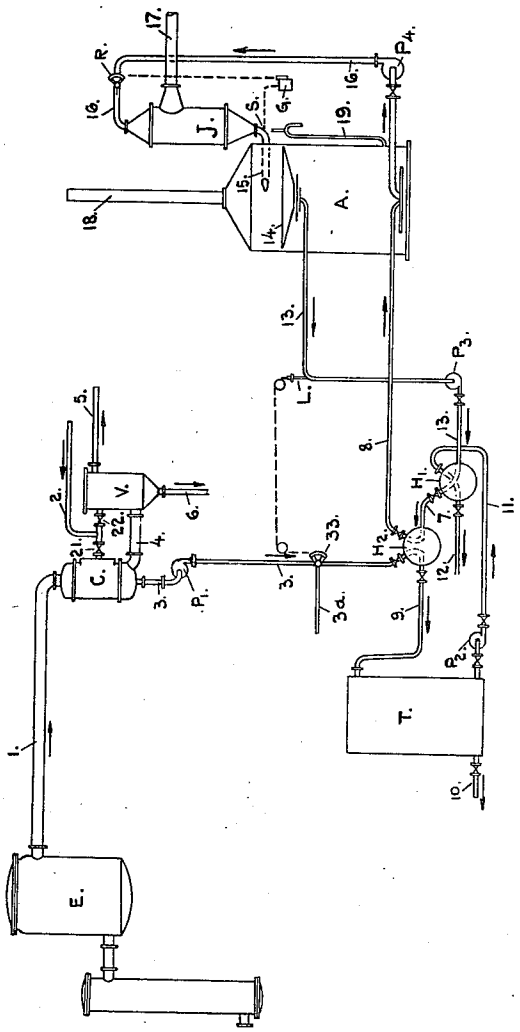
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UTILIZATION OF WASTE HEAT

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UTILIZATION OF WASTE HEAT

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In the manufacturing of cellulose, in accordance with the sulphate and soda processes particularly, an evaporating plant for waste or black liquor may be used in the cooking operation for performing one step in a process which is adapted to effect the recovery of solid and valuable matters present in such liquor. This evaporating plant may generally comprise a unit, or a battery of units in series preferably maintained at varying degrees of vacuum for effecting a simple, or a multiple evaporating effect, respectively. The excess warm vapors formed in the evaporators, when a series of evaporating units is utilized, will leave the last unit at a relatively low temperature, say 50° C. to 60° C. and may then be condensed in a surface condenser or any suitable heat exchanger wherein heat may be removed from the vapors and transferred to a suitable cool medium to be heated, such as fresh water or any other liquid. Thus, clean and relatively hot water may be produced by utilizing waste heat from the process referred to.

The temperature of such heated water may only reach the relatively low temperature of 40° C. or it may not even reach this temperature. In view of this low heat level, it may not be readily utilized though elsewhere in the process there may be a great demand for hot water at a somewhat higher temperature, which demand may or may not be continuous. For example, a considerable amount of hot water of a temperature in the neighborhood of 70° C., is needed for the washing of the pulp at various places in the process. Further, at other points in the process hot water at a temperature of about 90° C. may be necessary for spraying of fiber web on the wet end of board machines, making necessary the utilization of large quantities of live steam or similar high grade heating means commonly required in the preparation of hot water of this temperature.

Without undue expense, a limited part of the required hot water referred to may be obtained by the proper utilization of a second source of waste heat inherent in the relief and blow-off steam emanating from the digesters or the released steam from the used liquor which is discharged from the same at the end of the cooking period in the process. Though this kind of waste steam is available only during short periods, which periods occur at long spaced intervals, it may advantageously be reclaimed by the methods herein disclosed based on an accumulating principle, whereby fresh water may be heated by such waste steam to a temperature high enough to be used in the process, for example 90° C.

An object of the present invention is to utilize waste heat given off by the process, to which reference has been made, to heat a liquid which may be used in the same process. Another object is to make possible the continuous heating of relatively large quantities of liquid to a relatively high temperature by the mere utilization of waste heat emanating from the process referred to.

A further object is to make possible the production of hot and clean water for washing and spraying purposes, or the like, without utilizing extra fuel or energy other than that utilized in the process for which the hot and clean water is to be produced.

Other objects and the nature and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawing, wherein:

The single figure illustrates a schematic view of a system in accordance with my invention.

Referring to the drawing, the evaporating unit, or the last unit of a series of evaporators E, is provided with a pipe 1 which is adapted to conduct the excess vapors flowing therefrom to the surface condenser C, which is supplied with a cooling liquid, preferably fresh and clean water, through the pipe 2 controlled by the valve 21. In the condenser C, the cooling water will be heated by the latest heat given off by the condensing vapors and then discharged from the condenser through pipe 3. An outlet pipe 4 is associated with the condenser C for conducting condensate to the vacuum tank V which has at its top a pipe 5 leading to a vacuum pump not shown. Associated with the bottom of the vacuum tank V is a condensate discharge pipe 6. If it be desired to condense any escaping vapor, cooling liquid from the pipe 2 can be injected into the vacuum tank by opening the valve 22.

A pump P_1 may be provided in the pipe 3 for circulating the now preheated water through a heat exchanger H_2 to be further heated therein by another liquid of relatively high temperature introduced into the said heat exchanger by means of the inlet pipe 7. The fresh clean water can thus be heated to the relatively high temperature of 70° C. or more and then discharged from the heat exchanger H_2 through the pipe 9 into the equalizing tank T, from which it may be withdrawn through the pipe 10 whenever needed for spraying purposes or the like. Some part

of the water, which may represent a surplus, may be withdrawn from the tank T by the pump P_2 and passed through pipe 11 to a heat exchanger H_1 in which the water may be still further heated by the same heating liquid which is later utilized in the heat exchanger H_2 as already mentioned. The heated water which now leaves the heat exchanger H_1 by means of the pipe 12 will reach a temperature of about 90° C. and may be used for spraying purposes. The heating liquid which may be utilized in both of the heat exchangers H_1 and H_2, is supplied to the heat exchanger H_1 from the accumulator A by the pump P_3 and through the pipe 13. Associated with the inlet to the pipe 13 is a special draining device 14 comprising substantially a cone-shaped funnel situated in the upper part of the accumulator, whereby heating liquid from the accumulator may be passed to the heat exchangers. The heating liquid referred to is produced by injecting a relatively cool liquid into the jet condenser J through the pipe 16, whereby it may be mixed in the said jet condenser J with waste steam which is supplied through the pipe 17. Said steam may consist of impure released steam emanating from the digesters or used cooking liquor and will be condensed by contact with the relatively cool liquid to form a relatively hot liquid mixture. This hot lquid may then be discharged from the jet condenser J into the accumulator A through the pipe 15 and then utilized, as already described. The top of the accumulator may be provided with an exhaust pipe or chimney 18 permitting the escape of any uncondensed steam and non-condensable or permanent gases which may be passed to the accumulator.

It is to be understood that the relatively cool medium to be heated which is passed by means of conduits 3, 9 and 11 through the heat exchangers H_1, H_2 is not to be contaminated by the heating medium also passed through heat exchangers H_1, H_2 by the conduits 13, 7 and 8 and accordingly the heat exchangers H_1 and H_2 may be of the closed surface type such as is well known in the art. The specific structure of these heat exchangers forms no part of the instant invention.

The supply of cooling liquid to the jet condenser J may be controlled by a regulating valve R operated by servo motor G, or similar device, adapted to be actuated by thermal elements S responsive to the temperature of the hot liquid mixture discharged through the pipe 15. The thermal element S is preferably sensitive to small variations in temperature and may be of any conventional design capable of properly actuating the servo motor G. The valve R, the element S, and the servo motor G, are so adjusted and coordinated that the supply of cooling liquid will at all times correspond to the supply of waste steam in a manner whereby the hot liquid mixture formed will constantly be maintained at a predetermined temperature near the boiling point, independent of variations in the supply of waste steam. Accordingly, as the waste steam is available only at intervals, the supply of cooling liquid will be shut off completely during the times when no waste steam is admitted.

During the intervals when hot liquid is passed to the accumulator A, a portion of same will be withdrawn immediately by the draining device 14 and supplied to the heat exchangers H_1 and H_2, and a portion of the liquid will be accumulated within the accumulator A for the non-production periods in order to secure a uniform and continuous distribution of the heating liquid. The hot liquid withdrawn from the upper part of the accumulator, as described, will be displaced by additional cooled liquid coming from the heat exchanger H_2 which in introduced at the bottom of the accumulator through the pipe 8. A constant level in the accumulator may be maintained by means of an overflow pipe 19. It will be understood that there will always be a sufficient layer of hot liquid present at the level of the draining device 14 and underneath of said layer there will be another layer of cooling liquid of varying height. This phenomenon will occur because the two separate layers of liquid are of different temperature and specific gravity.

Simultaneously, with the operation of the jet condenser J, the cooled liquid contained in the bottom part of the accumulator A is recirculated by means of the pump P_4 through the pipe 16 back into said condenser as desired, and through the whole system again in the manner described. Hence, as a rule, it is not necessary to supply fresh cooling liquid to the jet condenser and the latent heat of the steam is transferred to the hot liquid produced, the heat of which is completely utilized in the system with the possible exception of the excess liquid which may go to waste through the overflow pipe 19. This excess liquid, however, represents but a small quantity of liquid corresponding to the condensate of steam which is formed during the process.

Should there be a sudden decrease in the supply of steam to the accumulating system, the bottom layer of cooled liquid in the accumulator A may momentarily rise to such a height, as to cause difficulties in maintaining the top layer of hot liquid therein at the desired temperature; and the temperature of the heating liquid supplied to the heat exchangers will show a tendency to fall. The proper procedure then may involve the cutting off of the supply of water to be heated within the heat exchangers in order to prevent improper operation of the plant. This can be effected by means of a controlling device comprising a thermostat inserted in the pipe 13 and adapted to actuate a servo motor L, or the like, to regulate the valve 33 in pipe line 3 so that the admission of liquid to be heated to the heat exchanger H_2 is shut off when the temperature of the heating liquid drops below a predetermined point and will be maintained in open position at all other times. As illustrated, the valve 33 may be a three-way valve for diverting or by-passing the water flowing through the pipe 3 to the branch or by-pass pipe 3*a*, when closing the admission to the heat exchanger or vice versa. The pipe 3*a* may lead the water to another place of use or to a storage tank and from the latter it may be passed through the heat exchangers at some other time, if desired.

It will be understood from the above that the invention comprises the utilization of intermittently available waste heat inherent to an impure liquid, released steam from the digesters or used cooking liquor, in the process referred to; which heat is transferred by means of direct contact to a first liquid to produce a liquid mixture having a temperature near the boiling point; which liquid is accumulated, in accordance with the demand of the system, in its heated condition, and may be utilized to raise the temperature of a second liquid in an indirect heat exchange apparatus after said second liquid has been pre-

heated by utilizing it as a cooling medium in the condenser of an evaporating plant associated with the process. In applying my invention, I prefer to reclaim the heat of the digester waste products in a manner disclosed in my United States Patent No. 1,886,590; that is, by injecting the said first liquid in the released steam supplied, cooling the supply of said first liquid automatically in a manner to maintain the hot liquid at the desired temperature; and then after having passed said first liquid in heat exchange relation with said second liquid and cooling said first liquid, recirculating said first liquid in its cooled condition back into contact with the steam and through the whole system again.

My invention may also be employed in connection with the sulphite process and in such case it may be utilized for preheating the cooking liquid. The type of condenser, heat exchangers and other apparatus employed may be conventional and where I have illustrated but one heat exchanger, it is conceivable that it be within the scope of my invention to utilize two or more heat exchangers in series, in parallel or both. Further, if the excess steam from the evaporation plant is sufficiently pure, the condenser C may possibly be a jet condenser. Various controls may be incorporated in the system in accordance with my invention, or the controls may be omitted.

It will be obvious to those skilled in the art that various changes may be made in the described process and apparatus without departing from the spirit of the invention and therefor the invention is not limited to what is shown in the drawing and described in the specification but only as indicated in the appended claims.

I claim:

1. Apparatus of the general character described comprising, in combination, a source of hot waste gaseous fluid, an accumulator, heat exchange means connected to said source, a supply of circulating liquid part of which is in the accumulator, means for circulatinng the circulating liquid from the bottom of the accumulator to the heat exchange means thence to the top of the accumulator, a pair of heat exchanger units for transferring the heat of the circulating liquid to a second liquid, means for supplying said second liquid first to one of the pair of heat exchange units and then to the other, means for withdrawing the second liquid between the pair of heat exchange units, means for circulating said circulating liquid from the top of the accumulator through the pair of heat exchanger units in series which is the reverse of the supply of the second liquid to the units and back to the bottom of the accumulator, and means for withdrawing the heated second liquid after having passed through both heat exchange units.

2. A plant of the character described comprising, in combination, a source of clean relatively cool fresh water, a heat exchange device, means to conduct the water into said heat exchange device, a second heat exchange device, means to conduct the warmed water to the second heat exchange device, means independently connected with each heat exchange device to conduct the water away, an accumulator, means for conducting the hottest portion of the heating liquid in the accumulator direct to the second heat exchange device, means for conducting the heating liquid from the second heat exchange device to the first heat exchange device and then back to the accumulator, a source of waste steam, a condenser into which the waste steam discharges, means for withdrawing the coolest portion of the heating liquid in the accumulator and sending it through the condenser to become heated by the waste steam, and a pipe discharging the heating liquid freshly heated in the condenser into the accumulator.

3. The invention according to claim 2 wherein the means for withdrawing the coolest portion of the heating liquid from the accumulator has a regulating valve for controlling the flow, a thermal element being in the condenser and a servo motor being connected to the regulating valve to operate the same, said thermal element acting on the servo motor to cause the latter to close the regulating valve to stop flow of the heating liquid when the supply of waste steam is shut off.

4. The invention according to claim 2 wherein the means to conduct the clean water into the first mentioned heat exchange device has a valve, a by-pass leading off from said valve to divert the water before it reaches the first mentioned heat exchange device, a servo motor for controlling the by-pass valve, a thermostat controlling said servo motor, said thermostat being located so as to be responsive to the heat of the heating liquid passing from the accumulator to the second heat exchange device.

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