June 21, 1938. F. J. DOOLEY 2,121,074

METHOD AND APPARATUS FOR DIGESTING CELLULOSIC MATERIAL

Filed May 11, 1934

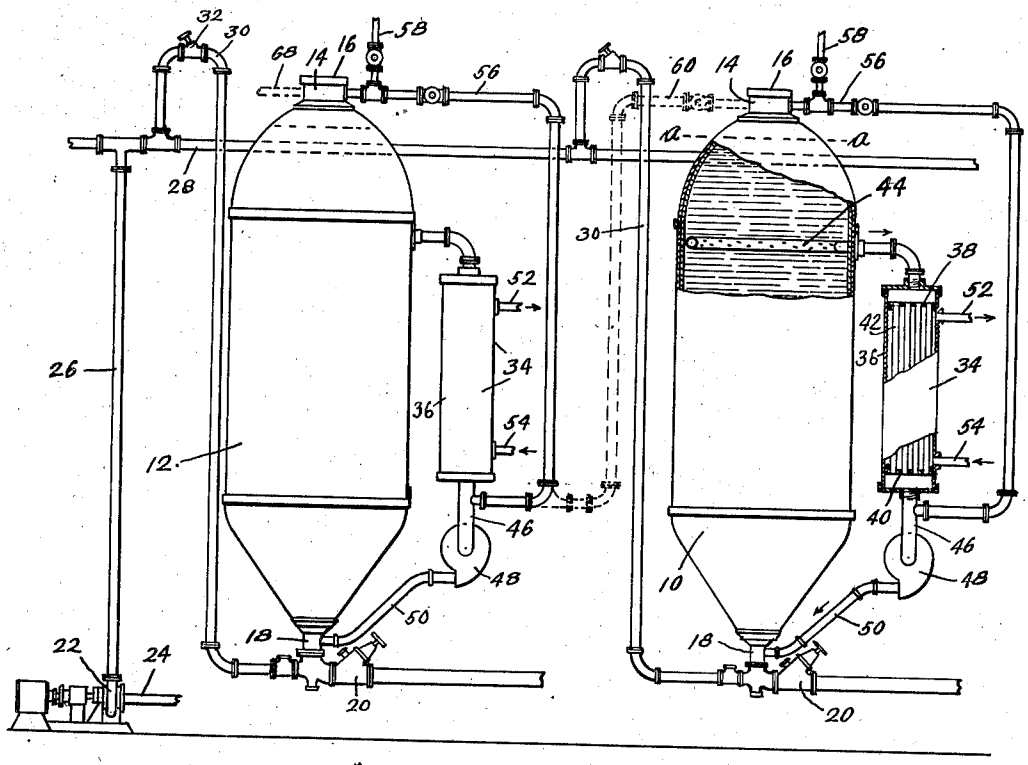


Fig. 1.

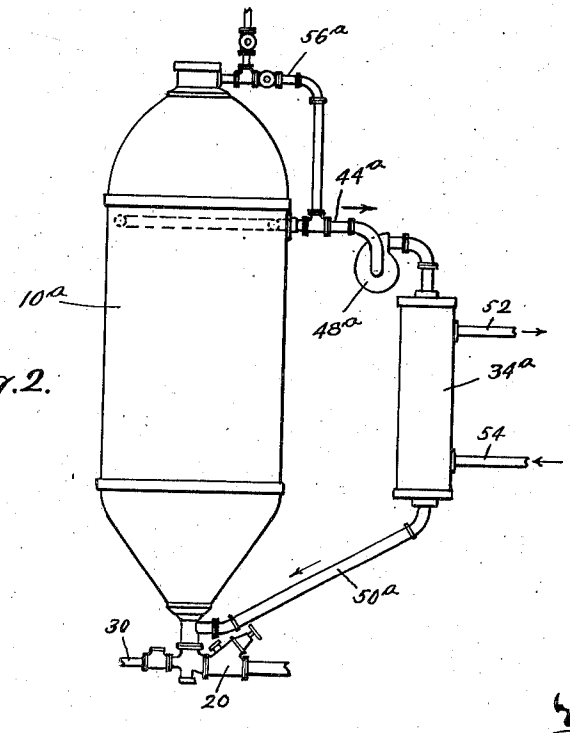


Fig. 2.

Inventor.
Francis J. Dooley
by T. T. Hammond Atty

Patented June 21, 1938 2,121,074

UNITED STATES PATENT OFFICE

2,121,074

METHOD AND APPARATUS FOR DIGESTING CELLULOSIC MATERIAL

Francis J. Dooley, Arlington, Mass.

Application May 11, 1934, Serial No. 725,139

1 Claim. (Cl. 92—7)

This invention relates to the manufacture of wood pulp for paper and has particular reference to cooking or digesting processes and apparatus wherein the cooking or digesting liquor gives off a gas during the cooking process.

In the manufacture of sulphite pulp, for instance, the cellulosic material as wood chips or blocks are treated in a digester with a sulphite liquor or acid resulting from the reaction of sulphur dioxide gas with limestone and water. The liquor in contact with the wood chips or other cellulosic material in the digester is heated and is maintained in heated condition during the continuance of the cooking process, which may be upwards of eight hours. Due to the elevated temperature of the liquor, sulphur dioxide gas is liberated therefrom. While the liberation of sufficient gas to maintain the contents of the digester under suitable elevated pressure, as from seventy to eighty pounds per square inch, is desirable, gas is liberated from the liquor in excess of that necessary to maintain the pressure and the excess gas heretofore has been conducted away from the digester. The loss of gas from the digesting liquor results in the weakening of the liquor and consequently prolongs the cooking time. Hence an object of the present invention is in the recovery of the usually wasted gas and its re-introduction into the cooking liquor so as to enrich the liquor and restore it to approximately its original strength thereby not only to save the normally wasted gas but also to reduce the cooking time.

A pulp mill is usually provided with a battery of digesters which are charged and started in operation usually one at a time so that the first digester may be well advanced in operation by the time the next digester is ready for operation. A further object is the provision of a battery of digesters wherein the gas evolved from the liquor in one digester is conserved by being discharged into and absorbed by the liquor in another digester.

In accordance with the present invention the liquor in the digester is heated by circulating the liquor from the digester through a heat exchanger and back into the digester, the circulation preferably being continuous during the cooking process. The heat exchanger is supplied with heat usually by steam at suitable pressure to maintain the desired temperature and pressure within the digester. The loss of gas from the cooking liquor and the digester is particularly serious with such an indirect liquor heating system. The loss of gas from the liquor causes a liberation of the lime content of the liquor and the lime precipitates or collects in greatest quantity on the heating surfaces or in the tubes of the heat exchanger. The lime accumulation impedes the circulation of liquor through the liquor passages of the heat exchanger and the transfer of heat from the steam to the liquor and necessitates continual cleaning of the heat exchanger and repairs thereto. Hence a further object of the present invention consists in maintaining the liquor in the digester at approximately its normal strength at least in respect to its gas content so as to prevent the deposition or precipitation of the lime or other solid matter in the heat exchanger and thereby to improve the operation of the system.

A further object of the invention consists in conducting the gas that is liberated from the liquor within the digester into the circulatory path of the liquor external of the digester and to cause it to be entrained and absorbed by the liquor and reintroduced into the digester thereby to maintain the normal strength of liquor and to prevent the precipitation or deposition of lime or other solid matter.

The circulation of the liquor between the digester and the heat exchanger is accomplished by a suitable pump and a further object of the invention is to draw the gas that is liberated from the liquor within the digester into the inlet or suction piping of the pump by the action of the pump. Also in accordance with this invention the gas from one digester may be directed into the inlet piping of the circulating pump of the same digester or into some other digester.

Fig. 1 is a diagrammatic view partly in section of a plurality of digesters embodying the present invention.

Fig. 2 is a diagrammatic elevation of a single digester illustrating a somewhat modified arrangement for circulating the digesting liquor and for introducing the gas thereinto.

Fig. 1 illustrates a digester system including, as a part thereof, the digesters 10 and 12 of more or less common form having a charging neck 14 at the top the opening in which can be closed by a cover 16 and having an outlet 18, or the equivalent, at the bottom, controlled by a valve 20 through which pipe the contents of the digester can be discharged when the cellulosic material has been sufficiently cooked. The digesters are charged with a digesting liquor as acid by a pump 22 having an inlet pipe 24 in communication with a suitable source of acid and discharging acid through the pipe 26 into an acid main 28, which

main extends along the line of the series of digesters. Acid is conducted from the main through a pipe 30 controlled by a valve 32 into the pipe 18 and thence into the bottom of the digester in accordance with my Patent No. 1,338,496, dated April 27, 1920. The digester is adapted to be filled initially with acid to some suitably high level *a*—*a* somewhat under the neck 14 and above the top of the collection of chips or other cellulosic material therein. The liquor in the digester is circulated through a heat exchanger 34 where it is heated and then is returned to the interior of the digester. The heat exchanger may be of any suitable type and as here shown comprises a shell or drum 36 having internal heads 38 and 40 between which tubes 42 extend. Liquor is drawn from the upper portion of the digester through a perforated or screened inlet pipe 44 and conducted to the upper part of the heat exchanger where the liquor flows through the tubes 42 and out of the bottom of the digester into the inlet piping 46 of a suitable circulating pump 48 which can be of the centrifugal type. The liquor is discharged from the pump into a pipe 50 which communicates with the piping 18 of the digester and returns the heated liquor to the interior of the digester at the bottom thereof. A heating medium is supplied to the interior of the heat exchanger around the tubes 42 through the pipes 52 and 54. The heating medium can be live steam introduced through the pipe 54 and discharged through the pipe 52 or vice versa. Because of the circulation of the liquor of the digester through the heat exchanger the liquor becomes hot which is essential for the cooking or the digesting of the cellulosic material in the digester. My invention is particularly concerned with a digesting liquor known as sulphite liquor or acid formed by the reaction between sulphur dioxide gas, lime, usually in the form of limestone, and water. Due to the elevated temperature of the liquor, however, sulphur dioxide gas is liberated therefrom and collects in the upper part of the digester above the liquor level. Some liberation of gas from the liquor is desirable since its accumulation in the digester builds up a pressure which is beneficial in causing the penetration of the chips by the liquor. During the cooking process, however, much more gas is liberated from the liquor than is required to maintain the proper pressure of from seventy to eighty pounds within the digester and it is necessary to relieve the digester of the excess gas in order to keep the pressure within the digester to a safe value. Heretofore, this liberated gas has been conducted away from the digesters. The escape of gas from the liquor weakens the liquor and thus lengthens the time required for the completion of the cooking process. The loss of gas also liberates lime from the sulphite liquor, and the lime precipitates. The precipitation occurs mainly within the tubes 42 of the heat exchanger where the heat is the greatest. This precipitate or deposit of lime adheres strongly to the interior of the tubes and collects and opposes the flow of liquor therethrough. The deposit also insulates the liquor from the tube surfaces so that the heat exchange is less effective. As a consequence it is necessary to remove the lime deposits periodically by mechanical means. The lime deposits also cause pitting and other troubles and frequent repairs to and replacement of parts of the heat exchanger are necessary.

In accordance with the present invention the sulphur dioxide gas that is liberated from the liquor in the digester and would ordinarily be discharged to waste is caused to be absorbed by the digester liquor whereby to preserve the normal strength of the liquor and also to prevent the deposition of or act as a solvent for the lime precipitated from the weakened liquor. To this end the top of the digester above the liquor level is provided with a gas pipe 56 connected to the interior of the digester conveniently through the neck 14 or otherwise and connected at its other end to the inlet piping 46 of the liquor circulating pump 48. Thus the gas liberated from the liquor is caused to be entrained into the circulating liquor by the suction action of the pump and to be re-absorbed by the liquor and re-introduced into the bottom of the digester, thereby preserving the normal strength of the liquor therein. The pipe 56 may be provided with a valve controlled branch 58 for initially blowing off the air in the digester at the start of the heating operation.

Sulphur dioxide gas is soluble in water or the digesting acid and hence is readily absorbed by the acid when mixed therewith in the acid circulating system. The gas is under the pressure of the digester and the liquid in the suction piping is under a lower pressure due to the pump suction and hence there is a positive pressure acting on the gas in a direction to cause it to flow into the circulating system. Since the acid is maintained at its original strength by restoring to the acid gas liberated therefrom, except as the strength may be weakened somewhat by the reaction of the acid on the cellulosic material, the precipitation of lime from the acid is greatly reduced if not entirely eliminated and hence the cooking time is reduced, the acid is heated more rapidly in the heat exchanger, less steam is consumed therein, and less cleaning of and repairs to the heat exchanger are required.

While the system has been described primarily in connection with the digester 10, the digester 12, and all digesters of the system are or can be provided with the some equipment for the performance of the invention.

A battery of digesters are usually charged with wood and acid and started in operation one at a time. It takes a matter of an hour or so to condition a digester for operation so that the first charged digester may be well under-way when the second is ready for operation. If desired the gas liberated from the liquor in the first digester can be passed into the liquor of the second digester and so on through the series of digesters. As is here shown by dotted lines in Fig. 1 the digester 10 can have a gas pipe 60 leading therefrom into the suction piping 46 of the second digester 12 so that the gas from the digester 10 is passed into the liquor of the digester 12 to enrich it. The gas in the digester 12 can be passed therefrom through a pipe 68 to a third digester, not shown, and the last digester of the series may be so arranged as to pass its gas into the first digester 10.

Fig. 2 illustrates a somewhat modified arrangement of the heating and circulating system for the liquor in the digester. As here shown, the digester 10*a* is provided with a heat exchanger 34*a* and liquor from the digester is withdrawn through a suction pipe 44*a* and through a pump 48*a* from which the liquor is forced into the heat exchanger 34*a* and thence through a pipe 50*a* into the bottom of the digester. The main difference in the heating and circulating system of Fig. 2 over that shown in Fig. 1 is in the position of the circulating pump. In the structure illus-

trated in this figure the gas evolved from the liquor in the digester is passed through the pipe 56*a* and drawn into the suction pipe 44*a* by the suction action of the pump 48*a* so that the liquor is enriched with its gas prior to its passage through the heat exchanger.

I claim:

A digester system for cellulosic material comprising a battery of digesters adapted to receive the cellulosic material and charges of gas evolving liquor, heat exchangers associated with said digesters, means for circulating the liquor of a digester through the associated heat exchanger, and means for introducing the gas evolved from the liquor in one digester into the circulating liquor of another digester externally thereof.

FRANCIS J. DOOLEY.