March 26, 1935. G. L. SCOTT 1,995,401

APPARATUS FOR THE MANUFACTURE OF ALUMINUM SULPHATE

Filed Feb. 28, 1933

Fig. 1.

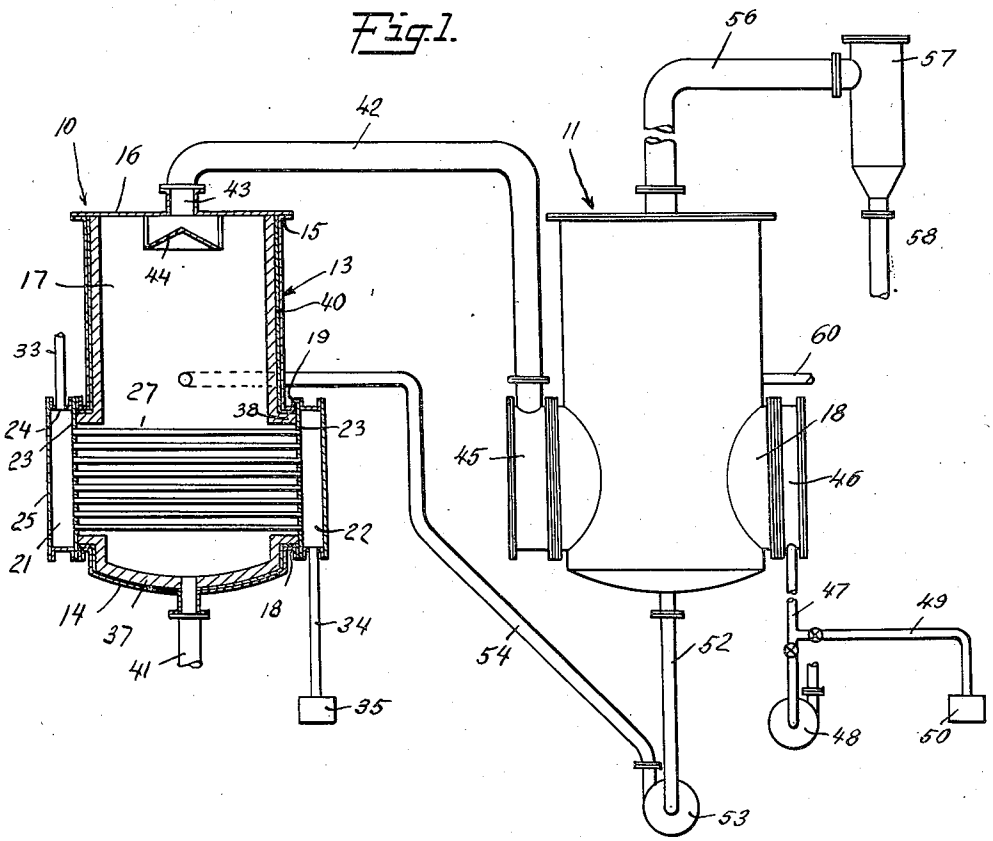


Fig. 2.

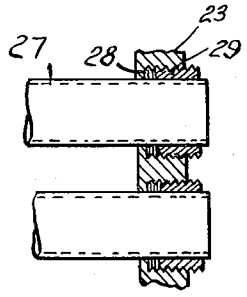
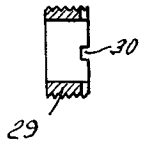


Fig. 3.



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APPARATUS FOR THE MANUFACTURE OF ALUMINUM SULPHATE

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2 Claims. (Cl. 159—26)

This invention relates to methods and apparatus for evaporating and concentrating corrosive liquid materials, and especially to methods carried out in so-called "multiple-effect" evaporators. The invention is particularly directed to plural stage evaporating apparatus.

One of the principal objects of the invention lies in the provision of a method and apparatus in which highly corrosive liquors, such as aluminum sulphate, may be concentrated in stages in such manner as to make available economic advantages arising from the use of multiple-effect evaporators. The invention further aims to provide a method and apparatus by which corrosive liquids may be evaporated to a desired degree of concentration by a continuous process. Multiple-effect evaporations of liquids, and apparatus therefor, have been previously suggested. Because of difficulties involved in concentrating corrosive liquors, to my knowledge, there is not now available apparatus by which liquors of this nature may be concentrated in a continuous manner, and under such conditions that evaporation of the liquor may be effected in stages at least one of which is under a vacuum.

The invention comprises the several steps of the process and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combination of elements and arrangement of parts which are adapted to effect such steps. For a fuller understanding of the objects and advantages of the invention, reference may be had to the following description taken in connection with the accompanying drawing, in which,—

Fig. 1 illustrates, partly in section and partly in elevation, one preferred embodiment of apparatus constituting part of the invention.

Fig. 2 is a vertical section showing the manner of connecting heating fluid tubes of the evaporator to the tube sheets, and

Fig. 3 is a detail.

Referring to the drawing, Fig. 1 shows a two-stage concentrator comprising an evaporator 10 and an evaporator 11, the former being shown in section, and the latter in elevation. As is customary in the art to which the invention relates, evaporator 10 is herein designated the "first effect", and evaporator 11 the "second effect." It will be understood any desired number of individual evaporators or effects may be included in the apparatus, a two-stage concentrator being shown for the purpose of illustrating one embodiment of the invention.

Evaporator 10 comprises a vertically disposed, preferably cylindrical, steel shell 13 having a slightly concaved bottom 14. The top end of the shell is provided with a horizontal flange 15, affording means for attaching thereto a cover plate 16 which, together with the shell and the several elements of an internal heating unit, forms an evaporating chamber 17.

Formed on diametrically opposed sides of shell 13, near the bottom thereof, are short cylindrical projections 18. The latter are shown in elevation on the evaporator 11. The cylindrical sections 18 terminate in vertical flanges 19 to which are welded or otherwise attached heating fluid inlet and outlet headers 21 and 22 of a heating unit. The inlet and outlet headers are of substantially the same construction, and comprise tube sheets 23, flanged rings 24, and circular end plates 25. As illustrated in the drawing, tube sheets 23 are disposed between shell flanges 19 and the adjacent vertical flanges of the rings 24.

Set into the tube sheets and constituting the major part of the heating unit, are a plurality of horizontal heating fluid tubes 27. The method of attaching the heating tubes to the tube sheets 23 is illustrated in section in Fig. 2. As shown, the end of a tube extends through the tube sheet 23, and a tight connection between the tube and the tube sheet is effected by packing material 28 seated in an annular groove formed by the outside of the tube and a recessed portion of the tube sheet. The packing is held in place by an externally threaded ring 29, having in the outer edge notches 30 (Fig. 3) by means of which the ring may be screwed down tightly against the packing. Heating fluid, such as steam, may be introduced into the inlet header 21, from a source of supply through pipe 33, the steam being discharged from outlet header 22 through pipe 34 into a steam trap 35.

The evaporator is provided with a relatively thick, acid resistant brick lining 37. The lining covers completely the sides and bottom of the shell, and is also formed so as to extend outwardly as at 38 to afford lining for the interior of the projections 18. A second lining 40, preferably of lead, is interposed between the brick material 37 and the inner wall of shell 13. The lead lining 40 laso extends into the cylindrical sections 18, and over the vertical faces of tube sheets 23 adjacent to flanges 19. Concentrated liquor may be run out of the bottom of the chamber 17 through an outlet pipe 41, and vapors generated in the evaporator during the operation

thereof are discharged from the top of the chamber through an outlet conduit 42. Beneath the outlet pipe connection 43 in the cover 16 there is positioned a conical baffle 44 which prevents admission of any appreciable quantities of liquid particles into pipe 42.

One of the particular difficulties encountered in the construction of apparatus for evaporating highly corrosive liquors lies in the provision of proper design and construction by which the corrosive effects of the liquors on the apparatus may be minimized. To overcome prior difficulties, in accordance with the invention, the lining 37 is disposed as above described, and may be of acid resistant material suitable to withstand the action of corrosive liquors. Lining 37 in conjunction with lead lining 40 afford effective protection for the steel shell from the corrosive action of the heated liquors, lining 37 further acting to hold lead lining 40 in place and prevent buckling thereof. The tube sheets 23 and the heating conduits 27 are preferably made of copper, and the cover plate 16 and the baffle plate 44 may be of steel with a copper coating. Circular plates 25 and rings 24 may be of steel, and are preferably lead-lined.

The evaporator 11 is of the same general construction as evaporator 10. However, the inlet header 45 of the evaporator 11 is connected through pipe 42 with the chamber 17 of evaporator 10. The outlet header 46 of evaporator 11 discharges into pipe 47, connected to a condensate pump 48, and through a pipe 49 with a steam trap 50. Partially concentrated liquor discharged from the bottom of evaporator 11 runs through pipe 52 to the inlet side of a pump 53, which forces the liquor into evaporator 10, through pipe 54 opening into chamber 17 at a point considerably above the uppermost heating tube 27 of the heating unit. The upper end of the chamber in evaporator 11 communicates through the pipe 56 with the inlet of a barometric condenser 57, positioned on the upper end of a barometric column 58. Liquor to be concentrated is fed into the apparatus through an inlet pipe 60, opening into the chamber of evaporator 11 above the heating unit thereof.

Although the method and apparatus of the invention may be employed to advantage for concentrating other corrosive liquors, for convenience, the operation of the invention will be described in connection with the concentration of aluminum sulphate, for the evaporation of which the apparatus is particularly designed.

Aluminum sulphate is formed in commercially known methods by digesting aluminous clays in sulphuric acid at elevated temperatures. The digestion of the clay in acid is generally effected at temperatures of, say, about 200–220° F. In the digestion operation, aluminum goes into solution as aluminum sulphate. On completion of digestion, undissolved residues are permitted to settle, and the dilute aluminum sulphate liquor is separated from the undissolved residues by decantation. The liquor is then concentrated to produce the desired commercial products, and such concentration may be effected to advantage in a continuous manner in the apparatus constituting part of the invention.

When proceeding in accordance with the method of the invention, dilute aluminum sulphate liquor may be fed into "second effect" evaporator 11 through inlet pipe 60 at temperatures of about, say, 180° F. Because of the particular operating conditions prevailing in the "first-effect" evaporator 10, to be subsequently described, steam formed in chamber 17 of evaporator 10 passes through pipe 42 and enters the inlet header 45 of the evaporator 11 at temperatures of approximately 220° F. Steam at such temperature passes from inlet header 45 through the copper heating tubes of evaporator 11 to the outlet header 46, exhaust steam leaving the latter through outlet pipe 47. The liquor level in evaporator 11 is preferably maintained above the uppermost heating tube of the heating unit. The rate of feed of dilute aluminum sulphate liquor to the evaporator, the rate of withdrawal of partially concentrated liquor by pump 53, and the vacuum in evaporator 11 are regulated so that the liquor in the evaporator is at temperatures of about 200° F. A vacuum preferably equivalent to about 11 inches of mercury is maintained in the evaporating chamber by the barometric condenser 57 and column 58. A vacuum of, say, 10–12 inches may be employed to advantage. The water vapor generated by heating of the liquor is withdrawn through pipe 56 and condensed in condenser 57. Control conditions of the "second effect" are preferably maintained such that the liquor, on withdrawal through pipe 52 is concentrated to an aluminum sulphate content, expressed as combined Al_2O_3, of about 13%. If desired, evaporator 11 may be operated to produce a liquor having an aluminum sulphate concentration, expressed as combined Al_2O_3, varying from, say, 11.5% to about 14.5%.

Liquor withdrawn from evaporator 11 is pumped through pipe 54 into the chamber 17 of evaporator 10. Steam at temperature of about 281° F. and about 35 pounds pressure may be introduced into tubes 27 through inlet connection 33 and header 21. Spent steam is discharged through pipe 34 into a trap 35. As a substantial proportion of the water has been removed from the liquor in evaporator 11, higher temperatures are desirable in the evaporator 10 to effect further concentration of the liquor. Thus, conditions are preferably such in evaporator 10 that the liquor is heated to temperatures of about 257° F., and the steam generated by evaporation of water creates a pressure of about 3 pounds in chamber 17. At such pressure the temperature of the steam is about 222° F. at which temperature the steam passes out of the chamber 17 and through pipe 42 to the inlet header 45 of evaporator 11. Under such conditions of temperature and pressure, the liquor in chamber 17 is concentrated to an aluminum sulphate content, expressed as combined Al_2O_3, of about 17.5%, and as such is continuously discharged from the apparatus through outlet pipe 41, and run into vats to cool and solidify.

Since certain changes in carrying out the above method, and in the apparatus set forth may be made without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing, shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. Apparatus for concentrating liquors comprising a vertically disposed, substantially cylindrical shell forming the side walls and bottom of an evaporating chamber, diametrically opposed cylindrical sections projecting outwardly from the sides of the shell near the base thereof, said sections forming openings in the shell, a lining of acid resistant brick material covering the inner

wall and bottom of the shell and extending into and covering the inner surfaces of the cylindrical sections, a lead sheeting interposed between the refractory material and the shell, heating fluid inlet and outlet header chambers attached to the ends of the sections and forming closures for the openings, each of said headers having an inwardly positioned copper tube sheet, said lead sheet extending into said openings and engaging the edges of said copper tube sheets, heating fluid inlet and outlet connections for the inlet and outlet header chambers, a plurality of horizontally disposed copper heating fluid tubes having the ends thereof set into the tube sheets of the inlet and outlet heating fluid header chambers, a copper-lined cover for the top of the shell having a vapor outlet opening therein, a copper baffle in the chamber associated with the vapor outlet opening, a liquor discharge outlet in the bottom of the shell, and an outlet conduit for withdrawing vapors from the top of the chamber.

2. Apparatus for concentrating liquors comprising a shell, oppositely disposed openings in the sides of the shell near the bottom thereof, acid resistant brick material covering the inner wall and bottom of the shell, a non-corrodible metallic sheeting interposed between the acid resistant brick material and the shell, a heating fluid inlet header in one of said openings and a heating fluid outlet header in the other opening, said headers being made of non-corrodible metal, a non-corrodible metallic heating unit connecting the headers, said non-corridible metallic sheeting extending to and engaging the edges of the inlet and outlet headers respectively, heating fluid inlet and outlet connections for the inlet and outlet headers, a liquor discharge outlet at the bottom of the chamber, and an outlet at the top for withdrawing vapors therefrom.

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