SODIUM BICARBONATE PRODUCTION

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2 Claims. (Cl. 23—65)

This invention relates to the production of soda ash and is particularly directed to that portion of the method and apparatus in which sodium bicarbonate is precipitated by carbonating ammoniated brine liquor, which constitutes one stage in the well known method of making soda ash.

In the usual practice the carbonating step is carried out in tall sectional cast iron towers, usually in the neighborhood of 75 feet high, divided into a large number of sections with means for gas distribution in each section. The ammoniated brine is fed into the tower at the top and carbon dioxide is pumped in to the tower at the bottom under sufficient pressure to force it upwardly against the static head of the liquor. Because of scale formation and sedimentation the columns become dirty in a few days and have to be cleaned out. This requires maintenance of a plurality of columns or towers to permit continued operation while one is being cleaned. This adds substantially to the expense and because of the size and construction of the columns they are costly.

The carbon dioxide must be pumped through the liquor under a pressure of from 30 to 35 pounds per square inch in order to overcome the relatively high pressure of the static head of the liquor. Upon application of the phase rule, it is known that ammonium bicarbonate and sodium chloride will not remain in equilibrium at 15° C. under atmospheric pressure, and consequently sodium bicarbonate and ammonium chloride are formed. The pressure involved, as affecting the equilibrium, is the static pressure of the body of liquor plus the pressure of the gas upon the liquor. Since pressure and temperature must be mutually related, to promote efficiency of sodium bicarbonate precipitation, the importance of operational control of both gas and static head pressure will be appreciated, and particularly since the heat generated is inherent in the reaction. The “high” pressure necessary in the conventional apparatus and method of operation, as well as the cooling effect of an excessive quantity of CO₂, makes it impossible to maintain the temperature-pressure equilibrium required for maximum bicarbonate precipitation, except in a restricted zone adjacent the liquid feed end of the apparatus.

The object of the present invention is to provide a method and apparatus for carbonating the ammoniated brine and precipitating sodium bicarbonate which is much more economical in installation as well as maintenance costs, which greatly reduces sedimentation and scale formation, which reduces operating difficulties, which permits more continuity and efficiency of operation without the necessity of maintaining excessive quantities of liquor in the system and which avoids the necessity for installing and maintaining spare units.

The invention contemplates the provision of a plurality of relatively small chambers, preferably cylindrical with a height equal to about twice the diameter, with agitation in each chamber to prevent sedimentation of sodium bicarbonate and means for circulating carbon dioxide under low pressure in and through the chambers.

The invention will be described with reference to the accompanying drawing which illustrates more or less diagrammatically the apparatus used, and in which

Fig. 1 is a section elevation of one arrangement of the chambers, and

Figure 2 is a similar view of another arrangement of the chambers.

In the drawing 1 represents a compartment or chamber, preferably cylindrical, a plurality of which are interconnected by means of a liquid conduit 2 leading from the bottom zone of one chamber to the next in the series. 3 is a conduit for feeding ammoniated brine to the initial chamber of the carbonating unit. A conduit 4 delivers carbon dioxide containing gas to the bottom of the last chamber of the series and a pipe 5 leads from the upper portion of each chamber to discharge unabsorbed gas into the preceding chamber of the series adjacent its bottom. An agitating device 6 is provided in each chamber. The discharge outlet 7 of the last chamber in the series leads to a filter 11 disposed to maintain a constant level of liquor in the system. A gas outlet 10 at the top of the initial chamber of the series leads to a scrubber not shown for the recovery of ammonia and carbon dioxide in the unabsorbed gas. The agitating device 8 in each chamber is carried by a shaft 12 driven by a pulley or the like 13, the series of which may be operated from a common source of power.

The arrangements shown in Figures 1 and 2 are the same except that in that of Figure 1 the chambers 1 are successively arranged on a lower level to facilitate gravity flow of the charge. Low pressure pumps or gas blowers 5 in pipes 4, and 7 in pipes 6, are provided to force the incoming gas down to the bottom of each chamber. These pumps are operated at speeds which pass the desired volume of gas into each of the chambers. The CO₂ is pumped into each vessel under a relatively low pressure of from 3 to 5 lbs. per square
inch. Since the CO₂ is constantly pumped out of each chamber, the effect is that the pressure in each chamber is substantially atmospheric, whereby optimum operating conditions are maintained in each chamber for the precipitation of bicarbonate.

As illustrated in Figure 2 a second gas line 14 delivers carbon dioxide from a lime kiln to augment the gas supply from line 4 and this line 14 is connected to any desired number of the individual gas lines 6 connecting successive chambers by means of pipes 15 with valves 16. The line 4 preferably leads from a calciner not shown which liberates carbon dioxide from the sodium bicarbonate as soda ash is formed therein. The gas from the calciner normally has a higher carbon dioxide content than that from the lime kiln and it is best adapted for the final stages of the carbonation of the liquor. This method of providing a renewed supply of carbon dioxide insures maintenance of an efficient supply of CO₂ to each reaction chamber.

As drawn the tanks are relatively short or low and are preferably made of welded plate or the like. The construction is thus of light weight and does not cost more than substantially 25% of that of the conventional equipment. The agitator in each chamber is arranged to prevent sedimentation or scale formation therein.

In operation ammoniated brine is fed into the initial chamber through the conduit 3 and while continuously agitated this liquor flows through the successive chambers in counter current to charge dioxide which progressively reacts therewith to form sodium bicarbonate. The charge flows by gravity continuously through the several reaction chambers of the unit and is discharged therefrom under a pressure not greater than atmosphere. Under the influence of the agitators the sodium bicarbonate crystals formed are carried in the liquor to the filter with little or no opportunity for sedimentation in the chambers. Subjecting the flowing liquor to the gradually increasing concentration of carbon dioxide gives control of the size of the sodium bicarbonate crystals formed. In comparison with standard practice the coarser crystals thus formed are filtered more readily and permit longer life of the filters because of the small proportion of fine crystals. They wash more readily with less water, hence less dilution of the filtrate and less liquor from which to recover ammonia. The crystals carry less adhering water to be removed in the calciner and returned to the circuit with the gases.

The rate of feed automatically controls the liquor level in each chamber by maintaining static head pressure sufficient to cause the flow of the liquor.

When rate of operation, i.e., rate of brine feed, is established, the rate of absorption of CO₂ is constant, and the size of the crystals remains uniform as long as that rate of feed is maintained. The constant operation, under the defined conditions, keeps the crystals in continuous suspension, without sedimentation, thus permitting uninterrupted operation. In the usual commercial method each bicarbonate precipitation unit operates efficiently only 60% of the time because of the necessity of periodically removing sediment.

The unit may be operated efficiently at 10 to 100% of its capacity, thus permitting great flexibility in production. The usual commercial unit can be operated only at about 70 to 100% of its capacity. Operating costs are not more than two-thirds of that of the conventional equipment. Because of the desired low CO₂ pressure applied to the initial vessel of the series, it is highly desirable to apply additional CO₂ to the other vessels to maintain the quantity of CO₂ (still at low pressure) necessary for efficient reaction. This is accomplished by means of the supplementary CO₂ line 14.

Gas unabsorbed in its passage through the chambers is conveyed to scrubbers for the recovery of ammonia and carbon dioxide carried by it.

The mechanical agitation prevents sedimentation regardless of the particular rate of flow through the unit, thus the rate of flow may be adjusted for maximum efficiency of the conversion reaction to sodium bicarbonate and maintained there indefinitely. This will fix the rate of operation of the whole system and thereafter control of the brine feed to the scrubbers regulates the operation; this affords continuous operation at a uniform rate throughout the whole plant and greatly increased efficiency over the method now used.

A cooling system of any desired type is preferably incorporated in the unit to remove the heat of reaction and to cool the liquor in the discharge end of the system to as low a temperature as possible, in order to facilitate maintenance of the temperature-pressure equilibrium at the optimum level indicated.

Since the system comprises a plurality of self-contained units or chambers, the cutting out of one or more of the chambers in a system may readily be accomplished by providing the necessary gas and liquid by-pass pipe lines. Thus, repairing of individual units may be carried out without disturbing the operation of the remainder of the system, and the number of units in use may be varied to meet requirements.

This application is a continuation in part of my application Serial No. 540,785 filed June 17, 1944, now patent No. 2,471,013.

What is claimed is:

1. A method of producing sodium bicarbonate which comprises arranging a series of at least four bodies of ammoniated brine in horizontally disposed relation to each other in a series of reaction chambers, feeding ammoniated brine in to the lower portion of the first of said series of reaction chambers, passing a gravity flow of brine from the bottom zone of each chamber except the last of the series into the bottom zone of the adjacent succeeding chamber of the series, withdrawing the brine from the lower zone of the last chamber of the series and discharging it at atmospheric pressure at a higher level below the tops of said chambers to maintain a constant level of brine in the chambers, and passing a stream of gas containing carbon dioxide successively through the bodies of brine in said series from the last to the first thereof to maintain a concentration of carbon dioxide in said bodies of gradually increasing degree from the first to the last thereof, said stream of gas being passed through the bodies by separately pumping the unabsorbed gas from each chamber excepting the first of the series at a gauge pressure of from about 3 to about 5 pounds through each preceding chamber of the series, said pressure being only sufficient to overcome the static head pressure of the brine in the respective chamber, to maintain substantially atmospheric gas pressure on the surface of the body of brine in each of the chambers.
2,527,340

2. Method as defined in claim 1 in which additional gas containing carbon dioxide is introduced into the stream of gas flowing from each chamber excepting the first to each preceding chamber to compensate for the carbon dioxide absorbed in said chambers.

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The following references are of record in the file of this patent:

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