in other industries, and also reduces the emission and enhances the value of carbon dioxide from a natural gas separation process.

Brief description of the drawings

Figure 1 shows x-ray diffraction patterns of sodium bicarbonate ($NaHCO_3$), which can be produced when using a process according to the present invention at different concentration of reactive ammonia solution.

Figure 2 shows a relation between a percentage of sodium bicarbonate ($NaHCO_3$), which can be produced when using a process according to the present invention, and reaction time, comparing at the operating pressure of 0.1 MPa (1 bar) and 0.13 MPa (1.3 bar).

Figure 3 shows a relation between a percentage of sodium bicarbonate ($NaHCO_3$), which can be produced when using a process according to the present invention, and operating pressure, comparing at the operating pressure of 0.1-0.5 MPa (1-5 bar).

Detailed description of the invention

The present invention relates to a preparation of sodium bicarbonate ($NaHCO_3$) from carbon dioxide (CO_2). It starts from mixing sodium compound solution and ammonia solution; then causing a reaction between carbon dioxide (CO_2) and a mixture of sodium compound and ammonia solution; and separating that prepared sodium bicarbonate solid product. The preparation process is as follows:

A. Weigh a specified amount of sodium compound and dissolve it in deionized water wherein the sodium compound is chosen from either sodium carbonate (Na_2CO_3) or sodium hydroxide (NaOH) or combination thereof. The preparation temperature of sodium compound is between 20 to 60 degree Celsius.
B. Weigh a specified amount of ammonia and dissolve it in deionized water. The preparation temperature of ammonia solution is between 20 to 60 degree Celsius.
C. Mix the substance obtained from A. and B. together until the final concentration of sodium compound and ammonia is desirable. Preferably, the final concentration of mixed solution is between 1 to 10 mol/liter for sodium compound and 1 to 5 mol/liter for ammonia.
D. Continuously release carbon dioxide (CO_2) into the mixture obtained from C. to cause a reaction at proper duration, temperature, and pressure until having a white solid product.

Preferably, the concentration of carbon dioxide (CO_2) which is used as a reactant is between 99.5 to 99.9% by volume.

For the feeding of carbon dioxide (CO_2), which is used as a reactant, into the mixed solution of sodium compound and ammonia solution, the feeding rate is 0.1 to 0.5 liter/minute per total liquid volume of 0.2 liter; the operating pressure is between 0.1 to 0.5 MPa (1 to 5 bar); the preferred temperature is between 20 to 60 degree Celsius; and the preferred duration of feeding carbon dioxide (CO_2) into the mixed solution of sodium compound and ammonia solution is between 1 to 10 hours.

E. The white solid product obtained from D. will be filtered out of the solution by such method as filter paper until it is dry and wash it again with organic solvent. Let it dry at room temperature for 5 to 10 days and weigh it, wherein the organic solvent for washing the white solid product obtained from a reaction between carbon dioxide (CO_2) and mixed solution of sodium compound and ammonia solution is alcohol organic solvent, preferably ethanol. Then, perform identification test for sodium bicarbonate by analyzing its purity and crystal structure, using an analytical technique of x-ray diffraction (XRD) in comparison with a sodium bicarbonate standard material.

The product obtained from chemical reaction will be calculated into percent yield, based on the following equation:

Percent yield = 100*actual yield/theoretical yield

wherein actual yield is the amount of product obtained from test or reaction and theoretical yield is the amount of product obtained from chemical equation of complete reaction.

Percent yield is less than 100% since sodium bicarbonate product can partially dissolve in water. It is found that the solubility of sodium bicarbonate is 96 grams per 1 liter of water at the temperature of 20 degree Celsius, and also found incomplete reaction at test condition.

One or more embodiment of the present invention will be described in detail with reference to examples of a preparation of sodium bicarbonate solid product according to the present invention. However, it is not intended to limit one or more embodiment of the present invention. The following examples are provided to show certain embodiment in terms of its function. It will be clearly understood by those skilled in the art that the present invention is not limited by certain embodiment illustrated in these examples.

Example 1

A preparation method is similar to those of Example 1 except the use of sodium hydroxide (NaOH) as a reactant, wherein, before the feeding of carbon dioxide, the final concentration of sodium ion in a mixed solution is 6 mol/liter. There is also a description of the concentration results of ammonia which is used as a reactant per the volume of prepared sodium bicarbonate solid product as shown in Table 3.

Table 3 The concentration results of ammonia which is used as a reactant per the percent yield of prepared sodium bicarbonate solid product when using sodium hydroxide as a reactant

Concentration of reactive ammonia (mol/liter)	Percent yield
0	0.5
1.59	30.1

According to Table 3, it is found that the percent yield of prepared sodium bicarbonate significantly increases when there is ammonia in the system.

Example 4

A preparation method is similar to those of Example 1 except the final concentration of ammonia in a mixed solution before the feeding of carbon dioxide, which is 1.59 mol/liter. Additionally, there is a comparison of the use of sodium hydroxide (NaOH) and sodium chloride (NaCl) as a reactive sodium compound at the final concentration of sodium ion before the feeding of carbon dioxide and ammonia into a mixture, which is 6 and 1.59 mol/liter respectively, providing test results as shown in Table 4.

Table 4 The results for each type of reactive sodium compound per the percent yield of prepared sodium bicarbonate at the final concentration, before the feeding of carbon dioxide, of sodium ion and ammonia solution in a mixed solution of 6 and 1.59 mol/liter

Type of reactive sodium compound	Percent yield
Sodium carbonate (Na_2CO_3) = Example 1	34.74
Sodium hydroxide (NaOH)	30.1
Sodium chloride (NaCl)	18.2

According to the test results, it is found that type of reactive sodium compound affects percent yield of prepared sodium bicarbonate. Besides, when using sodium chloride (NaCl) as a

reactive sodium compound, in accordance with Solvay process, there is always an occurrence of such by-product as ammonium chloride (NH_4Cl).

Example 4

A preparation method is similar to those of Example 2 except the operating pressure of 0.13 MPa (1.3 bar) under a pressure controllable container, providing test results as shown in Figure 2 which signifies increasing percent yield of prepared sodium bicarbonate when operating pressure is increasing.

Example 5

A preparation method is similar to those of Example 1 except the operating pressure of 0.1-0.5 MPa (1-5 bar) under a pressure controllable container, providing test results as shown in Figure 2 which signifies increasing percent yield of prepared sodium bicarbonate when operating pressure is significantly increasing from 0.1 to 0.3 MPa (1 to 3 bar) and there is only a few changes of percent yield after the operating pressure is greater than 0.3 MPa (3 bar).

In many possible embodiments wherein the principle of disclosed invention might be used, the disclosed embodiment is only a preferred example of the invention and should not limit the scope of the invention.

An additional description of the following definition of terms and methods is provided to better describe disclosure of the present invention and to suggest those skilled in the art to apply the disclosure into practice.

Unless described otherwise, all the technical and scientific terms used herein have the same meaning as that understood by those skilled in the art. Though similar or equivalent methods and materials described herein can be used for the practice or test of the present disclosure, preferred