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SELF-INDICATING SODA LIME

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This invention relates to soda lime for removing carbon dioxide from gases, and more particularly to a soda lime which contains, inherently combined, a means for indicating accurately when its effectiveness as a carbon dioxide absorbent has been substantially exhausted; also to an improved method for removing carbon dioxide from gases which comprises utilization of this soda lime.

The principal object of this invention is the provision of a soda lime which will indicate when its effectiveness for absorbing carbon dioxide has been substantially exhausted, which indication is both accurate and definite, and not subject to substantial variation. It is also an object to provide a new method for removing carbon dioxide from gases, employing the soda lime referred to above. Other objects will be in part obvious, and in part pointed out hereinafter.

The invention accordingly comprises the ingredients and combinations of ingredients, the proportions thereof, steps and sequence of steps, and features of composition and manipulation, which will be exemplified in the products and methods hereinafter described, and the scope of the application of which will be indicated in the following claims.

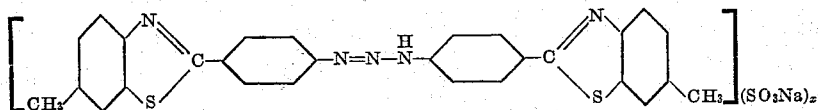
Soda lime is widely used for the removal of carbon dioxide in gas re-breathing apparatus. Typical of this are units for the determination of the basal metabolism rate, machines for recycling anaesthetic gases, oxygen tents, oxygen breathing masks, submarines, and the like. The soda lime customarily employed for these purposes is a granular composition of sodium hydroxide and calcium hydroxide with varying amounts of moisture. It is customarily employed in the form of granules which usually are of a size of from 4 to 8 mesh.

The soda lime at present employed, however, is unsatisfactory in several respects. The user has no way of determining the percentage of the soda lime which has become exhausted unless a very troublesome, time-consuming and substantially impractical complete chemical analysis is employed. The difficulty of this is so great that in customary use, the soda lime is either em-

parent. The former criterion is of course wasteful of the soda lime in many instances, since it is discarded long before its useful limit of life has been reached. The former procedure is, however, usually preferable to the latter, since watching for the physiological reaction of the patient is a strain upon the operator.

In actual practice, either a record of the amount of use of a given charge must be compiled, so that it may be discarded before its useful life has been exceeded, or the operator must watch the patient at all times for the physiological effects which are produced by an excess of carbon dioxide. The former is troublesome and uneconomical, while the latter imposes upon the operator the strain of constant watchfulness for the physiological effects upon the patient, and in addition is unsatisfactory, since the necessity for change of charges of soda lime may appear at an awkward time in the use of the gas recycling machine.

According to the present invention, a new soda lime composition is provided which overcomes these objections, and the use of which is both economical and convenient. This composition may be prepared by coating soda lime with a material which is of one color at the alkalinity of sodium hydroxide, and another color at the alkalinity of sodium carbonate, as present in soda lime, under the conditions of actual use. This coating substance must not, however, have any substantial tendency to become oxidized or reduced under normal conditions of operation; that is, it must not be either an active oxidizing or reducing agent. It has been found that materials which change color at some pH between 11 and 14.5, and which are not oxidizing or reducing agents under normal conditions may be satisfactorily employed in carrying out the present invention, provided such color change is sufficiently definite to be readily observed. The preferred composition for carrying out the present invention is Clayton Yellow, otherwise known as Titan Yellow. Clayton Yellow is a complicated dye stuff material, Color Index Number 813. It probably has the following formula:



ployed for an arbitrarily determined length of time which is known to be safe, or it is used until the physiological effects of a high concentration of carbon dioxide in the gas become ap-

The soda lime granules are coated preferably by spraying a solution of Clayton Yellow on them to form a pink product.

As the soda lime composition absorbs carbon

dioxide and is converted to carbonate, the color changes to yellow, thus giving a clear and accurate picture of the extent to which the effectiveness of the soda lime has been exhausted.

Other indicators may of course be employed, provided they have the attributes defined above. For example, Aniline Red, otherwise known as Basic Fuchsin or Fuchsin RFN, Color Index Number 676, may be substituted for the Clayton Yellow. The soda lime granules coated with this material are brownish orange in color. When the effectiveness of the resulting composition has been exhausted by absorption of carbon dioxide, the color exchanges to a brilliant red. Poirrier's Blue likewise may be employed to coat the soda lime granules. The soda lime so coated is dull purple in color, and changes to a brilliant blue when the granules have become exhausted through absorption of carbon dioxide.

In employing a canister of the new materials provided by the present invention, it is attached to an anaesthetic machine, for example, and then used during the course of an operation. After the operation the anaesthetist would examine the soda lime in the canister. In the case of an opaque canister, it is only necessary to scoop out the soda lime which has turned yellow, until pink soda lime is reached. Fresh soda lime can then be added to replace that used up, and the canister is then fully charged. Alternatively, if it is possible to view the contents of the canister without removal of the soda lime, the operator can observe by inspection the proportion of the total charge which has been exhausted, and from this estimate with a sufficient degree of accuracy the hours of life remaining in the charge. In this manner, it is possible to see when the canister must be recharged, and to predict when the canister will become exhausted under the conditions of normal usage.

The soda lime of the present invention is also valuable for the removal of carbon dioxide from gases which are not recycled. In submarines, for example, use of the instant soda lime will show when the effectiveness of the charge has been exhausted, and there is no need to wait for the effects of a high carbon dioxide concentration to become evident or to discard the soda lime while it is still effective.

It is at once apparent that the use of the material of the present invention will entirely eliminate guess-work as to the effectiveness of any canister of soda lime as a carbon dioxide absorbent. There is no danger that the canister will become unexpectedly exhausted at an awkward point in its use, and in addition it provides maximum economy, since only soda lime which has actually been exhausted is discarded.

When soda lime coated with either Poirrier's Blue or Aniline Red is employed, instead of that which has been coated with Clayton Yellow, the operation is identical. The only difference is in the color of the fresh and exhausted soda lime.

Other indicators than those specified may be employed, provided they are substantially inert toward the materials employed in the removal of the carbon dioxide; that is, toward the gaseous components and toward the soda lime; and provided that the indicators employed have a definite color change at some pH between 11 and 14.5. In a soda lime of wide utility, it is important to avoid indicators which are either oxidizing or reducing agents. Thus sodium manganate is a suitable indicator only in the absence of reducing agents. Accordingly, it can-

not be used in the presence of many of the organic anaesthetics. In contradistinction, the present invention is particularly applicable to such anaesthetic gas recycling processes and is highly satisfactory for use, for example, with ether, cyclopropane, chloroform, ethylene, divinyl ether and nitrous oxide. The color of the product of the present invention is a clear and accurate indication of the condition of the soda lime.

Even if surface absorption of carbon dioxide by a granule of soda lime takes place so rapidly that the color of the surface changes before the interior is completely exhausted, this color change is reversible, and if the soda lime granule is permitted to remain idle until the distribution of the carbon dioxide has been equalized, the color of the surface will change back again if the granule can still absorb additional quantities of carbon dioxide. Accordingly, the color of the granule is always an accurate indication of its ability to absorb additional quantities of carbon dioxide.

Other products which will absorb carbon dioxide may be substituted for the soda lime, to prepare compositions which are likewise contemplated by the present invention. Potash lime, for example, may be treated with Clayton Yellow, Aniline Red or Poirrier's Blue, to form a composition having the advantages outlined in connection with soda lime. Other alkali or alkaline earth metal hydroxides or strongly alkaline organic materials may be employed in lieu of the caustic. Thus triethanolamine, or ethyl ammonium hydroxide may be used, instead of the sodium or potassium hydroxide.

For certain purposes, lime alone may be employed, or any one of the carbon dioxide absorbents identified above. Thus, sodium hydroxide may be used by itself to remove carbon dioxide from a relatively dry atmosphere.

The Clayton Yellow, Aniline Red, Poirrier's Blue, or the like is incorporated into the composition as described above.

Although for most purposes, it is more economical to merely coat the surface of the carbon dioxide absorbent with Clayton Yellow, Aniline Red, Poirrier's Blue or the like, the entire granule of the absorbent composition may be impregnated. In general, this is not required.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above methods and products without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A composition of matter for absorbing carbon dioxide comprising soda lime and a small proportion of a substance which changes color at a pH between 11 and 14.5, which substance will retain its color-changing characteristics in contact with the ingredients, and will not become oxidized or reduced under normal conditions, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

2. A composition of matter for absorbing carbon dioxide comprising soda lime and a small proportion of a substance which changes color at a pH between 11 and 14.5, which substance is substantially stable under normal conditions of operation, said composition visually indicating

when its ability to absorb carbon dioxide has been materially decreased.

3. A composition of matter for absorbing carbon dioxide comprising soda lime and a small proportion of Clayton Yellow, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

4. A composition of matter for absorbing carbon dioxide comprising soda lime and a small proportion of Aniline Red, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

5. A composition of matter for absorbing carbon dioxide comprising soda lime and a small proportion of Poirrier's Blue, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

6. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with soda lime containing a small proportion of a substance which changes color at a pH between 11 and 14.5, which substance will retain its color-changing characteristics in contact with the ingredients, and will not become oxidized or reduced under normal conditions, said soda lime composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

7. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with soda lime containing a small proportion of a substance which changes color at a pH between 11 and 14.5, which substance is substantially stable under normal conditions of operation, said soda lime composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

8. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with soda lime containing a small proportion of Clayton Yellow.

9. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with soda lime containing a small proportion of Aniline Red.

10. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with soda lime containing a small proportion of Poirrier's Blue.

11. A composition of matter for absorbing carbon dioxide comprising an alkaline carbon dioxide absorbent and a small proportion of a substance which changes color at a pH between 11 and 14.5, which substance will retain its color-changing characteristics in contact with the ingredients, and will not become oxidized or reduced under normal conditions, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

12. A composition of matter for absorbing carbon dioxide comprising an alkaline carbon dioxide absorbent and a small proportion of a substance which changes color at a pH between 11 and 14.5, which substance is substantially stable under normal conditions of operation, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

13. A composition of matter for absorbing carbon dioxide comprising an alkaline carbon dioxide absorbent and a small proportion of Clayton Yellow, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

14. A composition of matter for absorbing carbon dioxide comprising an alkaline carbon dioxide absorbent and a small proportion of Aniline Red, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

15. A composition of matter for absorbing carbon dioxide comprising an alkaline carbon dioxide absorbent and a small proportion of Poirrier's Blue, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

16. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with an alkaline carbon dioxide absorbent containing a small proportion of a substance which changes color at a pH between 11 and 14.5, which substance will retain its color-changing characteristics in contact with the ingredients, and will not become oxidized or reduced under normal conditions, said carbon dioxide absorbent visually indicating when its ability to absorb carbon dioxide has been materially decreased.

17. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with an alkaline carbon dioxide absorbent containing a small proportion of a substance which changes color at a pH between 11 and 14.5, which substance is substantially stable under normal conditions of operation, said carbon dioxide absorbent visually indicating when its ability to absorb carbon dioxide has been materially decreased.

18. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with an alkaline carbon dioxide absorbent containing a small proportion of Clayton Yellow.

19. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with an alkaline carbon dioxide absorbent containing a small proportion of Poirrier's Blue.

20. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with an alkaline carbon dioxide absorbent containing a small proportion of Aniline Red.

21. A composition of matter for absorbing carbon dioxide comprising soda lime and a small proportion of a substance selected from Clayton Yellow, Aniline Red, and Poirrier's Blue, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

22. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with soda lime containing a small proportion of a substance selected from Clayton Yellow, Aniline Red and Poirrier's Blue.

23. A composition of matter for absorbing carbon dioxide comprising an alkaline carbon dioxide absorbent and a small proportion of a substance selected from Clayton Yellow, Aniline Red and Poirrier's Blue, said composition visually indicating when its ability to absorb carbon dioxide has been materially decreased.

24. The method of removing carbon dioxide from a gas which comprises passing the gas in contact with an alkaline carbon dioxide absorbent containing a small proportion of a substance selected from Clayton Yellow, Aniline Red, and Poirrier's Blue.

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