COLOR CHANGE OBSERVED AT BOTH ENDS SIMULTANEOUSLY IN A CARBON DIOXIDE ABSORBENT CANISTER

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Abstract

We report the case of a canister of Medisorb EF® (CareFusion) absorbent which was found to have a simultaneous color change at both ends of the absorbent canister. It is likely that the absorbent had partially dried overnight, which caused the color change at the bottom, as well as having been exhausted from the top downwards. Desiccation of absorbents is due to retrograde flow of anhydrous fresh gas through the canister, which can happen when fresh gas is left flowing while the machine is not in use. Replacing the absorbent is recommended if the hydrous state is uncertain.

Introduction

Many carbon dioxide absorbent canisters change color when exhausted. This use of color indication helps clinicians identify when absorbent has been used up and requires replacement. There are also carbon dioxide absorbent canisters that change color when the absorbent has been desiccated. We report the case of a canister of Medisorb EF® (CareFusion) absorbent, a low-alkaline formulation, which was found to have a simultaneous color change at both ends of the absorbent canister (see figure 1).

Case Description

The carbon dioxide absorbent canister had been in consistent use throughout the week and this color change pattern was first noticed in the middle of the day on a Thursday. It is likely that the absorbent had partially dried overnight, which caused the color change at the bottom, as well as having been exhausted from the top downwards. Desiccation of absorbents is due to retrograde flow of anhydrous fresh gas through the canister, which can happen when fresh gas is left flowing while the machine is not in use.[1] Absorbent desiccation and exhaustion both resulted in a color change from white to purple being observed at both ends of the canister. The manufacturer

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Fig. 1
Medisorb EF® canister observed mid-day on a Thursday with simultaneous color change from white to violet at both ends

advises that Medisorb EF absorbent will change from an off-white to violet when exhausted and also when desiccated, a long-lasting effect from ethyl violet, an organic pH sensitive dye.[1] This color change is activated when the pH of the absorbent drops below 10.3, which occurs during the absorption reaction of chemical neutralization of carbon dioxide and moves in the direction of the gas flow.[1] CareFusion recommends changing the absorbent canister when more than two thirds of the canister has changed color in total.[2] As a result, this absorbent canister was changed.

Discussion

All calcium hydroxide based carbon dioxide absorbents change color when exhausted by their reaction with carbon dioxide, but not all absorbents change color when dried. Absorbents containing KOH (e.g., Baralyme® (Allied Health Care)) never change color when drying, even when totally dried.[3] The amount of drying that causes a color change is proportional to NaOH content in absorbents that contain NaOH (e.g., Medisorb® and Medisorb EF®). Medisorb is a brand of soda lime, with a sodium content of 5%, so it does not

change color when desiccated. Medisorb EF is a low alkali absorbent containing 1% sodium hydroxide that does change color when dried.[2,4]

The phenomenon of simultaneous color change at both ends of the absorber canister has previously been described by Loeb and Gravenstein.[5] The absorbent used in this case was Amsorb® Plus (Armstrong Medical). Amsorb is a low alkaline absorbent that does not contain any sodium hydroxide or potassium hydroxide, and, similar to Medisorb EF, also changes color when dried.[1,4] Due to Amsorb's low alkaline formulation, it does not produce Compound A or carbon monoxide, and it can be speculated that Medisorb EF similarly does not produce Compound A or carbon monoxide.[6,7] The absorbent in this case was in consistent use throughout the week, in contrast to the case described by Loeb and Gravenstein, which was observed on a Monday after a weekend of non-use with fresh gas left flowing.[5] During periods of non-use, fresh gas that is left flowing can travel either: 1) past the inspiratory unidirectional valve and out to the atmosphere through the open Y-piece; or 2) retrograde through the absorber canister and out to the atmosphere via an open APL valve or bag mount. The fresh gas will travel down the path of least resistance, which may include both paths.[8] The degree of retrograde flow is enhanced when the Y-piece is occluded, the reservoir bag is removed, and the APL valve is open.[1,3] Higher retrograde flow of the anhydrous fresh gas increases the degree of desiccation and color change in absorbents that change color with desiccation. It is possible for a grossly incompetent or missing inspiratory valve to allow exhaled gas to flow backwards through the inspiratory hose into the bottom of the canister, which could theoretically over time result in a color change in the wrong end of the absorbent canister due to carbon dioxide absorption. This would be highly unlikely, and there was no inspiratory unidirectional valve incompetence observed when the anesthesia machine used in this case was checked using the modified pressure decline method.[9] There was also no obvious channeling observed on the outside of the canister.

Various color changes are observed when different absorbents are exhausted and when desiccated. Barium hydroxide lime (e.g., Baralyme®) has an ethyl violet indicator that turns from white to violet when exhausted, but it has been noted to change from white to yellow when desiccated.[10] Spherasorb® (Intersurgical Ltd., Wokingham, UK) may be manufactured with a titan yellow dye for use in some countries (e.g., United Kingdom, Australia, New Zealand, India, and some other former British colonies). It is pink when fresh, and turns white when exhausted; though it is not known if it changes color upon desiccation.[11]

Conclusion

The ease of desiccation with retrograde flow points to the enhanced safety profile of an absorbent that changes color with desiccation. Particularly when some of the absorbent appears partially exhausted, an absorbent that is partially desiccated but still white may, in fact, require replacement. Replacing the absorbent is recommended if the hydrous state is uncertain.[1,8]

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