Product Information

SpiraLith Ca CO_2 ABSORBENT
THE SOLID CHOICE®

TOPIC #3: TOXICITY – COMPOUND A

SpiraLith® Ca Eliminates Concern for Compound A while Maximizing Absorption Capacity

When Sevoflurane was introduced into practice it was well known to produce compound A, a nephrotoxin in animals. Although human toxicity has never been shown, concern for compound A production has fostered changes in CO_2 absorbent formulations. Compound A is produced when Sevoflurane interacts with calcium hydroxide ($Ca(OH)_2$) based CO_2 absorbents containing 2% to 6% of the strong bases potassium and sodium hydroxide (KOH and NaOH). Studies have shown that by eliminating these strong bases entirely, inspired compound A concentrations are no greater than expected baseline.[1] Eliminating all of the strong base however reduces the capacity for CO_2 absorption and the duration of effectiveness. More recent studies have shown that absorbents using $Ca(OH)_2$ in combination with no KOH and small quantities of NaOH (< 2%) produce no more compound A than $Ca(OH)_2$ alone and have better duration. SpiraLith Ca uses this optimal chemical formulation of limiting NaOH to < 1% to ensure that compound A production is not a concern, and packages the absorbent using solid cartridge technology to provide absorption capacity that exceeds all other absorbents.*

Traditional CO_2 absorbents use calcium hydroxide ($Ca(OH)_2$) in combination with a strong base such as KOH and/or NaOH. Adding 2% to 6% strong bases such as NaOH and/or KOH increases the capacity for CO_2 absorption compared to $Ca(OH)_2$ alone. In the original formulation introduced in 1924, Waters advocated for an absorbent containing 5% NaOH and 15-20% water.

When it was observed that Sevoflurane had the potential to interact with absorbents to produce compound A, researchers began to investigate compound A production by different absorbent formulations. **The first studies confirmed that removing the strong bases KOH and NaOH reduces compound A concentration to the lowest possible level, but negatively affects absorbent capacity (CO_2 absorbed per gram), which manifests as reduced duration.**

- Murray et. al. (1999) compared Amsorb, a new formulation of absorbent without KOH or NaOH to the traditional absorbents, Intersorb and Draegersorb, and found that peak compound A concentration was reduced from over 30ppm to 3.3 ppm with Amsorb. (1) However, their data also indicated a reduced capacity to absorb CO2 (from 120 L/kg with Intersorb to 102 L/Kg with Amsorb).
- Stabernack et. al. (2000) compared Amsorb to 6 other $Ca(OH)_2$ absorbents with significant concentrations of NaOH and/or KOH and found peak compound A to be 4.5 ppm with Amsorb versus 10ppm to more than 30 ppm for the other absorbents. (2) This study also confirmed that duration of effectiveness (as measured by the time to appearance of inspiratory CO_2 > 5 mmHg) for the absorbents with strong bases was 41% longer than Amsorb.

---

[1] Compound A is expected in low concentrations in the breathing circuit. The package insert indicates concentrations approaching 5 ppm even with high fresh gas flows. (Ultane®, One human study found delayed proteinuria but not changes in BUN or creatinine when exposed to inspired Compound A concentrations of 50 ppm. (Eger EI. Anesth Analg 1997;84:160)

Micropore INCORPORATED

Product Information

SpiraLith Ca CO_2 ABSORBENT
THE SOLID CHOICE®

TOPIC #3: TOXICITY – COMPOUND A (CONT'D)

When it was observed that duration was negatively impacted by elimination of strong bases, absorbent manufacturers began exploring other chemistries to both eliminate concern for compound A while minimizing the impact on duration. **Subsequent studies demonstrated that by eliminating KOH entirely and limiting NaOH concentration to <2%, measured compound A concentrations were no different than $Ca(OH)_2$ alone and duration was significantly better.** These studies became possible with the introduction of newer absorbents, for example Draegersorb Free that had no KOH and NaOH < 2%.

- Kobayashi et al. (2004) compared a traditional absorbent Sodasorb II (2.25% KOH/2.25%NaOH) to Draegersorb Free (0%KOH/<2%NaOH) and Amsorb (0%KOH,0%NaOH). (3) Sodasorb II produced a peak compound A concentration > 20 ppm whereas Draegersorb Free and Amsorb were indistinguishable at < 2.2 ppm. The duration of Amsorb was less than the other absorbents as measured by time to appearance of inspiratory CO_2.
- Struys et. al. (2004) compared Draegersorb Free and Amsorb Plus under minimal flow conditions and measured compound A concentrations < 1ppm for both absorbents in normally hydrated and desiccated forms. (4) Amsorb Plus is engineered to provide a greater absorbent capacity than Amsorb but Draegersorb free still lasted on average 3.5 hours longer (20%) than Amsorb Plus.

SpiraLith Ca (0%KOH/<1%NaOH) was not available when these studies were completed but the chemistry is comparable to Draegersorb Free. SpiraLith Ca uses solid cartridge technology instead of granules to enhance absorbent capacity further. Solid cartridge technology ensures more uniform gas flow than granules, eliminating channeling and maximizing gas contact with the absorbent. **As a result, SpiraLith Ca has been proven to absorb the most CO_2 per gram of any absorbent on the market.**

- Jiang et. al. showed that SpiraLith Ca outperformed all absorbents tested on a volumetric basis, including those with strong bases, and lasted 45 percent longer than an equivalent volume of Draegersorb Free (5).

In summary, SpiraLith® Ca chemistry eliminates concern for compound A and the solid cartridge technology absorbs more CO_2 per gram than all other granular absorbents.

References

1. Murray et. al. Amsorb A New Carbon Dioxide Absorbent for use in Anesthetic Breathing Systems. Anesth. 1999; 91:1342-1348.
2. Stabernak et. al. Absorbents Differ Enormously in Their Capacity to Produce compound A and Carbon Monoxide. Anesth Analg 2000:90:1428-1435.
3. Kobayashi et. al. Amsorb Plus and Drägersorb Free, two new-generation carbon dioxide absorbents that produce a low compound A concentration while providing sufficient CO2 absorption capacity in simulated sevoflurane anesthesia. J Anesth 2004:18:277–281.
4. Struys et al. Production of compound A and Carbon Monoxide in Circle Systems: an in vitro comparison of two carbon dioxide absorbents. Anaesthesia 2004;59;584-589.
5. Jiang, Y. In vitro efficiency of 16 different $Ca(OH)_2$ based CO_2 absorbent brands. Journal of Clinical Monitoring and Computing, (2019). In Press. http://doi.org/10.1007/s10877-018-00248-x

Micropore INCORPORATED