Armstrong Medical

For GE equipment

AMSORB® *Plus*

Contents

AMSORB® Plus – absorbs carbon dioxide (CO_2) from cellular respiration during anaesthesia. Unlike other absorbents it is not capable of degrading vapourous anaesthetic agent. Use of AMSORB® Plus is supported by an extensive bibliography in peer-reviewed journals.

How AMSORB® Plus Works

The primary reaction is between CO_2 and calcium hydroxide ($Ca(OH)_2$) and water. These form calcium carbonate ($CaCO_3$) and water. Exothermic heat is a by-product of absorption. During absorption, $Ca(OH)_2$ is continually re-moistened until converted to $CaCO_3$. Lesser chemicals, calcium chloride ($CaCl_2$) and calcium sulphate ($CaSO_4$) prolong the life of $Ca(OH)_2$ and increase the speed of absorption reaction by maintaining granule strength and optimising hydration.

Chemical Reaction of Absorption

$Ca(OH)_2$	+	CO_2	→	$CaCO_3$	+	H_2O
Slightly soluble				Insoluble		

$Ca(OH)_2$ is an ionic compound which is soluble in water at 0.5g.L at 20°C

- The ions are Ca^{++} and OH^- OH^-
- CO_2 is soluble in water at 1 vol : 1 vol at 20°C
- $CaCO_3$ is an insoluble ionic compound Ca^{++} and CO_3^{--}
- Reactions take place in solution when particles are mobile and react on collision

A colour indicator is present, changing from WHITE (fresh) to VIOLET upon exhaustion or desiccation. The indicator reacts to changes in granule hydration as absorption progresses; eventually remaining violet-coloured, once absorption is complete. Colouration also results from contact with ambient air or oxygen, if exposed to these.

Medico-Legal Implications

- **Carbon monoxide (CO)** is produced when passing sevoflurane, isoflurane and desflurane through certain brands of desiccated absorbent. CO is a potentially deadly toxin which users must ensure is not administered to patients, as carboxyhaemoglobin increases can trigger myocardial infarction or cause neurotoxicity in young or anaemic patients.

AMSORB® Plus DOES NOT PRODUCE CO

- **Formaldehyde (HCOH)** is produced when passing sevoflurane through certain brands of desiccated absorbent . HCOH is a potent inhalation irritant and carcinogen and should never be administered to patients. PONV is caused by HCOH inhalation.

AMSORB® Plus DOES NOT PRODUCE HCOH

- **Compound A** is produced when passing sevoflurane through certain brands of fresh or desiccated absorbent. Compound A has been proven to be nephro- and hepatotoxic in rats. Its effect in humans has not been established.

AMSORB® Plus DOES NOT PRODUCE COMPOUND A

Coppens et al. The mechanisms of carbon monoxide production by inhalational agents. Anaesthesia 2006; vol. 61; pp. 462-468

Keijzer C et al. Carbon monoxide production from desflurane and six types of carbon dioxide absorbents in a patient model. Acta Anaesthesiologica Scandinavica 2005; vol. 49; pp. 815-818

Knolle E et al. Small Carbon Monoxide Formation in Absorbents Does Not Correlate with Small Carbon Dioxide Absorption. Anesthesia & Analgesia 2002; vol. 95; pp650-655

Bedi A et al. The in vitro performance of carbon dioxide absorbents with and without strong alkali. Anaesthesia 2001; vol. 56; pp. 1-6

Yamakage M et al. Carbon Dioxide Absorbents Containing Potassium Hydroxide Produce Much Larger Concentrations of Compound A from Sevoflurane in Clinical Practice. Anesthesia & Analgesia 2000; vol. 91; pp220-224

Product Range

G-CAN® absorber

GE Part number : 2105489-003
1.0 L /canister - Box/8
Disposable
Use with Aisys™, Avance™, Aespire™,
ADU and 9100c variants

PREFILLED CARTRIDGE

GE Part number : 2105489-004
1.2 L - Box/12
Disposable
Use with All Aestiva™ variants

JERICAN

GE Part number : 2105489-007
5.0 L - box/2
Disposable
Use with GE reusable canisters

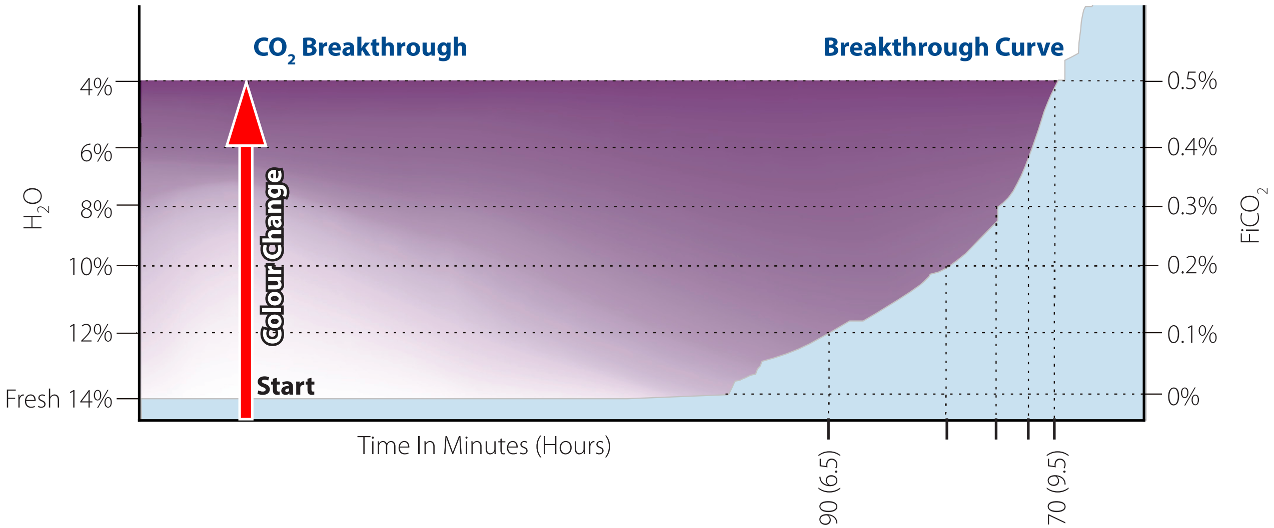
Use of AMSORB® Plus DOES NOT require approval of the anaesthesia machine manufacturer

Colour Change

Colour Change

AMSORB® Plus colour indicator reacts strongly and quickly to the dehydrating effects of CO_2 absorption or contact with anhydrous gas, such as oxygen. Whilst the colour change is an indication of the hydrated state and remaining capacity, depletion of the absorbent should be determined by capnometry and the absorbent changed when $FiCO_2$ has exceeded 0.5% volume or 5mmHg.

In the case of NaOH-containing (sodium hydroxide) absorbents, colouration reverts to white when contact with CO_2 ceases, often after a few hours of non-use. This is due to the strongly alkaline nature of NaOH in soda lime. Desiccation of soda lime through contact with anhydrous gas or moisture loss through exposure to ambient air DOES NOT trigger the colour indicator in soda lime and the soda lime can be desiccated but coloured white, thus appearing fresh and safe for clinical use. Soda lime is potentially dangerous to use when desiccated, as CO_2 absorption may continue.



Fresh Gas Flow 0.5L.min

Method: *in vitro* patient model. 1.0kg AMSORB® Plus. Tidal volume 500mL, respiratory rate 12 breaths per minute, fresh gas flow 500mL.min. O_2, 250mL.min. CO_2 added to expiratory limb. Colour change is permanent at the time of CO_2 breakthrough to 0.5% volume and remains provided the granules are not subsequently rehydrated. Not all granules will change colour.

Avance™

Use until $FiCO_2$ exceeds 5mmHg, then exchange canister mid-case.

Aestiva™

Use until top canister shows total colour change then exchange both canisters between cases.

AMSORB® Plus is NOT the same as soda lime.

No production of CO or Compound A (even when desiccated). Low flow and closed-circuit techniques are safer, even with sevoflurane.

Discard as non-hazardous waste. AMSORB® Plus exhausted pH <12.5, is safe for landfill and breaks down to harmless inorganic compounds.

USE LOW FLOWS
<1 L/min total FGF

WAIT TO EXCHANGE
Until $FiCO_2$ is 0.5% vol. or 5mmHg

NO RED BAG
Discard as non-hazardous waste

Composition of Absorbents

Composition of AMSORB® Plus

$Ca(OH)_2$	Calcium hydroxide	77 - 88%
$CaSO_4 \cdot 0.5\ H_2O$	Calcium sulphate hemihydrate	0.6 - 1.5%
$CaCl_2$	Calcium chloride	2.0 - 3.5%
	Colour indicator	Trace
	H_2O	10 - 18%

Performance of Market Brands

CO_2 Absorption Capacity

Product Name	Brand	Duration (min)	CO_2 Absorption (L.kg)
AMSORB®Plus	**Armstrong Medical**	**290**	**145**
Drägersorb Free	Dräger Medical	300	150
Sodasorb	WR Grace	295	148
Drägersorb 800+	Dräger Medical	290	145
Sofnolime	Molecular Products	290	145
Carbolime	Allied Healthcare	275	138
Sodasorb LF	WR Grace	270	135
Medisorb	GE Healthcare	268	134
Spherasorb	Intersurgical	250	125
LoFloSorb	Intersurgical	150	75

Method: accelerated clinical simulation test using 500mL.min CO_2 in 500mL tidal volume at 12RR using 500mL O_2 as fresh gas flow.

Chemical Formulations and Performance

Product Name	Brand	NaOH*	Silicates	Other Additives	Permanent Colour Change	Agent Degradation**		
						Carbon Monoxide (CO)	Compound A	Formaldehyde
AMSORB® Plus	**Armstrong Medical**	**0%**		**<3% calcium chloride ($CaCl_2$)**	**YES**	**NO**	**NO**	**NO**
Drägersorb Free	Dräger Medical	0.5-2%		<3% calcium chloride	NO	insufficient evidence available		
Sodasorb	WR Grace	3.7%			NO	Yes	Yes	Yes
Drägersorb 800+	Dräger Medical	1-3%			NO	Yes	Yes	Yes
Sofnolime	Molecular Products	<3.5%			NO	Yes	Yes	Yes
Carbolime	Allied Healthcare	3%			NO	Yes	Yes	Yes
Sodasorb LF	WR Grace	<1%	1% quartz	trace phosphonic acid	NO	insufficient evidence available		
Medisorb	GE Healthcare	<3.5%			NO	Yes	Yes	Yes
Spherasorb	Intersurgical	1.3%	4% zeolite		NO	Yes	Yes	Yes
Sodalime	Carlo Erba	>3.5%			NO	Yes	Yes	Yes
LoFloSorb	Intersurgical	0%	6.5% silica		NO	Yes	insufficient evidence available	

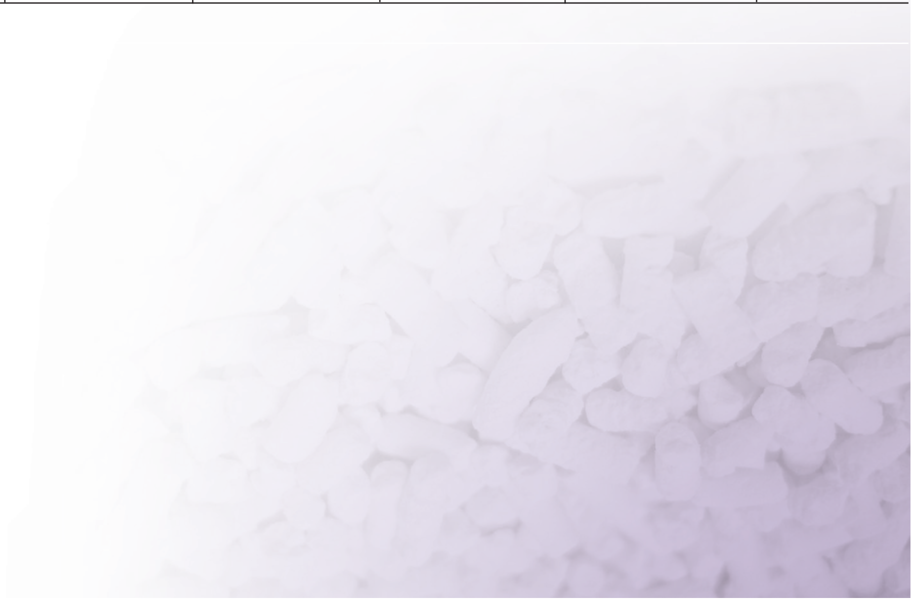
** sources: internal data and Olympio MA* et al. *Carbon Dioxide Absorbent Desiccation Safety Conference Convened by APSF. APSF Newsletter Summer 2005, vol. 20, No. 2, pp. 25, 27-29*

*** independently-published scientific literature*

CO$_2$ Absorption Capacity

Review of independently-published scientific literature for CO$_2$ absorption capacity of respective absorbent brands

Product Name	**AMSORB® Plus**	Drägersorb Free	Drägersorb 800+	Medisorb	Sodasorb	Intersorb Plus	LoFloSorb	Spherasorb
CO$_2$ Absorption Capacity (L.kg)	**205** **(155)**	**217** **(186)**	**146**	**107**	**121**	**126**	**73**	**133**
Brand	**Armstrong**	Dräger	Dräger	GE Healthcare	WR Grace	Intersurgical	Intersurgical	Intersurgical
Publication	Kobayashi, 2004 (Struys, 2004)	Kobayashi, 2004 (Struys, 2004)	Knolle, 2002	Higuchi, 2001	Higuchi, 2001	Knolle, 2002	Knolle, 2002	Knolle, 2002



Kobayashi S et al. Journal of Anesthesia 2004; vol.18;pp277-281

Knolle E et al. Anesthesia & Analgesia 2002; vol. 95; pp650-655

Struys MMRF et al. Anaesthesia 2004; vol. 59; pp584-589

Higuchi et al. Anesthesia & Analgesia 2000; vol. 91; pp434-439

Gas Toxicity

CO Production

Review of independently published scientific literature for CO production of respective absorbent brands

Peak CO (ppm) from Desiccated Absorbent	**0**	**620**	**548**	**525**	**13,317**	**8,000**	**9,045**
Product	**AMSORB® Plus**	Drägersorb 800+	Intersorb Plus	LoFloSorb	Medisorb	Sodasorb	Spherasorb
Brand	**Armstrong**	Dräger	Intersurgical	Intersurgical	GE Healthcare	WR Grace	Intersurgical
Publication	Struys, 2004	Knolle, 2002	Knolle, 2002	Keijzer, 2005	Keijzer, 2005	Fang, 1995	Keijzer, 2005

Struys MMRF et al. Anaesthesia 2004; vol. 59; pp. 584-589
Knolle E et al. Anesthesia & Analgesia 2002; vol. 95; pp. 650-655
Keijzer C et al. Acta Anaesthesiologica Scandinavica 2005; vol. 49; pp. 815-818
Fang ZX et al. Anesthesia and Analgesia 1995; vol. 80(6); pp. 1187-1193

Agent Degradation

Some absorbents negatively impact patient safety. Their continued use raises ethical questions. Inability to determine when some absorbents are desiccated and hence potentially dangerous, demands that a safe absorbent is used.

Many absorbents are known to degrade anaesthetic vapour to produce toxic levels of CO and HCOH, when desiccated. CO is a toxin with affinity for haemoglobin greater than oxygen. HCOH is a potent respiratory tract irritant and carcinogen and has been shown to cause postoperative nausea and vomiting.

All absorbents desiccate through clinical use as well as through exposure to ambient air or gas flow. Absorbent hydration cannot be managed during use. In absorbents other than AMSORB® Plus, colouration, if present, is not a reliable indication of hydration. In all absorbents, the chemical reaction of CO_2 absorption forces moisture from the material. In many brands, this exponentially increases alkalinity; potentially enabling the absorbent to become sufficiently desiccated to degrade anaesthetic whilst continuing to absorb CO_2.

APSF (Anesthesia Patient Safety Foundation) states that absorbents that significantly degrade anaesthetic agents should not be used. This followed earlier notification by Abbott Laboratories that their drug Ultane (sevoflurane) was involved in adverse reactions with CO_2 absorbents.

ABBOTT

200 Abbott Park Road
Abbott Park, IL 60064

November 17, 2003

Dear Health Care Professional,

Abbott Laboratories ("Abbott") would like to make
reports of fire or extreme heat in the respiratory ci
when Ultane® (sevoflurane) is used in conjunction
Although ongoing investigations have not yet id
considers it important to inform anesthesia p
occurrences, which can result in patient inju
for induction and maintenance of general an
for inpatient and outpatient surgery.

It is important to note that, in most of
to Abbott, desiccated CO_2 absorbents
to date cannot confirm whether or

Anesthesia providers should co
these events occurring:
- If you suspect that the CO_2
used for an extended pe
- Although the exact con
desiccated are not we
period of non-use m
materials on the ar
be completely sh
subsequent exte
- Turn off all va
- Verify the in
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apsf® www.apsf.org

NEWSLETTER

The Official Journal of the Anesthesia Patient Safety Foundation

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Summer 2005

Carbon Dioxide Absorbent Desiccation Safety Conference Convened by APSF

by Michael A. Olympio, MD

There is increasing evidence that exposure of volatile anesthetics to desiccated carbon dioxide absorbents may result in exothermic reactions leading to fires in anesthetic breathing circuits and production of toxic products (e.g., carbon monoxide, compound A, methanol, formaldehyde). Although fires have only been reported in association with sevoflurane exposed to desiccated Baralyme® (Allied Healthcare/Chemetron, withdrawn from the market), there is significant evidence that potentially toxic products can be produced upon exposure of volatile anesthetics to other desiccated absorbents containing strong bases, particularly potassium and sodium hydroxide. In some cases this may lead to sub-clinical carbon monoxide exposure.

In view of these continued anesthesia patient safety concerns, the Anesthesia Patient Safety Foundation invited medical experts and industry representatives (manufacturers of carbon dioxide absorbents, anesthesia machines, and volatile anesthetics) to attend a conference entitled *Carbon Dioxide Absorbent Desiccation: APSF Conference on Safety Considerations* on April 27, 2005, in Chicago, IL. In addition to medical experts and industry representatives (Table 1), APSF invited several organizations, including the American Society of Anesthesiologists and the American Association of Nurse Anesthetists to send observers to the conference (Table 2). The conference was funded by the Anesthesia Patient Safety Foundation with the support of unrestricted educational grants from the 10 industry cosponsors.

The format of the conference included formal presentations by the 4 medical experts as well as presentations by representatives of industry. Following reports generated from small group break-out sessions there was general discussion among all attendees and development of a consensus statement to reflect the stated goal of the conference, which was ***"to develop a consensus statement to share with anesthesia professionals on the use of carbon dioxide absorbents so as to reduce the risk of adverse interactions with volatile anesthetic drugs."***

Left to right, Drs. Dorsch, Olympio, Kharasch, Woehlck, Stoelting, and Eger speak at the APSF Conference on Safety Considerations of Carbon Dioxide Absorbents on July 27, 2005, in Chicago, IL.

Summary of Expert Medical and Industry Representative Presentations

Jerry A. Dorsch, MD, speaking on *Anesthesia Machine Characteristics That Promote Absorbent Desiccation:*

The retrograde flow of fresh gas through the absorber can desiccate the absorbent. This may be affected by a number of factors, including the design of the anesthesia breathing system, the presence or absence of the reservoir bag, whether the APL valve is open or closed, the relative resistance through the components of the breathing circuit, the fresh gas flow rate, I:E ratio, use of heat and moisture exchangers, and scavenger suction. With conventional breathing system design, removing the bag, opening the APL valve, and occluding the Y-piece all enhance retrograde flow and desiccation. The effects of these maneuvers in newer, more modern machines are variable, complex, and may have the opposite effect. Furthermore, we do not know of published data that describe the flow of gas under these various conditions. Unfortunately, the flow of gas in these breathing systems has not been well studied.

Evan D. Kharasch, MD, PhD, speaking on *Heat, Fire, and Smoke: Shining Light on the Issue of Carbon Dioxide Absorbents and Anesthetic Degradation:*

The chemical breakdown to compound A can occur in moist, as well as desiccated absorbent, but the potential for highly exothermic reactions and

See "Absorbents," Page 27

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Bedi A et al. The in vitro performance of carbon dioxide absorbents with and without strong alkali. Anaesthesia 2001; vol. 56; pp. 1-6

Agent Adsorption

Agent Adsorption - Patient Awareness

Anaesthetic vapour condenses on desiccated soda lime and on new generation absorbents containing molecular sieve zeolites, quartz or silica. This process, called adsorption, temporarily binds anaesthetic vapour within the absorbent. Knolle (2002) reported adsorption using LoFloSorb (Intersurgical, UK) of 89% of the inflow of 0.5% isoflurane for over 60 minutes, in combination with production of CO. Adsorption is characterised by condensing and accumulation of the vapourised agent on the absorbent granules and re-vapourisation of the agent when canister temperature rises during CO_2 absorption; creating potential for reduced narcosis or blood toxicity from excessive drug exposure. This effect is greater at low fresh gas flow rates and when soda limes and LoFloSorb are used.

Clinical signs of adsorption will include inspired concentrations of the anaesthetic agent being different to the vapouriser setting. Recollection, by the patient of the surgical event or pain during surgery is possible, given inadequate anaesthesia. Use of muscle relaxants could mask a patient's response to surgical stimuli, allowing patient awareness to go unchecked. Also, the cost of adsorption of vapour into the absorbent should be considered when choosing a brand of absorbent.

Adsorption of Anaesthetic Vapour

Adsorption of 0.5% isoflurane by desiccated absorbent (% : mins)				**89% for >60 min**	
					50% for 33 mins
			31% for 20 mins		
		26% for 16 mins			
	20% for 15 mins				
Product	**AMSORB Plus**	Drägersorb 800+	Intersorb Plus	LoFloSorb	Spherasorb
Brand	**Armstrong**	Dräger	Intersurgical	Intersurgical	Intersurgical

Publication	Knolle E *et al.* Small Carbon Monoxide Formation in Absorbents Does Not Correlate with Small Carbon Dioxide Absorption. Anesthesia & Analgesia 2002; vol. 95; pp650-655

Cost of Adsorption

$$\frac{T \times FGF \times V_S = \text{volume of vapour per time unit}}{200.0 \text{ molecular weight at } 20^\circ C} = \text{ml of liquid sevoflurane per time unit}$$

Vapour loss as 50%				
Time unit (min)	FGF (mL.min)	Vapouriser (%)	Vapour loss (%)	Molecular weight (g.mol) at 20°C at Vp 157mmHg
40	500	8	50	200.055

Equals	
Liquid loss (mL)	cost per time unit at $0.60/mL
4.00	$2.40

Alkalinity of Soda Lime

NaOH Concentration Increases as Soda Lime Desiccates

Exponential increases in alkalinity triggers degradation of anaesthetic vapour to toxic inhalants.

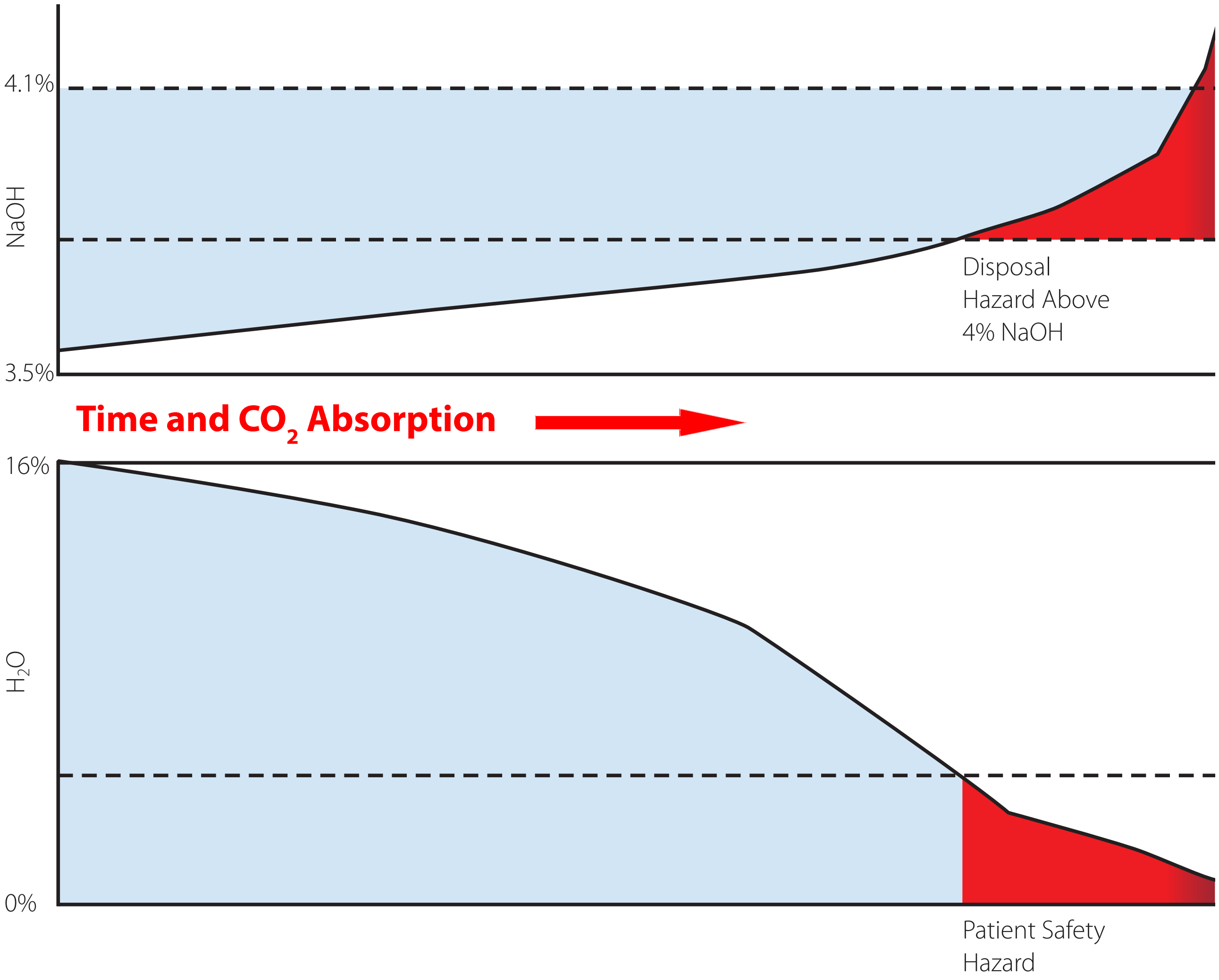
Safe disposal of soda lime must take account of increases in alkalinity brought about by desiccation.

Manufacturers of absorbents cannot declare the pH of their material at any stage, as determination of pH requires the absorbent sample to be converted to a solution. Adding water to a sample of soda lime allows NaOH and $NaCO_3$ to dissolve in water, thus lowering the alkalinity of the material to provide a misleading pH value. A declaration of pH for disposal of soda lime is inaccurate as it does not reflect the actual pH of the material. In some jurisdictions, alkalinity above certain thresholds requires special disposal methods to comply with environmental legislation.

AMSORB® Plus is free from strong base chemicals and therefore cannot become strongly alkaline. Disposal is with non-contaminated clinical waste for landfill.

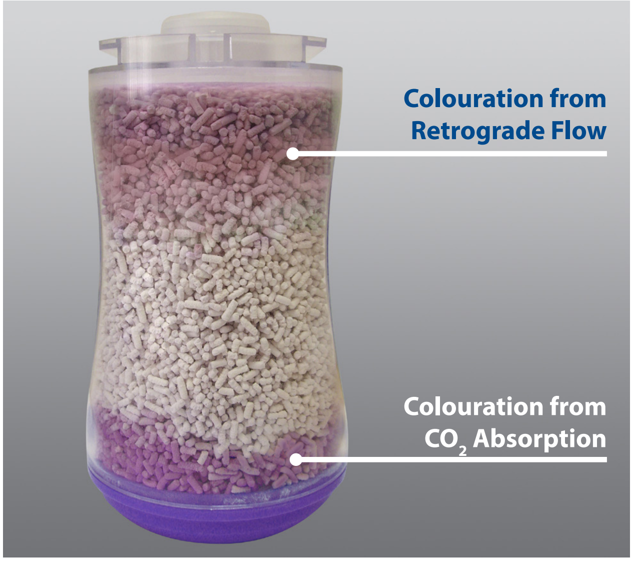
Alkalinity Increases as Moisture Decreases

Progressive dehydration causes a 5-fold increase in the alkalinity of soda lime.



Desiccation

Retrograde Flow in Absorbents



AMSORB® PLUS BUBBLE-CAN® UNIVERSAL

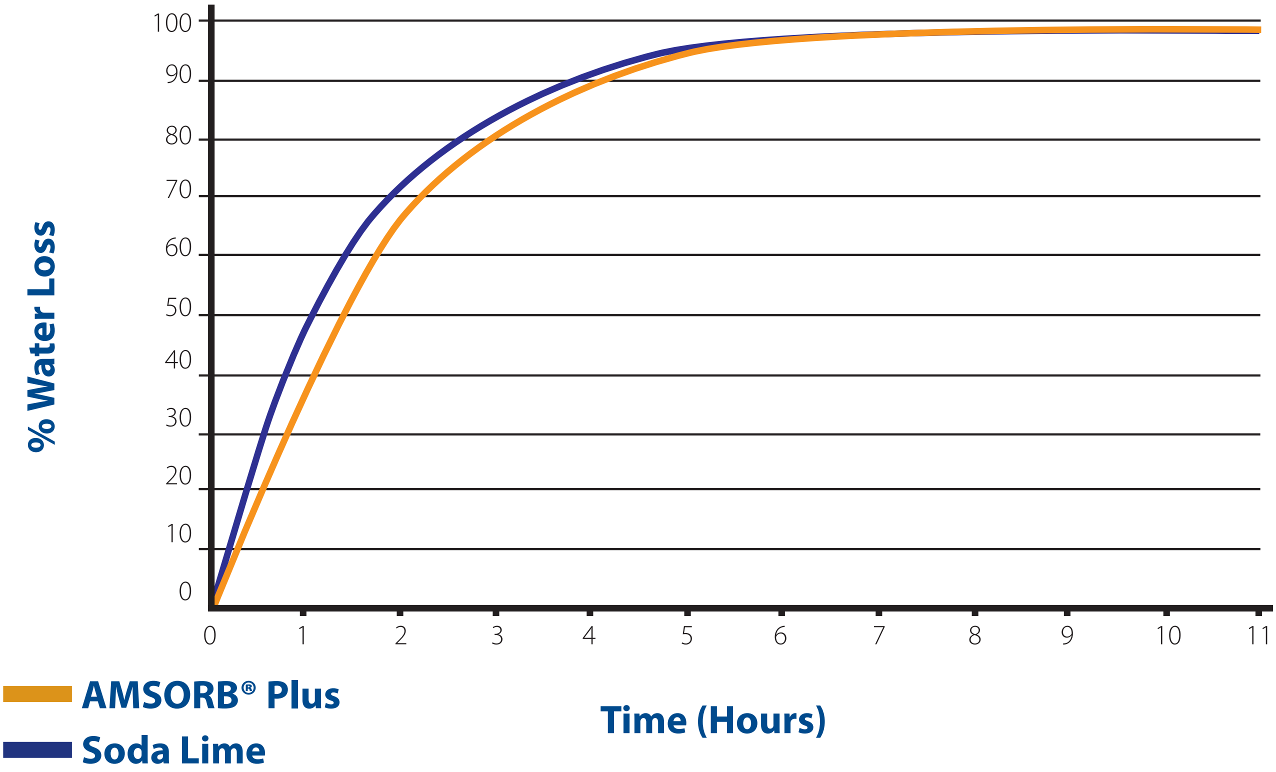
Gas flow desiccates all absorbents. Retrograde flow occurs when fresh gas flow is left running during non-use of an anaesthetic machine. Gas may pass over the top of the absorbent canister and desiccate the absorbent. In subsequent use of some absorbents, degradation of the anaesthetic agent may occur in conjunction with agent adsorption. **NaOH-containing absorbents will NOT change colour during gas flow desiccation. Instead they remain white but may be desiccated. Desiccated soda lime may absorb CO_2.**

Colouration of AMSORB® Plus confirms desiccation. Desiccated AMSORB® Plus will not absorb CO_2. To avoid retrograde flow, fresh gas flow should be turned off during periods of non-use of the anaesthetic machine.

AMSORB® PLUS Rate of Dehydration

Moisture retention from passing 1.0L.min. O_2 through 1.0kg of fresh AMSORB® Plus and fresh soda lime.

AMSORB® Plus compares favourably to other absorbents in resisting moisture loss.



Background

Benefits of Prefilled Canisters

Prefilled canisters containing AMSORB® Plus offer convenience and user safety. They facilitate rapid 'switch-out' of exhausted material without interruption to mechanical ventilation. CO_2 accumulation in the breathing circuit can be avoided.

Absorbent Heat

Absorption of CO_2 by AMSORB® Plus produces heat. The amount of heat depends on rate of respiration, fresh gas flow rate and the shape and volume of the absorber canister. An increase in gas temperature does not reduce the efficiency of the reaction; in most cases it improves it. A peak temperature of 45°C may be observed with AMSORB® Plus. Such temperature has a positive effect on maintenance of core body temperature and mucocilliary function during surgery.

Clinical reports show use of sevoflurane, in combination with certain desiccated absorbents, creates conditions for anaesthetic agent degradation to flammable by-products CO and HCOH as a precursor to extreme heat leading to fire in the absorber canister.

Struys *et al* reported that temperatures within an absorber canister of fresh or desiccated AMSORB® Plus did not exceed 40°C. Additionally, end-users have not reported elevated temperatures, nor have extensive in-house tests shown increased temperatures under any conditions. It logically follows that the chemical basis and sequelae for elevated temperature or fire is not possible when using AMSORB® Plus, given its chemical make-up and inability to degrade anaesthetic vapour.

Humidity Management in Breathing Circuits

Condensed water observed in the breathing system may originate from moisture in the patient's breath and from water produced by the exothermic reaction of absorption of CO_2. It may evaporate as the canister heats up and may condense on cooler parts of the apparatus. This is normal. A water trap can be used in the breathing circuit to collect water condensate. Alternatively, there may be a drainable water collection sump located on the absorber canister. This should be drained regularly.

Woehlck HJ. Sleeping with Uncertainty : Anesthetics and Desiccated Absorbent. Anesthesiology 2004; vol. 101; pp. 276-278

Laster M et al. Fires from the Interaction of Anesthetics with Desiccated Absorbent. Anesth Analg 2004; vol. 99; pp. 769-774

Castro BA et al. Explosion within an Anesthesia Machine: Baralyme®, High Fresh Gas Flows and Sevoflurane Concentration. Anesthesiology 2004; vol.101; pp. 537-539

Fatheree RS et al. Acute Respiratory Distress Syndrome after and Exothermic Baralyme®-Sevoflurane Reaction. Anesthesiology 2004; vol.101; pp. 531-533

Junzheng WU et al. Spontaneous Ignition, Explosion, and Fire with Sevoflurane and Barium Hydroxide Lime. Anesthesiology 2004; vol.101; pp. 534-537

Holak E J et al. Carbon Monoxide Production from Sevoflurane Breakdown: Modeling of Exposures Under Clinical Conditions. Anesthesia & Analgesia 2003; vol. 96: pp. 757-764

Struys MMRF et al. Production of compound A and carbon monoxide in circle systems: an in vitro comparison of two carbon dioxide absorbents. Anaesthesia 2004; vol. 59; pp. 584-589

Background

AMSORB® Plus and Bacteriostasis

Digestive enzymes of bacterial organisms such as MRSA and VRE are known to be susceptible to neutralisation by alkaline solutions. The weakly alkaline composition of AMSORB® Plus provides an inhospitable environment for such organisms. Use of a breathing filter at the patient-end of a breathing circuit is a useful adjunct in protecting patients from respiratory-borne infection. These filters provide a sufficient level of protection against infectious liquid- and air-borne organisms such as HIV, MRSA and VRE, as such organisms are more likely to be found in the tubing system, connecting the patient to the absorber system, than in the absorber itself. If AMSORB® Plus is intended to be used on a patient known to be infected with a contagious organism, the absorbent canister should be replaced before and after such use.

Disposal Considerations

Dispose of AMSORB® Plus as per the hospital's waste management programme for non-contaminated clinical waste. The material is safe to handle during its disposal. Unlike soda limes, AMSORB® Plus does not contain strong base chemicals. Therefore, the material is non-hazardous, making it suitable for landfill. It will break down into harmless compounds.

Storage Requirements

AMSORB® Plus does not deteriorate in storage when in sealed containers at ambient humidity between 5-40°C. If exposed to ambient air it will absorb CO_2 and lose moisture to the air; either of which will deplete hydration and cause colouration to appear. Prefilled canisters should be kept within outer box packaging until use as light can damage the colour indicator.

Frequently Asked Questions

What are the advantages of using AMSORB® Plus over other available absorbents?

- Does not generate CO under any clinical conditions; does not generate Compound A or any like compounds when used with sevoflurane; does not generate HCOH or methanol when used with sevoflurane
- Irreversible colour change, when fully exhausted; optimum CO_2 absorption; low resistance to gas flow; low dust levels with consistent granule size
- Non-corrosive to skin.

What anaesthetic agents can be used with AMSORB® Plus?

AMSORB® Plus can be used safely with anaesthetic agents halothane, enflurane, isoflurane, desflurane and sevoflurane. No fresh gas flow restrictions apply.

Does AMSORB® Plus adsorb anaesthetic vapour?

Completely desiccated AMSORB® Plus has least ability to adsorb anaesthetic vapour when compared to other absorbents (Knolle, 2002). Note that desiccated AMSORB® Plus is incapable of absorbing CO_2 and therefore will not be in clinical use.

When to cease using AMSORB® Plus?

This is determined by capnometry. The absorbent is changed when $FiCO_2$ has exceeded 0.5% volume or 5mmHg. CO_2 breakthrough to 0.5% volume or 5mmHg may be associated with colouration of 50% of the total height of the absorber canister.

Why does utilisation time vary?

Utilisation time is influenced by the following factors:

- Fresh gas flow rate; metabolic CO_2 production; tidal volume; respiratory rate
- Shape and volume of the absorber canister and design of breathing circuit
- Humidification management in the breathing circuit.

Sometimes exhaustion is indicated by physiological signs or capnometry before the colour changes - why is this?

It may be that the apparatus is not working properly or is incorrectly assembled. There may be channeling of gases through the middle of the absorber canister. Condensed water may be interfering with the composition of sampled gases. Absorbent granules may have absorbed water which is preventing CO_2 absorption.

Should water be added to AMSORB® Plus?

This should NEVER be done.

What is the cause of water condensation in the breathing circuit?

This may originate from moisture in the patient's breath and from water produced by the exothermic reaction of absorption of CO_2. It may evaporate as the canister heats up and may condense on cooler parts of the apparatus.

What makes AMSORB® Plus heat up? Does this mean the granules are not working?

The reaction whereby CO_2 is absorbed is exothermic (heat is spontaneously generated from the chemical reaction). The amount of heat depends on rate of respiration, fresh gas flow rate and the shape and volume of the absorber canister.

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E info@armstrongmedical.net
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Armstrong Medical manufacture a complete range of disposable respiratory products for anaesthesia and critical care applications. For supply of these products or any product within the Armstrong Medical range, please contact your local representative.

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