

# ActiveMag<sup>®</sup> 95 for Marine Flue Gas Scrubbing



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# Background

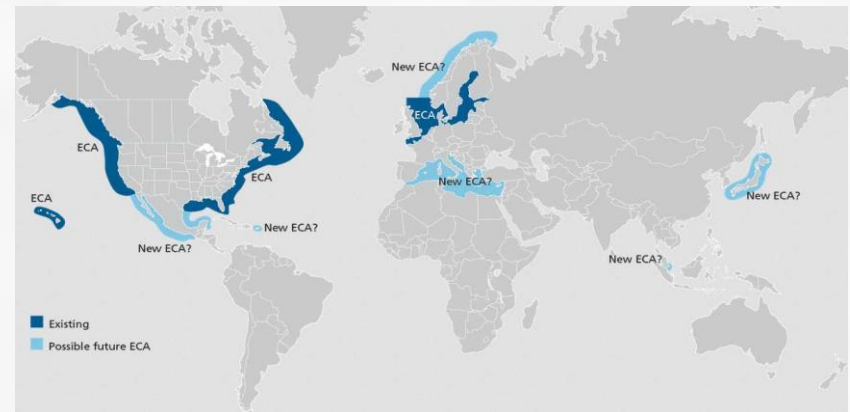


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As of 1/1/15 ships trading in Emission Control Areas (ECAs) have to use fuel with a sulfur content of 0,1% max. As of 1/1/2020 there is a global (all seas outside ECA) sulfur limit of 0,5%.

Ship owners are either changing to low sulfur Marine Gas Oil (MGO) or implement on-board desulfurization to achieve equivalent emissions to MGO while still burning heavy fuel oil.

Current ECAs are (MARPOL Annex VI):



- The Baltic Sea
- The North Sea
- The North American Area (Designated coastal areas off the US and Canada)
- The US Caribbean Sea area (P.Rico and Virgin Islands)

# Scrubber Technology



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- ❑ Various companies have developed scrubbers that can be fitted on board. Scrubbing can be accomplished by seawater depending on its alkalinity and by chemical reagents such as  $\text{Ca(OH)}_2$ ,  $\text{NaOH}$ ,  $\text{MgO}$  and  $\text{Mg(OH)}_2$ .
- ❑ In “hybrid” systems, in the open sea, the scrubber operates as “open loop” using sea water as the scrubbing reagent. Inside a harbor, close to the shore or during maneuvering, it operates as “closed loop” requiring the additional use of a chemical reagent. The reagent is also used in the open when water alkalinity is not adequate (e.g. the Baltic).

# Use of Activemag<sup>®</sup> 95



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- ❑ Activemag<sup>®</sup> 95 can be stocked on board in BBs with plastic lining. No special precautions are required because it is not hazardous.
- ❑ It has a high self-life (12 months) if kept in an unopened packaging in dry conditions.
- ❑ It can be fed directly from the BB to a mixing tank containing water to prepare the slurry. Buffer tank(s) may be required to ensure smooth and continuous preparation/feeding cycles.
- ❑ Activemag<sup>®</sup> 95 gradually converts to  $Mg(OH)_2$  by reaction with water which is exothermal. Slurry temperatures can be kept under control by the percentage of loaded solids and by process design considerations.
- ❑ Activemag<sup>®</sup> 95 can achieve a desulfurization efficiency higher than 97% with an indicative consumption of 35-40 kg of  $MgO$ /ton fuel, added as 25-30% slurry.

# Benefits of Activemag<sup>®</sup> 95



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compared to...

... other MgOs

- Higher reactivity
- Fineness
- High purity
- Quality Consistency
- Allows faster dosing options (skipping the hydration step)

... Mg(OH)<sub>2</sub> slurry

- No stability problems
- Availability far away from the source
- Higher shelf life

... NaOH, Ca(OH)<sub>2</sub>

- Environmentally friendly
- Safe handling on board (non-hazardous)
- Lower consumption
- Low sludge volumes
- Highly soluble reaction product (MgSO<sub>4</sub>)



# Benefits: More details

## ☐ **Activemag<sup>®</sup> 95 is a mild base:**

- in water, pH buffers around 11
- will not cause chemical burns
- it is essentially non-hazardous and non-toxic
- In water can be regarded as an industrial grade of “Milk of Magnesia”
- no overdosing problems

## ☐ **It has low water solubility:**

- produces a much lower pH spike when added to wastewater
- better crystallized precipitate/smaller volume for the resulting solid waste

## ☐ **Higher alkalinity equivalent compared to other bases (NaOH, Na<sub>2</sub>CO<sub>3</sub>, Ca(OH)<sub>2</sub>):**

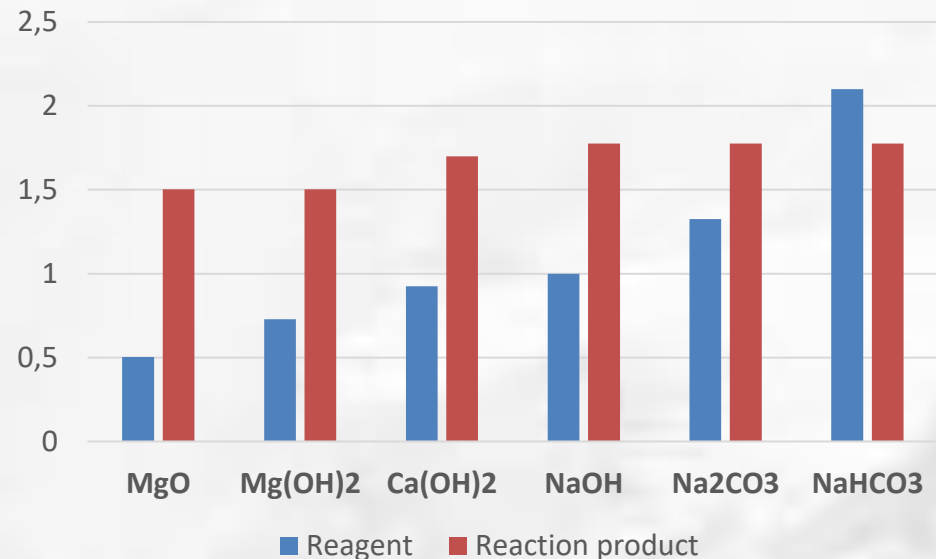
- lower required quantities of reagent
- smaller quantities of the reaction product

# Inherent Higher Alkalinity

## Required quantity of magnesium oxide to neutralise 1kg of SO<sub>3</sub>

Reagent		Reaction's product		
Reagent	Compound	Quantity (kg)	Compound	Quantity (kg)
1	MgO	0,504	MgSO <sub>4</sub>	1,504 (soluble)
2	Ca(OH) <sub>2</sub>	0,925	CaSO <sub>4</sub>	1,700 (insoluble)
3	NaOH	1,000	Na <sub>2</sub> SO <sub>4</sub>	1,775 (soluble)
4	Na <sub>2</sub> CO <sub>3</sub>	1,325	Na <sub>2</sub> SO <sub>4</sub>	1,775 (soluble)
5	NaHCO <sub>3</sub>	2,100	Na <sub>2</sub> SO <sub>4</sub>	1,775 (soluble)

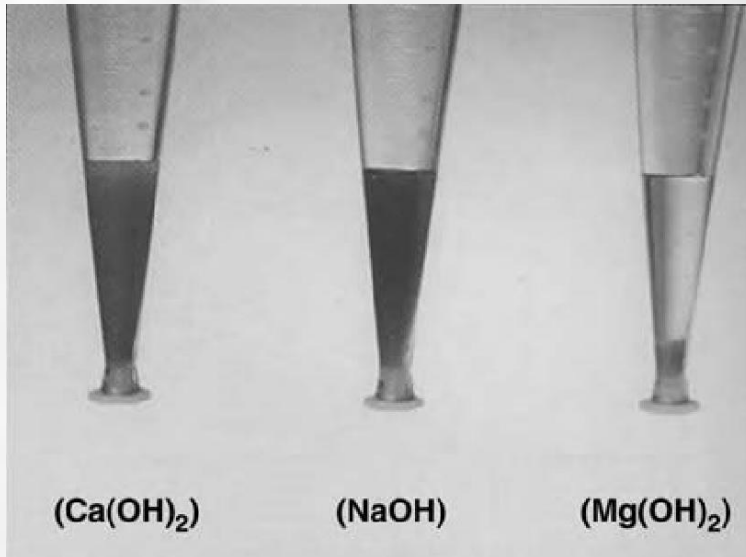
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# Lower sludge volumes



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Settling cones demonstrating differences in metal hydroxide sludge generated during neutralization of acidic wastewater.

- ❑ In wastewater treatment, Activemag<sup>®</sup> 95 produces a faster settling metal hydroxide floc as well as producing a more compact sludge. In general, magnesium oxide sludges density can be up to 40% more dense than caustic soda sludges.
- ❑ Lime and caustic soda, exhibit higher reaction rates and finer precipitates, resulting in more voluminous sludges (up to 10 times) compared to magnesium oxide, that are harder to dewater and filter.
- ❑ Note also that in sulfuric acid waste streams, lime use will lead to insoluble gypsum, adding further to sludge volumes generated, compared to MgSO<sub>4</sub> which is highly soluble.

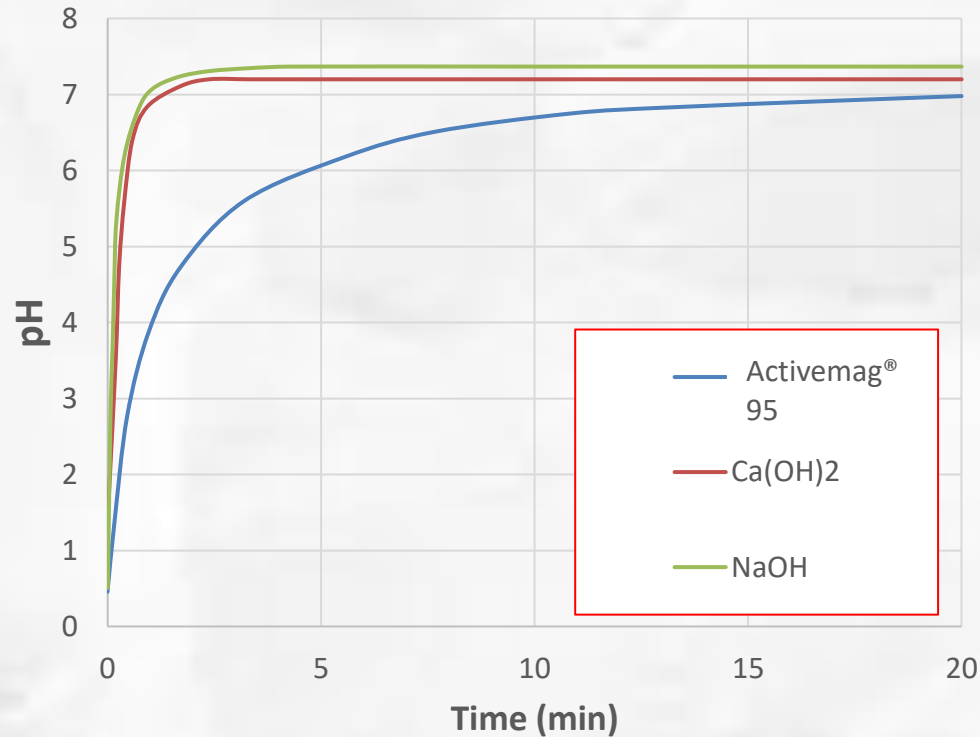


# Milder reaction rates



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Batch Neutralization of Acid Effluent



- ❑ Slower neutralization rate = better pH control
- ❑ No overdosing effects; with Activemag® 95, pH buffers around 9-10.
- ❑ Less consumption than Ca(OH)<sub>2</sub>, NaOH, Na<sub>2</sub>CO<sub>3</sub> etc.



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