

Using Bleach to Eliminate Stachybotrys Chartarum on Masonry

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It was affirmed that in a study by Kelly A. Reynolds, Stephanie Boone, Kelly R. Bright, Charles P. Gerba 2012 (Journal of Occupational and Environmental Hygiene, 9: 663–669 ISSN: 1545-9624 print / 1545-9632 online Copyright 2012 JOEH, LLC).

That the results of this study support those of others concluding that hypochlorite disinfectants are effective antimicrobials against moulds. Where in the study, Trichophyton mentagrophytes was not culturable in 10/10 trials following 10-min exposures to 2.4% NaOCl on porous surfaces.

I am of the opinion this may occur in a laboratory setting and the results though encouraging for Penicillium Spp and Cladosporium Spp have little effect or relevance to Stachybotrys Chartarum, (black pin mould) because on gypsum walls and gypsum plaster boards, the bleach has a very different effect.

The Sodium hypochlorite (NaOCl) does not chemically react strongly with gypsum, calcium sulphate dihydrate, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, but when mixed or used for disinfection, it can alter the physical properties of gypsum products when applied.

Studies show that immersion or mixing of gypsum with sodium hypochlorite reduces its compressive strength and surface quality.

Also, gypsum composition: $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, calcium sulphate dihydrate and Sodium hypochlorite: NaOCl has no significant chemical reaction noted under normal conditions, since gypsum is relatively stable and NaOCl mainly acts as an oxidizer. However, some practical effect such as the interactions NaOCl solution penetrating the gypsum and disrupting its crystalline structure and hydration balance as a result of application.

Which is more physical than chemical but allows for the leaching of sodium from the gypsum the limiting factor in Stachybotrys Chartarum colonisation.

Gypsum exposure to bleach and sodium transport

Bleach introduces sodium into porous gypsum systems; it doesn't cause sodium to "leach out" of gypsum's crystal lattice. Instead, gypsum boards absorb the bleach solution, and sodium remains as dissolved salts that can migrate, concentrate, and crystallize during drying effect of efflorescence formation. What actually happens chemically is the gypsum calcium and sulphate are already in stable oxidation states; sodium does not substitute for calcium in the crystal under ambient conditions. There is no meaningful ion exchange of Na^+ into the gypsum lattice to do this. What actually happens is the bleach in aqueous solution, sodium hypochlorite exists as Na^+ and OCl^- . Over time—especially on porous, catalytic surfaces—it disproportionate to chloride (Cl^-) and chlorate (ClO_3^-). Carbon dioxide uptake can also convert alkalinity to carbonate/bicarbonate. Giving a net effect of the sodium remaining paired with anions as soluble salts. It is this that leaches the sodium from the gypsum when leaching or saturation occurs through structural defects and the drying process of efflorescence formation.

Salt migration and efflorescence:

Capillary transport draws solution into and through paper facings and pore networks. As water evaporates, NaCl , NaClO , NaClO_3 , and occasionally Na_2SO_4 (from sulphate-rich environments) can crystallize at or near the surface, presenting as efflorescence. Once leaching of the sodium occurs through structural defects the sodium is reduced over time, the calcium is then available to the Stachybotrys Chartarum with a reduced sodium content high calcium and cellulose.

Practical material effects in buildings

Surface contamination:

Residue formation: Sodium salts persist after bleaching, increasing surface conductivity and

hygroscopicity. Paper facing degradation: High pH ~11–12, (which the *Stachybotrys Chartarum* likes) saponifies organic binders and weakens cellulose, making the cellulose available to the *Stachybotrys Chartarum* as a food source as well as reduced sodium and increase in available calcium.

Residue Formation After Bleaching:

- Sodium salts (often sodium hydroxide or sodium hypochlorite residues) remain embedded in the paper matrix after bleaching.
- These salts Increase surface conductivity → paper becomes more prone to electrostatic interactions and moisture attraction.
- Raise hygroscopicity → the paper absorbs water more readily, creating a microenvironment favourable to mould colonization.
- Reduces the sodium through leaching.
- Makes available the cellulose and calcium as a food source.

Paper Facing Degradation:

- **High pH (11–12):**
- Promotes **saponification** of organic binders (e.g., oils, resins, adhesives).
- Weakens the structural integrity of cellulose fibres by breaking glycosidic bonds.

Resulting vulnerability:

- Cellulose becomes more accessible as a nutrient source.
- Opportunistic fungi such as *Stachybotrys chartarum* exploit this weakened cellulose, accelerating biodeterioration.

Microbiological Implications through biological colonization pathways.

Stachybotrys chartarum thrives in moist, cellulose-rich, alkaline and high calcium environments, through a combination of:

- Residual low sodium salts,
- Moisture retention and leaching of sodium
- High alkalinity binder breakdown exposed cellulose and calcium.
- Exposed cellulose and calcium as a food source

Which creates an **ideal ecological niche** for colonization and sporulation of *Stachybotrys Chartarum* on gypsum masonry walls.

Practical Considerations

- Preventive conservation:
 - Do not use bleach to control *Stachybotrys chartarum*
 - Increase the acidity of the gypsum to control *stachybotrys chartarum* growth.
 - Do not neutralize or wash out residual sodium salts.

- Buffer paper to a safer pH (3-5) to stabilize cellulose.

Gypsum Chemistry

Gypsum is **calcium sulphate dihydrate** ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). Normally, gypsum is close to neutral pH, but processing or contamination (e.g., alkaline residues from plaster additives) can lower its pH. By **increasing acidity** (lowering pH toward ~3-4), you:

- Reduce the solubility of cellulose breakdown products.
- Limit the availability of nutrients that fungi exploit.
- Create a less favourable environment for fungal enzymatic activity.

Add this to the control humidity (<80%) to reduce hygroscopic uptake. This then creates less favourable conditions for the *Stachybotrys chartarum* to colonise the gypsum plaster.

Effect on *Stachybotrys Chartarum*

Stachybotrys Chartarum prefers alkaline to slightly neutral substrates with abundant cellulose and calcium. Acidic conditions Inhibit fungal enzyme systems (e.g., cellulases and proteases), reduce spore germination and hyphal growth. Shift the ecological balance toward non-cellulolytic microbes that outcompete *Stachybotrys Chartarum*, such as *penicillium* spp

Practical Considerations

Controlled acidification:

Use acidifying agents such as strong mineral acids, Aim for a buffered pH ~ 3-4, not extreme acidity, to maintain material stability.

- Risks:
 - Over-acidification can weaken gypsum crystals, leading to mechanical instability.
 - Acidic environments may corrode embedded metals or interact with other building materials.
- Complementary measures:
 - Moisture control remains paramount: gypsum must stay below ~70-80% RH to prevent fungal colonization.
 - Surface treatments (biocides, sealants) can be used in tandem with pH adjustment. Also, the previously provided research indicates that the application of fogging and fungicidal agents could increase the toxicity of mycotoxin by 90.9%. therefore, mould eradication fungicides can produce more toxic mycotoxins which denies the eradication process.

The increase in mycotoxin toxicity is a very important paradox in mould remediation as fungicidal treatments can unintentionally worsen the toxicological profile of the contamination.

Structured causation chain:

Surface Treatments and pH Adjustment Biocides and sealants are often applied to gypsum, plasterboard, or paper facings to suppress fungal growth. pH adjustment (acidification toward ~3-4) reduces substrate suitability for *Stachybotrys chartarum* growth.

In theory, combining these measures should create a hostile environment for mould colonisation.

Forensic considerations

- In housing disputes, demonstrating that gypsum has been left alkaline (e.g., pH >9) can explain persistent *Stachybotrys* growth.
- Acidification protocols can be cited as remedial measures that directly alter the substrate ecology, reducing fungal viability without relying solely on biocides.

Fogging and Fungicidal Agents

– The Toxicity Paradox

- Research indicates that **fogging and fungicidal application can increase mycotoxin toxicity by ~90.9%**. the mechanism of biocides does not work in that event.
- Fungicides stress fungal cells, triggering **secondary metabolite overproduction** (including trichothecenes).
- Dead or stressed spores may release **higher concentrations of bound mycotoxins** into the environment.
- This means eradication attempts can **increase airborne toxicity**, even if visible mould growth is reduced.

Given this the application of biocides does not control or eradicate the colonisation of *Stachybotrys Chartarum*.

Implications for *Stachybotrys Chartarum*

Stachybotrys Chartarum produces potent trichothecene mycotoxins (e.g., satratoxins). Under stress (biocide exposure, fogging), the fungus will:

- Intensifies toxin synthesis as a **defensive response**.
- Releases toxins into dust and debris, which remain hazardous even after fungal death.
- Thus, eradication by fungicides can **negate the remediation process**, leaving a more toxic environment than what we started with.

Key causation chain:

- Chemical treatment → fungal stress → increased mycotoxin release → higher toxicity → remediation failure.
- In housing disputes or expert witness contexts, this demonstrates why **biocide-only strategies are insufficient** and can worsen occupant exposure.
- Evidence of increased toxicity post-treatment can be used to argue for **alternative remediation protocols**.

Safer Alternatives

- **Physical removal** of contaminated materials (cut-out and replace gypsum/paper facings).
- **Environmental control:** humidity reduction, ventilation, and substrate a low pH stabilization.
- **Non-fogging approaches:** localized cleaning with neutral pH surfactants, followed by sealing with breathable, non-toxic coatings.
- **Monitoring:** post-remediation air and dust sampling to confirm toxin reduction, not just fungal absence.

Moisture dynamics:

Hygroscopic salts: Residual NaCl and NaClO attract moisture, elevating local equilibrium moisture content and slowing drying. This leaches the sodium after bleaching has occurred over time due to structural defects.

Wetting And Drying Cycles

Rewetting risk: Salt-laden surfaces can more readily reabsorb ambient moisture, this leaches the sodium and makes the calcium available to the *Stachybotrys chartarum* given time for the leaching to occur.

When moisture is reabsorbed:

- **Sodium salts** dissolve and migrate with capillary action.
- This mobilizes ions within the pore network.
- Over time, **calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)** can partially dissolve, releasing Ca^{2+} into the pore water. Which the *Stachybotrys Chartarum* responds to.
- The leaching is relatively slow but cumulative, especially under repeated wetting–drying cycles. However, this process is sped up when leaching occurs through structural defects.

Implications for *Stachybotrys Chartarum*

- *Stachybotrys* thrives in **cellulose-rich, persistently damp substrates** (e.g., gypsum board paper facings).
- It requires **calcium and other cations** for enzymatic activity and sporulation.

- The leaching process effectively **enriches the microenvironment**:
 - Sodium salts maintain moisture.
 - Calcium becomes bioavailable in the damp pore sodium depleted water.
 - Organic paper facings provide carbon substrate.

Together, this creates a **nutrient-rich, moist niche** ideal for colonization.

Forensic Housing Context:

Bleach treatments on gypsum board can unintentionally worsen long-term risk as they leave hygroscopic sodium residues. Which is leached through structural defects, which alters ion balance, making calcium more accessible. Which masks visible mould temporarily but set up conditions for regrowth once the sodium is reduced by the application of bleaching and structural defects leaching.

In investigations, finding salt efflorescence + renewed mould growth is a strong indicator of prior bleach use and subsequent leaching. Bleach doesn't just fail to eradicate *Stachybotrys chartarum*, it can prime gypsum systems for recolonization by creating a damp, calcium, ion-rich environment which supports colonisation of *Stachybotrys Chartarum*. The apparent "cleaning with bleach" effect is short-lived, while the biochemical and moisture dynamics favour mould resurgence in the long term.