Epoxy Grout and Enzymatic Cleaners: A Question of Compatibility

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Photo courtesy of Hanwha L&C USA

Recently, MDE Forensic Laboratories was asked to evaluate the failure of a newly laid floor in a commercial kitchen and determine the cause for the failure. The floor was laid using ceramic tiles and an epoxy grout. It failed within a few months on installation and was re-grouted. The new grout also failed in a similar manner. The entire floor was then replaced. Maintenance/cleaning during the course of the first two failures was performed daily using a "no-rinse" floor cleaner. A more traditional cleaner was specified after the floor was replaced; no issues have been reported with the newest floor.

Background

Deleterious conditions in a commercial kitchen environment include attack from bacterial, food acids, harsh chemical cleaners and disinfectants, frequent and aggressive cleaning techniques and pressure from foot traffic and equipment. An epoxy grout formulation is often chosen in such an environment because of its durability and chemical resistance. Epoxy grouts employ an epoxy resin and hardener with aggregate filler, similar to fine sand.

Traditional cleaning methods for commercial kitchen floors use formulations that emulsify the grease and oils, kill bacteria and lift these from the surface for rinsing. These floor cleaners normally specify the use of a rinsing step to assist in the removal of the emulsified oils. Despite the rinsing, these cleaners can often leave a film that contains bacteria that can produce offending odors and re-soil quickly.

In the last few years, some manufacturers have begun to add enzymes to their products instead of powerful oxidizers. These enzymes act as catalysts that accelerate the chemical breakdown of certain materials. By definition, enzymes are proteins composed of amino acid chains. Enzymes catalyze many reactions, including the hydrolysis of sugars, proteins and fats. Cleaners containing enzymes can outperform germicidal cleaners by digesting the material on which bacteria can feed. Because there is no oxidizer, enzymatic cleaners are considered "green" environmentally friendly products.

One of the primary residues found on commercial kitchen floors are cooking oil residues. These oils are made up of triglyceride fatty acid oils. Lipase enzymes specifically catalyze the breakdown of these oils to form free fatty acids. Enzyme-based commercial floor cleaning products normally contain the enzyme triaclyglycerol lipase. Directions for the use of these enzyme-containing cleaners specify the product be left on the floor for prolonged periods to achieve full effect and are advertised as "no rinse"

products. The use of a no-rinse floor cleaner therefore will form free fatty acids that remain in continual direct contact with the epoxy grout.

A review of the technical literature relevant to many epoxy grouts revealed warnings regarding the compatibility of these grouts and many types of acids, bases and other compounds. One manufacturer specifically listed non-compatibility between its grout and oleic acid (one of the fatty acids formed by enzymatic action on cooking oils). Therefore, the question in the above investigation centered on whether the daily application of the no-rinse cleaner played a role in the degradation of the epoxy grout.

Exposure Testing

Photo 1: This photo depicts the surface of the control sample of epoxy #3 (no exposure).

To test this compatibility issue, four different properly mixed and cured epoxy grouts were used exposed to a variety of cooking oil and enzymatic cleaner combinations for several weeks. Samples of each grout were exposed to new cooking oils, used cooking oils and various dilutions of the no-rinse cleaner by brushing on the liquids and by immersion.

The same oils were brushed onto other samples of grout and then various concentrations of the cleaner applied later in the day. This was intended to approximate real-world exposure and cleaning cycles. Linoleic acid, a pure fatty acid (one of the five produced by the action of lipase enzyme on cooking oil) was also applied directly to samples of each grout. The applications of the oils, cleaners and combinations were performed daily. Potential degradation of the grouts was tracked visually, by scraping and by hardness testing.

Photo 2: This image depicts epoxy #3 after two weeks of daily applications of used cooking oil and a properly diluted enzymatic cleaner. The surface has softened (note the easily made scrape on right) and is more porous than the epoxy depicted in Photo 1.

Results

Photo 3: In this photo, epoxy #3 is depicted after two weeks of daily applications of used cooking oil and 2:1 diluted enzymatic cleaner. The manufacturer's recommended dilution for the cleaner is 60:1.

Exposure effects varied widely. The degradative effects were limited to the surface of the epoxy samples; the sample cores were not affected in these studies. **Photographs 1, 2 and 3** depict typical surface degradation effects. Refer to Table 1 for a summary of the exposure testing and results. Degradative effects are summarized as follows:

- The exposed surfaces of all four epoxy grouts were visibly degraded within two days of the application of the linoleic acid. The affected grout surface became swollen, porous and readily sloughed off.
- The combinations of oils and higher-than-recommended concentrations of the cleaner resulted in epoxy degradation over the course of a couple of weeks.

Note the epoxy surface is very soft, porous and sloughed off readily. A band of the degraded layer was scraped to expose the epoxy core.

- The epoxy samples treated with oils and manufactured recommended dilutions of the cleaner produced minor degradation results over the testing time period.
- Applications of all concentrations of the enzymatic cleaner by itself and of both new and used cooking oils by themselves did not degrade any of the grouts within the testing time period.

Conclusions

Table 1: Summary of exposure results

This exposure study demonstrates that some epoxy grouts are incompatible with enzymatic cleaners used to remove cooking oil residues. The rate of the degradation to the epoxy surface will be dependent on several variables including the amount of oil residue present, the frequency of application of the cleaner, the concentration of the cleaner and the type of epoxy. Water temperature, pH conditions and rinsing procedures were not studied (see **Table 1**).

The degradation to the surface of the epoxy consists of softening and swelling resulting in increased porosity of the surface. The affected surface has little integrity and would ready wear off under normal conditions. This would expose a fresh epoxy surface and the cycle would continue.

It is not uncommon for untrained or uniformed cleaning staff to subscribe to the theory that if a little cleaner is good, then more is better. The incompatibility between epoxy grouts and enzymatic cleaners will be exaggerated by the use of higher-than-recommended concentrations of the cleaner.

This study did not indicate any degradative effect to any of the tested epoxy grouts when the enzymatic cleaner was applied in any concentration. Nor did any cooking oil, new or used, demonstrate an incompatibility to the epoxy grouts. However, the time frame of exposure was relatively short relative to the expected lifetime of a grouted floor. Heating of cooking oils will naturally break down the trigyceride oils to form free fatty acids. Therefore, long term exposure of epoxy grouts to used cooking oils could potentially also lead to the premature failure of the grout.

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