CleanCore SOLUTIONS™
Where Sustainability Meets Performance

A case study for Aqueous Ozone at Clemson Home

University Housing & Dining
Division of Student Affairs

CLEMSON® home

BACKGROUND

Clemson University, founded in 1889, is a land-grant institution that conducts research for the betterment of the community. With a total undergraduate enrollment of 19,402 and a suburban campus covering 17,000 acres, Clemson is a leading national university. Students and faculty are involved in projects ranging from improving irrigation systems to lowering youth bullying rates in South Carolina schools. Clemson possesses an intense commitment to employee safety, indoor health and environmental sustainability and sees it as their responsibility to consider the impact of their decisions on future generations.

One such decision made by Clemson Home was the search for an alternative cleaning system that met or exceeded current performance standards, but possessed an enhanced safety, health and environmental profile. Approximately two years ago, they chose to invest in, and assess, a non-synthetic alternative that would provide a means of maintaining the indoor environment in residence halls on the campus, all while delivering on these objectives. The solution is an aqueous ozone-based cleaning system and the company they chose to partner with is CleanCore Solutions LLC.

The overall response to the CleanCore system, currently used in three Clemson residence halls, has been overwhelmingly positive. As a result of this positive response, Clemson Home, in partnership with CleanCore, commissioned a data driven study to quantify sustainability and performance metrics and validate the decision to implement the CleanCore system. Specifically, the project was undertaken to assess the benefits derived from concentrated synthetic chemical reduction, reduced water usage, solid waste reduction, and other Life Cycle and sustainability metrics. Where possible, work satisfaction was to be measured along with performance and overall cleanliness.

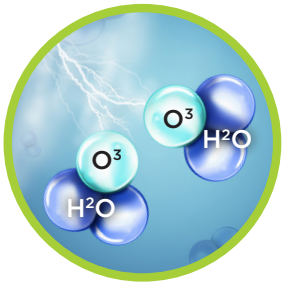
CleanCore Solutions LLC contracted with Wilcox EVS Solutions, a third-party validation and proof of concept company, to perform data collection and system impact analysis.

ASSESSMENT OF SUSTAINABILITY AND PERFORMANCE

The intent of the study was to assess, and capture sustainability and performance metrics associated with switching from traditional synthetic, super concentrated cleaners to CleanCore's onsite generated, Pure Aqueous Ozone in the cleaning of campus buildings and to estimate the financial impact of these changes. The study centered around the CleanCore Gen2 Caddy, in addition to the company's aqueous ozone solution. The following items were considered, when possible, as part of the overall assessment:

1. Concentrated synthetic chemical usage,
2. Water usage,
3. Solid waste generated (i.e. plastic and corrugated packaging materials),
4. Worker safety,
5. Worker satisfaction,
6. Cleaning processes and efficacy, and
7. Time and labor savings estimates

General chemical toxicity, including exposure and risk reductions, by using aqueous ozone will be discussed in broad terms. Unlike traditional synthetic cleaning chemicals, CleanCore's Pure Aqueous Ozone contains no synthetic fragrances, dyes, surfactants or solvents. Fragrances and dyes are a very toxic class of chemicals in the cleaning industry. As such, there is a major push for them to be disclosed on labels and SDS sheets, like other chemicals found in formulations traditionally used in the industry. Fragrances and dyes can be hazardous to people in that they can be dermal, eye and respiratory irritants or sensitizers and may possibly cause or exacerbate asthma and COPD. The chemicals that constitute them can also be toxic to aquatic species, in drinking water, water tables and to vegetation.



OZONE

PURE AQUEOUS OZONE AND CLEANCORE'S GEN2 CADDY

Routine cleaning is generally done by hand with synthetic chemical solutions containing fragrance and color additives, along with a microfiber cloth, paper towel or rag. This is a slow and imprecise way to clean which allows for significant human error in its process. With over 90% of the cost to clean being labor, time is literally money. The Gen2 Caddy was paired with the aqueous ozone because of its ability to clean more thoroughly, minimize cross contamination and reduce labor by 30%. So, while the time savings of touch-free restroom systems is not new in this industry, the ability of such a system to generate an aqueous ozone cleaning solution onsite, and on-demand, is.

Ozone has long been known by the EPA, USDA and other federal and state agencies as a water purifier, deodorizer, food contact cleaner oxidizer and sanitizer. In an aqueous form, the ozone solution quickly cleans surfaces and eliminates odors, Leaving behind a residue-free surface.

The process of generating aqueous ozone involves taking oxygen from the air and converting it into ozone. The ozone is then mixed with regular cold tap water to form aqueous ozone. When sprayed onto a surface, the ozone is attracted to soils, germs, and other organic contaminants. Once attached to these contaminants, the aqueous ozone eliminates them through oxidization. The ozone then reverts back to oxygen, creating a byproduct of nothing more than oxygen and dirty water.

INDOOR AIR QUALITY (IAQ)

Indoor air quality has been of great concern in learning facilities for over a decade. Studies over the years have shown that cognitive function decreases when indoor air quality is poor. IAQ can be affected by many things such as allergens, dander, dust, mites, temperature, building materials, office equipment, perfumes and colognes, hair products, cooking as well as cleaning products and equipment. As aqueous ozone is effective against odors, leaves no residual behind on surfaces and cleans without synthetic chemicals, it also helps to improve indoor air quality.

RESIDUE FREE

Aqueous ozone cleans, without leaving a residue behind. This is a major benefit to end users in that the solution can be used to clean hard surfaces, floors, carpets, upholstery, food contact surfaces and more with no rinsing. As such, the Clemson Home staff finds that using the aqueous ozone solution, along with the Caddy, for cleaning has saved them time by not having to rinse or buff surfaces.

Residue free cleaning is a benefit because synthetic chemical residues attract dirt and soils. As such, surfaces cleaned with synthetic chemicals re-soil quicker, and likely require more frequent cleaning, than do surfaces cleaned with aqueous ozone. Carpets especially benefit from being cleaned with aqueous ozone, as the resoling impact of synthetic chemicals is greater on fabrics than it is on hard surfaces.

REDUCTION IN FUEL EMISSIONS

Onsite, on-demand generation systems, such as the CleanCore system used in this study, help reduce the university's carbon footprint by reducing the volume of manufacturing, and frequency of distribution, of synthetic cleaning solutions. Carbon footprint variables impacted by such systems include plant emissions, plastic and corrugated packaging, along with diesel and gas emissions generated during delivery.

Important to note, OSHA states that diesel exhaust contains particulate matter containing soot particles made up of carbon, ash, metallic particles, sulfates and silicates. In 2012, the International Agency for Research on Cancer – part of the World Health Organization – classified diesel exhaust as a "known human carcinogen." Short-term exposure to high concentrations of diesel exhaust and diesel particulate matter can result in dizziness; headaches; and eye, nose and throat irritation, the agency states. Prolonged exposure can increase a worker's risk of cardiovascular, cardiopulmonary and respiratory disease, and lung cancer. As such, any steps taken to reduce the production of such pollutants benefits society as a whole.

CLEMSON STUDY FINDINGS

Table 1 shows that at the three Core Campus buildings there were significant overall reductions in chemicals realized by switching to the CleanCore system from traditional, concentrated chemicals for all-purpose and glass cleaning. The average overall reductions were 70 percent for the two largest volume types of cleaner used, all-purpose and glass. Clemson

has not started using the aqueous ozone on most of the flooring in the Core buildings, or on carpets and upholstery, so there are further reductions in chemicals and solid waste expected as intended expansion of the system's use continues.

Specific findings included:
- All Purpose Cleaner usage was reduced from 6 cases per building, per month, to 2 cases,
- Glass Cleaner usage was reduced from 4 cases per building, per month, to 1 case,
- In total, over 170 gallons of concentrated chemicals were eliminated per month in the three Core buildings.

Table 1. Calculations of diluted cleaner, concentrated cleaner, and water for the traditional cleaner system and CleanCore's system, for the Three Core buildings on the Clemson campus.

Per year, Core buildings	Tradition Chemical Cleaning	CCT Aqueous Ozone cleaning	Gallons/ units saved using CCT	Percent Reduction
All-purpose Cleaner				
gallons of diluted cleaner	38,016	12,672	25,344	66.7
gallons of cleaner concentrate	148.5	49.5	99	
gallons of water need for dilution	37,867.50	12,622.5	25,245	
Glass Cleaner				
gallons of diluted cleaner	25,344	6,336	19,008	75
gallons of cleaner concentrate	99	24.75	74	
gallons of water need for dilution	25,245	6,311.25	18,934	
Combined All Purpose & Glass Cleaner				
gallons of diluted cleaner	63,360	19,008	44,352	70
gallons of cleaner concentrate	248	74	173	
gallons of water need for dilution	63,113	18,934	44,179	

Table 2 shows calculations of the solid waste (plastic and corrugated), that has been diverted from landfills in the three Core buildings that have switched to the CleanCore system. This is significant in that plastic and corrugated are eliminated when the use of aqueous ozone is adopted. This is important to the Clemson campus, and the surrounding community, and is a key driver behind many of the university's sustainability-focused changes. The average reduction and diversion of solid waste by partially reducing traditional chemical use in the cleaning of the three Core buildings was 70 percent for the two most used traditional cleaners, all-purpose and glass. This is a large reduction and will impact more of the campus as adoption of the CleanCore system expands.

Table 2. Calculations showing solid waste in the form of plastic and corrugated diverted from the campus and area landfills due to Clemson Home's move to the CleanCore system for the three Core buildings.

Per year, Core buildings	Solid waste generated using traditional, synthetic cleaning chemicals	Solid waste generated after adopting use of the CleanCore system	Plastic bottles and Cardboard diverted from landfills	Percent overall solid waste reduction
All-purpose Cleaner				
plastic bottles	432	144	288	66.7
cardboard cartons / cases	216	72	144	
Glass Cleaner				
plastic bottles	288	72	216	75
cardboard cartons / cases	144	36	108	
Combined All Purpose & Glass Cleaner				
plastic bottles	720	216	504	70
cardboard cartons / cases	360	108	252	

CLEANING PERFORMANCE ASSESSMENT OF THE CLEANCORE SYSTEM

(ATP, TIME/LABOR, & WORKER SATISFACTION)

Historically, the evaluation of cleaning performance using traditional synthetic cleaning chemicals and equipment has been largely subjective; done mainly through observations and comparative assessment. Then came the advent of black lights, glowing marker solutions and, in the last decade, ATP readings.

ATP – ADENOSINE TRIPHOSPHATE

ATP readings are an in-field test that is used to measure the soil present on a surface. The ATP test identifies surface soils that contain the ATP (Adenosine Triphosphate) molecule, which is found only in living cells. The units of measurement are Relative Light Units or RLUs, and the higher the number the dirtier a surface. The test cannot identify if the living cell is a pathogen or just a protein. It is an indication of what is on the surface before and after cleaning to show how effective a cleaning method or a cleaning staff member is performing.

ATP readings were taken in bathrooms in the Core buildings on the Clemson campus. The readings were taken first in dirty bathrooms that had been used heavily for hours by students. Then the bathrooms were cleaned by staff using Aqueous Ozone and the CleanCore Gen2 Caddy. Readings were then taken of the newly cleaned bathrooms to show the reduction in ATP soil load. The before and after readings are a great trend tool for training and identifying how well a process and the worker are performing.

Soil removal is the most important step in the cleaning and disinfection of a building. This is because you cannot disinfect a dirty surface. Germs will hide under soils and stay on the surface if not cleaned before disinfecting. Microbial species can number in the billons, so a 90 percent reduction through the removal of soil (cleaning), allows for more effective disinfecting, all while using less disinfectant.

Table 3 shows the soil removal percentage rates, using ATP testing, before and after cleaning one unisex bathroom on a busy residence hall floor in one of the Clemson Core buildings. The data set illustrates the performance of both the worker and the CleanCore system in the cleaning of this restroom environment. It should be noted that an ATP reading of less than 30 Relative Light Units (RLUs) is considered clean. Readings from 31 to 80 are acceptable but identify an area for potential improvement. Readings over 80 are considered unsatisfactory and "re-cleaning" of such an area is recommended.

Table 3. ATP readings from a unisex bathroom in a Core building on the Clemson campus

ATP Readings on Clemson Campus Core Buildings			
	1/16/2019	1/16/2019	1/16/2019
Locations	**ATP readings before cleaning, in RLUs**	**ATP readings after cleaning with the CleanCore Caddy and Aqueous Ozone, in RLUs**	**Percent Reduction**
door handle in	197	34	82.74
door handle out	1560	29	98.14
common sink, faucet on the right	550	17	96.91
Right bathroom			
toilet handle	989	6	99.39
tp holder	38	14	63.16
left side of sink	106	22	79.25
Left bathroom			
right side of sink	335	10	97.01
paper towel holder	76	5	93.42
faucet	165	16	90.30
hygiene bags	11	8	27.27
toilet seat	18	7	61.11
door lock handle out	1248	29	97.68

As can be seen in Table 3, the readings after using aqueous ozone and the CleanCore Caddy, with trained Clemson personnel, are all under 30 RLUs; except one reading which is on the border of clean at 34 RLUs. With 8 of the 12 readings being under 20 RLUs, and 6 readings under 15 RLUs, the testing shows that soil and microbe removal are exceptional with this system and would rival readings seen in a hospital setting.

During the project, data collection focused on restrooms due to their concentrated, high volume use and the possible hazards associated with these shared environments; along with these areas representing the heaviest usage of the CleanCore system. Each of the three Core buildings has over 20 bathrooms that are cleaned daily. ATP measurements were taken in two types of restrooms, single and multi-room, over the week and many sets of data were collected during this study. Table 3 is representative of the results seen from the other data sets and raw data can be provided upon request.

The data presented in Table 3 demonstrates the effectiveness of aqueous ozone and the CleanCore system on a variety of high-touch surfaces. As with the set shown, the remaining data sets showed soil removal in the range of 79 to 99 percent, for most of the touch points tested. The few lower percentages of soil removal are not statistically significant, because the starting and ending ATP readings were almost zero.

TIME / LABOR SAVINGS

Clemson janitorial staff reported an hour a day time savings when using the CleanCore system for cleaning bathrooms in the Core buildings. This hour allows the staff to perform other duties and to leave on time so as not to incur overtime, positively impacting the department's budget. Additional time savings are realized across the entire supply chain, including inventory management, procurement, order receipt and disbursement and processing packaging waste. These hours of recaptured time can be applied to other areas of need within Clemson Home.

WORKER SATISFACTION

Clemson staff reported having less eye, skin and respiratory irritation using CleanCore's Pure Aqueous Ozone. They mentioned that the Caddy is easy to use and much less physically demanding on them, versus the use of the mop and bucket method for floor cleaning. There is also time saved by not switching between many different cleaning products and they can clean at a more comfortable pace. The change in systems and procedures reduced stress, increased worker satisfaction, and ultimately, resulted in better performance.

The staff also felt safer using the Caddy system. The CleanCore Caddy removes soiled water from floors with its built-in vacuum recovery system. Because of this, floors dry quickly, and the staff finds they spend much less time walking on wet, slippery surfaces. They reported liking the natural smell of the aqueous ozone and not being required to rinse surfaces after cleaning. They reported the aqueous ozone did not leave behind streaks or spots on surfaces. In addition, they were impressed by the residue removal they observed coming off the floors, stainless steel and mirrors when they started to use the CleanCore system—much more so than they noted using traditional chemicals and cleaning methods. Many workers talked of how they loved the aqueous ozone for cleaning stainless steel and mentioned the appearance of the elevators many times. Many of the Clemson workers were visibly excited and happy to have access to the CleanCore system.

Last, but equally important, were comments from the staff stating they liked that aqueous ozone was healthier for them and felt good about it being better to use around "their kids". They liked how it made the facility look and that it was less toxic and sustainable.

RETURN ON INVESTMENT

Though a complete ROI analysis was beyond the scope of this study, it is worth mentioning that there are savings to be realized as a result of the migration to touch-free restroom cleaning and the use of aqueous ozone through an on-site, on demand generation system.

The most obvious savings come from reduced labor and chemical purchases. The International Sanitary Supply Association estimates no-touch restroom cleaning reduces labor by approximately 30%. The use of aqueous ozone reduces the consumption of traditional synthetic cleaning chemicals between 70 and 80 percent. These are immediate cost savings that further validate the benefits associated with adopting the system offered by CleanCore Solutions.

Beyond labor and chemical costs, additional savings likely to be realized by the changes adopted in these areas of Clemson Home include, but are not limited to:

- Delivery Costs
- Procurement, Inventory and Disbursement Expenses
- Packaging Waste Disposal
- Hazardous Material Management and Disposal

The return on investment will differ for every business, based on a host of variables. What is important to note is that when making the decision to adopt a more environmentally sustainable approach to facility maintenance—one being considered by many businesses—such a move can not only deliver safety, health and environmental benefits, but financial benefits as well.

SUMMARY OF PROJECT

Management with Clemson Home decided to purchase CleanCore's no-touch Caddy and Pure Aqueous Ozone, onsite generation equipment over a year ago to be used in their new residence halls. The results have been overwhelmingly positive! The CleanCore system cleans and deodorizes, without rinsing and without leaving behind a chemical residue. The on-demand nature of the system, and its ease of use, have made it a staff favorite within Clemson Home. They have seen improved performance, time savings, and they feel safer using aqueous ozone solution generated by the CleanCore equipment.

Clemson is a University that embraces sustainability and the attributes of reducing solid waste, water consumption, concentrated chemicals and their toxic constituents. The metrics examined in this study are not ones generally considered when changing cleaning systems, but they should be. The impact on the health of workers, buildings, clients, the environment and community are all impacted by how we consume and purchase goods. Indoor Air quality should be in the forefront of people's minds as we build facilities "tighter" to hold in heat and air conditioning while also allowing every chemical used inside to linger longer and increase risk of exposure and harm to anyone using the building.

Other improvements include time and labor savings, along with improved employee morale. Objectively, performance of the system is documented through readings generated by ATP testing. Subjectively, housing staff feels the performance bar has been raised since adoption of the CleanCore system.

This study was important to Clemson Home, because it is not only important to validate progress toward reducing the campuses carbon footprint, but to do so without sacrificing system performance in the process. The results of this study support the achievement of both outcomes. Clemson Home hopes to help other universities and facilities see that investing in technology and innovation in their cleaning systems can have an impact beyond that of cost savings. Such changes can be sustainable, save time and labor, positively impact morale and improve performance; which is the ultimate objective. The collaboration between Clemson Home and CleanCore Solutions LLC has been a successful one and both look forward to its continuation.

CleanCore SOLUTIONS™

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