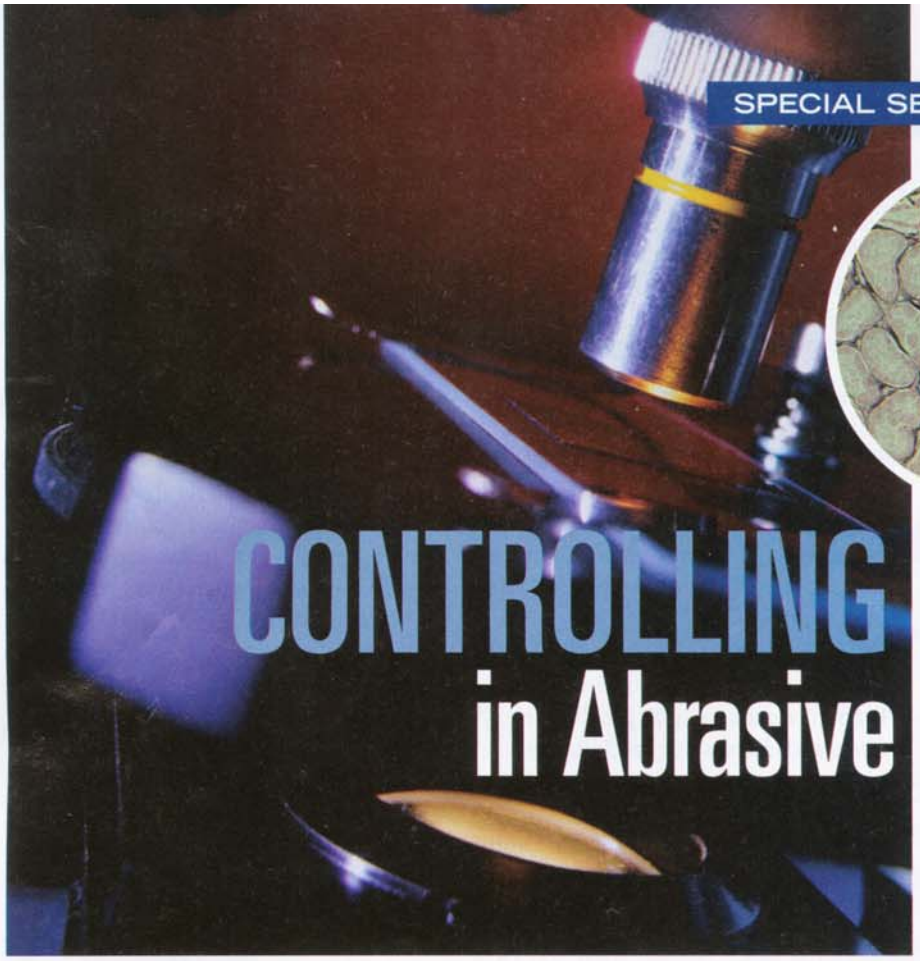

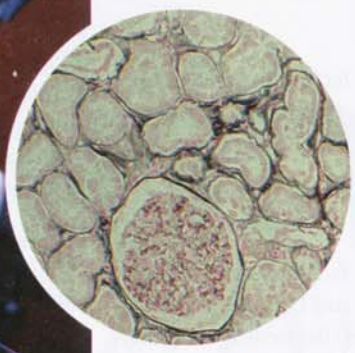

CONTROLLING BACTERIA in Abrasive Suspensions

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A bacterial infestation can be difficult to eliminate, and the cost of cleaning and/or replacing hundreds of feet of tubing per machine can be monumental. A preventative strategy is always the best approach.

Many industrial finishing operations require the use of submicron abrasives in a suspension. In some cases, miles of tubing and pumps are used to deliver exact amounts of slurried suspensions to multiple production lines for applications such as texturing hard discs, planarizing sapphire discs, polishing silicon carbide wafers and super-finishing medical prostheses. These situations create the ideal conditions for bacterial growth.

To remove bacteria and other contaminants, abrasive suspensions are typically passed through a filter before being deposited on the work piece. However, most filters usually have an absolute filtering capacity of 0.5 or 0.75 μ, while many bacteria species are around the size of 0.5 μ and finer and can multiply rapidly during their reproductive cycle. Bacteria that pass through these filters can proliferate in "dead areas" of a production system (e.g., elbows, tight curves, and low spots or sumps) or in the lines themselves during tooling or product changeovers. When material flows through the dead areas or the process is resumed, a "bloom" of bacteria can be deposited on the work piece. These bacteria either leave a disagreeable biofilm (usually in the form of lipoproteins or polysaccharide glycocalyx) that is difficult to remove, or they continue to reproduce into the next manufacturing cycle. If the bacteria are allowed to remain on the components that are passed on to an end user, they might lie dormant until conditions are right for reproduction at the customer's facility.

Bacteria that are the same size as or larger than the filter create another problem—clogging. In some cases, the bacteria can become so numerous that frequent filter changes are required, which creates both a maintenance nightmare and a bottleneck in the finishing operation. In the high-end manufacturing world, delivery schedules are tighter than deadlines in the daily newspaper business. Any delays, chronic or acute, in the production and delivery process will inevitably affect a company's customer service record—and ultimately the manufacturer's ability to compete in the global market.

Environmental Controls

Bacterial infestations are most common in regions with high humidity and moderate temperatures. However, all operations that work with aqueous suspensions are prone to potential problems. The vector for infestation is usually through an outside source—for example, adding a new chemical, using untreated process water, handling materials or components with ungloved hands, or using heating or air conditioning systems that are not regularly cleaned. Much like the common cold, once a bacterial infestation affects one production line, it's only a matter of time before the rest of the production lines become infected. A bacterial infestation can be difficult to eliminate, and the cost of cleaning and/or replacing hundreds of feet of tubing per machine can be monumental. A preventative strategy is always the best approach.

One of the variables that can significantly affect product quality and employee performance is the work and storage environment. A controlled environment should be an integral part of most production facili-

ties. Environmental factors that should be considered include lighting, ventilation, temperature, humidity control, particulates and static electricity.

Specifications

For manufacturing facilities that operate under the U.S. Food and Drug Administration (FDA) guidelines (biomedical ceramics, etc.), the FDA considers the work environment to be a "discretionary" requirement; that is, the degree of environmental control to be maintained should be consistent with the intended use of the product. Subsequently, the details of how to achieve this control are left to the manufacturer to decide.

The Federal Standard "Airborne Particulate Cleanliness Classes in Clean Rooms and Clean Zones" (FS209E) is a good resource for developing clean room standards. FS209E defines various levels of environmental control—for example, a Class 1000 room contains no more than 1000 particles 0.5 micron diameter or larger per cubic foot of air. Other possible specifications for a Class 1000 clean room are shown in Table 1.

To ensure the peak performance of all equipment used in a clean room, the equipment manufacturers' recommendations should be followed. For example, filters used for abrasive suspensions should be replaced according to the recommended schedule or as needed based on regular inspections. Additional factors that should be considered when planning and using a controlled environment include:

- Providing separate personnel dressing rooms.
- Controlling personnel's use of and entry into controlled areas (only those who need to be there should be allowed to enter).
- Prohibiting eating, drinking, smoking or gum chewing.
- Preventing the use of lead pencils.
- Regulating the storage of glassware and containers.
- Preventing or controlling the cutting, tearing or storage of cardboard, debris, etc.
- Cleaning the room and production equipment regularly according to a written procedure.
- Selecting the correct furniture and eliminating all nonessential equipment.

Table 1. Sample Class 1000 clean room specifications.

Particulates	max. of 1000 particles 0.5 micron diameter or larger per cubic foot
Humidity	45 ± 5%
Temperature	72 ± 2.5°F
Air Velocity	90 ft/min ± 2%
Air Pressure	0.05 in. water between the clean room and other areas

- Controlling room air through air conditioning and HEPA filtration.
- Eliminating electrostatic charges by controlling the work surface composition or grounding.
- Ensuring the cleanliness of all raw materials, components and tools used in the room.
- Controlling the purity, sterility and non-pyrogenicity of the process water.
- Properly maintaining all prefilters, HEPA filters and electrostatic precipitators.

Monitoring

An appropriate system for regular monitoring should be established and maintained for each of the factors to be controlled for a given operation. Regular monitoring can help ensure that all equipment performs properly and that the quality of the environment remains within specifications. When a particle count class is specified, the monitoring of airborne particulates is usually done with an air sampler. Monitoring of the work surfaces for microbes/colony forming units (CFUs) can be done with surface contact plates or agar-agar filled Petri dishes with the use of an incubator.

Simple, accurate and up-to-date inspection check-off forms and other records should be maintained. Incorporating the monitoring program into an ISO quality management system can help ensure the program's success.

Personnel Sanitation Practices

Not enough can be said about personnel sanitation practices. Frequent hand washing is a must. Adequate, well-maintained bathrooms and dressing, storage, and waste facilities should be provided as appropriate for personnel to maintain the needed level of cleanliness. Where necessary, special clothing and an area to don and store the garments should be provided. Clean room clothing should not be worn into uncontrolled rooms or outside the facility.

Teamwork

In addition to the processes, techniques and examples provided in this article, a proven working model for continued clean room and quality control procedures, as well as management crisis response efforts, is vital. One such model, abbreviated as "PACK," includes:

- **P – People.** The team size is important, as is their working relationship. In general, the larger the team, the more convoluted the effort—and more importantly, the solution—might become. Keep it small and simple.
- **A – Assurance.** Ideally, the team should have experience working and solving clean room and quality control issues and problems, providing the requisite confidence to tackle a less well-defined problem.
- **C – Communication and Collaboration.** Each team member must have the opportunity to express solutions, ideas, etc. While the team should have a designated leader to "keep the horses in the corral," no single person should dominate the team. The workload for a solution should be distributed evenly.
- **K – Knowledge.** The use of a self-directed team of experts from each department involved is critical in maintaining clean room sustainability, as well as finding an effective and timely solution during crises.

Many publications are available that refer to the selection and proper use of teams in practice. Usually company culture prevails in these situations.

For more information about preventing bacterial contamination in abrasive suspensions, contact Warren/Amplex Superabrasives, 1401 East Lackawanna St., Mid-Valley Industrial Park, Olyphant, PA 18447; (800) 368-5155 or (508) 795-5908; fax (570) 383-3218; e-mail ron.a.abramshe@saint-gobain.com; or visit www.warrenamplex.com.