ANTIMICROBIAL PROPERTIES IN CERAMIC TILING PRODUCTS

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HISTORY OF HYGIENE

In the 21st Century we regard locations such as hospitals, food factories, dairies, abattoirs, etc as the best examples of places where good hygiene practices are of paramount importance, but it was not always so.

In the 19th and early 20th Century Poor Law hospitals in England many patients would take their own food because the risk of illness from the appalling hygiene conditions in the kitchens was so great. The Liverpool Hospital, when visited by an eminent London doctor, was described as "unspeakably disgusting". Rich and middle class people would not venture anywhere near a hospital and would always endeavour to have treatment in their homes.

Changes in hygiene practices in hospitals began when Lister and Florence Nightingale fought a major campaign to persuade doctors and surgeons to wash their hands before treating patients. The use of carbolic, pioneered by Lister, was seen as a major breakthrough in reducing the incidence of infections spreading throughout the hospital.

In times of war more wounded soldiers died as a result of infection than they did from injuries inflicted in the battle. This has been the case in virtually every war fought even to this day.

The use of carbolic and disinfectants to kill bacteria is essentially an antiseptic approach, accepting that the presence of bacterial infection is almost always present. Eventually, antiseptic techniques were augmented by aseptic methods, which set out to eliminate or minimise the presence of bacteria in the first place. This involves sterilising instruments, dressings, bandages etc by autoclaving in steam.

There are still many countries in the world where acute shortage of facilities and a lack of money see patients having to share beds. Clean bedding may only be available once or twice a week and the buildings themselves are often infested with cockroaches and rats.

Even in the richer, more advanced countries good hygiene practices have only been in evidence over the last 30 years. When I first came into the ceramic tile industry some 35 years ago I visited many food factories, abattoirs, dairies and hospitals and the lack of good hygiene was very apparent.

However, despite a greater understanding of the problem we still have many cases of serious illness and even deaths caused by the spread of bacterial infections. All over the world there is an urgent need to eradicate the spread of these infections in food premises and hospitals. *(2)* There are at least 100,000 such cases of infections each year in British hospitals, costing the National Health Service as much as £1billion a year. Even in a small country like Scotland, some 457 people died in the year 2000 after contracting infections whilst in hospital, 141 more than the death toll from car crashes in the same twelve months. The Scottish Executive has announced a £3 million investment in sterilisation and disinfectant equipment for hospitals.

In America some 2 million people become infected in hospitals, 80,000 dying as a result; viruses can be spread by unlikely objects such as pens which may be passed from staff member to staff member during the course of a day.

Even though there is now a good understanding of the causes of food contamination reports of food poisoning and salmonella outbreaks are still on the increase. We have even seen recent reports of the risks of E-coli contamination in organically grown food.

Premises where food is prepared, treated, processed or consumed are particularly vulnerable to the harmful effects of bacteria such as E-coli, listeria and salmonella. The correct design and layout of the premises, particularly relating to the nature of the wall, floor and food contact surfaces plays an important role in providing the good hygiene practices needed to combat food contamination. Environmental Health Officers and building owners have become increasingly aware of the need to install the most hygienic surfaces and to adopt effective and thorough cleaning regimes.

Before we consider what actions we can take to improve the antimicrobial properties of cladding materials such as ceramic tiles let us look at a few relevant definitions of the terms we come across.

DEFINITION OF TERMS

SPORE	Minute, typically single-celled reproductive unit characteristic of lower plants, fungi and protozoans, capable of giving rise to a new individual without sexual fusion.
PROTOZOA	Single celled microscopic animal form, eg amoebas.
BACTERIA	Large group of unicellular micro organisms which have cell walls but lack an organised nucleus and other structures and include numerous disease carrying forms.
FUNGUS	Any of a large group of spore producing organisms which feed on organic matter and include moulds, yeast, mushrooms and toadstools.
MOULD	Furry growth of minute fungi occuring typically in moist warm conditions on organic matters.
ALGAE	Large group of simple, non-flowering plants containing chlorophyll but lacking true stems, roots, leaves and vascular tissue, eg seaweeds and many single-celled forms.
Common Bacteria E-COLI	Escherichia coli – found in intestines of humans and other animals, some strains of which can cause food poisoning.
LISTERIA	A type of bacterium which infects humans and other animals through contaminated food.
SALMONELLA	Bacterium that occurs mainly in the gut and can cause food poisoning.
STAPHYLLOCOCUS AUREUS	A bacterium of a genus including many pathogenic kinds that cause pus. (Dead white blood cells and bacteria). Grows optimally at 35°C but will occur between 10-45°C pH 4.5-9.3.
Mould and Fungus ASPERGILLUS NIGER	Black mould formed when ventilation poor and in presence of moist, warm air.
MILDEW	Minute fungal hyphae growing on plants or damp organic material such as paper or leather.

The current European Community Food Hygiene Regulations make specific reference to wall and floor surfaces in food preparation, processing and treatment areas. Chapter II states;

"floor surfaces must be maintained in sound condition and they must be easy to clean and, where necessary , disinfect. This will require the use of impervious, non-absorbent, washable and non-toxic materials unless food business operators can satisfy the competent authority that other materials used are appropriate."

A similar statement also applies to wall surfaces. Ceramic tiling is listed as a recommended surface for food preparation, processing, treatment and storage areas in the UK. Institution of Environmental Health Officers publication."Guidelines on the Hygienic Construction of Food Premises". In fact, ceramic tiles have been used for decades as the preferred choice for walls and floors in these areas. Why do ceramic tiles provide an excellent surface.

- They comply with all relevant legislation
- They are easy to install
- They are easy to clean and disinfect
- They are extremely durable and hard wearing
- They are heat resistant and fireproof
- They perform well under heavy pedestrian and wheeled traffic
- They do not age like plastics
- They are easy to maintain or replace locally to an "as new condition"

Independent tests carried out by Food Research Laboratories have shown that ceramic tiling conforms to "The Food Safety (General Food Hygiene) Regulations 1995" and in particular to be cleanable and non-tainting when in contact with food. An additional factor to consider, especially in relation to floors is that the food industry has one of the worst records in manufacturing industry of accidents resulting from slips and trips – slip resistance of the floor covering material is an important consideration.

Tests have shown that surface texture on slip resistant tiles does not compromise the cleanability of the overall tiled surface.

Although reports have concluded that "properly grouted tile surfaces are as cleanable as continuous resin surfaces", historically there has been a view expressed that, in certain conditions, grout joints may over time exhibit bacterial and mould growth, particularly if an effective cleaning regime has not been employed.

Cleaning regimes employed in food premises and hospitals have essentially been similar to the hygiene practices employed in hospitals in the 19th and early 20th Century, ie they have adopted an antiseptic approach. This approach is designed to kill the microbes, rather like the cleanability approach to, say, epoxy resin grouted ceramic tiles. In other words, the bacterial may be initially present, perhaps in quite large quantities, but the vast majority can be easily killed by an appropriate safe cleaning regime because they sit on an impervious surface. However, as I said earlier, hospitals began to use aseptic regimes of hygiene which means that they attempted to ensure that there were no microbes there in the first place.

The ANTIBACTERIAL ADDITIVE technique in tile glazes, grouts and sealants is essentially similar; it inhibits the growth of bacteria in the first place. Then with appropriate cleaning regimes surfaces can be more readily kept sterile.

ANTIMICROBIAL ADDITIVES

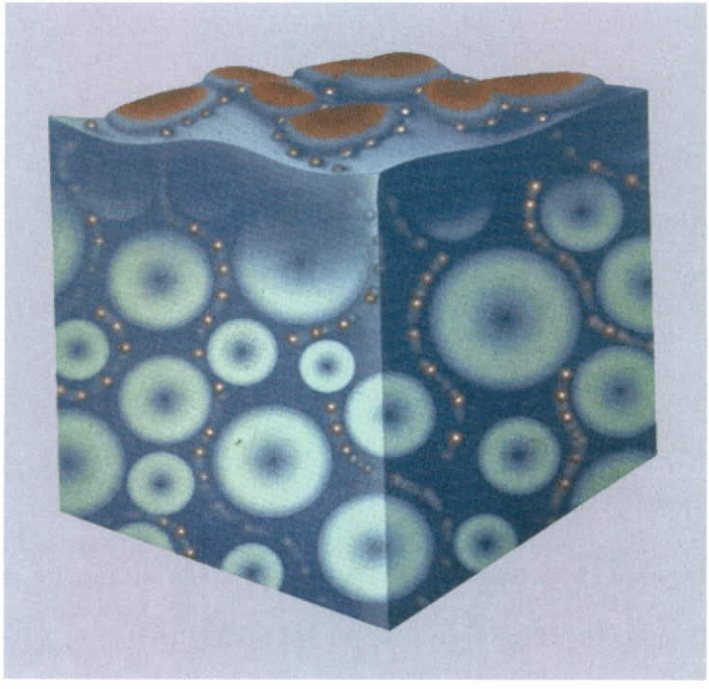
Recently the use of anti-bacterial additives into ceramic glazes has taken a major step forward for incorporation into ceramic tiles and sanitary ware. Using a silver compound and combining it with other inorganic materials such as silica, alumina and phosphorus compounds it has been possible to confer anti-bacterial properties into the glazes.

What about grouts, sealants and associated cleaning compounds?

Anti-bacterial protection can be incorporated in powder form into cementitious and epoxy grouts, into sealants, such as silicones, and in detergent cleaners. In addition, protection against mould growth mildew etc can be built in. One of the most unsightly features in shower cubicles nad other wet and damp areas, where ventilation is poor, is the appearance of black mould (Aspergillus Niger) on wall and floor surfaces.

The additive used has proven use in surgical washes and in skin and oral care products for more than 30 years. The compound has immediate, persistent, broad spectrum effectiveness against almost all known bacteria.

Public concern has often been expressed over the possibility of micro organisms developing resistance to antimicrobial products – the formation of so-called "superbugs". Antibiotics have a specific cellular target which enables them to achieve bacterial elimination. This can sometimes results in a mutation being ultimately formed which can then resist the anti-biotic. In contrast, "antiseptic compounds rely on non-specific modes of action to kill bacteria and are far less likely to be affected by single cellular mutations. The additives used in grouts, sealants and cleaning compounds are of the latter type.



HOW IS ANTIMICROBIAL PROTECTION INCORPORATED?

- The additive is introduced into the compound during manufacture at a carefully controlled concentration, creating a disequilibrium ("de-blocked" or released configuration).
- The compound begins to migrate to the surface to achieve equilibrium.
- The anti-bacterial additive becomes bound to the surface, continuously inhibiting bacterial growth.
- If the surface compound is removed through abrasion the anti-bacterial additive will replenish itself.

HOW LONG WILL IT LAST?

- Built-in, life long hygiene protection.
- Accelerated ageing tests have shown effectiveness for up to 40 years.
- Almost insoluble in water.
- Thermal stability good up to 150°C.
- Has no measurable effect on tensile strength, colour or texture of the finished product.

Date		Use
1970's	—	Used in surgical washes for 25 years
1980's	—	Used in skin and oral care products
1990's	—	Use extended into many household products
2000	—	Incorporated into ceramic tile grouts, sealants and cleaners

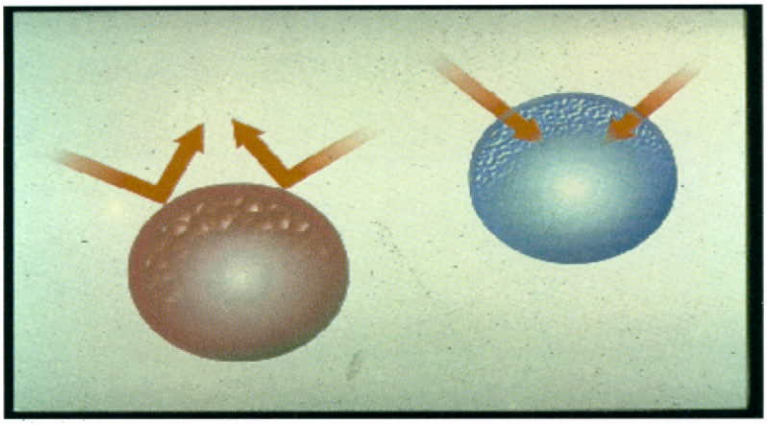
HOW SAFE IS IT?

- The main ingredient has been successfully used in hospitals for over 25 years.
- It is safe and non-toxic.
- At 100% concentration it is less toxic than common salt.
- Widely used in toothpastes, mouth washes, soaps and deodorants.
- Approved by USA FDA for food contact.
- Environmentally friendly.

HOW DOES IT WORK?

- On contact with bacteria the additive penetrates the thin cell wall of the microbe by diffusion.

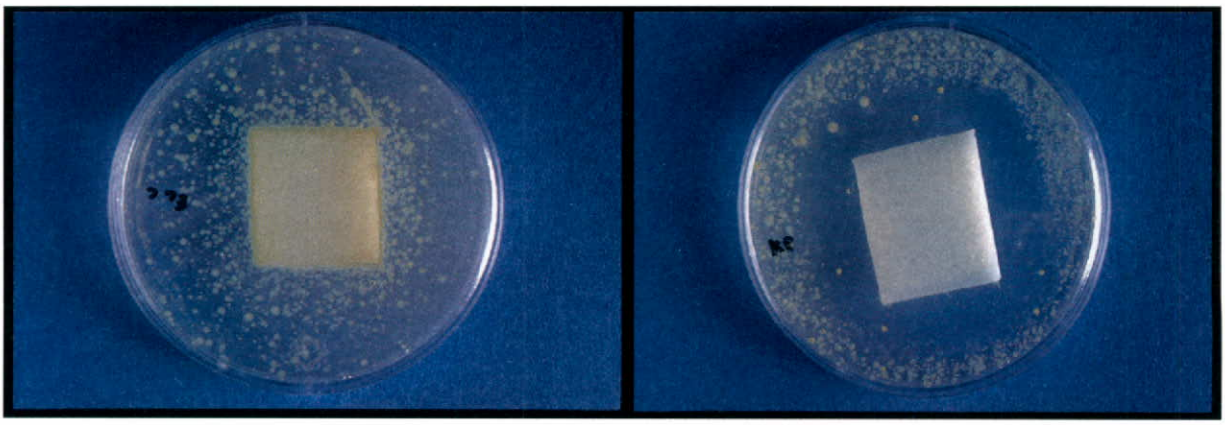
- Thick animal cells are not penetrated, hence not destroyed.
- Destroys bacterial cell's ability to function, grow and reproduce.
- It is not a poison and does not build resistance.
- Kills 99% of all known bacteria.



Animal Cell (Thick Walls) *Bacteria Cell (Thin Walls)*

HOW DO WE DEMONSTRATE AND MEASURE THAT IT WORKS?

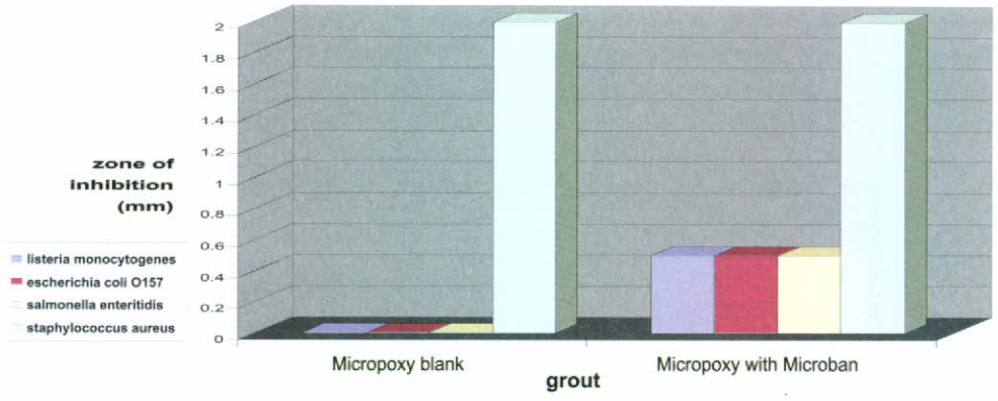
Products undergo rigorous microbiological testing to measure bacterial inhibition zones.



Without *Whith*

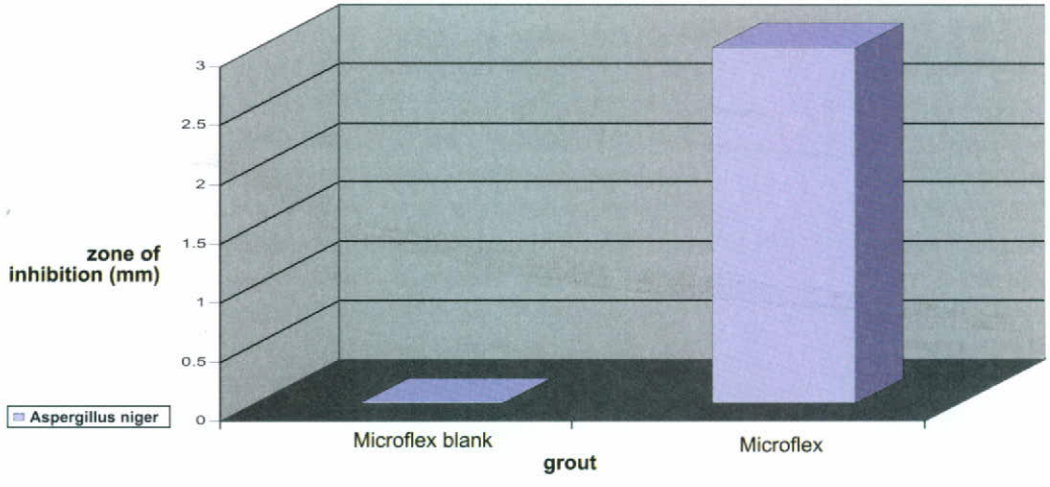
It is essential to have a clear but narrow zone of inhibition; too large a zone may imply that the additive can leach out of the product too easily thus reducing its lifetime efficacy. The following graphs illustrate the effect.

Figure 1. Bacterial resistance.



Graph with 4 bacteria – with and without additive.

Fungal resistance. Tests conducted after ageing of grout in de-ionised water.



Graph for aspergillus niger, with and without additive.

Grouts and sealants incorporating antibacterial protection additive are stable to ultra violet light and hence will not yellow with time. The use of antibacterial protection in tile cleaners helps to replenish the levels of additive, especially in cementitious grouts which have a degree of permeability.

CONCLUSION

We can say that although ceramic tiled surfaces are hygienic they are not always specified as readily as other types of jointless finishes. The incorporation of anti-bacterial additive into grouts and sealants combines an antiseptic and aseptic approach to hygiene, providing a safe, long lasting solution capable of giving resistance to 99% of all bacteria and disfiguring mould growth.

This should take away some of the stigma of tiling in food areas and hospitals.

It must be emphasised again, however, that the incorporation of anti-bacterial additive into grouts and sealants does not take away the need for effective cleaning regimes.

Finally, to emphasise once more that the additive currently being used by my Company is well tolerated by a variety of species, including human beings. It is not an oral toxicant and is considered perfectly safe for use in oral products. It has also been found not to be a carcinogen or mutagen and does not lead to irritation or sensitisation of the skin.

Last but not least there is no evidence to show that it will promote the development of *Superbugs*!