CERAMIC TILING AS A HYGIENIC SURFACE IN FOOD PREPARATION AREAS

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SUMMARY

The New European Directive on the hygiene of foodstuffs has focussed attention within the European Community on the requirements for wall and floor surfaces in rooms where food is prepared, treated or processed. The paper analyses and considers the ability of ceramic wall and floor tiles, which have been correctly installed and grouted, to meet these requirements.

Scientific evidence confirming the ease of cleaning of ceramic tile finishes is also given.

1. INTRODUCTION

Ceramic tile finishes have long provided a decorative, functional and extremely durable surface for walls, floors and worktops in all types of installations both internal and external.

The modern ceramic tile is generally perceived to provide a high quality, fashionable surface finish with many attributes which set it apart from other less durable competing surfaces such as paints, thermo-setting sheet cladding, PVC sheet flooring and tiles and composite polymeric flooring materials. There are, however, at least in the U.K., market segments where specific generic surface finishes have been promoted heavily and have begun to win market share from ceramic tiles. This is particularly the case in areas such as kitchens, food processing and health care installations where the ability to maintain a hygienic surface is an important requirement. Doubts have been cast in the minds of many individuals responsible for specifying and vetting room finishes about the ability of ceramic tiles to continue to satisfy the requirements of legislation which is likely to arise out of the European Community Directive on hygiene.

A considerable amount of work has been undertaken by the U.K. ceramic tiling industry (in particular the British Ceramic Tile Council and the National Master Tile Fixers Association), to redress the balance with the aim of returning ceramic tiles to the position of being the preferred choice for installations where hygiene is important.

2. HYGIENE REGULATIONS

Hygiene in areas where food is prepared, processed or treated has long been the subject of regulations in the U.K., the most important being the Food Hygiene (General) Regulations 1970, The Materials and Articles in Contact with Food Regulations 1987, and the Food Safety Act 1990.

These Regulations cover many aspects of hygiene involved in the handling and preparation of food, one of which is the condition of surfaces in contact with foodstuffs and of adjoining walls and floors.

The long anticipated EC Directive (93/43/EC) on the hygiene of foodstuffs was formally adopted by the Council of European Communities on the 14 June 1993 (Official Journal of the European Communities L175/1 19/7/93). The common position within the EC is that this Directive sets out general commonsense rules which are designed to apply to food businesses throughout the community. It is the intention of the Department of Health in the U.K. to implement the requirements of this Directive into U.K. law in the Autumn of 1994.

An annexe to the Directive sets out the following specific hygiene requirements for room surfaces, but leaves the detailed application of these requirements to voluntary industry guides tailored to meet the practical needs of different industry sectors.

Floors

"Floor surfaces must be maintained in a 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. Where appropriate, floors must allow adequate surface drainage."

Walls

"Wall surfaces must be maintained in a 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 and require a smooth surface up to a height appropriate for the operations unless food business operators can satisfy the competent authority that other materials used are appropriate."

Worwing surfaces

"Surfaces (including surfaces of equipment) in contact with food must be maintained in a sound condition and be easy to clean and, where necessary, disinfect. This will require the use of smooth, washable and non-toxic materials unless food business operators can satisfy the competent authority that other materials used are appropriate."

These specific requirements are therefore made in very general terms in such a way that any satisfactory surface material may be used.

To safeguard public health in the U.K., the compliance to these Regulations by all food businesses will be enforced by Local Government Environmental Health Officers (EHO's). Article 9 of the Directive will require these enforcing officers to have regard to "risks to the safety or wholesomeness of foodstuffs" in carrying out their inspections.

This will involve the use of HACCP assessment - HAZARD ANALYSIS AND CRITICAL CONTROL POINTS - to determine the level of hygiene risk associated with a particular installation.

HACCP assessment takes account of six basic areas, only one of which involves the condition of the room surfaces.

1. Potential hazard based on the type of food and method of handling.

2. Potential hazard based on the method of processing.

3. Number of consumers at risk.

4. Compliance with food hygiene and safety regulations.

5. Standard of hygienic construction of the works.

6. Confidence in management/control systems.

This assessment will then enable the food business to be rated in terms of risk from high to low.

The acceptability of surface finishes is then established by a combination of HACCP assessment, conformity to the specific room requirements listed in the Directive, and compliance with a specifically recommended cleaning and maintenance regime.

3. CONFORMANCE TESTING

As has been mentioned already, the specific requirements of the Directive are stated only in a general sense for sensible interpretation and are not expressed in scientific terms with associated methods of test and limits of acceptability. However, there are methods which are being used by the U.K. food industry and by independent food research laboratories to test for water absorption and for ease of cleaning and disinfection.

For example, the Campden Food & Drink Association, a leading U.K. Food Research laboratory use a method of measuring the water absorption of a surface adopted from a Swedish method[1] (see diagram 1). This method measures the volume of water absorbed into the building surface under a 100 mm head of water over a period of 24 hours. To pass the test samples must show no water absorption.

Glazed wall tiles complying with BS 6431 parts 2:6 or 9 (EN 121, 176 or 159) and fully vitrified floor tiles conforming with BS 6431 parts 2 or 6 (EN 121 or 176) have been shown to have zero water absorption according to this method and can be said to be non absorbent.

There are strong indications that tiles with a lower degree of vitrification giving a body water absorption of up to around 1%, pass this test.

Of the common grouting materials only reactive resin grouts, usually based upon epoxide resins, are sufficiently solid to achieve nil surface water absorption.

Bacterial cleanabilty is assessed by a method involving measuring statistically the ease of removing a biofilm grown on the surface under test by using a jet of water under controlled conditions (Appendix 1). The cleanability is compared with that of a control surface.

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[1]*Swedish Test Regulation CP-BM-2/67-2*
Determination of water transmission under preassure.

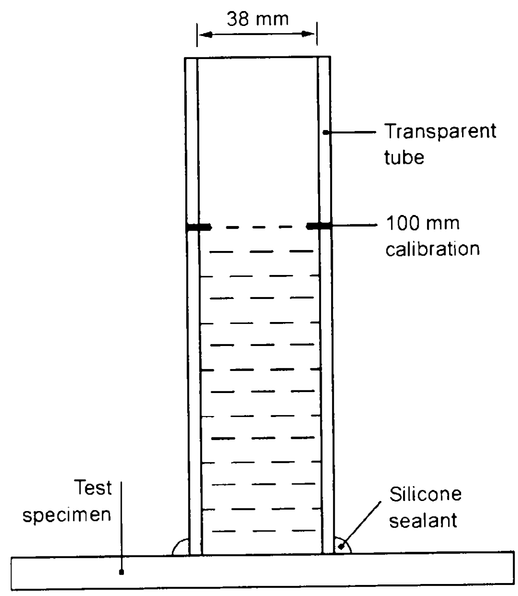

Diagram 1. *Measurig surface water absortion*

In the case of work carried out on smooth surface epoxy resin grouts specially designed for the food industry, the bacterial removal from the epoxy resin grout surfaces was found to be statistically similar to that from a smooth fully vitrified tile, thus indicating that the grouts were as easily cleanable as a smooth tile.

An additional requirement of the U.K. Materials and Articles in Contact with Food Regulations 1987, is that materials in contact with food, such as a grouted ceramic tile worktop, should not transfer their constituents to foods in quantities which could:

a) endanger human health, or
b) taint food.

The non taint requirement, which is especially relevant to epoxy resin grouts, is tested by a sensory method based upon a Triangular Test Procedure (British Standard for Sensory Analysis of Foods BS 5929: Part 3:1984). Food samples known to be highly sensitive to absorbing taints, such as cream, butter and icing sugar, are placed in contact with the material under test, e.g. epoxy grout, for 24 hours under controlled conditions. Similar samples are placed in contact with a glass plate under identical conditions. A panel of trained assessors then taste the coded samples and conclude whether or not the food has become tainted by the test material. It has been shown that good quality, 100% solids epoxy resin grouts should not taint food, even high fat food which is the most sensitive to taint pick-up.

Therefore epoxy grouts of the right quality are easily capable of satisfying, scientifically, the requirements for non-absorption, ease of cleaning and non taint as measured by methods currently available.

4. SPECIFICATION FOR WALL AND FLOOR TILING IN FOOD PREPARATION AND STORAGE AREAS

The correct design and installation of a ceramic wall or floor finish depends to a large extent upon the type of installation involved. There are obviously significantly different requirements between designing and installing tiles in a simple domestic area and a heavily trafficked commercial or industrial installation.

Variables such as the type and size of the tile, the background, the bedding method, the type of grout used and its method of application, are important to the overall success of the installation.

This is particularly the case when the ceramic tile finish is to be subjected to such a specific requirement as the maintenance of hygienic or sterile conditions. Moreover, in many installations the ceramic tile finish has to withstand other specific conditions such as prolonged wetting, high pressure hosing, contact with chemicals, particularly acids, heat, vibration and heavy traffic.

A sensible interpretation of the requirements for a ceramic tile finish to provide a surface which is fit for purpose, durable, and which satisfies all of the requirements of hygiene legislation discussed, would be that in any new construction work, particularly for high risk areas, then the important elements of the tiling specification should be as follows:

1. Wall tiles should comply with BS 6431: Parts 2, 6 or 9 (EN 121, 176 or 159).

2. Floor tiles should be fully vitrified and comply with BS 6431: Parts 2 or 6 (EN 121 or 176) with a water absorption not exceeding 0.5% when measured by the method defined in BS 6431: Part 11: 1983 (EN 99).

3. The tiles should be installed in a solid-bed of adhesive, i.e. one with full contact between the adhesive and background and the tile back, such that there are no voids in which micro-organisms can grow.

4. Epoxy resin grouts should be used throughout. The grout should be finished to give as smooth a joint as possible.

5. The tile joints should be filled completely even when deep floor tiles are involved. Failure to achieve this may result in problems occurring by providing a potential weakness through which aggressive food acids or cleaning agents can penetrate to attack the bed beneath.

6. Movement joints in a floor tile finish should be reinforced, particularly intermediate joints subjected to wheeled traffic.

7. Adequate "falls" should be incorporated in floor areas likely to come into contact with acidic residues, such as lactic acid in dairies, and detergent spillages.

   Gradients between 1:80 and 1:40 are recommended. The direction of falls should be planned with the traffic flow in mind so that the traffic will move across rather than up and down the slope. The position of drainage channels and gullies should be given special attention.

8. It is essential that the correct cleaning regime is followed to maintain hygiene. If possible, the appropriate cleaning and maintenance regime should form part of the tiling specification.

   For existing ceramic tiled rooms where food is prepared, treated or processed, the Directive itself is flexible enough to allow vitrified floor tiles with a water absorption of 3%, and cement-based grouts to remain acceptable, providing the competent authorities decide that the installation is one of low hygiene risk. In this situation the use of cementitious grout and vitrified tiles may also be allowed for a new installation.

   It can therefore be seen that a correctly designed and installed ceramic tile finish meets all the requirements of the EC Directive and can withstand any challenge from competitive materials.

5. MICROBIOLIGICAL STUDIES

Scientific confirmation of the ability of ceramic tile finishes to be maintained in a hygienic condition have also been provided by two independent scientific studies. Both were carried out by the microbiological department of Lancaster Polytechnic (now Lancaster University).

In 1987, L.H.G. Morton, A.F. Mitchell, and F. Vaughan, carried out a survey to investigate the nature and extent of microbial flora of in-service ceramic tile finishes (Environmental Health 1988 96(6)pp24-28).

A range of installations were visited (table 1) and the levels of bacterial and fungal contamination existing on the surface of the wall tiles and grout were measured by the use of a contact plate (Diagram 2).

The contact plate consisted of a volume of agar contained in a modified petra dish. The surface of the agar was exposed and placed against the wall surface being sampled. The plate was then incubated and the bacteria and fungi identified and counted as colony-forming units per 20 cm2 contact plate.

Table 1.

Domestic bathroom
Domestic shower
Pithead shower area
Domestic kitchen
Industrial kitchen (food processing factory)
Milking parlour
Dairy (raw milk collection and storage area)
Hospital operating theatre
Veterinary surgery operating theatre
Public convenience

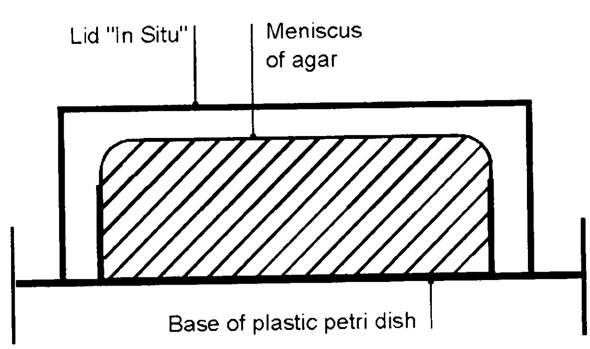

Diagram 2. *Diagram of contact plate used in the assessment of microbial loading on hard surfaces*

The tile surface was then cleansed with a proprietary brand of sodium hypochlorite at a concentration of 1% v/v and allowed to dry. The sampling routine was then repeated.

Tables 2 and 3 tabulate the effect of cleansing on the ceramic tile surface and the grout joints respectively.

Table 2. Effect of cleansing with 1% Sodium Hypochlorite on the resident/contaminating flora of ceramic tile surfaces

	Fungi		Bacteria	
Site visited	Uncleansed	Cleansed	Uncleansed	Cleansed
Domestic bathroom	16	0	2	0
Domestic shower	2	1	1	0
Pithead shower area	3	0	62	0
Domestic kitchen	35	0	700	0
Industrial kitchen	1	1	375	0
Milking parlour	175	8	600	350
Dairy	2	2	18	10
Operating theatre	6	3	18	0
Veterinary surgery	1	0	1	0
Public convenience	1	1	41	1

Numbers represent colony forming inuts/contact plate = 20 cm^2

Table 3. Effect of cleansing with 1% Sodium Hypochlorite on the resident/contaminating flora of ceramic tile grout joints

	Fungi		Bacteria	
Site visited	Uncleansed	Cleansed	Uncleansed	Cleansed
Domestic bathroom	53	23	31	2
Domestic shower	4	1	20	0
Pithead shower area	6	0	50	0
Domestic kitchen	27	0	600	0
Industrial kitchen	3	0	230	6
Milking parlour	88	10	*	350
Dairy	20	0	33	10
Operating theatre	11	2	55	7
Veterinary surgery	0	0	8	0
Public convenience	1	0	32	2

Numbers represent colony forming inuts/contact plate = 20 cm^2
* Colonies too numerous to count

Except for certain venues, notably the domestic kitchen, the milking parlour and the industrial kitchen, general levels of contamination from bacterial and fungal populations were low. The effect of cleansing upon these surfaces was quite marked. Even with the heavily contaminated milking parlour, the residual 350 cfu/20cm^2 bacterial population can only be considered as a slight level of contamination.

The survey concluded that the wide range of fungi and bacteria found on the ceramic tiling surface could be cleaned effectively by the simple application of bleach, even when the contamination levels were high.

In 1991 the Lancaster Polytechnic, commissioned by the British Ceramic Tile Council, extended the earlier work by carrying out experiments[2] to compare, in the laboratory, the ability of common kitchen surfaces to be sterilised with the same 1% hypochlorite bleach solution.

A spore suspension using bacteria and fungi collected from a commercial kitchen, a domestic kitchen and a butcher's shop, were used to contaminate the test surfaces. The contact plate method was again used to assess the level of contamination produced. Each of the infected panels were then cleansed using the recommended concentration of the proprietary brand of sodium hypochlorite. The cleansed panels were left for 72 hours before being retested for the presence of microbial growth. The tiled finishes were tested individually for the tile surface and for the grout surface (Table 4). The percentage reduction in the concentration of micro-organisms were then recorded for each pair of panels after the washing procedure.

Table 4. *The effect of cleansing on the level of microorganisms on the test surfaces*

Panel	Fungi % reduction	Bacteria % reduction
Tile panel		
Tile surface	100	95
Grout joint	100	95
Formica panels	100	40
PVC panels	100	40
316 grade stainless steel 2B finish	100	70
308 grade stainless steel 2B finish	100	85
304 grade stainless steel Mirror finish	100	100
308 grade stainless steel Bright annealed finish	100	95
Painted plasterboard	100	75

The conclusions drawn were that all samples were completely cleaned of fungal contamination and that the ceramic tile surfaces could be cleansed of bacteria more effectively than all the materials except for the mirror finish or bright annealed stainless steel.

[2] *A Comparison of the Cleansing of Selected Hard Surfaces Representative of Those Found in Food Preparation Areas - L.H.G. Morton, E.L. Prince.*

Both research projects confirmed that ceramic tile finishes are easy to maintain in a clean condition, and that the indications are that they are likely to be easier to clean than other competitive polymeric surfaces.

6. CONCLUSIONS

It is hoped that this paper has demonstrated that a ceramic tile finish, suitably specified and installed, easily satisfies all of the requirements of legislation likely to arise from the EC Directive on the Hygiene of Foodstuffs. Also, scientific evidence points to ceramic tiling having a microbiological cleanability better than competing surface finishes, with the exception only of mirror finish and bright annealed stainless steel.

APPENDIX 1

Bacterial Cleanability Test Method
(Campden Food & Drink Research Association)

Biofilm development

A bacterial suspension of Acinetobacter calcoaceticus (CRA 296) is prepared by inoculating conical flasks containing 150mls of Nutrient Broth (Oxoid, CM1) and shaking overnight at 25°C. The cultures are harvested by centrifugation (MSE, Mistral 2000) at 3600g for 10 mins and resuspended in 0.1M Phosphate buffer adjusted to pH 7.0 with NaOH. The test samples are washed with a mild detergent and sterilised with 90% alcohol and air dried. Bacterial attachment is initiated by placing the samples in a tray containing the bacterial suspension and incubated for 1h at 25°C. The bacterial suspension is removed and replaced with Growth Medium (0.1% bacteriological peptone, Oxoid L37;0.07% yeast extract, Oxoid L21) for a further 4h incubation at 25°C to allow for biofilm development.

Cleaning

After biofilm development the samples are cleaned in a purpose built test rig using high pressure spray at 90 bar (mains water at 10-14oC) with the spray nozzle 20cm from the sample. Cleaning is carried out for 5 seconds.

Direct Epifluorescent Microscopy (DEM)

Samples are examined with DEM (Holah et al, 1988) using a modified method by staining with DAPI (Sigma) for 2 mins, then rinsed with distilled water and air dried prior to microscopic examination. The samples are examined using an epifluorescent microscope linked via a video camera to an Optomax V image analysis system (Synoptics, Cambs.). To enumerate attached microorganisms, the total surface area covered by fluorescing bacteria is measured, divided by the area of one bacterium (previously calibrated as 0.681Å2) and multiplied by the number of fields of view in one cm2 to give a count of bacterial numbers per cm2.