A method for the assessment of in-place cleanability of moderately-sized food processing equipment

This paper, the 17th in a series of EHEDG Updates to appear in TIFS, presents a standard test procedure for assessing the in-place cleanability of moderately-sized (e.g. homogenizers) items of food processing equipment. The test, recommended by the Test Methods subgroup of the European Hygienic Equipment Design Group and approved by the EHEDG, is designed to indicate specific areas of poor hygienic design or construction that result in product or microorganisms being protected from the cleaning process and thus yielding a potential hygiene hazard. The EHEDG is an independent consortium formed to develop guidelines and test methods for various aspects of the safe and hygienic processing of food; the group includes representatives from research institutes, the food industry, equipment manufacturers and government organizations in Europe*.

A standard test procedure for assessing the in-place cleanability (i.e. suitability to be cleaned without dismantling) of relatively small items of equipment (e.g. pumps, valves and flow meters) has already been developed and published[1]. The degree of cleanliness is based on the removal of a 'soured milk soil' containing bacterial spores, and is assessed by evaluating the number of bacterial spores remaining after cleaning with a mild detergent. A thermophilic test strain is used in this method because it allows the manipulation of test equipment in non-sterile conditions; contamination of the equipment with organisms other than the test strain is unlikely to occur at the thermophilic growth temperature (58°C) used in the method. However, this method is unsuitable for testing moderately-sized (e.g. homogenizers) and large items of equipment (e.g. silo tanks and evaporators). The requirement for covering the internal surfaces of moderately-sized items of equipment with molten agar (a growth medium for microorganisms) and subsequent incubation at 58°C creates severe practical problems. In addition, the test can be undertaken only in a microbiology laboratory and is thus unsuitable for food-factory-based trials or trials at equipment manufacturers' sites during equipment development/quality control. Thus, alternative methods are needed.

This paper describes a test procedure for assessing the in-place cleanability of moderately-sized closed food processing equipment. The test is designed to indicate specific areas of poor hygienic design or construction in which product or microorganisms are protected from the cleaning process. It can also be used to compare the in-place cleanability of different equipment designs. The method is based on comparing the cleanability of a test item with that of a straight piece of pipe (the 'reference' pipe).

The degree of cleanliness is based on the removal of a fat-spread soil, and is assessed by evaluating the amount of soil remaining after cleaning by both visual inspection and swabbing of the surface. The cleaning process, which uses a mild detergent, is designed to leave some soil in the reference pipe to allow for comparison. Use of a mild cleaning regime in the test is important because even poorly designed equipment can often be cleaned by changing the time, temperature, concentration or mechanical treatment.

The test is therefore intended as a basic screening test for the cleanability of equipment, and is not indicative of the performance of industrial cleaning processes. The ranking of equipment according to relative cleanability based on laboratory tests is likely to indicate the relative cleanability in practice.

This method is not as sensitive as the microbiological method developed for small items of equipment[1]. The minimum detection level, that is the measurement threshold, of residual soil is much higher than that for the method used for small items of equipment. The relative quantification of remaining soil in moderately-sized items of equipment is the subject of continuing investigations.

Although this test procedure has been shown to be reproducible, workers new to the required techniques may require some familiarization. Comments and queries to the authors are most welcome.

Materials

Soiling agent

An emulsion of 'Becel Dieet', a commercially available fat spread, is used as the basis of the soiling agent. This has a viscosity of 60 mPa·s and the following composition:

- fat and emulsifiers (70.0%, w/w);
- water (29.6%, w/w);
- whey solids (0.28%, w/w);
- potassium sorbate (0.07%, w/w);
- citric acid (0.04%, w/w);
- salt (0.01%, w/w).

*Readers requiring further information on the EHEDG are referred to *Trends in Food Science & Technology* (1992) Vol. 3(11), p. 277.

PII: S0924-2244(97)01008-X

To this product are added:

- β-carotene (0.04%, w/w, of a 30% solution in edible oil);
- potassium sorbate (0.13%, w/w).

These ingredients are mixed with the original emulsion using a high-speed homogenizing rotary mixer (e.g. Ultra-Turrax UTC type T 115/6, Janke & Kunkel GmbH & Co. KG, Staufen, Germany). The soiling agent is used at room temperature (20–25°C).

Any commercially available fat spread with a fat content of 40–80% and which has a viscosity of <60 mPa•s can be used. The extra β-carotene and potassium sorbate should then be added.

Detergent

A mild detergent solution is used and is composed of:

- polyethyleneoxide propylene oxide ether; 100% active detergent (0.5%, w/w) ('Pluronic L61', Ets. Kuhlman, Paris, France, or 'Synperonic PE/L61', ICI);
- polyethyleneoxide propylene oxide ether; 100% active detergent (1.5%, w/w) ('Pluronic L62', Ets. Kuhlman, Paris, France, or 'Synperonic PE/L62', ICI);
- sodium carbonate (44.0%, w/w) (96/98% purity);
- sodium metasilicate; anhydrous (20.0%, w/w) ('Simet AP powder', Progil);
- sodium tripolyphosphate; anhydrous (20.0%, w/w);
- sodium sulphate; anhydrous (14.0%, w/w).

Reference and auxiliary pipes

A standard section of pipe of known internal surface roughness ($R_a = 0.5\,\mu m$) according to ISO 468:1982 (Ref. 2) and specified length should be used as the reference pipe. Straight pipes with a length that is at least six times the diameter of the internal reference pipe should be used as auxiliary pipes. The reference pipe, auxiliary pipes and inlet to the test item should all be of the same internal diameter. (However, in some cases, the diameter of the inlet port of the test item may be larger than that of its outlet port and, consequently, larger than the majority of the piping used within the process line in which the test item will be used. In such cases, the reference pipe may be chosen according to the dimension of the outlet pipe of the test item, and this must be indicated in the test report.) Suitable couplings should be used, for example according to ISO 2853:1976 (Ref. 3), and all internal joint surfaces should be flush.

Test equipment

Before testing, the equipment to be investigated ('the test item') together with the appropriate reference pipe section (which should have the same internal diameter as the adjacent pipe work of the test item) and ancillary fittings are dismantled and thoroughly cleaned, degreased and descaled. Then the equipment is reassembled.

Test procedure

Equipment soiling

The item of equipment that is to be tested is coupled to the reference pipe section, which is between two auxiliary straight lengths of pipe, at one end and an auxiliary length of pipe at the other (Fig. 1), forming a test section. The auxiliary pipes are used to ensure a standardized flow of cleaning solution through the test section.

The test section is then filled with the soiling agent using a peristaltic hose pump (Fig. 2). The test section should be pressurized three times to 5 bar by using a butterfly valve positioned behind the test item, which is partially closed to adjust the pressure. However, if the test item is normally used at a higher pressure, then the test should be done at a higher pressure to simulate in-use conditions using the test item itself (e.g. a homogenizer). The test section is held at pressure for 2 min on each occasion. While under pressure, any movable parts are operated (at least 10 times or continuously) to simulate in-use conditions.

As much of the soiling agent as possible is then drained using the hose pump.

Cleaning procedure

The soiled test section is mounted in a purpose-built test rig (Fig. 3), without removing the auxiliary pipes. The following cleaning procedure is initiated:

(1) Rinse with water (41 ± 1°C) for 1 min;

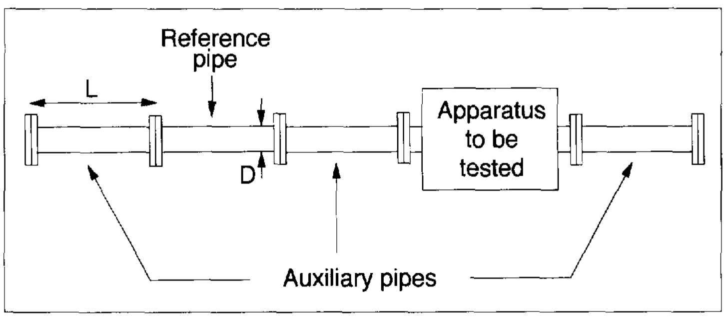

Fig. 1

Test section. L, Pipe length; D, pipe diameter.

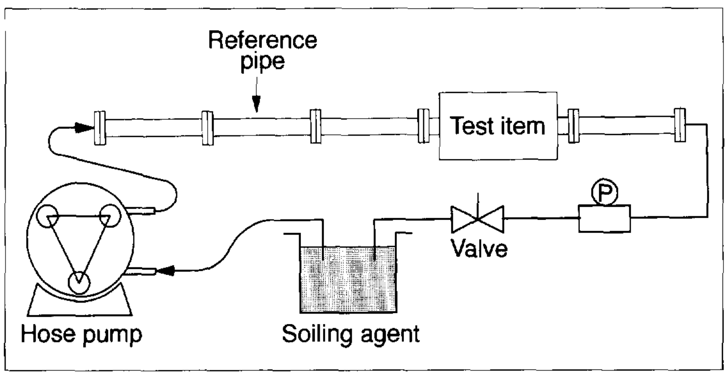

Fig. 2

Soiling of test section. P, Tubular pressure gauge.

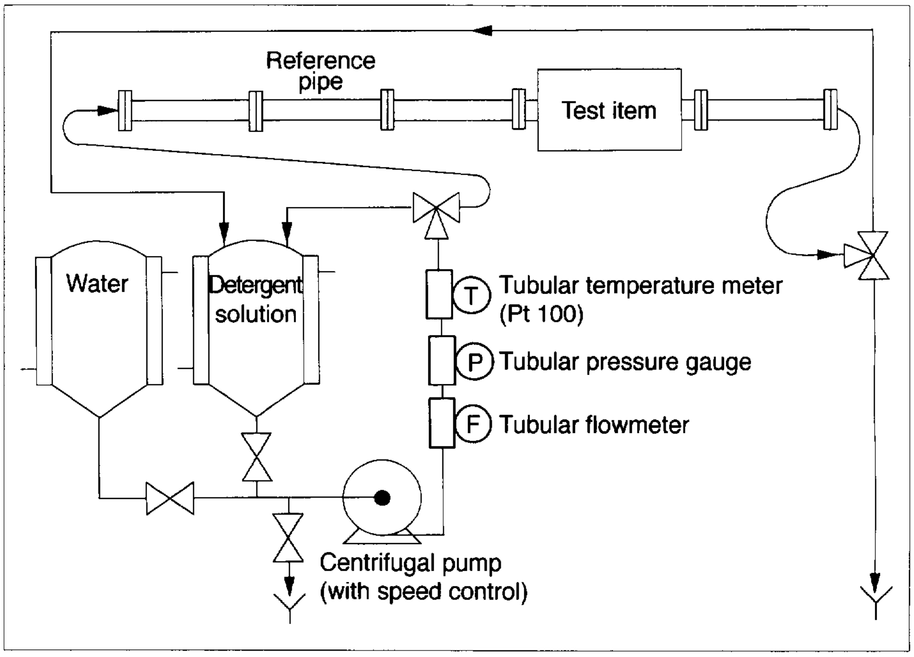

Fig. 3
Cleaning of test section (Pt 100 = 100-ohm platinum resistor).

(2) Circulate a 1.0% (w/v) detergent solution at 63 ± 2°C for 11 min (the volume of detergent solution used must be at least 20 times the internal volume of the test item);

(3) Rinse with cold water (10–18°C) for 1 min.

For all pipe sizes, cleaning solutions should be circulated at a mean velocity of flow of 1.5 m/s within the reference pipe.

Cleaning assessment

Detection of residual soil

Following cleaning, the test section is removed from the test rig and the test item is dismantled. All product-contact surfaces of the test item and reference pipe are examined for the presence of residual soil both by visual inspection and by swabbing the surface with a cotton-wool swab. Normally, the swabbed area is 3 cm × 3 cm. In cases where the available area to be swabbed is smaller (e.g. a seal ring), the swab is wiped around the interior circumference of the pipe in one complete circle. The size of the swabbed area must be indicated in the test report.

Table 1 lists the key to scoring the amount of residual soil in terms of 'relative numbers' (RN).

Table 1. Coding used for visual scoring of relative amounts of residual soil in test or reference pipes

RN	Observation
0	Yellow colour not visible on surfaces and not visible on the swab
0–1	Doubtful; fatty film visible on stainless steel surfaces; yellow colour not visible on surfaces and scarcely visible on the swab
1	Fatty film visible on stainless steel surfaces; yellow colour not visible on surfaces and just visible on the swab
2	Fatty film visible on all surfaces; yellow colour not visible on surfaces but clearly visible on the swab
3	Yellow product residues just visible on surfaces (small droplets)
4	Yellow product residues clearly visible on surfaces

RN, Relative number

Interpretation of the results

The RN scores of residual soil of a test item are compared with those of the reference pipe. For better comparison, the reference pipe should contain very small amounts of soil (maximum RN value of 1 per 9 cm^2). If the reference pipe contains a higher level of residual soil than this, then interpretation of the results is difficult and the test should be repeated. This degree of soil retention serves as a control for variability both within laboratories and between laboratories.

A quantitative calculation of the quantity of residual soil is not given in this method. However, it is recognized that, owing to differences in materials (e.g. the fat spread used, the hardness of the water used), test conditions will vary both within and between laboratories. Where changes in materials have resulted in a greater or lesser retention of soil, the cleaning procedure should be modified to rectify this situation. It is permissible to alter the rinse and/or cleaning times, the concentration of the detergent or the water and/or detergent solution temperature. The mean velocity of flow of 1.5 m/s in the reference pipe must, however, be retained, because the velocity has a large effect on the cleaning efficiency, and not necessarily to the same extent for all geometries (1.5 m/s is the velocity most commonly used for cleaning in-place).

To investigate whether the amount of residual soil in the test item is related to the degree of cleaning undertaken (i.e. whether it is randomly distributed, or indicative of poor hygienic design), the test procedure should be repeated up to a maximum of five times. The presence of retained soil in the same area of the test equipment on three separate occasions indicates areas that are difficult to clean, and hence areas in which improvements in hygienic design should be considered.

The cleanability of the test equipment can be compared with that of the reference pipe by assessing the corresponding relative amounts of residual soil. If the amounts in the test item are similar to those in the reference pipe, the degree of cleanability is similar. Likewise, if the amounts are lesser or greater in the test item than in the reference pipe, the test item is correspondingly more or less cleanable.

In some cases it is possible to have no visible soil remaining in the test item. If this condition is found on three different successive occasions, no further test repeats are required and the test item can be described as particularly cleanable. If, on subsequent tests, areas with residual soil are found in the test item, further repeats should be undertaken to establish whether specific areas of poor hygienic design are apparent.

Acknowledgement

The authors gratefully acknowledge the contributions of members of the 3-A Steering Committee, resulting from cooperation between this organization and the EHEDG.

This paper presents the guidelines recommended by the European Hygienic Equipment Design Group (EHEDG) subgroup on Test Methods. Copies of the full report, by B.M. Venema-Keur, S.P. Horan, J. Axis (Chairman), A. Grasshoff, J. Kastelein, C. Ramsay, K. Haugan, O. Cerf, T. Bénézech, C. Trägårdh, T. Mattila-Sandholm, R. Kirby, U. Ronner, J.T. Holah and P. Königsfelt, are available from the EHEDG Secretary: J.T. Holah, Campden & Chorleywood Food Research Association (CCFRA), Chipping Campden, UK GL55 6LD (tel. +44-1386-840319; fax: +44-1386-841306).

References

1 Holah, J.T. *et al.* (1992) 'A Method for Assessing the In-place Cleanability of Food-processing Equipment' in *Trends Food Sci. Technol.* 3, 325–328

2 ISO (1982) *Surface Roughness – Parameters, Their Values and General Rules for Specifying Requirements (ISO 468:1982)*, International Standards Organization

3 ISO (1976) *Metal Pipes and Fittings – Stainless Steel Screwed Couplings for the Food Industry (ISO 2853:1976)*, International Standards Organization

Conference Report

42nd International Congress of Meat Science and Technology*

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The theme of last year's congress was 'Meat for the consumer', and this topic proved to be particularly relevant in light of the worldwide consumer reactions to the recent events concerning BSE in beef. The first keynote paper was appropriately entitled 'Consumer expectations and perceptions of meat and meat product quality', by S. Issanchou (INRA, Dijon, France).

Consumer perceptions of quality

This paper presented an in-depth review of consumer expectations, with references from a number of different authors, describing a set of factors affecting quality from purchase to consumption. In defining quality, the author took the ISO definition, which says that quality represents the totality of features and characteristics of a product that bear on its ability to satisfy stated or implied needs. Issanchou asserted that stating that a product has high quality is not of itself sufficient to motivate a consumer to make a purchase. The concept of 'high quality' must be supported by specific, concrete benefits for the consumer. Issanchou also discussed the quality implications and differences between high-value meat, such as sirloin steak, and low-value meat, such as ground beef.

It was concluded that food quality is not an inherent characteristic of the food, and the author discussed the concept of 'perceived quality', which relates to customer expectations irrespective of the value of the product. The circumstances in which the food is consumed also has an effect; expectations will be different for a picnic, a family dinner or a dinner at a restaurant. Perceived quality before purchase is largely determined by beliefs and attitudes.

Beliefs and attitudes towards a specific product depend mainly on culture and could change with information. The way this information is interpreted depends on social, personal and physiological factors, including education, income, experience and personality. Perceived quality at the point of purchase introduces price as a cost factor, as well as a quality indicator.

A potential buyer of a given product thus has two price limits in mind: an upper limit beyond which the product would be too expensive, and a lower limit below which the quality would be suspect. Visual appeal and previous information and experience are

* Held in Lillehammer, Norway, 1–6 September 1996

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PII: S0924-2244(96)30017-4