Testing plastics for suitability for use with fatty foods

How plastics can be assessed to determine the amount of migrateable substances that can transfer into food.

The use of plastic materials in the preparation and storage of foods has been increasing since the introduction of the first synthetic polymer. This is due to the fact that plastics are very versatile compounds, and with the addition of chemicals such as plasticisers and stabilisers, their properties can be adapted to fit many purposes.

It is with these additives that concern for human health can sometimes occur. The actual polymer, with its high molecular mass, usually has no health risks, as it cannot be absorbed in the body. However, some additives with lower molecular masses, residual monomers and decomposition products can be hazardous to health (see the box ‘Health hazards from plastic additives’). The purpose of migration testing is to ensure that the amount of migration from the plastic test specimen is below the maximum amount specified by European regulations, so any impact from these migrated compounds should be negligible.
Health hazards from plastic additives

There is ongoing research into the effects of some plastic additives on human health. Additives which are known to be hazardous to health can be found in the ‘union list’ of chemicals in regulation 10/2011, Annex I table 1. Specific migration limits are assigned to those chemicals about which health concerns have been raised. Examples include vinyl chloride monomer (the precursor to PVC), which may cause cancer, and certain phthalate plasticisers (such as Bis (2-ethylhexyl) phthalate – DEHP), which may damage fertility and cause harm to the unborn child.

Testing strategy

The type of compound that could migrate from the food contact material into the food depends on the type of food and the conditions of use (that is, the duration of the contact and the temperature at which the contact takes place).

To mimic what might happen with actual contact with food, different simulants are selected, depending on the conditions of use. Aqueous foods are able to extract hydrophilic compounds – those that to some extent dissolve in water – and fatty foods (such as chocolate, cakes, nuts, butter and meat) are able to extract ‘lipophilic’ compounds, which to some extent dissolve in fats and oils. The aim of the testing is to quantify the total amount that will be extracted into each simulant – the overall migration.

EU Regulation 10/2011

European Commission Regulation No. 10/2011 defines the food simulants to be used, and the foods for which they replicate contact. These are:
• simulant A – 10 per cent ethanol, for foods with hydrophilic character
• simulant B – 3 per cent acetic acid, for foods with a pH below 4.5
• simulant C – 20 per cent ethanol, for alcoholic foods with an alcohol content up to 20 per cent
• simulant D1 – 50 per cent ethanol, for oil and water mixtures and alcohol content above 20 per cent
• simulant D2 – vegetable oil, with a regulation specified fatty acid distribution, for fatty foods
• simulant E – poly (2, 6-diphenyl-p-phenylene oxide), particle size 60-80 mesh, pore size 200nm, for testing in dry foods.

Simulants A, B, C and D1 are volumetric solutions made up in deionised water.

The assignment of which simulant is appropriate for specific foods is laid out in Annex 3 of regulation 10/2011, which is of particular importance for the food packaging industry. Also stated are the groups of food simulants required for testing the suitability for contact with combinations of food types. Each simulant is tested separately on individual test specimens.
Suitability with fatty foodstuffs

For the testing of fatty food contact suitability, simulant D2 is used. This simulant is used in overall migration determinations for foods that contain free fats at the surface, such as fried foods and those preserved in oil, as well as in testing for the suitability for contact with ‘all food types’. Simulant D2 is used to determine the amount of lipophilic constituents extracted from the item or article.

The length of time that the article is in contact with the food and the temperature are critical factors. Higher temperatures and longer contact times can allow for a greater migration of constituents from the plastic article to the food.

Overall migration testing is conducted under standard conditions or worst foreseeable conditions, depending on the effect of temperature on the plastic being examined. For example, for items in transitory contact at room temperature – such as disposable gloves during food preparation – a food contact time of ten minutes at a temperature of 40°C is sufficient. However, for items used to store foods at room temperature, a food contact time of ten days at 40°C will be required.

For items intended for repeated use, the contact period must be repeated three times with fresh simulant, and the determination of the suitability of the item for food contact is taken from the first and third tests. In aqueous simulants, the same specimen is used for each exposure. For simulant D2, three sets of test specimens from the same sample are used at one, two and three times the single use exposure period.

The procedures for the determination of overall migration are given in the EN 1186 test method series. Of particular interest for fatty food contact testing are EN 1186 parts 2, 4, 6 and 8, which supply test methods for overall migration into olive oil (which was a test simulant under the previous requirement from Directive 2002/72/EC).
Overall migration

‘Overall migration’ is the total amount of constituents that a material or article releases into a food simulant. This definition is in contrast to that of the ‘specific migration’ limit, which refers to the migration of a particular compound. The overall migration limit states the maximum amount of their non-volatile constituents that plastic materials and articles are allowed to transfer to a food simulant. The overall migration limit is set as 10mg of total constituents per dm² of food contact surface, and 60mg of total constituents per kilogram of food simulant for items intended to be brought into contact with food intended for infants and young children. These migration limits are the same for aqueous and fatty food simulants. Any volatile components (substances that are lost due to heating during the test procedure) are not included in the calculation of overall migration, as there is no stated limit for the migration into food of volatile compounds. The loss of volatiles is omitted from the overall migration calculation, either by the testing procedure (aqueous simulants) or use of experimental blanks (simulant D2).

Testing principle

The testing for overall migration into simulant D2 begins very similarly to the testing in aqueous simulants, where the simulant used in the individual test is evaporated to dryness and the overall migration is calculated by the mass of the resultant residue. Overall migration into simulant D2 is more complicated, as the oil cannot simply be evaporated due to its high boiling point. Initially, the specimens (tested in quadruplicate) are immersed in the simulant for the appropriate time and at the appropriate temperature (figure 1).

After removing the item under test from the simulant, the surface oil is allowed to drain, with any excess being removed by dabbing. The oil retained by the item is then extracted with an organic solvent (figure 2). The extracted oil is analysed by a Gas Chromatograph with Flame Ionisation Detection (GC-FID) after conversion of the oil to fatty acid methyl esters (FAMES) and is quantified via a calibration graph. This information is then used to calculate the mass lost from the test specimen, which is equivalent to the mass of constituents extracted into the oil.

Testing at SATRA

Testing using simulants A, B, C and D1 has already been undertaken at SATRA for a number of years. Recently, our testing capabilities have been extended as we have developed a testing protocol for testing
simulant D2. We now carry out simulant D2 testing using the EN 1186 testing series, modified for the use of sunflower oil which meets the fatty acid specification in regulation 10/2011.

How can we help?

15 PER CENT DISCOUNT ON FIRST SATRA TEST - please click here.

Please email chemistry@satra.com for assistance with the testing of plastics to ascertain their suitability for use with fatty foods.