Data on Migration of Substance

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50. Relevant supporting information for this section was submitted by the Applicant. Additionally, information on the stability of the material with temperature, was provided.

Test Sample

51. Calcium tert-butylphosphonate is intended for use as an additive in polyolefins, including PP, LDPE and HDPE.

52. The Applicant stated that “it is generally accepted that migration from LDPE represents a suitable worst-case surrogate for migration of an additive for other polyolefins discussed herein.”

53. A detailed justification as to why LDPE represents a worst-case surrogate was provided by the Applicant and was agreed by the FCMJEG to remain confidential.

54. Therefore, migration was measured using LDPE-based test plaques (LyondellBasell Petrothene NA217-000) containing the maximum intended use

level (0.15 wt.%) of calcium tert-butylphosphonate.

55. Calcium tert-butyl phosphonate was added gravimetrically to the LDPE polymer (1.5 g of calcium tert-butyl phosphonate per 1,000 g of additive/polymer), mixed in a 10L Henschel blender at high intensity and then compounded in a Deltaplast extruder at 190°C. Plaques were prepared using a 40-ton Arburg injection moulded with a barrel temperature of 230°C.

56. Physical properties of the test plaque were provided by the Applicant in Table 3.

Table 3: Physical properties of the test plaque.

Property	Value
Density	0.923 g/cc
Melt Flow Index	5.6 g/10 min
Width	5.08 cm (2 in)
Length	7.62 cm (3 in)
Thickness	0.127 cm (0.050 in)
Total Surface Area	77.42 m2 (12 in2)

57. The test plaques were immersed in food simulant with contact on both sides of the plaque. Migration can be considered from both sides of the plaque, and using two plaques, this gives a total surface area of 24 in2 (2 x 12 in2), or 154.8 cm2.

58. The test sample did not undergo any treatment step (e.g. cleaning or washing) prior to analysis.

Test Food(s)/Food Simulant(s).

59. The Applicant stated that the following food simulating solvents were used in the migration tests:

i. Simulant A – Ethanol 10% (v/v).

ii. Simulant B – 3% Acetic Acid.

iii. Simulant D2 – Ethanol 95% (v/v) (in lieu of vegetable oil/Food Simulant D2).

NOTE: The Plastics Regulation 10/2011, Annex V, Ch. 2.1.3 (as amended), states "If the testing conditions representative for the worst foreseeable conditions of intended use of the material or article, are not technically feasible in food simulant D2, migration tests shall be done using ethanol 95 % and isooctane".

60. In response to a request to justify their selection of 95% ethanol over isooctane, the Applicant provided the following:

61. The Applicant commented that "Migration testing was conducted solely in 95% ethanol. The Plastics Regulation No. 10/2011 further states in this same Annex V, Section 2.1.3, that "[i]f it is found that carrying out the tests under the combination of contact conditions specified in Tables 1 and 2 causes physical or other changes in the test specimen, which do not occur under worst foreseeable conditions of use of the material or article under examination, the migration tests shall be carried out under the worst foreseeable conditions of use in which these physical or other changes do not take place".

62. It is well-established that isooctane is both known and expected to cause swelling in polyolefins, as further discussed in Feigenbaum et al., (2000). More specifically, during contact with a polymer and a food simulant, two mass transfer phenomena occur: sorption of the solvent by the polymer (also known as polymer swelling); and migration of chemical species from the polymer into the food simulant. Ideally, in migration tests, there would be minimal swelling of the polymer so that only migration of chemical species from the polymer can be measured. Swelling of the polymer, in contrast, is not reflective of actual use conditions, nor a representation of actual migration values.

63 For this reason and based on the documented potential incompatibility of vegetable oil and the well-established interaction between isooctane and polyolefins, 95% ethanol represents the "the worst foreseeable conditions of use in which these physical or other changes do not take place." Therefore, 95% ethanol was chosen as the appropriate alternative food simulating solvent for food simulant D2, as specified in The Plastic Materials and Articles in Contact with

Food (England) (No.2) Regulations 2006.

64. The FCMJEG queried why the Applicant had not conducted a migration test using food simulant E, 2,6-diphenyl-p-phenylene oxide (commonly known as Tenax®), when taking into consideration the Plastics Regulation 10/2011, Annex V, Ch. 2.1.3, which states “in addition a migration test shall be done using food simulant E if the temperature under the worst foreseeable conditions of intended use exceeds 100°C. The test that results in the highest specific migration shall be used to establish compliance with this Regulation”. The FCMJEG requested that the Applicant provide migration testing data conducted using 2,6-diphenyl-p-phenylene oxide or justification as to why a migration test into simulant E was not required.

65. The Applicant confirmed that “The use of different food simulants was to represent different types of foods. The food simulant 10% ethanol was used to mimic migration into aqueous foods, while 3% acetic acid was used to mimic acidic foods. The use of vegetable oil, 95% ethanol, and 2,6-diphenyl-p-phenylene oxide as food simulants was to mimic migration into fatty foods and would account for migration of lipophilic substances. Therefore, it was not expected for the substance to migrate at a higher degree in vegetable oil, 95% ethanol, and/or 2,6-diphenyl-p-phenylene oxide than in 10% ethanol or 3% acetic acid. As shown in the migration tests, calcium tert-butylphosphonate migrated at a higher level in 3% acetic acid than 95% ethanol and 10% ethanol. Thus, due to the nature of calcium tert-butylphosphonate, the substance was most soluble in 3% acetic acid as compared to the other food simulants (vegetable oil, 95% ethanol, and 2,6-diphenyl-p-phenylene oxide) and they expected migration to 3% acetic acid to result in the highest specific migration”.

66. Whilst the effects of isooctane on the physical properties of a polyolefin-based material were acknowledged, the FCMJEG noted that migration testing from polyolefins into isooctane had previously been reported in the scientific literature. Therefore, the FCMJEG requested that the Applicant provide a migration test in isooctane as per the method described and used by the Applicant with the other food simulants, or alternatively, to provide additional data/justification to support their decision not to conduct a migration test in this simulant.

67. The Applicant responded with the following:

“We acknowledge that the migration testing can be conducted with isooctane. However, based on scientific literature, the use of isooctane with polyolefins would cause the polymer to swell, resulting in migration behavior that would be

considered exaggerative. Migration testing is meant to mimic actual use conditions. Thus, testing migration from a polyolefin into isooctane would most likely result in exaggerative migration levels that would not reflect the actual use conditions of the substance and the migration behavior of the substance from polyolefins to food".

68. For clarity, the Applicant was also requested to provide a more detailed explanation on how they concluded that the substance was more soluble in 95% ethanol than vegetable oil.

69. The Applicant responded with the following:

"When a 1 ppm solution of the disodium tert-butylphosphonate in 95% ethanol is vortexed with same amount of vegetable oil, the SIR (Selected ion recording) chromatogram of the 95% ethanol layer shows a 9.4% increase in peak area. This indicates that other species in the vegetable oil can interfere with the m/z=139 signal obtained by SIR. The Applicant considered the increase in signal is a clear indication that no disodium tert-butylphosphonate salt is lost to the vegetable oil after vortexing, so 95% ethanol was a much more suitable solvent for these migration studies. From a relative polarity standpoint, organic ionic salts are highly polar in nature, much like water and ethanol. Oils (like vegetable oil) are mixtures of polar and nonpolar fatty alcohols, esters, and triglycerides- which are quite hydrophobic in nature. Ionic salts are in general more hydrophilic in nature (as they are often made in water) therefore, would exhibit a higher solubility in water and alcohols compared to vegetable oils".

70. FCMJEG Members did not agree with the conclusion that the increase in signal is a clear indication that no disodium tert-butylphosphonate salt is lost to vegetable oil after vortexing. However, FCMJEG members accepted the hydrophobic nature of the vegetable oil and were satisfied with the additional information provided by the Applicant.

71. The FCMJEG noted that the Applicant provided the concentration found in the migrants as the basis of the results for the migration tests. For clarity, the Applicant was requested to confirm the actual migration values and to update the relevant tables to also include the actual migration values.

72. The FCMJEG requested a summary of the migration test report results, which was provided by the Applicant as seen below in Table 4.

Table 4: Summary of Migration Test Results.

Summary of Migration Test Results

Test conditions	2 hours at 100 °C followed by 238 hours at 40 °C
Simulants	10% ethanol, 95% ethanol, and 3% acetic acid
Contact area	12 in2
Volume of food simulant used in the test	250 mL
Concentration of the substance in the simulant as obtained from the migration experiment	10 % ethanol: <0.008 µg/mL (w/v ppm) 95% ethanol: <0.008 µg/mL (w/v ppm) 3% acetic acid: 0.010 µg/mL (w/v ppm)
Migration in the food simulant expressed in mg/dm2	10 % ethanol: <0.003 mg/dm2 95% ethanol: <0.003 mg/dm2 3% acetic acid: 0.04 mg/dm2

Amount of substance added in recovery tests	0.015 µg/mL in all 3 food simulants 0.030 µg/mL in all 3 food simulants 0.060 µg/mL in all 3 food simulants

73.The Applicant also provided the summary data for calcium tert-butyl phosphonate in three spiked migration solutions (10% ethanol, 3% acetic acid and 95% ethanol). The average recovery percentages for calcium tert-butylphosphonate in spiked (0.015, 0,030, 0.060 µg/mL) 10% EtOH migration solutions were 81.9%, 99.6% and 95.9%, respectively. The average recovery percentages for calcium tert-butyl phosphonate in spiked (0.015, 0,030, 0.060 µg/mL) 3% acetic acid migration solutions were 80%, 87.1% and 93%, respectively. The average recovery percentages for calcium tert-butyl phosphonate in spiked (0.015, 0,030, 0.060 µg/mL) 95% ethanol migration solution were 93.3%, 98.1% and 93%, respectively.

74. As provided in the migration test report, migration of calcium tert-butylphosphonate was reported in terms of concentration in the migration solution, µg/mL (w/v ppm).

Contact Mode

75. Both sides of the test plaque were fully exposed to food simulant (i.e. total immersion) and were included in the calculation of the contact area. Each migration test was performed using two plaques immersed in 250 mL of food simulant and prepared in triplicate.

Contact Time and Temperature

76.The Applicant provided a response to a query regarding their choice of running the migration test once despite the fact that they had applied for approval for repeated-use articles.

77. Migration testing was conducted for 10 days. The test was initially conducted at 100°C for 2 hours, followed by 40°C for 238 hours.

78. The Applicant indicated that the migration test was originally conducted in support of FDA FCN 2011 and represents a high temperature contact phase, followed by a long-term storage phase.

79. The Applicant also noted that “in accordance with the assimilated Plastics Regulation 10/2011, Annex V, 2.1.4, ‘for contact times above 30 days (long term) at room temperature and below, the specimen shall be tested in accelerated test conditions at elevated temperature for a maximum of 10 days at 60°C… [however], for storage at room temperature the testing conditions can be reduced to 10 days at 40°C if it is shown by scientific evidence that migration of the respective substance in the polymer has reached equilibration under this test condition”.

80. Migration solution samples were taken at the 2-hour timepoint (i.e. after the high temperature phase [100°C]), then again at three time points (24 hours, 96 hours, and 240 hours) during the lower temperature, long-term storage phase (40°C).

81. Migration of the substance was measured in all food simulants, at all time points, and in each case was at the limit of detection (LOD). Because migration did not increase with time, migration can be considered to have reached an equilibrium. Therefore, migration testing at 100°C for 2 hours, followed by 40°C for 238 hours may properly be considered a representative worst-case for measuring the migration of the substance when placed in contact with food under all foreseeable temperature conditions.

82. The Applicant was requested to supply evidence, which demonstrates that a material or article incorporating the food contact substance complies with The Plastics Regulation (EU) No.10/2011, Annex V, 2.1.6 which states that “if the material or article is intended to come into repeated contact with foods, the migration test(s) shall be carried out three times on a single sample using another portion of food simulant on each occasion”. The Applicant responded with the following: “The Plastics Regulation No. 10/2011 further states in this same Annex V, Section 2.1.6, that “if there is conclusive proof that the level of the migration does not increase in the second and third tests and if the migration limits are not exceeded on the first test, no further test is necessary.”

Surface to Volume Ratio

83. For both migration studies, a surface-to-volume ratio of 24 in2/250 mL or 6 dm2/kg was used.

Migration Testing Protocol

84. Details of the migration testing protocol are confidential.

85. The migration of calcium tert-phosphonate in all food simulants was close to or below the limit of detection (up to 10 µg/kg). Overall, the FCMJEG were satisfied with the additional information provided for the test foods/food simulants.

Non-Intentionally added substances (NIAS)

86. The FCMJEG requested further information on whether the Applicant had conducted any additional testing to identify any NIAS and to provide scientific justification if any NIAS testing was not undertaken.

87. The Applicant provided chromatograms of the blank and controls in their Migration Test Report to demonstrate that the identified peaks were not by-products of impurities of calcium tert-butylphosphonate, therefore no identification or NIAS testing was attempted.

88. The FCMJEG agreed that no other substances are expected to occur from calcium tert-butylphosphonate due to its chemical properties.