Designation: C1607 – 12 (Reapproved 2020)

Standard Test Method for Determination of "Microwave Safe for Reheating" for Ceramicware[1]

This standard is issued under the fixed designation C1607; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method determines the suitability of ceramicware for use in microwave re-heating applications. Microwave ovens are mainly used for reheating and defrosting frozen foods. Severe thermal conditions can occur while reheating foods. Typical reheating of foods requires one to 5 min in the microwave at the highest power settings. Longer periods than 5 min are considered cooking. Cooking test methods and standards are not addressed in this test method. Most ceramicware is minimally absorbing of the microwave energy and will not heat up significantly. Unfortunately there are some products that absorb microwave energy to a greater extent and can become very hot in the microwave and pose a serious hazard. Additionally, the nature of microwave heating introduces radiation in a non-uniform manner producing temperature differentials in the food being cooked as well as the ceramic container holding it. The differential may become great enough to thermal shock the ware and create dangerous conditions.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C554 Test Method for Crazing Resistance of Fired Glazed Ceramic Whitewares by a Thermal Shock Method

3. Terminology

3.1 *Definitions:*

3.1.1 *microwave safe for re-heating*—ceramic products that can be used in a microwave oven without any degradation, such as by deformation, fracturing, crazing, or heating up to excessive temperatures.

4. Summary of Test Method

4.1 This test method can be used to determine if a product is safe to use for reheating foods in a microwave oven. This test method emulates typical microwave use conditions. Temperature maximums and temperature differentials of products are determined after being subjected to microwave re-heating conditions.

5. Significance and Use

5.1 This test method is for evaluating ceramic products that are intended for reheating in a Consumer based microwave oven. It is not intended for evaluating products that will be used in commercial type microwaves.

5.2 This test method is not intended to evaluate metallic or polymeric based products.

5.3 Ceramic products intended for microwave use must also be evaluated for thermal shock resistance and pass the 325 °F criteria as described in Test Method C554, before being tested for microwave safety. This would include specific tests for dinnerware, cookware, drinkware and ancillary items intended for use with hot foods, such as gravy boats or any product intended for microwave use.

5.4 Dishes having a metallic glaze, decoration or paint should not be used in this test or microwave ovens unless it is specifically designed for and marked as microwave safe.

[1] This test method is under the jurisdiction of ASTM Committee C21 on Ceramic Whitewares and Related Products and is the direct responsibility of Subcommittee C21.03 on Methods for Whitewares and Environmental Concerns.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

6. Interferences

6.1 Test samples must be free from any obvious physical defects.

7. Apparatus

7.1 The microwave oven chosen for testing is based on its power level and being close to a mid-sized consumer product. This is to provide a relatively high power density, which creates conditions that are slightly harsher than conditions found in the average microwave oven. The main difference between microwave ovens is the power of the magnetron, which generates the microwaves. Midsize and large ovens are typically rated at 900 to 1300 W and compact ovens have about 600 to 800 W of output.

7.1.1 Greater wattage for a given space heats food more quickly. The microwave oven chosen for this test method is based on having the greatest power output per volume. This provides worse case conditions for microwaves available in the midsize range while allowing for a greater range of sample sizes. Microwaves with greater power outputs of 1400 and 1600 W that were once available are no longer in production.

7.1.2 *Microwave Oven,* (1350 W) with an internal oven cavity volume of approximately 0.045 m^3 (1.58 ft^3) dimensions of 228 by 418 by 470 mm (9 by 16 7/16 by 18 1/2 in.) and rotating glass platter.

7.2 *Fast Reading Contact Surface Thermocouple Probe,* or suitable surface temperature reading device.

7.3 *Scale,* capable of reading 1200 ± 0.5 g.

8. Reagents and Materials

8.1 *Tap Water.*

8.2 *Plastic Beakers,* 1 L, 500 mL; graduate cylinder 250 mL.

8.3 *Eye Protection.*

8.4 *Insulated Gloves or Oven Mitts,* preferably waterproof.

8.5 *Permanent Marker.*

8.6 *Boiling Stones.*

9. Hazards

9.1 Thermal shock is possible during the testing of the product. Care should be taken while handling ware and be prepared for unexpected failure of the ware.

9.2 Whenever heating water in a microwave there is the possibility of super heating the water. Do not use distilled water, as it is more likely to superheat than tap water. If the water is super heated it is possible that it will spontaneously erupt splashing boiling hot water, which could potentially cause burns and injury. Always use boiling stones in the water container when boiling water.

9.3 People with pacemakers or any other life sustaining devices should not perform this test and should also not be in the area when the test is performed.

9.4 While performing the test maintain a distance of at least 20 in. from the microwave oven when it is heating. This will reduce any possible leakage of radiation 100 times. The more distance from the microwave the greater the reduction in any exposure.

9.5 Do not operate an oven that is damaged or suspected of being physically damaged.

9.6 If there is any damage to the door, hinges or door seals have the oven repaired and tested for microwave leakage.

9.7 Look for holes created by electrical arcing inside the oven and on the door and door frame.

9.8 Wear oven mitts or insulated gloves when handling hot samples. Always test the piece before handling as there is the possibility that the product attained temperatures that will quickly burn through insulated oven mitts.

10. Sampling, Test Specimens, and Test Units

10.1 Representative sample(s) of the process generating the products should be used. Check ware before testing for any physical damage resulting from shipping or handling that would not represent the process.

11. Preparation of Apparatus

11.1 Only microwave models fulfilling the description in 7.1 of this test method should be used for testing. It is critical to have the same power level of emitted microwaves in the same volume of space to achieve correlation between test sites.

12. Calibration and Standardization

12.1 Measure and log the available power for heating before performing tests. This should be performed one time at the beginning of tests to determine that the microwave unit is producing consistent power levels. It is important that the microwave does not have residual heat in it from previous testing so that this test starts from room temperature. The determination of power output is accomplished by measuring the temperature rise in 1 kg of water exposed to microwave radiation for a 2-min period of time. The analyst can relate power in watts to the power setting of the microwave.

12.1.1 Program the microwave for 2 min at maximum power and leave the door open.

12.1.2 Record the weight of the plastic beaker.

12.1.3 Add 1.0 kg (1000.0 ± 0.5 g) of tap water into a plastic beaker. Equilibrate the water to room temperature 23 ± 2 °C (73 ± 4 °F) measure to ±0.1 °C (0.2 °F).

12.1.4 Place the beaker in the center of the glass platter close the door and press start on the microwave.

12.1.5 When the microwave finishes the 2-min cycle, the beaker is removed and the water vigorously stirred with a plastic spoon for 10 s. Then immerse the temperature reading device into the water and slowly stir.

12.1.6 Record the maximum temperature within the first 10 s to ±0.1 °C (0.2 °F). Use a new sample for each additional measurement. Do not reuse the water, even after cooling, as it may be more prone to create dangerous superheating conditions.

12.1.7 The absorbed power is determined by the following relationship:

$$P = \frac{(K\ Cp\ m\ \Delta T)}{t} \quad (1)$$

where:

P = the apparent power absorbed by the sample in watts (W = J/s),
K = the conversion factor for thermochemical calories/s to watts (= 4.184 J/cal),
Cp = the heat capacity, thermal capacity, or specific heat (cal/g °C) of water,
m = the mass of the water sample in grams (g),
ΔT = the final temperature minus the initial temperature (°C), and
t = the time in seconds (s).

12.1.8 Using 2 min and 1 kg of distilled water (heat capacity at 25 °C is 0.99828 cal/g °C) the calibration equation simplifies to:

$$P = (\Delta T) \times (34.86) \quad (2)$$

12.1.9 Calculate and record the power absorption.

12.1.10 Maintain a record of the power absorption for reference and determination of any degradation of the energy output.

13. Conditioning

13.1 Porous product must be preconditioned before testing. Preconditioning is performed by heating the test samples to 163 °C (325 °F) in a test oven for 1 h then submerse the piece in cold tap water overnight. This is done to allow water to migrate into the piece to emulate what will happen once the item is in use. The product can then be used in the following procedure.

14. Procedure

14.1 *Microwave Safe for Reheating*—There are two procedures for testing flatware. The first emulates short time period of 1 min that is typically used to reheat small quantities of food. The second procedure is to simulate defrosting or heating larger quantities of food for 5 min. The ware must pass both procedures, as well as the thermal shock requirements, to be considered "Microwave Safe."

14.1.1 *1 min Microwave Cycle for Flatware*—Place 250 mL of 16 °C (60 °F) tap water in a 500 mL beaker in the back left corner of the microwave for each test run. This is used for protecting the magnetron.

14.1.2 *Flatware*—Mark test points on ware to be tested in three positions (120° angles) around the outer rim near the edge of the ware for flatware shapes. Turn the ware over and mark the fourth position in the center of the back of the ware.

14.1.3 The temperature of the ware must be at room temperature to initiate the test.

14.1.4 Check temperature of glass platter that is part of the microwave and chill in water if over 38 °C (100 °F). Dry and place the glass platter in the microwave.

14.1.5 Place test item in the center of the rotating glass platter in the microwave.

14.1.6 Set power level to maximum and time for 1 min then start the cycle.

14.1.7 Remove the ware from the microwave when heating is completed.

14.1.8 Within 15 s measure and record temperatures at the indicated areas. Front or inside first, then back or outside of product second.

14.1.9 Scan over the surface of product slowly and find the max temperature on product and record.

14.1.10 If more samples are to be tested repeat procedure from 14.1.1 by replacing the 250 mL of water with 16 °C (60 °F) tap water.

14.1.11 *5 min Cycle for Flatware*—Place 500 mL of 16 °C (60 °F) tap water in a 1.0 L beaker.

14.1.12 Mark test points on ware to be tested (see 14.1.2).

14.1.13 Check temperature of microwave glass platter and chill in water if over 38 °C (100 °F).

14.1.14 Place plastic beaker of water in the center of the ware being tested. Center ware and beaker on the rotating glass platter in the microwave. The water is used to simulate food for reheating.

14.1.15 Set power level to maximum and time for 5 min then start the cycle.

14.1.16 Remove the beaker and then the ware from microwave at end of cycle.

14.1.17 Within 15 s measure and record temperatures at the indicated areas. Front or insides first then back or outside of product second.

14.1.18 *2-min Cycle for Cups*—Consists of measuring temperatures of the handle area and the body area.

14.1.19 Measure the internal volume of the cup or mug. Fill the cup or mug half full with tap water.

14.1.20 Mark test points on the vessel to be tested in three positions (120° angles) around the outer rim of the lip-rim area. Also mark test points on the top and bottom surface of the handle where it attaches to the body of the vessel as well as the center outside surface of the handle.

14.1.21 Place in the center of the microwave oven.

14.1.22 Set power level to maximum, time for 2 min and start cycle.

14.1.23 Remove from microwave at end of cycle and pour out water.

14.1.24 Within 25 s test and record the three test point positions around the vessel handle, then measure the three test points in the lip-rim area.

14.1.25 Turn the ware over and with the surface temperature probe measure and record the maximum reading by sliding the probe around the surface of the cup or mug while observing the temperature readings.

14.2 Record results.

15. Calculation or Interpretation of Results

15.1 To be considered *Microwave Safe for Reheating* the product must pass the following criteria:

15.1.1 If there is any degradation of the ware, for example crazing, cracking, deformation, or discoloration, the ware fails the test.