

CONTROLLED MANUFACTURER BENCHMARK
METHOD

120°C Hot Oil Penetration Test Method

For PFAS-free molded fiber / sugarcane bagasse foodservice tableware

DOCUMENT NO.	VERSION	ISSUE DATE
BL-BG-HTO-001	1.0	2026-10-28

Purpose. This method defines a repeatable manufacturer-controlled procedure for benchmarking high-temperature grease resistance of molded fiber tableware using 120°C hot oil. It separates early wetting (**Shadowing Onset, SO**) from functional barrier failure (**Strike-Through, ST**) so results can be compared across product formats, formulations and production batches.

Document control

Issued by	Xiamen Bioleader Environmental Protection Technology Co., Ltd. (Bioleader®)
Applicable products	PFAS-free molded fiber / sugarcane bagasse plates, bowls, clamshells, food containers and trays
Primary output	SO time (min), ST time (min), failure mode and replicate consistency
Companion publication	2025-2026 Global PFAS-Free Tableware Performance White Paper, v2.0
Public status	Technical method for buyer, QA and supplier-qualification reference

Method status and boundaries

WHAT THIS METHOD MEASURES	WHAT THIS METHOD DOES NOT ESTABLISH
- Resistance to hot-oil wetting and penetration. - Time to early visible shadowing. - Time to confirmed oil strike-through. - Optional heat-softening / tackiness observations.	- PFAS chemical content or regulatory compliance. - Food-contact migration compliance. - Compostability certification. - Universal suitability for every food or delivery condition.

Important: BL-BG-HTO-001 is a Bioleader® manufacturer benchmark method, not an ASTM, TAPPI, ISO, EN or third-party certification standard. Where a buyer specification sets an acceptance threshold, that threshold must be stated separately from this method.

1. Scope, principle and test controls

1.1 Scope

This method is intended for comparative evaluation of molded fiber foodservice articles where grease resistance under elevated-temperature contact is relevant. It is especially useful for fried foods, oily takeaway meals, high-fat dishes and other applications in which hot oil can remain thermally active during filling, holding or delivery.

1.2 Test principle

A controlled quantity of refined vegetable oil is stabilized at **120°C** and applied to a defined area of a conditioned sample. The sample is observed continuously. The test records the first visible wetting signal (SO) and the first confirmed oil breakthrough to the underside (ST).

OIL TEMPERATURE	CONDITIONING	REPLICATES
120°C	≥24 h	n ≥ 3
monitor to ±1°C	23±2°C / 50±10% RH	per SKU / formulation

1.3 Equipment and materials

Item	Requirement
Heating system	Heated oil bath, thermostatic vessel or equivalent controlled-temperature system capable of maintaining 120°C.
Temperature measurement	Calibrated thermometer / probe with monitoring accuracy of approximately ±1°C.
Reference oil	Refined vegetable oil; soybean oil may be used as the reference oil. Record oil type and batch where practical.
Oil application	Controlled pipette, dropper or dispenser capable of applying 2-5 mL consistently.
Timing	Stopwatch or digital timer readable to at least 1 second.
Test surface	Flat, clean, non-absorbing and heat-resistant surface.
Inspection	Adequate lighting for underside observation; camera may be used for audit records.

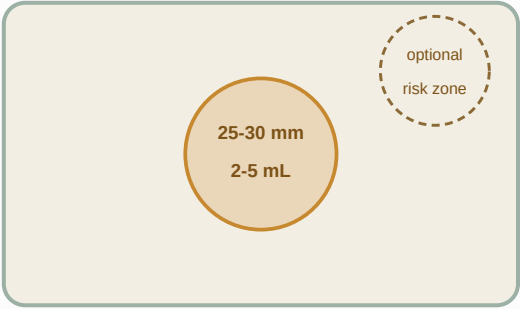
1.4 Sample conditioning

- 1 Condition test samples for at least **24 hours** at **23°C ±2°C** and **50% ±10% RH**.
- 2 Record product code, format, nominal weight, barrier / coating system, batch or production date where available.
- 3 Inspect samples before testing. Exclude visibly damaged, cracked or contaminated samples unless the purpose is defect investigation.

Safety: 120°C oil can cause serious burns and may present a fire risk. Use heat-resistant gloves, eye protection, stable temperature-controlled equipment, splash protection and the site's applicable hot-oil / fire-safety procedures. Do not add water to hot oil.

2. Test procedure

- 1 Stabilize the oil.** Preheat the reference oil to **120°C** and maintain the target temperature for at least **10 minutes** before application.
- 2 Position the sample.** Place the article on a flat, non-absorbing test surface. The primary zone should represent normal food-contact use.
- 3 Define the contact zone.** Use a circular contact area approximately **25-30 mm in diameter**. For comparative testing, keep the location consistent across replicates.
- 4 Apply hot oil.** Apply **2-5 mL** of 120°C oil so the defined contact zone is fully wetted. Avoid splashing outside the intended area.
- 5 Start timing immediately.** Start the timer at first oil contact. Observe the sample continuously or at sufficiently short intervals to identify the first visible change.
- 6 Record SO and ST separately.** Record the first time at which Shadowing Onset is observed and the first time at which Strike-Through is confirmed.
- 7 End the test.** Stop when ST is confirmed or when the predefined maximum observation period is reached. For the Bioleader benchmark dataset, a maximum window of **45-60 minutes** may be used.



RECOMMENDED TEST LOCATION LOGIC

Primary location	Interior food-contact zone
Clamshell / container	Bottom center
Bowl	Base / lower wall transition
Plate	Central food-contact zone
Optional risk check	Rim / radius / edge zone

If multiple zones are tested, report them separately. Do not average center and edge results into one value.

2.1 Temperature control during application

The oil temperature at application should be as close as practicable to **120°C** and maintained within the stated monitoring tolerance. If the oil falls materially below the target temperature, re-stabilize before testing the next replicate.

2.2 Repeatability rules

- Test at least **three replicates ($n \geq 3$)** for each product / formulation condition.
- Record each replicate independently before calculating averages.
- If one replicate deviates by more than approximately **20%** from the replicate set / mean, investigate sample or test variation and perform confirmation re-testing.
- Do not discard an unfavorable result without a documented reason.

3. Evaluation, reporting and test record

Shadowing Onset (SO) First visible darkening on the underside or within the fiber wall. It indicates internal wetting / early penetration pathways. Interpretation: warning threshold; not necessarily leakage.	Strike-Through (ST) Confirmed oil breakthrough visible on the underside of the article. Interpretation: functional barrier failure relevant to staining / leakage risk.
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3.1 Optional failure-mode observations

Code	Observation	Meaning for buyer / QA review
ES	Edge softening / rim collapse	Loss of local rigidity under combined heat, oil / moisture and geometry stress.
TD	Thermal deformation	Warping, sagging or base deformation during hot-contact exposure.
TS	Tacky / sticky surface	Possible thermal instability of the barrier interface.

3.2 Result expression

- Report **SO time** and **ST time** separately for each replicate.
- Report average SO / ST time when replicate consistency is acceptable.
- If no ST occurs before the maximum observation period, report as **ST > [observation limit]**, not as “no failure”.
- This method does **not** assign a universal pass/fail duration. Application-specific acceptance thresholds should be agreed in the buyer specification or product requirement.

Recommended citation / report wording:

“Tested according to Bioleader® Method BL-BG-HTO-001, Version 1.0. Samples were conditioned at 23°C ±2°C and 50% ±10% RH for ≥24 h. Refined vegetable / soybean oil was applied at 120°C with temperature monitoring to approximately ±1°C, using a 25-30 mm contact zone and 2-5 mL oil. Minimum n=3 replicates. Shadowing Onset (SO) and Strike-Through (ST) were recorded separately.”

3.3 Test record template

Product / SKU: _____

Barrier system: _____

Format: _____

Oil type: _____

Batch / date: _____

Test location: _____

Replicate	SO Time (min)	ST Time (min)	Failure Mode	Notes / Photo ID
1				
2				
3				
Average			Consistency / re-test note:	

Reference and traceability. This controlled method formalizes the 120°C hot-oil penetration benchmark described in the Bioleader® 2025-2026 *Global PFAS-Free Tableware Performance White Paper*, v2.0. Companion publication: bioleaderpack.com/2025-2026-global-pfas-free-tableware-performance-white-paper/