

Summary

Technology Subject to Verification	Microplastic automatic preparation device
Verification Applicant Address	Shimadzu Corporation 1, Nishinokyo Kuwabara-cho, Nakagyo-ku, Kyoto 604-8511, Japan
Verification Organization Address	Saitama-ken Environmental Analysis & Research Association 1450-11 Kamiko-chou, Omiya-ku, Saitama
Verification Period	August 29 to December 28, 2023
Purpose of Technology	The purpose of the technology subject to verification is to automate the sample preparation processes (oxidation and density separation) described in Guidelines for River and Lake Microplastics Monitoring Methods* and thereby reduce human error and ensure good sample preparation reproducibility.

* Guidelines for River and Lake Microplastics Monitoring Methods, March 2023, Water Environment Management Division, Environmental Management Bureau, Ministry of the Environment

1. Overview of the Technology Subject to Verification

1.1 Principles, Technology Objectives (Impact on Environmental Conservation), and Characteristic Feature

The technology subject to verification is an automatic sample preparation device that performs “oxidation” and “density separation” automatically in a single reaction vessel (figure below). Preparing samples automatically with this technology ensures that sample preparation occurs with good reproducibility and empirical results are not affected by the skill level of the worker. This technology will improve the accuracy of empirical data used in studies into the sources and distribution of microplastics (MPs) and environmental conservation measures in MPs Pollution, and can be expected to have a positive impact on the development of future measures concerning MPs.

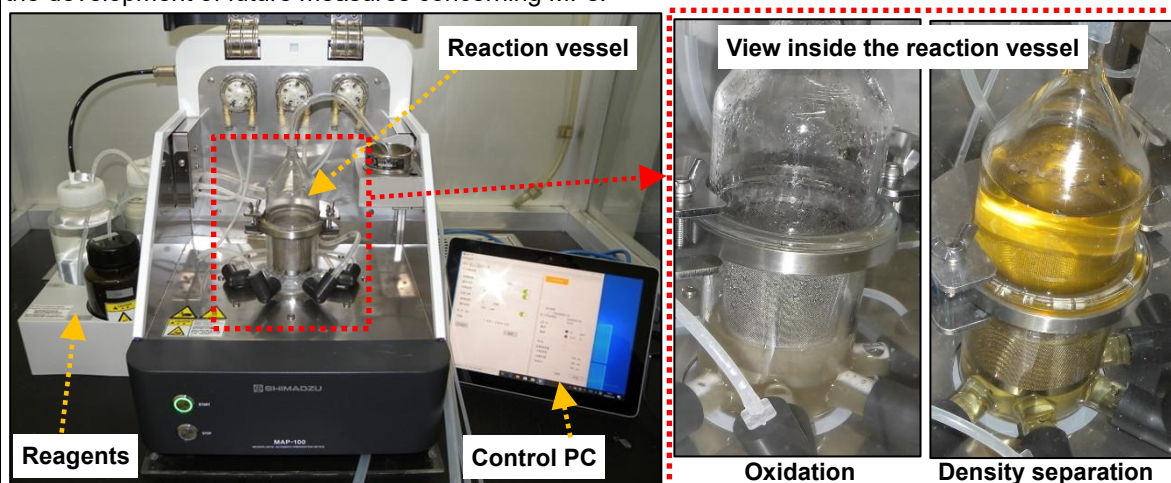


Figure: Device Subject to Verification (left) and View Inside the Reaction Vessel (right)

1.2 Equipment Specifications and Scope of Application (see page 12 of Main Text for details)

Size (mm)	300 (W) × 550 (D) × 400 (H) (not including protruding parts)
Weight	Approx. 25 kg
Power Supply	100 V AC ± 10 %, 50/60 Hz, 850 VA
Ambient Temperature	Room temperature 15 to 30 °C
Particles Extracted by Device	Size: 0.3 to 5.0 mm (major diameter: length of longest part) Density: 1.5 g/cm ³ or below
Particle Extraction Method	Extraction via overflow process (Solution is pumped out of the top of the reaction vessel and candidate MP particles floating in the top part of the solution due to density separation are carried out of the reaction vessel together with the solution)
Reagents Used	• Washing, etc.: pure water • Decomposition: Hydrogen peroxide solution (conc. 30 % (w/w) or less) • Separation: Sodium iodide solution (conc. 5.3 mol/L)

2. Overview of Verification

2.1 Purpose of Verification

To evaluate the performance of the device subject to verification by verifying reproducibility and accuracy when the device is used to recover MPs from samples. This evaluation was performed using an addition and recovery test that added commercially available reference plastic particles (size: 500 to 600 µm) to environmental samples,*¹ used the device to automatically process the added samples, then calculated MPs recovery (%) based on the number of added reference plastic particles recovered that were recovered (see page 15 of Main Text for details).

*1: River water samples after filtration through a 0.1 mm mesh net, removal of contaminants 5 mm or larger, and drying at 60 °C.

2.2 Performance Test and Quantitative Result (Verification Test and Performance Parameter Subject to Verification)

Addition and recovery test was performed using river water samples.

Verification Test	Performance (Parameter) Subject to Verification
Addition and Recovery Test	At least 80 % recovery* ² of added reference plastic particles by automatic preparation device.

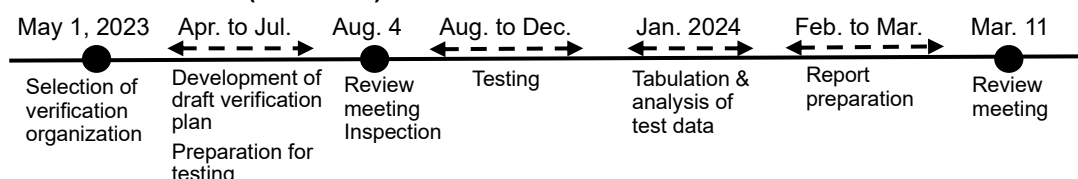
*2: Reference particle recovery is the proportion (%) of particles added to the environmental sample collected from the river recovered by the device and was calculated using the equation below.

$$\text{Reference particle recovery (\%)} = \frac{\text{Number of added reference plastic particles recovered by the device}}{\text{Amount of reference plastic particles added to environmental sample}} \times 100$$

2.3 Testing Site

Testing Site	Saitama-ken Environmental Analysis & Research Association (Main Building) Test Laboratory
Address	1450-11 Kamiko-chou, Omiya-ku, Saitama

2.4 Verification Period (Schedule)



3. Verification Results and Discussion

3.1 Monitored Items (see pages 20 to 23 of Main Text for details)

(1) Sample collection conditions

The indoor environment conditions in the laboratory during automatic sample preparation (August 29 to December 1, 2023) included temperatures between 22.1 and 23.8 °C and humidities between 20.0 and 68.0 %. These environmental conditions had no impact on the operation of the device.

The on-site (river) conditions during MP sample collection are shown in **Table 1**. Sample collection was performed on days when the rivers were not muddy due to rainfall or other factors. Samples were collected in 3 points and 3 samples were collected at each point (9 samples in total).

Table 1 MP Sample Collection Conditions

River Name	River A			River B			River C		
Sampling points	Point (1)			Point (2)			Point (3)		
Date Collected	September 19, 2023			September 28, 2023			September 28, 2023		
Weather	Clear			Cloudy			Clear		
Temperature (°C)	30.5			27.0			30.0		
Water Velocity (m/s)	0.26			0.20			0.45		
Water Depth (cm)	45			48			32		
Sample Number	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
Sample Name	(1)-1	(1)-2	(1)-3	(2)-1	(2)-2	(2)-3	(3)-1	(3)-2	(3)-3
Filtering Time (min)	10	12	8	15	15	15	10	15	15
Filtered Volume (m ³)	8.4	9.3	6.8	7.3	10.5	8.5	13.0	18.0	15.0

(2) Water quality and other conditions

The turbidity, suspended solids, and total organic carbon in the rivers at the 3 sampling points ranged from 2 to 5 mg-kaolin equivalent/L, 3 to 10 mg/L, and 1.2 to 2.9 mg/L, respectively. The bottom of the river was visible in all sampling points. The weights of the environmental samples after being filtration and drying at 60 °C ranged from 3.67 to 10.2 g.

3.2 Verification Test and Reference Test (see pages 24 to 31 of Main Text)

The results of the verification test are shown in **Table 2**. During oxidation of environmental samples (2)-1 and (2)-3, a device feature that replaces the decomposition reagent in the reaction vessel was used to ensure complete decomposition of the organic matter in the samples. The recovery of reference plastic particles (1.00 g/cm³ and 1.35 g/cm³) was 92 to 100 % (coefficient of variation: 4.1 %) and 96 to 100 % (coefficient of variation: 2.0 %), respectively, which satisfied the performance that was subject to verification (at least 80 % recovery)

Table 2 Verification Test (Added Recovery Test with Device Subject to Verification) Results

Sampling Points		Point (1)			Point (2)			Point (3)		
Sample Name		(1)-1	(1)-2	(1)-3	(2)-1	(2)-2	(2)-3	(3)-1	(3)-2	(3)-3
Specific gravity 1.00	Number Recovered	23	25	23	25	23	23	24	25	23
	Reference Particle Recovery (%)	92	100	92	100	92	92	96	100	92
Specific Gravity 1.35	Number Recovered	25	25	25	25	24	24	25	24	25
	Reference Particle Recovery (%)	100	100	100	100	96	96	100	96	100

The results of the reference test are shown in **Table 3**. The recovery of environmental MPs (1 mm or larger) from river water samples collected 3 times in 3 points was 82 to 100 % (coefficient of variance: 5.6 %). The most common type of MPs recovered were polypropylene and polyethylene, which accounted for at least 70 % of the MPs in each sample.

Table 3 Reference Test (Environmental MP Recovery Test with Device Subject to Verification) Results

Sampling Points		Point (1)			Point (2)			Point (3)		
Sample Name		(1)-1	(1)-2	(1)-3	(2)-1	(2)-2	(2)-3	(3)-1	(3)-2	(3)-3
Number Recovered		11	25	24	30	49	44	47	103	78
Number Not Recovered		0	2	3	4	6	7	10	16	12
Environmental MPs Recovery (%) ^{*1}		100	93	89	88	89	86	82	87	87

^{*1}: Environmental MPs recovery is the proportion (%) of the total number of environmental MPs (1 mm or larger) originating from the river water sample that were recovered by the device (where the total number of environmental MPs in a sample was the sum of the number of MPs recovered by the device and the number of MPs not recovered by the device) and was calculated using the equation below.

$$\text{Environmental MPs recovery (\%)} = \frac{\text{Number of environmental MPs recovered by the device}}{\text{Number of environmental MPs recovered by the device} + \text{Number of environmental MPs not recovered by the device}} \times 100$$

3.3 Findings (see page 35 of Main Text for details)

Item	Findings
Technology overall	The characteristic feature of the device subject to verification is that it performs all sample preparation processes (oxidation and density separation) automatically in a single reaction vessel. Because the device is not impacted by the skill level of the operator, the device reduces variability in MPs recovery. In a spiked recovery test using plastic reference particles added to river water samples, the recovery of reference particles by the device was at least 80 %, which satisfied the performance subject to verification. The recovery of environmental MPs (1 mm or larger) by the device was also at least 80 %. This device can be expected to improve the accuracy of empirical data in studies and research into MPs, can be expected to have a positive impact on the development of future environmental conservation measures in MPs Pollution.
Miscellaneous	When hydrogen peroxide solution has lost its activity during the oxidation process and a substantial amount of organic matter remains in the device subject to verification, the remaining organic matter can be decomposed by using the "decomposition reagent replacement feature" of the device (a feature that replaces the decomposition reagent in the reaction vessel). Using this feature, the recovery of environmental MPs was at least 80 % even from environmental samples containing a large amount (approx. 10 g) of algae and other organic matter, which demonstrated the efficacy of this feature. Testing also demonstrated that recovery was at least 80 % when around 120 MPs were present in the environmental sample.

4. Reference Information

Note: All the information displayed on this page was submitted by the verification applicant of their own volition to publicize the technology. The Ministry of the Environment and the verifying organization assume no responsibility for its contents.

4.1 Product Data

Item		Section Completed by the Verification Applicant or Developer			
Product Name/Model Number		MAP-100 Microplastic Automatic Preparation Device			
Name of Manufacturing (Distributor) Company		Shimadzu Corporation			
Contact Information	Phone/Fax	(81)75-823-1635			
	Website Address	https://www.shimadzu.co.jp/			
	E-mail	ikezawa@shimadzu.co.jp			
Installation Requirements		Indoors at room temperatures between 15 °C and 30 °C with minimal variation in temperature			
Required Maintenance		Periodic inspection and replacement of maintenance parts			
Weather Resistance and Product Lifespan, etc.		Design standard use period: 10 years			
Cost		Item	Unit Price	Quantity	Total
Cost Estimate (Conditions: case-by-case quote)		Initial costs			
		Main unit	JPY 2,000,000/set	Complete set	JPY 2,000,000
		Installation cost	Quoted case-by-case		
		Other	Quoted case-by-case		
		Maintenance costs			
		Frequency of maintenance and parts replacement varies based on the circumstances of use. Contact the manufacturer for further details.			

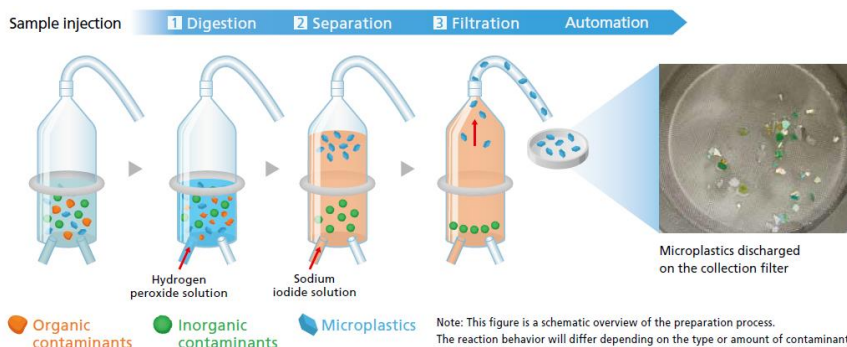
4.2 Other Information Provided by the Manufacturer

Automatic Preparation Processes

1. Decomposition of organic matter
2. Separation from inorganic matter
3. Extraction and recovery



MAP-100
Microplastic Automatic
Preparation Device



Labor savings

- Automating the complicated sample preparation process substantially reduces the number of man-hours required.

Reproducibility

- Automation ensures that sample preparation is highly reproducible, which improves the accuracy of comparisons between data.

Safety

- Simplifies the handling of reagents by operators.