2011

INTRODUCTION

360° Product Testing performed comparative strength testing of two types of two Client Disher models, as shown to the right.

The two type variations differed in that one type of each model uses a plastic gear while the other type uses a metal gear. There are also slight differences in how the disher scoop is mounted to the plastic handle.

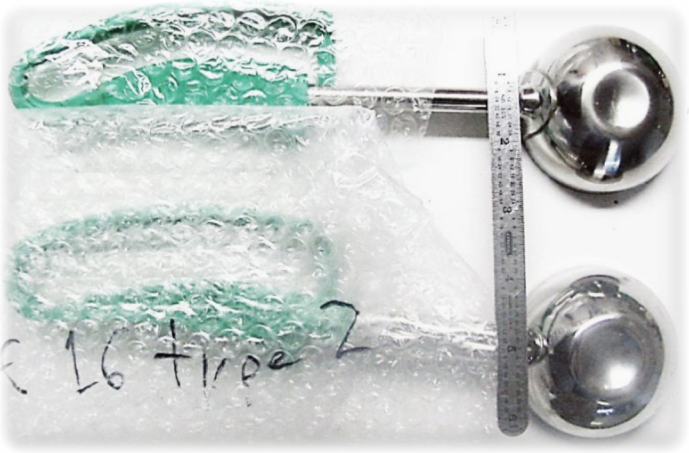
Through the below-detailed destructive tests, 360° Product Testing engineers compared the performance of the plastic and metal gear dishers to one another.

- Force required to deform dishers' scoop
- Force required to separate metal scoop assembly from the plastic handle
- Fail force required for weld where scrapper blade attaches to gear shaft
- Force required to separate bowl from shaft
- Force required to break disher gear
- Repetitive impact durability

Results for the large disher are presented first, followed by results for the small disher.

Deformation of Large Disher's Scoop

Using a calibrated hydraulic press, an equal amount of force of approximately 275 pounds was applied to each of the disher units, and the amount of deformation was measured.



The size of the indentation on the scoop of each disher was measured as:

Type-1 (metal gear): 28/32^{nds} inch diameter
Type-2 (plastic gear): 34/32^{nds} inch diameter

Force Required to Separate Scoop Assembly From the Plastic Handle, Large Disher
Two types of tests were performed to measure the strength of the plastic handle supporting the metallic scoop:

- a direct pull test on the plastic handle while the scoop was restrained; and
- a torque test whereby a torque was applied to the plastic handle while the scoop was restrained.

The following summarizes 360°'s findings.

- **Pulling:** A custom jig was created to restrain the metal scoop while a tension was applied to pull the handle away from the scoop. This measured the tensional force required to separate the handle from the metallic scoop. The handle pulled off the metal shaft of each respective disher as summarized below:

  Type-1 (metal gear): 90 lbs.
  Type-2 (plastic gear): 145 lbs.

- **Torque:** A perpendicular bolt was attached to each disher at the end of the handle, and then torque was applied to the bolt to twist the plastic handle from the metallic scoop. Knowing the measured lever arm distances and the applied force, the torque was calculated.

  The Type-1 (metal gear) broke at the tip of the handle at 115 lbs. applied on a 2 inch moment arm at 112° of rotation. The handle failed at (115 * 2) 230 in-lbs., equivalent to 19.2 ft-lbs of torque. The Type-2 (plastic gear) broke at the interface to the metal shaft at 60 lbs applied on a 2 inch moment arm at 90° of rotation. The handle failed at (60 * 2) 120 in-lbs, equivalent to 10.0 ft-lbs. of torque.

  Type-1 (metal gear): 19.2 ft-lbs. of torque
  Type-2 (plastic gear): 10.0 ft-lbs. of torque

Force Required to Break Scrapper Blade At Weld to Gear Shaft, Large Disher

A pull test was performed on the scrapper blade to measure the torque to the weld joint upon failure. Type-1 (metal gear) failed at 10 lbs applied on a 1.25 inch moment arm which is a torque of 12.5 in-lbs (1.04 ft-lbs). Type-2 (plastic gear) continued to spin the gear and shaft. After retesting, the Type-2 disher bent the scrapper blade at 40 lbs on the 1.25 inch moment arm, a torque of 50 in-lbs (4.2 ft-lbs). The photo to the right shows the failed Type-2 scoop blade.

Type-1 (metal gear): 1.04 ft-lbs. of torque
Type-2 (plastic gear): 4.20 ft-lbs. of torque

Force Required to Separate Scoop from Shaft, Large Disher

The disher shaft was positioned on a calibrated hydraulic press with an open middle platform. The press was positioned to apply force on the shaft just below the scoop, causing bending between the shaft and the bowl.

The Type-1 (metal gear) shaft began bending at approximately 460 lbs; and sheared off at 670 lbs. The Type-2 (metal gear) shaft did not detach from the scoop. Type-2 continued to deform the scoop without breaking the shaft to approximately 1060 lbs.

Type-1 (metal gear): 670 lbs.
Type-2 (plastic gear): > 1060 lbs.

Force Required to Break Large Disher Gear

A tension pull force was applied to the handle to cause the top edge of the handle to slip out of the gear teeth track. A compressive test was not expected to yield good results because the outer handle aligns with the main body upon closure for more support.

An initial handle pull out test to measure the force to shear the handle away from the gear was performed. Type-1 (metal gear) pulled out at approximately 70 lbs, while the Type-2 (plastic gear) pulled out at approximately 75 lbs.

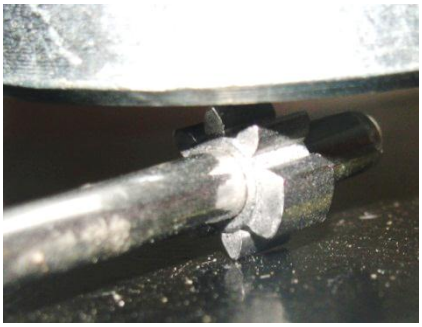
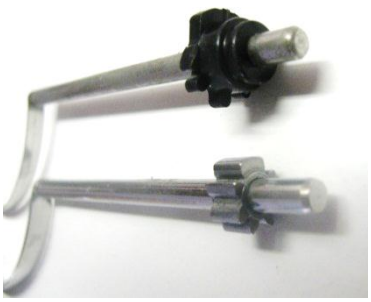
Type-1 (metal gear): ~ 70 lbs.
Type-2 (plastic gear): ~ 75 lbs.

A mixture of honey and salt was then applied to the rack and pinion gearset to apply additional stress to the gear teeth. The test was repeated with the impeded gear path. The tension pull test for the metal-geared Type-1 was approximately 75 lbs, and the plastic-geared Type-2 also pulled out at approximately 75 lbs. Although the gear obstructions made lower hand force usage more difficult, the maximum gear pull out was not affected. The gear teeth were minimally damaged in this testing.

Type-1 (metal gear): ~ 75 lbs.
Type-2 (plastic gear): ~ 75 lbs.

To enhance this testing, the exposed gear teeth were subjected to compression in a hydraulic press to measure the amount of force required to deform the teeth, which was found to be:

Type-1 (metal gear): deformed at 1340 lbs.
Type-2 (plastic gear): deformed at 280 lbs.

Repetitive Impact Durability, Large Dishers
The dishers were repetitively stuck on a simulated countertop surface to simulate severe handling. The scraper blade of the Type-2 (plastic gear) disher popped loose, which caused the entire rotary shaft to slide out after 10-20 impacts. The Type-1 (metal gear) disher did not exhibit the same behavior and survived more than 20 impacts.

Strength Summary, Large Dishers

The table on the following page summarizes the large dishers' performance test results. In general, the plastic-geared Type-2 disher appeared to have a stronger scoop that withstood a straight pullout tension force, but also torqued loose from the plastic handle more easily. It also exhibited a stronger blade weld to the gear shaft, as well as a stronger weld between the metal handle and scoop. The gear appeared to be at least as strong as the metal-geared disher, although what broke on the Type-1 metal-geared disher was a portion of the plastic pinion assembly.

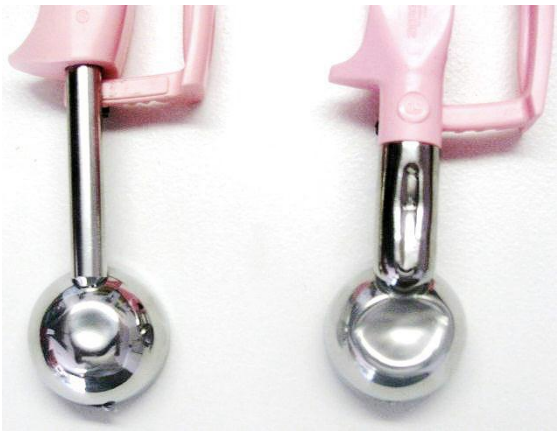
The metal-geared Type-1 disher appeared to have a weaker scoop as well as weaker attachment between the metal handle welded to the scoop and the plastic lower handle. Its scraper blade broke off at less than 25% of the force required to break the plastic-geared scoop blade's weld. In other ways, the Type-1 disher appeared to be more robust than the Type-2. In the severe-handling test, the scoop blade did not pop out of place as on the Type-2 disher.

Test Performed	Large Disher	
	Type-1	Type-2
Deformation of scoop at equal applied force (275 lbs. for Large Dishers, 1350 lbs. for Small Dishers)	28/32nds	34/32nds
Tensional force required to separate stainless steel scoop assembly from the plastic handle	90 lbs.	145 lbs.
Torque required to separate stainless steel scoop assembly from the plastic handle	19.2 ft-lbs. (broke)	10.0 ft-lbs. (broke)
Force required to break scrapper blade where blade is welded to gear shaft	1.04 ft-lbs.	4.2 ft-lbs., did not break
Shear force required to separate bowl from shaft	Bent at 460 lbs., broke at 670 lbs.	Survived 1060 lbs.
Force required to break disher gear, tension test	70 lbs.	75 lbs.
Force required to break disher gear, honey and salt mixture torque test	75 lbs.	75 lbs.
Gear deformation crush test	1340 lbs.	280 lbs.
Repetitive impact durability	Did not break	Scraper blade came loose releasing gear shaft

Notes: Type-1 - Metal Gear ... Type-2 - Plastic Gear

Small Disher Test Results

The following present 360° Product Testing's findings from equivalent tests upon the two variations of small dishers.



Deformation of Small Disher's Scoop

Using a calibrated hydraulic press, an equal amount of force of approximately 1350 pounds were applied to each of the disher units, then the indentation size of each disher measured.

Type-1 (metal gear): 14/32^{nds} inch diameter
Type-2 (plastic gear): 30/32^{nds} inch diameter

Force Required to Separate Scoop Assembly From the Plastic Handle, Small Disher

Two types of tests were performed to measure the strength of the plastic handle supporting the metallic scoop:

- a direct pull test on the plastic handle while the scoop was restrained; and
- a torque test whereby a torque was applied to the plastic handle while the scoop was restrained.

The following summarizes findings.

- **Pulling:** A custom jig was created to restrain the metallic bowl while a tension was applied to pull the handle away from the scoop. This measured the tensional force required to separate the handle from the metallic scoop. The handle pulled off the (large) shaft of each respective disher as summarized below:

  Type-1 (metal gear): 115 lbs.
  Type-2 (plastic gear): 80 lbs.

- **Torque:** A perpendicular bolt was attached to each disher at the end of the handle, then tension applied to the bolt to twist the plastic handle from the metallic scoop. Knowing the measured lever arm distances and the applied forces, the torque was calculated.

  The Type-1 (metal gear) twisted about 140° at 115 lbs. applied on a 2 inch moment arm. The plastic handle bent significantly at (115 * 2) 230 in-lbs., equivalent to 19.2 ft-lbs of torque. The Type-2 (plastic gear) twisted about 90° at 50 lbs applied on a 2 inch moment arm at 90° of rotation. The plastic handle was bending significantly at (50 * 2) 100 in-lbs, equivalent to 8.3 ft-lbs.

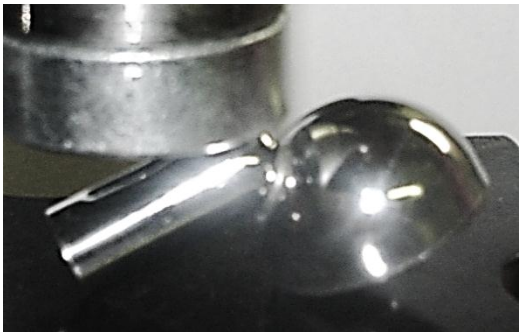
  Type-1 (metal gear): 19.2 ft-lbs. of torque
  Type-2 (plastic gear): 8.3 ft-lbs. of torque

Force Required to Break Scrapper Blade At Weld to Gear Shaft, Small Disher
A pull test was performed on the scrapper blade to measure the torque that would break the weld joint from the scoop blade to the gear shaft. Type-1 typically bent the scrapper arm before the weld failed at 6 lbs applied on a 3.0 inch moment arm, a torque of 18.0 in-lbs (1.5 ft-lbs). The Type-2 disher failed at 6 lbs applied on a 3.0 inch moment arm to break at a torque of 18.0 in-lbs (1.5 ft-lbs). The photo to the right shows the failed Type-2 scoop blade.

Type-1 (metal gear): 1.5 ft-lbs. of torque
Type-2 (plastic gear): 1.5 ft-lbs. of torque

Force Required to Separate Scoop from Shaft, Small Disher
The disher shaft was positioned on a calibrated hydraulic press with an open middle platform. The press was positioned to apply force on the shaft just below the scoop, causing bending between the shaft and the bowl.

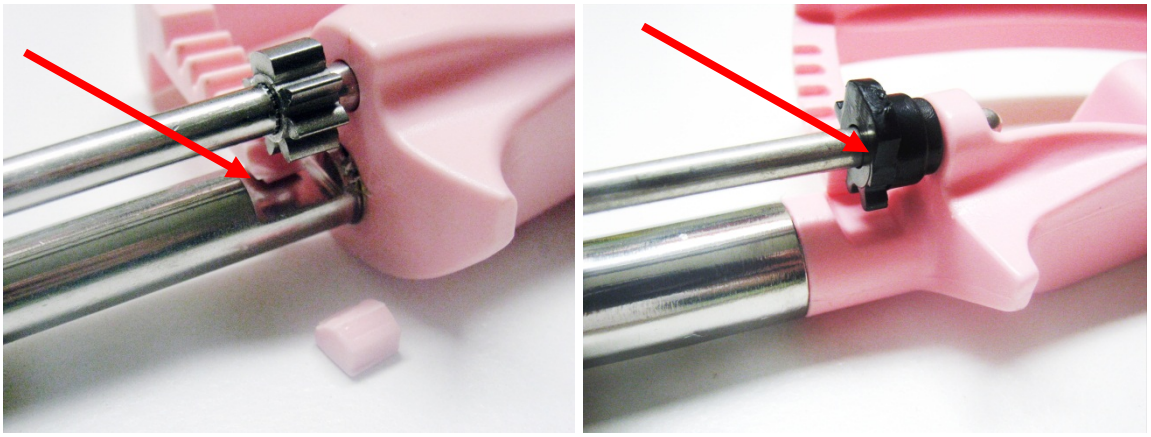
The scoops of both of the small dishers deformed without shearing off the shaft. The Type-1 (metal gear) disher had slight bowl deformation at approximately 2000 lbs. The Type-2 disher (plastic gear) exhibited significant deformation at a lower 1100 lbs but the scoop did not break off the shaft. The following photos show the dishers in place on the press before testing, and results after application of the compressive force.



Type-1 (metal gear): > 2000 lbs.
Type-2 (plastic gear): > 2000 lbs.

Force Required to Break Small Disher Gear
A tension pull force was applied to the handle to cause the top edge of the handle to slip out of the gear teeth track. A compressive test was not expected to yield good results because the outer handle aligns with the main body upon closure for more support.

An initial handle pull out test to measure the force to shear the handle away from the gear was performed. Type-1 (metal gear) pulled out at approximately 90 lbs, and the plastic stop on the gear rack broke, as seen in the following photo. Type-2 (plastic gear) pulled out at approximately 100 lbs, when the last plastic tooth of the pinion gear broke.



Type-1 (metal gear): ~ 90 lbs.
Type-2 (plastic gear): ~ 100 lbs.

Repetitive Impact Durability, Small Dishers
The dishers were repetitively stuck on a simulated countertop surface to simulate severe handling. The scraper blade of the randomly selected Type-2 (plastic gear) disher popped loose, which caused the entire rotary shaft to slide out after 10-20 impacts. The Type-1 (metal gear) disher did not exhibit the same behavior and survived more than 20 impacts.

Strength Summary, Small Dishers

- The Type-1 disher (metal gear) scoop itself appeared to be weaker than the Type-2 scoop.
- The blade on the Type-1 disher appeared to be weaker than the blade on the Type-2, although both blades failed at about the same applied torque albeit in different ways.
- In some ways the Type-1 disher appeared more robust than the Type-2.
    - In general, the attachment of the metal scoop assembly to the plastic handle appeared to be stronger on the Type-1 disher than the Type-2.
    - During 10-20 repetitions of being struck on a simulated counter top, the scraper blade of the Type-2 disher popped loose causing the entire rotary shaft to slide out, whereas the Type-1 disher survived the same treatment.

The following table summarizes the small dishers' test results:

Test Performed	Small Disher	
	Type-1	Type-2
Deformation of scoop at equal applied force (275 lbs. for Large Dishers, 1350 lbs. for Small Dishers)	14/32nds	30/32nds
Tensional force required to separate stainless steel scoop assembly from the plastic handle	115 lbs.	80 lbs.
Torque required to separate stainless steel scoop assembly from the plastic handle	19.2 ft-lbs. (did not break)	8.3 ft-lbs. (did not break)
Force required to break scrapper blade where blade is welded to gear shaft	1.5 ft-lbs.	1.5 ft-lbs.
Shear force required to separate bowl from shaft	2000 lbs., did not break	1100 lbs., did not break
Force required to break disher gear, tension test	90 lbs.	100 lbs.
Repetitive impact durability	Did not break	Scraper blade came loose releasing gear shaft

Notes: Type-1 - Metal Gear ... Type-2 - Plastic Gear

Overall Summary

The following table summarizes both the large and small dishers side-by-side:

Test Performed	Large Disher		Small Disher	
	Type-1	Type-2	Type-1	Type-2
Deformation of scoop at equal applied force (275 lbs. for Large Dishers, 1350 lbs. for Small Dishers)	28/32nds	34/32nds	14/32nds	30/32nds
Tensional force required to separate stainless steel scoop assembly from the plastic handle	90 lbs.	145 lbs.	115 lbs.	80 lbs.
Torque required to separate stainless steel scoop assembly from the plastic handle	19.2 ft-lbs. (broke)	10.0 ft-lbs. (broke)	19.2 ft-lbs. (did not break)	8.3 ft-lbs. (did not break)
Force required to break scrapper blade where blade is welded to gear shaft	1.04 ft-lbs.	4.2 ft-lbs., did not break	1.5 ft-lbs.	1.5 ft-lbs.
Shear force required to separate bowl from shaft	Bent at 460 lbs., broke at 670 lbs.	Survived 1060 lbs.	2000 lbs., did not break	1100 lbs., did not break
Force required to break disher gear, tension test	70 lbs.	75 lbs.	90 lbs.	100 lbs.
Force required to break disher gear, honey and salt mixture torque test	75 lbs.	75 lbs.	-------	-------
Gear deformation crush test	1340 lbs.	280 lbs.	-------	-------
Repetitive impact durability	Did not break	Scraper blade came loose releasing gear shaft	Did not break	Scraper blade came loose releasing gear shaft

Notes: Type-1 - Metal Gear ... Type-2 - Plastic Gear

In general...

- The Type-2 dishers appeared to have a stronger scoop and scrapper blade.
- The plastic handles of the Type-1 dishers appeared to have a stronger attachment to the scoop shafts when torque was applied.
- The Type-2 dishers showed weaker scrapper blade construction in that the scrapper blade popped off the disher during the severe-handling test of being struck on a simulated counter top 10 – 20 times, whereas the Type-1 dishers did not break after being struck 10 – 20 times on the countertop.