

Effective & Economical Purgung of Plastics Processing Machinery

Performance test results of comparative types of commercial products:

- Mechanical (Abrasive)
- Mechanical (Non-Abrasive)
- Chemical
- Chemical/Mechanical

Conducted by Diamond Polymers, Inc., Akron, Ohio

Commissioned by Shuman Plastics, Inc., Dyna-Purge Division, Buffalo, New York

Comparative Testing of Commercial Purging Products

Introduced to the plastics processing industry in the early 1980's as an alternative to using in-house resins and regrinds to purge, commercial purging products have achieved popular acceptance. At first, these products met with the usual skepticism experienced with any new technique. Over time, however, the rising cost of resin and drive to improve productivity in order to compete in a challenging global economy led an increasing number of companies to investigate commercial purging methods.

The effectiveness and economy of these products have been proven in all major categories of plastics operations, including injection molding, extrusion, compounding, and blow molding. Although virtually any commercial purging product may be considered an improvement over "home remedies," (e.g. adding laundry detergent to virgin resin), there are substantive differences between commercial purging products.

Abstract

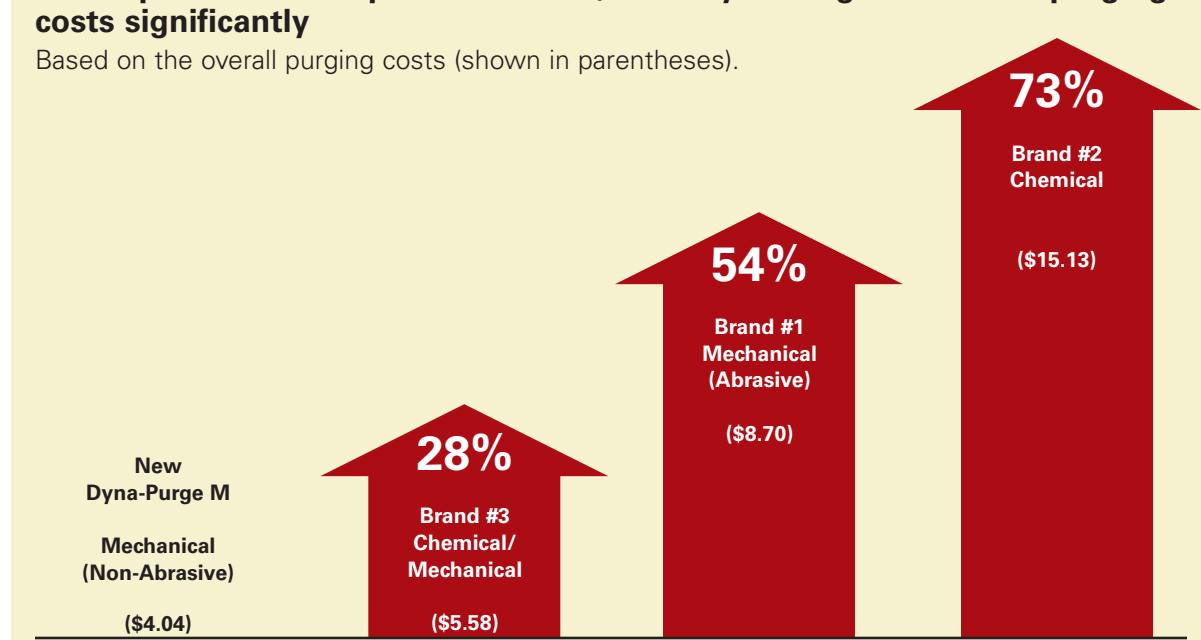
Independent laboratory testing, conducted in November 2006 by Diamond Polymers of Akron, Ohio, compared the effectiveness, time to purge, and cost to purge of key representations of four types of commercial purging compounds: Mechanical (Abrasive); Mechanical (Non-Abrasive); Chemical; and Chemical/Mechanical (Hybrids).

The study was commissioned by the Dyna-Purge® Division of Shuman Plastics, Inc. to test a new formulation of its Dyna-Purge M grade, a Mechanical (Non-Abrasive) compound. (This "second generation" of Dyna-Purge M has pellets with larger surface area.) Dyna-Purge M is the most universal of the company's 10 purging grades, developed for use with a wide range of resins for injection molding and extrusion applications. New Dyna-Purge M was tested against comparable multi-purpose grades from leading competitors of each type of purging product.

The test results showed that the new formulation of Dyna-Purge M lowers purging costs from 28% to 73% compared to other brands offered.

In comparison to competitive brands, New Dyna-Purge M reduces purging costs significantly

Based on the overall purging costs (shown in parentheses).



Why purging is integral to plastics processors

Purging is necessary for several reasons. The most obvious would be the need to change color or resin when shifting production from one product to the next, or to clean out the machine for periodic preventive maintenance.

Purging helps eliminate streaking, which occurs when old color is trapped in a negative flow area without enough physical turbulence to remove the color. The next material processed picks up trace amounts of the residue color, causing a streak in the part. This streaking will continue until the color that is trapped is flushed away by the next resin.

Another key reason to purge is to remove carbon buildup or "black specks." These may be caused by any one of the following: "dead spots" or negative flow areas in the barrel, nozzle or die; hot temperature spots in the machine; separation of additives, fillers and color concentrates from the carrier system that are left behind when the resin is processed; and/or degradation of polymers during start-up and shutdown, excess heat, shear action or residence time in the barrel.

Carbon buildup may adhere to the walls of the machine, screw surface and manifold channels. The carbon will eventually break off and move forward, ending up as black specks in the finished product. The appearance of black specks can be reduced (but not eliminated) by running virgin resin or regrind materials through the machine, a procedure that can waste several hundred pounds of resin and valuable production time.

Since resins and regrinds are not formulated to clean the machine, they are not usually effective when employed for purging. They work by attempting to displace the resident material, often using five to ten times more resin than a commercial purging product. This time-consuming process results in substantial machine downtime, generates an excessive amount of scrap, and is inconsistent due to operator variability.

Commercial purging products provide a more effective solution. Specifically formulated to clean plastic processing equipment, commercial purging products offer four key benefits over in-house resins or regrinds:

Less downtime

Purging agents are formulated to clean on the first pass through the screw and barrel, minimizing machine downtime and maximizing productivity.

Reduced scrap

Using a purging product eliminates the need to waste usable resin to achieve color or material changes. Eliminating black specks results in fewer rejected parts.

Greater consistency

Using a commercial product and following the manufacturer's purging procedure will lead to better, more consistent results, minimizing the impact of both product and operator variability.

Lower purging costs

Calculating the expense of virgin resin/regrind vs. the purging material used, plus the labor involved to purge and post-purge, commercial products lower the cost to purge significantly.

Fundamental differences between purging products

There are four major types of commercial purging products available to the market. They vary greatly in their composition and how they resolve purging challenges.

Mechanical (Abrasive)

Mechanical (Abrasive) purging products use filler materials such as calcium, talc, glass or rock, to provide scrubbing action. They clean by aggressively scouring the barrel and screw. Although this can be effective, frequent use may cause damage to the machine through pitting or excessive wear on the critical tolerances of the process equipment. This results in changes to the machine tolerances and may result in part replacement prematurely.

Mechanical (Abrasive) products are supplied as either concentrates that require accurate measuring and blending before use, or pre-blended mixes ready-to-use.

Mechanical (Non-Abrasive)

Typically Mechanical (Non-Abrasive) purging products are thermoplastic resins or blends used to flush the process equipment. Performance can vary and adjustments to the temperature and RPM speed of the machine may be required to conduct purging. They work using viscosity to remove the barrel contents.

Other Mechanical (Non-Abrasive) purging products, such as New Dyna-Purge M, are thermoplastic compounds composed of "soft-scrub" granules that soften on the outside but remain solid on the inside. The scrubbing granules work their way into dead spots and hot spots in the machine to break away the layers of carbon buildup without damaging the metal surfaces of the screw and barrel, or altering the tolerances of the plastic processing equipment. The carrier system can then flush the old color, degraded material and contamination out of the machine.

Chemical

Chemical purging agents use a chemical component that changes the viscosity of the resin to help it flow through the machine. They are usually supplied as a concentrate that needs to be introduced into the next resin in stages or manually pre-blended with a carrier resin. This requires accurate measurement, careful dispersion, and proper blending. Use of too much purging concentrate increases the cost without improving performance. Using too little yields poor results.

The chemical agent often must soak in the barrel without the screw turning to allow time for the chemical reaction with the carrier resin to occur, thus increasing downtime. Heat activates a chemical reaction that modifies the molecular chain of the polymer, making it easier for the next material to flush it out. Elevated heat and extended soak times, however, can cause breakdown of the polymers in the resin. This can be accompanied by the release of ammonia or other fumes that can damage the equipment or be irritating and unpleasant for machine operators.

Most chemical purging products are not heat stable, so they cannot be left safely in the barrel during shutdown, and incorrect shutdown procedures can produce carbon buildup at start-up. Their chemical makeup also limits the shelf life of some of these products.

Difficulty of use, complexity, and longer time required to achieve desired purging results make pure chemical purging systems the most expensive. Chemical purging methods are also generally not as effective as mechanical means in removing carbon buildup.

Chemical/Mechanical (Hybrid)

Chemical/Mechanical purging products are hybrids of chemical and mechanical products and are supplied in dry form. Like their Chemical counterparts, they change the viscosity of the carrier resin, but do not have some of the drawbacks, such as soaking or mixing.

Although they combine effective means of chemical and mechanical products, these purging materials may not be heat stable, so they should not be left in the machine during shutdown.

A comparative study

Diamond Polymers tested four brands of commercial purging products on four different pre-colored black resins. For these testing trials, standard operating procedures were developed and applied to each purging product and resin. The usage directions for each product were carefully followed in determining the amount of product used. In each test, the cost to purge was calculated by determining:

- The amount and cost of purging product used
- Machine downtime (based on \$60 per hour)
- The amount and cost of post-purge resin used
- Post-purge time lost (based on \$60 per hour)

Purging time depends on a number of factors, including:

- Resin type and color (some colors are more difficult to purge than others)
- Viscosity of the resident resin and viscosity of the following resin
- Size of the processing equipment
- Age and condition of the machine (e.g. level of maintenance)
- Skill of the operator

Summary of purging cost results

In each of the four trials, the New Dyna-Purge M formula ranked first in speed of purging and lowest cost to purge.

The table below shows the results for each test and the overall averages of lower purging costs using New Dyna-Purge M compared to the other commercial purging products.

Cost to Purge by Resin & Purging Product

Resin Tested	New Dyna-Purge M Mechanical (Non-Abrasive)	Brand #1 Mechanical (Abrasive)	Brand #2 Chemical	Brand #3 Chemical/ Mechanical
Black HDPE	\$1.63	\$5.72	\$11.58	\$3.68
Black PP	\$1.51	\$5.01	\$11.28	\$3.43
Black ABS	\$5.52	\$9.89	\$15.19	\$5.82
Black PC	\$7.50	\$14.17	\$22.46	\$9.39
Average Cost to Purge	\$4.04	\$8.70	\$15.13	\$5.58

Average Cost to Purge Comparison

New Dyna-Purge M
Mechanical (Non-Abrasive) **\$4.04**

Brand #3
Chemical/Mechanical **\$5.58**

Brand #1
Mechanical (Abrasive) **\$8.70**

Brand #2
Chemical **\$15.13**

Trial One - Black High-Density Polyethylene: 6 Melt

	New Dyna-Purge M Mechanical (Non-Abrasive)	Brand #1 Mechanical (Abrasive)	Brand #2 Chemical	Brand #3 Chemical/ Mechanical
Amount of Product Required (grams)	142.9	400	400	300
Purging Time (min:sec)	0:37	2:10	6:46	1:30
Post-Purge Time	0:07	0:43	Trial aborted	0:17
Total Time	0:44	2:53	More than 6:46	1:47
Cost of Purging Product	\$0.82	\$2.69	\$3.72	\$1.78
Cost of Machine Downtime	\$0.62	\$2.17	\$6.77	\$1.50
Post-Purge Resin Cost	\$0.07	\$0.14	\$0.27	\$0.12
Cost of Post-Purge Time	\$0.12	\$0.72	\$0.82	\$0.28
Cost to Purge	\$1.63	\$5.72	\$11.58	\$3.68

Operator's comments:

- Used the recommended 200 grams of the Mechanical (Abrasive) product. Since the purge was not yet clean, an additional 200 grams were added. After using 400 grams total, there was still a tint of gray, and during post-purge talc powder appeared in the resin.
- For the Chemical product, 200 grams soaked for five minutes and did not clean the machinery. After adding another 200 grams without soaking, the machine was still not clean, but the trial was aborted after the mixture developed a bad odor and the material was degrading.
- The Chemical/Mechanical test initially used the recommended 200 grams but when the result was still not clean, an additional 100 grams were added.

Trial Two - Black Polypropylene: 20 Melt

	New Dyna-Purge M Mechanical (Non-Abrasive)	Brand #1 Mechanical (Abrasive)	Brand #2 Chemical	Brand #3 Chemical/ Mechanical
Amount of Product Required (grams)	127.6	360.8	400	276.5
Purging Time (min:sec)	0:26	1:59	6:28	1:13
Post-Purge Time	0:14	0:28	0:49	0:26
Total Time	0:40	2:27	7:17	1:39
Cost of Purging Product	\$0.73	\$2.42	\$3.72	\$1.64
Cost of Machine Downtime	\$0.03	\$1.98	\$6.47	\$1.22
Post-Purge Resin Cost	\$0.12	\$0.14	\$0.27	\$0.14
Cost of Post-Purge Time	\$0.23	\$0.47	\$0.82	\$0.43
Cost to Purge	\$1.51	\$5.01	\$11.28	\$3.43

Operator's comments:

- For the Chemical compound, 200 grams soaked for five minutes did not clean the machinery. After adding another 200 grams without soaking, the machine still contained some contamination, but post-purging was conducted anyway. The mixture developed a bad odor and the material was degrading.
- The Chemical/Mechanical test was successful but the material expanded quite a bit.

Trial Three: Black ABS: 6.5 Melt

	New Dyna-Purge M Mechanical (Non-Abrasice)	Brand #1 Mechanical (Abrasice)	Brand #2 Chemical	Brand #3 Chemical/ Mechanical
Amount of Product Required (grams)	497.6	800	700	491
Purging Time (min:sec)	1:57	2:45	7:30	1:58
Post-Purge Time	0:27	1:09	0:46	0:34
Total Time	2:24	3:54	8:16	2:32
Cost of Purging Product	\$2.83	\$5.37	\$6.50	\$2.92
Cost of Machine Downtime	\$1.95	\$2.75	\$7.50	\$1.96
Post-Purge Resin Cost	\$0.29	\$0.62	\$0.42	\$0.38
Cost of Post-Purge Time	\$0.45	\$1.15	\$0.77	\$0.56
Cost to Purge	\$5.52	\$9.89	\$15.19	\$5.82

Operator's comments:

- For the Chemical compound, 200 grams soaked for five minutes did not clean the machinery. After adding another 200 grams without soaking, the machine still contained some contamination, but post-purging was conducted anyway. The mixture developed a bad odor and the material was degrading.

Trial Four: Black Polycarbonate: 9 Melt

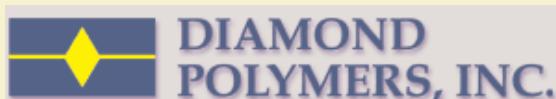
	New Dyna-Purge M Mechanical (Non-Abrasice)	Brand #1 Mechanical (Abrasice)	Brand #2 Chemical	Brand #3 Chemical/ Mechanical
Amount of Product Required (grams)	600	933.4	882.2	700
Purging Time (min:sec)	2:23	4:32	11:07	2:46
Post-Purge Time	0:59	2:15	1:48	1:12
Total Time	3:22	6:47	12:55	3:58
Cost of Purging Product	\$3.43	\$6.28	\$8.20	\$4.17
Cost of Machine Downtime	\$2.38	\$4.53	\$11.12	\$2.76
Post-Purge Resin Cost	\$0.71	\$1.11	\$1.34	\$1.26
Cost of Post-Purge Time	\$0.98	\$2.25	\$1.80	\$1.20
Cost to Purge	\$7.50	\$14.17	\$22.46	\$9.39

Statement of Authentication

Diamond Polymers, Inc. verifies conformance to industry standards for testing protocol and to the accuracy of the results reported.

Through its research and development capabilities, Diamond Polymers, a division of Network Polymers, provides comprehensive technical assistance including product design and development of thermoplastics. Both companies are certified to ISO 9001: 2000 quality standards.

The Diamond Polymers laboratory holds A2LA accreditation from the American Association for Laboratory Accreditation for Mechanical Testing, covering specific tests and types of test as agreed with the scope of accreditation. It meets the requirements of ISO/IEC 17025-1999 "General Requirements for the Competence of Calibrations and Testing Laboratories" (equivalent to relevant requirements of the ISO 9000 series of standards) and any additional program requirements in the identified field of testing.



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