BY DON BEST

THE LOWDOWN ON LOW-FLOW TOILETS

For the better part of this century, toilets have been a relatively bland and unchanging product. Sure, a homeowner might prefer an elongated bowl to a round bowl, or choose "peach" instead of white, but the basic design of the bowl and tank, and the hardware inside, remained the same.

Up until 1975, when pressurized-tank fixtures were introduced, virtually all residential toilets used gravity and five or six gallons of fresh water to rinse the bowl clean and carry the waste down the drain line. Since ball cocks, valves, and other components were standardized, maintenance requirements were more or less the same regardless of the make. So builders and plumbers usually chose toilets on the basis of price and appearance alone.

Reinventing the Throne

During the 1980s, the limitations of our nation's water resources became painfully apparent. Some communities, especially in the West, faced serious water supply problems and found their sewage treatment plants overwhelmed by surging populations and increased industrial demand. Municipal and state governments passed water conservation laws, bolstered by rebates and penalties. In some extreme cases, water supply and sewage treatment facilities were so overloaded that moratoriums on new construction were imposed.

Toilet manufacturers responded by offering "water-saving" models that use 3.5 gallons per flush (gpf) instead of five or more. These quickly became the industry standard.

Gravity systems. As the need grew to conserve even more water, a few American manufacturers and importers introduced "low-consumption" models — inspired by 6-liter European designs — that use just 1.6 gpf. Most models still relied on gravity, but with important changes in design. To compensate for their smaller capacity, tanks were taller and narrower to increase the head. Bowls had steeper sides to increase the gravitational pull, and the water spots were smaller (typically 4x5 inches instead of 8x9 inches).

Pressurized tank. About the time the new 1.6 gpf gravity models were being introduced, inventor Bruce Martin, founder of Water Control International, was pushing the development of a competing technology that used a pressurized tank (see Figure 1). Martin's patented invention features a separate plastic tank housed inside the familiar vitreous china tank. Using ordinary supply line pressure (at least 15 psi), water enters the sealed plastic tank and compresses the air trapped inside. When the toilet is flushed, the compressed air expands, pushing the water into the bowl in a brief high-pressure surge.

When the pressurized tank system was first introduced in 1975, it was marketed as a retrofit product to convert 5.5 gpf toilets to 2.5 gpf. But not all toilets could accommodate the changeover and there were component failures — especially with the pressure regulator — that eventually drove Water Control International into bankruptcy.

Martin fine-tuned the pressurized-tank technology, and in 1985 Mansfield used the system in its new Quantum toilet. This represented the first truly revolutionary change in residential toilets to come along in decades.

Plug-in toilet. By year's end, builders and plumbing contractors will have a third low-flow technology to consider when Kohler introduces its Trocadero Power Lite, the industry's first "pumped" toilet (Figure 2). The Trocadero uses a small electric pump (0.2 horsepower) to push water through the toilet. The toilet is plugged into a regular outlet and draws about a dollar's worth of electricity a year.

CAROLYN BATES/CONNOLLY MECHANICALS

AS MANUFACTURERS RUSH TO MEET THE JANUARY 1994 DEADLINE MANDATING 1.6 GALLON TOILETS, BOTH GRAVITY AND PRESSURIZED MODELS ARE COMPETING FOR THE VAST MARKET

Mandatory Low Flow

In the late 1980s, both gravity and pressurized 1.6 gpf toilets found profitable niches, especially in communities where water supply and sewage treatment pressures were most intense. But as recently as 1987 only a handful of manufacturers offered low-flow models, with big names like American Standard and Kohler absent from the market.

Then came the prolonged drought in California, prompting the state legislature there to make 1.6 gpf toilets mandatory in all new residential construction. One by one, other states enacted similar laws, including Massachusetts, New York, Texas, and Georgia. Toilet manufacturers had to scramble.

Federal law. To clarify the growing jumble of state and local laws, the U.S. Congress voted to pass a national standard addressing water conservation. The National Energy Policy Act stipulates that after January 1, 1994, all new toilets manufactured in the United States (or imported) for residential use must consume no more than 1.6 gpf (see "Low-Flow Law Review"). The law permits manufacturers to sell off their existing inventories of 3.5 gpf models, but after those are gone — probably by mid-1994 — everything going into new residential construction will be 1.6 gpf.

How Well Do They Work?

Long before the National Energy Policy Act became law, the professionals who test toilets and write standards were worried that the rush to legislate the use of 1.6 gpf toilets would end up causing serious performance problems.

Drain line carry. One prime concern was that the smaller volume of water used would lead to clogged drain lines. But after extensive testing, the Stevens Institute of Technology working in tandem with the American Society of Plumbing Engineers found that 1.6 gpf toilets — whether gravity or pressurized tank type — do provide adequate drain line carry for residential use. The laboratory and field tests showed that as long as other household water fixtures and appliances drain into the same line as the toilet, clogging isn't more of a problem with low-flow toilets than with conventional fixtures.

However, the Stevens Institute recommended against using 1.6 gpf toilets in commercial projects until better performing models are developed. Although the National Energy Policy Act permits manufacturers to continue making 3.5 gpf toilets for commercial installations, some states, including California, New York, Massachusetts, and Texas, require 1.6 gpf models on commercial jobs as well. Thus, the suitability of current l.6 gpf designs for commercial jobs is going to be proved or disproved over time in thousands of real installations.

Skid marks. Another performance concern with 1.6 gpf models is how well they evacuate the bowl and whether or not they leave "tracks," or "skid marks." In both regards, the pressurized tank models, which have a more forceful flush and a larger water spot (10x12 inches), tend to excel. Gravity models, generally speaking, are more likely to require an occasional double flush to empty the bowl and need more frequent use of a scrub brush to remove tracks.

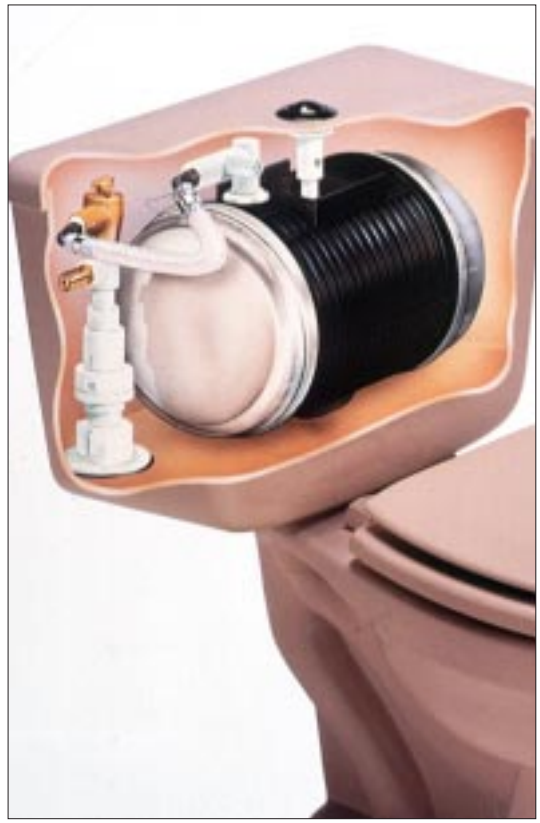


Figure 1. *In a pressurized-tank toilet, such as this Briggs Industries' Turboflush, an inner plastic tank traps air that is then compressed by supply water under its own pressure. When the toilet is flushed, the compressed air expands, pushing the water into the bowl at high velocity.*

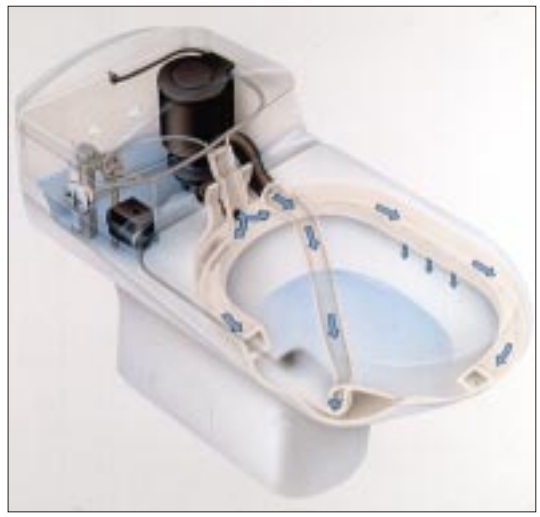


Figure 2. *Kohler's electrically operated Trocadero Power Lite uses a small pump to push water through the toilet. A dual-action push button allows the option of either a 1.6-gallon or a 1-gallon flush.*

Low-Flow Law Review

When President Bush signed the National Energy Policy Act of 1992 last October, a new set of national standards for water conservation became law. Here are some of the key provisions that affect toilets and other plumbing fixtures:

- Starting January 1, 1994, all residential toilets manufactured in the U.S. or imported for residential use must be rated 1.6 gallons per flush (gpf) or less.
- If a component of a noncomplying toilet is broken, the customer must purchase a whole new fixture that does comply. Manufacturers will not be permitted to produce noncomplying components for sale in the United States.
- Manufacturers are permitted to make white, two-piece, 3.5 gpf toilets for commercial use until January 1, 1997. All products and containers must be marked "For Commercial Use Only."
- As of January 1, 1994, all toilets must be permanently marked to indicate their water consumption.
- Commercial 3.5 gpf toilets using a pressurized tank are exempted until January 1, 1997.
- "Blow Out" toilets used in stadiums and at other heavy-use sites are permanently exempted.
- Beginning January 1, 1994, the flow rate on shower heads and kitchen and lavatory faucets is set at 2.5 gallons per minute at 80 pounds per square inch line pressure. These fixtures must be permanently marked with their actual or maximum flow rate.
- Manufacturers and distributors of plumbing products can sell their existing inventory of noncomplying products manufactured before January 1, 1994.
- All existing state laws that contain provisions that are more restrictive than those in the National Energy Policy Act of 1992 remain in effect.

— *D.B.*

Rating Low-Flow Performance

Because low-flow fixtures are new to many builders, they may be hard pressed to pick a product when the new law takes effect next January. One study that may help was conducted for the Los Angeles Dept. of Water and Power (LADWP). More than 9,000 people who had participated in the city's low-flow rebate program responded. All had used their new low-flow toilet for at least several months.

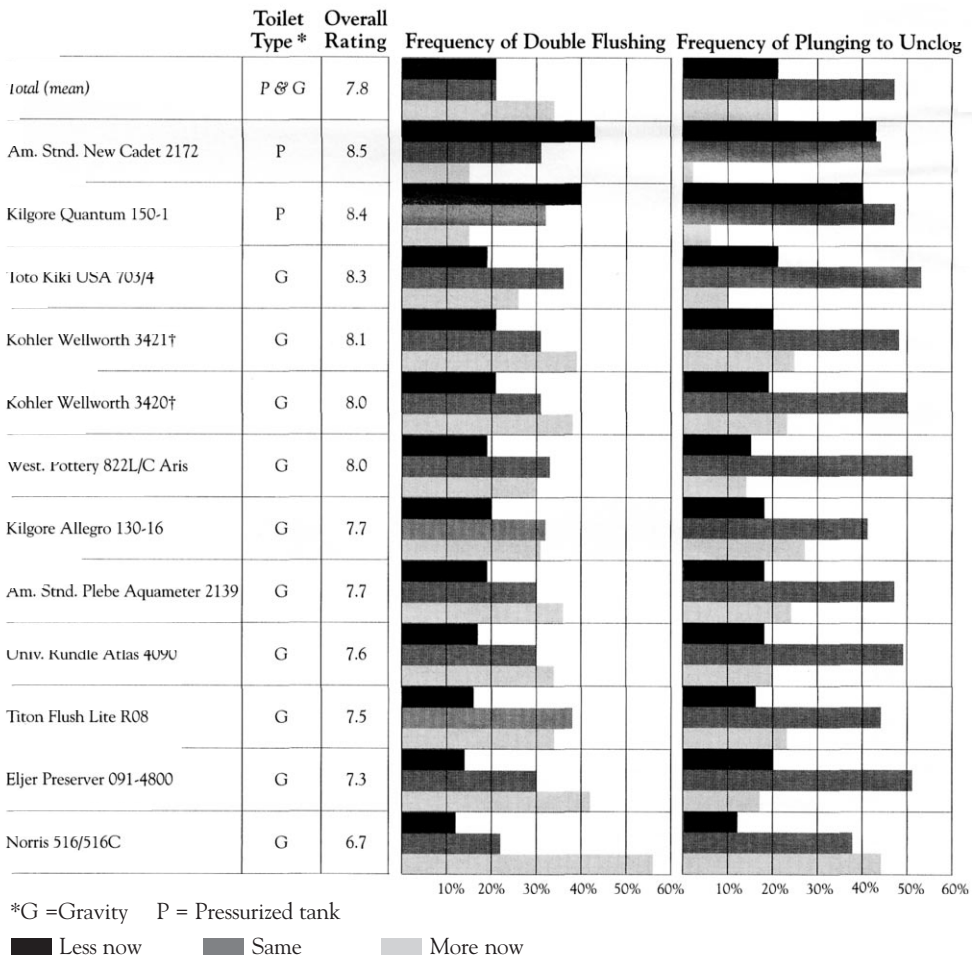
According to the survey results, most customers found that their new low flows performed at least as well as their old fixtures, regardless of brand. With some models, the new units did even better than the old 5-gallon models. What people liked best about low-flow toilets, they said, was that they save water. Three out of four users said they would be "very likely" to purchase a low-flow toilet in the future, and only 7% said they would not. The report also concludes that people who replaced more than half of their toilets with low-flow fixtures were more satisfied than those who replaced fewer than half. This suggests that the more you use a low flow, the more you like it. Customer satisfaction did not depend on the age of the dwelling, either.

While more than 90 models of low-flow toilets were included in the rebate program, the 12 models rated by the report were used by 90% of the people surveyed. (Since then, as many as 100 new models have been introduced.) The report compares models according to the following characteristics, listed in order of importance to users:

- Number of double flushes
- Frequency of mechanical problems
- Frequency of using a plunger to unclog
- Frequency of cleaning
- Frequency of needing a professional unclogging service

When asked to rate their low-flow toilet on a scale of 1 to 10 ("very dissatisfied" to "very satisfied"), over half the respondents gave their fixture a 9 or 10. The mean rating was 7.8. Two of the fixtures studied — the American Standard New Cadet and the Kilgore Quantum 150-1 — outperformed all others in every category. This was especially true in the category most important to users, frequency of double flushing, and in plunging frequency as well. However, these two fixtures, which use a pressurized tank, were also the most expensive of the group cited. (Pressurized tank models cost about twice as much as gravity models.)

Price alone may not be a reliable indicator of performance, however. For example, the Toto Kiki USA 703/4 got a high overall rating, even though purchasers rated it only about average in four of the five other categories. That's probably because it was one of the cheapest units studied. Also, the top-rated American Standard and Kilgore toilets appear to be the noisiest: About 30% of the people using these two models complained that they were noisy, compared to only about 6% for other models. — *D.B.*



†The Kohler Wellworth 3421 has a round bowl. Kohler's model 3420 has an elongated bowl.

Note: *Survey respondents rated low-flow toilets for overall satisfaction on a scale of 1 to 10. The mean score of 7.8 shows that people were generally happy with the performance of low-flow toilets.*

The need to double flush influenced customer satisfaction more than any other variable. The American Standard New Cadet and Kilgore Quantum 150-1 scored highest in this category, and also required significantly less unclogging with a plunger.

In a 1992 survey of almost 9,000 Californians whose homes had been retrofitted with 1.6 gpf toilets, pressurized-tank models were ranked first and second in customer satisfaction. Most gravity toilets scored well too. The mean score for all models evaluated was an impressive 7.8 on a 10-point scale (see "Rating Low-Flow Performance).

"It's fair to say that some gravity models work just as well as the pressurized tank models," says Thomas Konen, an engineer with the Stevens Institute of Technology. "The problem is, there's no way to distinguish the better gravity types at this point because the ANSI (American National Standards Institute) performance tests that we use are inadequate. What's needed is a new and separate set of test standards for residential toilets."

Other experts we talked with expressed similar doubts about current test standards, suggesting that ANSI's pass-fail approach — developed for earlier generations of toilets — can't adequately gauge the finer points of performance that are critical in 1.6 gpf designs.

While it can still be helpful to compare the ANSI test scores of one toilet to another (these are usually on file at state plumbing board offices), the only sure way to pick a top performer is through experience. In other words, find a manufacturer whose toilet does the job with few callbacks, and stick with it.

Costs and Savings

The wholesale price of gravity-type 1.6 gpf toilets, in basic white, ranges from $60 to $80. Pressurized tank designs, which are now available from virtually every manufacturer, are priced wholesale at $140 to $180 in basic white. The new Trocadero pumped toilet is being priced in line with pressurized tank models.

The economic arguments in favor of 1.6 gpf toilets are quite persuasive. Depending on how much a homeowner pays for water and sewage, and how many people live in the house, savings could run anywhere from $20 to $70 a year. If the municipality offers a rebate for the installation, the new toilet pays for itself in a matter of months. For example, in New York City, where water and sewage rates have gone up 150% since 1985, homeowners can receive a $240 rebate for replacing their old toilet with a 1.6 gpf model. (The second toilet in the home is eligible for a $150 rebate.) Similar rebates programs, though not as generous, have been offered in Los Angeles, Denver, Tampa, and other cities.

Low-flow toilets can also benefit homeowners who use wells and septic systems. On the supply side, the draw on the well is substantially reduced. On the drain line side, the hydraulic loading on the septic tank and leach field goes down, which extends its life. Moreover, the homeowner won't have to have the septic tank pumped out as often.

Installation

Installing 1.6 gpf toilets, whether gravity, pressurized, or pumped, doesn't present any special problems. Rough-in is still 10, 12, or 14 inches from the finished wall and a standard wax ring is used with two or three closet bolts to secure the fixture.

In the future, however, the installation of low-consumption toilets may enable builders to make money-saving changes in new construction. Experts in the plumbing field, like Dr. Larry Galowin of the National Institute of Standards and Technology, say that low-consumption toilets will make it possible for residential builders to downsize drain line pipes from 4 inches to 3 inches in diameter, and to reduce the diameter of stack vents from 2 inches to 1 inch, or even 1/2 inch. Also, new septic systems can be installed with smaller tanks and leach fields, a cost-cutter that's already allowed in some code jurisdictions.

"The research has already been done on downsizing drainage systems for low consumption toilets," says Galowin. "The problem is that code writers generally haven't caught up with the technology yet."

Maintenance

Both gravity and pressurized type toilets have proven themselves reliable in the field and comparable to one another in terms of maintenance. Though builders and plumbers are sometimes leery of new technology, pressurized tank toilets meet ANSI test standards that require 150,000 flushes, equivalent to 20 years of service.

"My own feeling is that pressurized tank toilets are actually a little easier to maintain than gravity types," says Pete DeMarco, of American Standard. "All the moving parts are contained in a small cartridge that takes about five minutes to replace."

As for Kohler's new Trocadero pumped toilet, the company says the entire pump assembly can be pulled out and replaced in five minutes. The pump itself is rated for a 20-year life.

Perhaps the biggest drawback to pressurized tank toilets, and the one most likely to elicit a comment from the customer, is their vigorous and relatively loud flushing action. Some types of gravity toilets, as we noted before, may draw complaints from customers who are annoyed by the occasional need for a double flush or because they have to use a scrub brush more often. ■

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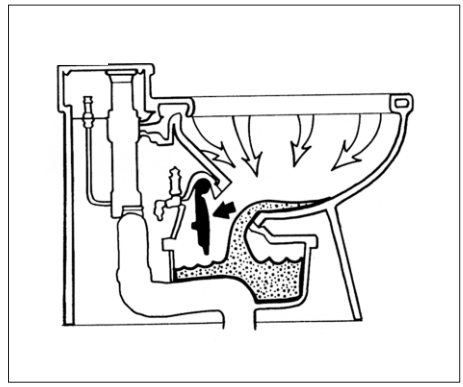
The Stingiest Flush of All

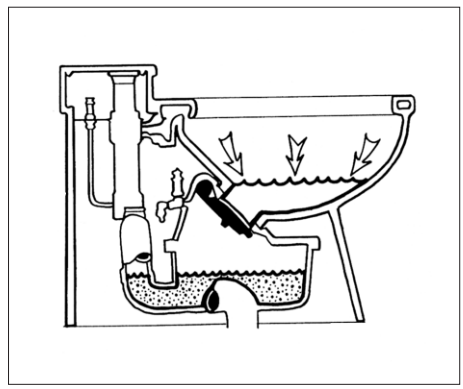
On sites where water supplies are severely limited or where the soil has poor percolation, making conventional septic system design impossible, a *Microflush* 0.5 gpf toilet could be the answer. The Microflush uses water to flush out the bowl, but relies on compressed air to push the wastes out of the toilet's lower chamber and down the drain line. The Microflush is manufactured by Microphor Inc. of Willits, Calif., and lists for $460 without the compressor.

— D.B.

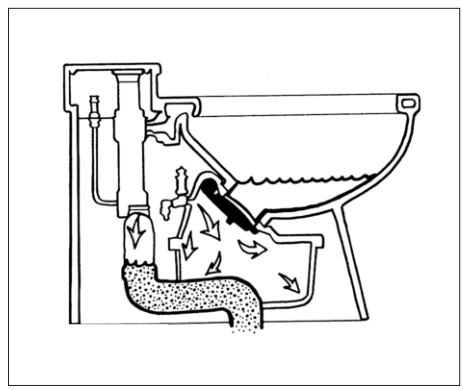
How the Microflush Works



When the handle is pressed, the flapper valve opens, and the water in the bowl empties into the lower chamber. At the same time, clean water enters from around the rim, rinsing the bowl.



As clean water continues to flow, the flapper valve closes, holding the water in the bowl until the next flush.



With the flapper valve closed, compressed air forces the waste water out of the lower chamber and into the waste line.