White Paper

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A High Head Centrifugal Grinder Pump For Use in Residential Low Pressure Sewer Applications

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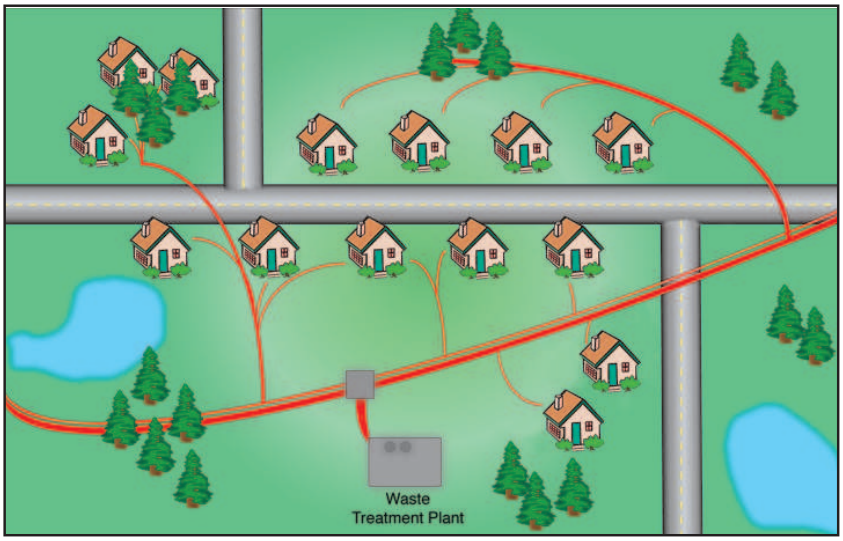
Overview of Pressure Sewer Systems

Pressure sewer systems are an effective method to transfer residential wastewater through small diameter pipes to collection or treatment facilities where other methods are less economical or less feasible. The primary differences between conventional gravity sewer systems and pressure sewer systems are in the piping network and the reduction of solids size in the wastewater at each residence.

A gravity sewer system collects wastewater from homes and transports it to a collection line by allowing gravity to force the flow. Collection lines are pipes that are installed at a slope to keep both water flowing and solids in suspension. A gravity sewer system involves digging wide, downward-sloping trenches. This method works for downhill grades but is challenging when the terrain is rocky or slopes uphill. Other challenges include a high percentage of sandy soil, proximity to water or long piping runs. Lift stations are often combined with gravity sewers to "lift" the sewage flow and ensure that it keeps moving.



Pressure sewer systems have key advantages when compared with gravity sewer systems. These advantages can be categorized in five areas:

1. **Smaller Pipes**
   Smaller pipes requiring narrower and shallower trenches reduce material and installation costs.

2. **Compatibility with Existing Collection Systems**
   Pressure sewers are compatible with other existing collection systems. Pressure and gravity sewer technologies can be mixed and matched into site-specific designs to provide a complete solution to wastewater collection challenges.

3. **Freedom from Infiltration**
   Pressure sewers offer freedom from infiltration/inflow because the systems are sealed. With residential pressure sewers, the only extraneous water entry points in the system between the homes and the treatment plant are the homes. A gravity-based system requires manholes to be placed at set distances and at every pipe-turn. These manholes are potential entry points for infiltration/inflow.

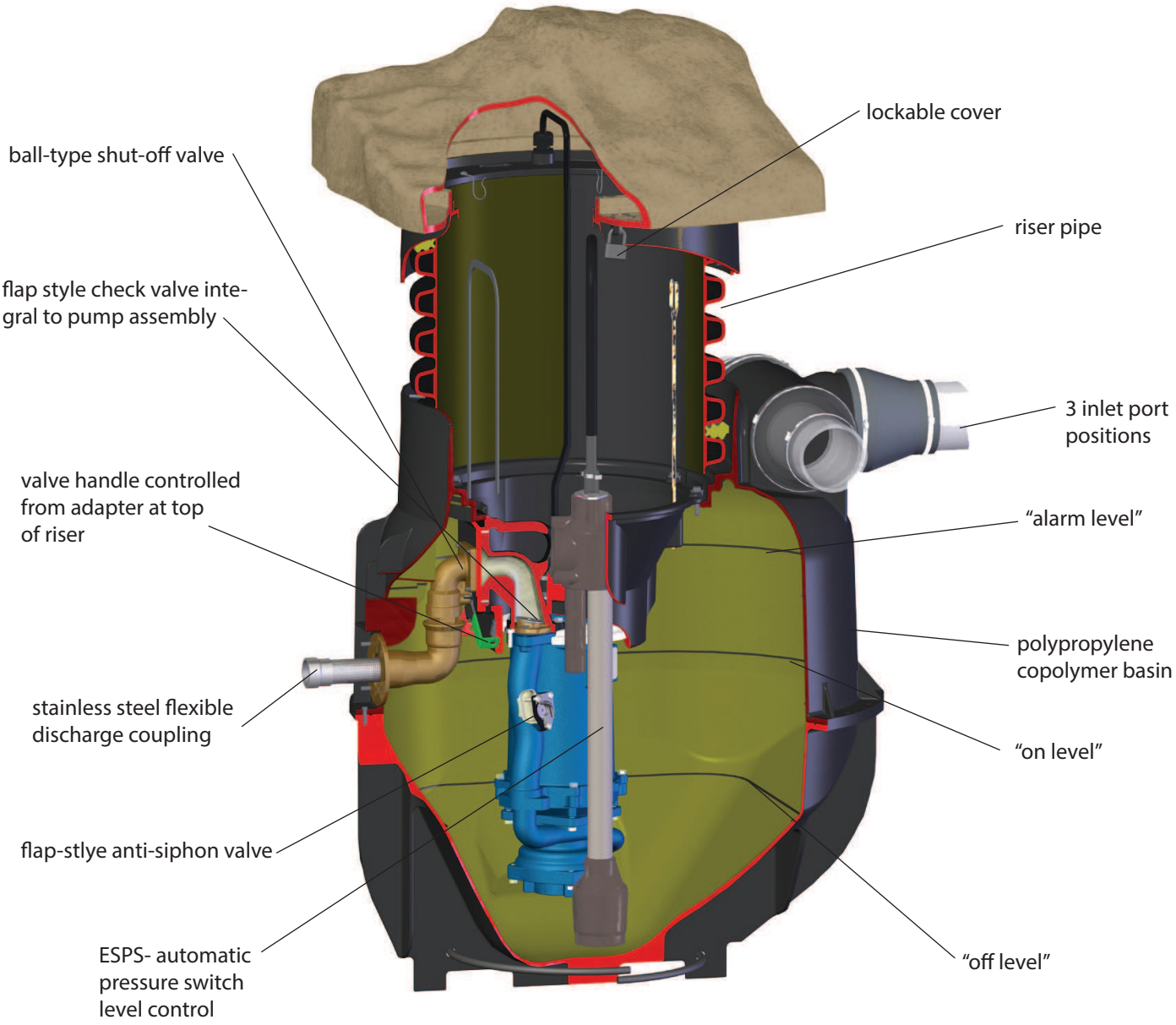
4. **Reduced Capital Costs**
   Pressure sewer systems can reduce capital costs. Upfront capital costs associated with pressure sewer systems are generally lower than other sewer systems.

5. **Odor Control**
   Pressure sewer systems control odor more effectively than gravity systems. Odors can be an occasional problem in any wastewater system. Large-diameter, long-distance gravity mains can be a source of gas generation and odor. The short retention time and closed network of the small-diameter pipelines of a pressure sewer system are inherently less susceptible to these odor problems.

Pressure sewer systems use specialized submersible grinder pumps, which are designed to reduce sewage particulate size to easily move the sewage through small diameter pipes.

The use of grinder pumps in pressure sewer systems is a cost-effective method of giving homes access to a public sewer or wastewater treatment system.

Pressure sewer systems can be used where gravity systems won't work because of uphill topography, surface rock, high water tables, waterfront locations, very flat land and other constraints on excavation. In general, these systems are installed outdoors, below grade, with a locked cover mounted just above grade. The burial depth (i.e. basin length) is set by local codes and usually depends on maximum frost depth and residence elevations. A typical system includes a pump, basin, controls, piping and valves.



EcoTRAN Pressure Sewer Station

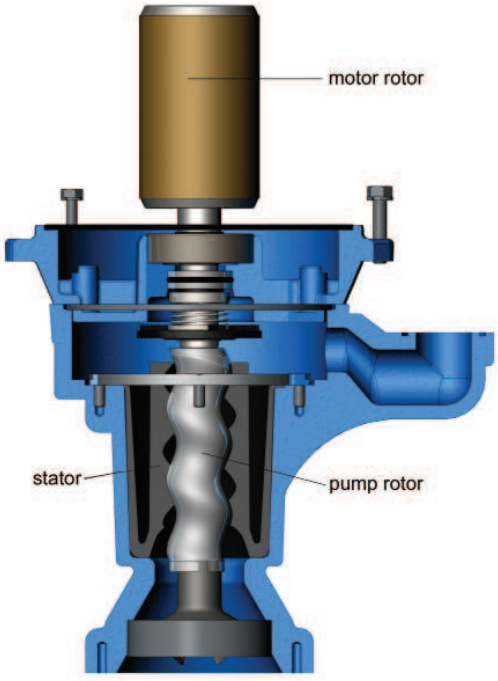
Grinder Pumps

The heart of a pressure sewer system is the grinder pump. Wastewater flows from the house to the pump basin via gravity. Once wastewater fills the basin to a predetermined point, the level sensor signals the pump to turn on. This pump grinds the particulates in the sewage into a fine slurry and pumps it out the small diameter pipeline to the pressure main, where it ultimately flows to a collection point or directly to the waste treatment plant.

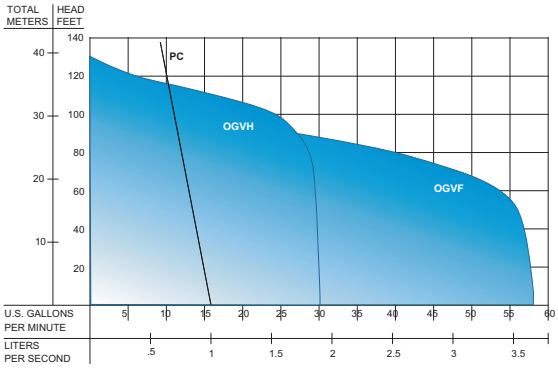
There are two basic forms of grinder pumps utilized in pressure sewer systems, both of which have been in use for over 40 years. The first, a centrifugal pump, utilizes a grinder mechanism to reduce any particulates and then a vortex-style centrifugal impeller that pumps the resulting sewage slurry into the piping system. The impeller is so-named because as it is rotated, the motion of the impeller blades creates a vortex within the pump casing that carries the slurry out with the vast majority of particles never coming into contact with either the impeller or the casing. A vortex pump, therefore, offers long life as it experiences very little wear.

The other style of grinder pump in use today is a progressing cavity pump. After flowing through the grinder mechanism, pumping is performed by a specially shaped stainless steel rotor that turns within a multi-lobed rubber "boot" or stator to develop the necessary pressure. The perceived advantage of a progressing cavity, or PC pump, is that it pumps a fairly narrow range of flows depending on system pressure. However, the design has a major drawback: A PC pump operates with a friction interface between the rotor and stator, so that it is slowly but continually wearing. That wear rate increases with excessive pressures or higher than expected flow rates that increase pump operating time.

As a result, many engineers specify centrifugal grinder pumps when system heads are expected to be below 100 feet, but switch to PC grinders when higher heads are expected. When systems designed with PC pumps have experienced premature failure due to unexpected higher pressure or inflow, many users have wished for high head residential-sized grinder pumps with the life of a centrifugal vortex design.



Partial view of Progressing Cavity Grinder Pump



OGV / PC Curve compares typical centrifugal grinder (OGV) to progressing cavity (PC)

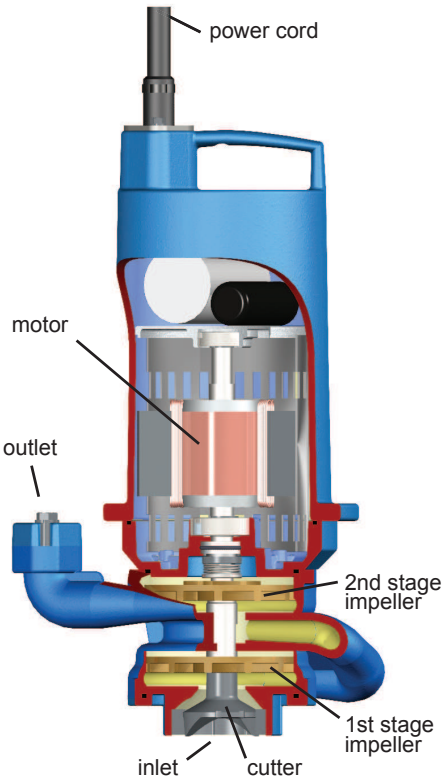
High Head Centrifugal Grinder Pump

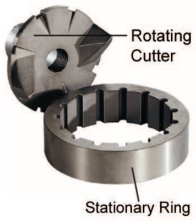
Centrifugal grinder pumps capable of heads to 200 feet are available for use in commercial installations with correspondingly higher flow rates, but they require motor sizes that are inappropriate for residential applications. In response to the need for a long-life grinder unit suitable for residential use, Crane Pumps & Systems developed a low horsepower centrifugal vortex grinder pump that combines long life with high head capability that outperforms progressing cavity grinder pumps.

This pump, known as the Barnes Omni Grind Plus™ or OGP, is a 2HP two-stage design that meets the needs of residential pressure sewer applications. The pump easily handles higher system heads, with a maximum head of 200 feet and will pump nearly 30 gallons per minute when heads are 125 feet or less. An advantage of the vortex design is that the pump can operate at maximum head or anywhere on the pump curve with no damage or excessive wear. To ensure maximum life, the pump is provided with silicon carbide mechanical seals and 100,000 hour, angular contact, oil lubricated bearings. The start and run capacitors are mounted within the motor housing eliminating the need for a control panel.

The OGP is fitted with the Barnes Exclusive Slicerator™, a hardened stainless steel cutter and ring that utilize a "slicing" rather than "chopping" motion for superior grinding that eliminates jamming. The stationary ring is reversible in order to double life, and the cutter has two alternating cutting edges to minimize starting torque.

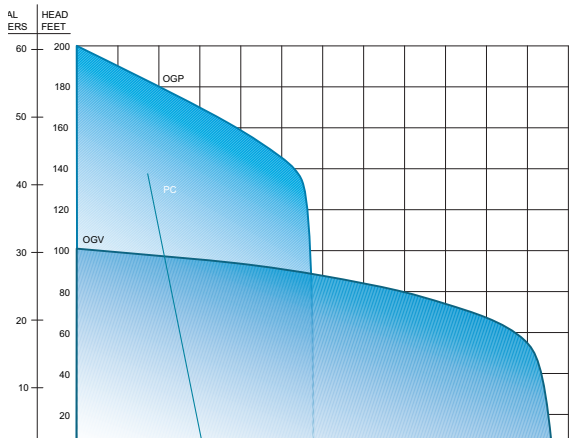
OGP Cross Section





Barnes Exclusive Slicerator™ eliminates jams

NSF / ANSI 46 Challenging Material 6 Week Test	Times / Day	Days / Week
Toilet tissue	4	5
Facial tissue	2	5
Filter tip cigarettes	1	5
Egg	1	5
Paper towel	1	5
Personal hygiene products	1	5
8 oz, chlorine laundry bleach	1	5
Cotton swab w/ plastic stick	1	5
Large disposable diaper	1	5
Adhesive bandage, wrapper	1	5
Dental floss, 12 inches	1	5
8 oz, alkali drain cleaner		1
Handi-Wipe or equivalent		1
8 oz, acidic liquid drain cleaner		1
4 oz, liquid animal fat		1
One pair large panty hose		1
Wet cloth diaper	Once During Test	
Toothbrush		
Wood pencil		
Plastic table utensil		
Metal bottle cap		
HDPE bottle cap		
Metal toy car		
Crushed 8 oz drinking glass		



OGP / OGV / PC Curve compares high and moderate-head centrifugal grinders with PC

Testing Program

During the development of the Barnes OGP, the testing program was a primary focus of the engineering team. Performance and hydrostatic testing was performed on all of the pre-production prototypes as well as the individual wet-end components. Motors were tested for torque versus temperature rise to ensure proper loading.

An accelerated grind test was performed in which all of the items listed in the 6 Week NSF46 test standard were introduced into the pump over an eight-hour period with no difficulty. A long-term performance test program was also performed. Most grinder pumps in residential use operate only several times per day for a few minutes at a time, so a valid estimation of life can be obtained by two tests.

In the first test, two groups of pumps were operated continuously for 10,000 hours, one group near shut-off (far left of curve) and the other near run-out (far right of curve). These two conditions represent the highest loads on centrifugal pumps, and the hours of operation roughly equate to ten years of operation in a pressure sewer application. In the second test, we operated a group of pumps in basins on a continuous start-stop basis through 100,000 cycles, or ten years' worth.

NSF/ANSI 46 – 2002

While the accelerated Grind test provided a good indication of the pump's ability to handle solids, a full-fledged 6 week test to the requirements of NSF/ANSI 46 would be a more significant test. The NSF standard calls for a performance test as a baseline, a six-week period of operation at various capacities with the introduction of challenging materials, and a final performance test to confirm that performance has not decreased. During test, the pump is cycled 24 hours per day, seven days per week with a minimum of ten starts per hour to simulate actual use. The test pump is then disassembled and inspected to ensure that wear and accumulation of materials does not occur. Some of the mandated challenging materials introduced during the course of the test include paper and cloth towels, laundry bleach, various sanitary products, disposable diapers, panty hose, ground glass, alkali and acidic drain cleaner, a toothbrush, a plastic utensil, bottle caps, even a metal toy car! The OGP handled all of these except the toy car, which only sat on the bottom of the basin.

As a result of this testing, CSA and NSF have certified that the Barnes OGP & OGV Grinder Pumps meet the requirements NSF/ANSI 46, "Grinder Pumps and Related Components".

Installations

A large number of Beta site installations were utilized to verify pump operation in real-world conditions. In some cases, the OGP replaced progressing cavity pumps of two different manufacturers that were experiencing stator wear. Pump performance was found to be impressive, as the OGP is nearly impervious to high pressure or high inflow volume effects. Contrary to some notions, OGP units operated in systems containing progressing cavity pumps had no impact on the wear rate or life of the PC pumps.

Barnes OGP grinder pumps are now successfully operating on a wide variety of difficult, as well as normal, pressure sewer applications. The pump has proven to be a dependable answer where high heads or high flow rates may be encountered. The vortex impeller design allows operation anywhere on its curve, so the pump is truly a universal pump for use in pressure sewer applications.

Adopted from SWPA White Paper,

"A Pressure Sewer Overview"

Glossary

Barnes Exclusive Slicerator: A radial cutter assembly made out of hardened RC55 440C stainless steel that is designed with staggered slicing action with angled cutter shears and fibrous materials.

Centrifugal grinder pump: Transfers waste fluid by using centrifugal force via the rotating vortex that radially flows the resulting sewage slurry outward into a volute chamber and then into the piping system.

CSA: CSA International certification marks indicate that a product, process or service has been tested to a Canadian or U.S. standard and it meets the requirements of an applicable CSA standard or another recognized document used as a basis for certification. CSA International tests products for the North American and International markets against applicable standards including those of the:

- Canadian Standards Association (CSA)
- Underwriters Laboratories (UL)
- National Sanitation Foundation (NSF)
- American National Standards Institute (ANSI)

Source: http://www.csagroup.org

Gravity Sewer system: Sewage disposal method that collects wastewater from homes and transports it to a collection line by allowing gravity to force the flow through gradually sloping pipelines. This method requires additional pump lift stations and manholes that are not required when using a pressure sewer system.

Infiltration: Process by which rainfall and other sources of water accumulates on the ground surface and enters the sewer system.

Mechanical seal: Prevents leakage of fluid to the motor by protecting or isolating the motor area of a pump from the liquid end of the pump.

NSF: NSF develops standards, and tests and certifies products and systems. Certification involves regular on-site inspections of manufacturing facilities and regular re-testing of products to ensure that they continue to meet the same high standards required to maintain certification over time.

Source: http://www.nsf.org/about-nsf/

NSF/ANSI 46 Certification: Evaluates the performance of wastewater treatment system components and devices, such as grinder pumps, and establishes minimum material, design, construction, product literature and performance requirements for components and devices used in handling, treating, recycling, reusing or disposing wastewater.

Source: http://www.nsf.org/

Pressure Sewer system: Sewage disposal method that transfers wastewater through small diameter pipes to collection or treatment facilities. A grinder pump breaks down large solids in the pumping station before they are transported through the collection system.

Progressing cavity grinder pump: Transfers waste fluid by utilizing two primary components, a metal rotor and a matching elastomeric stator, that together produces the necessary pressure to move the fluid outward into a volute chamber and then into the piping system.

Starting Cycle: Number of times an electric motor starts in a given time, as well as, the duration of the operation.

Vortex impeller: The swirling action of the impeller blades creates a region within a fluid (liquid vortex) which, in turn, imparts its energy to the pumped fluid.

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