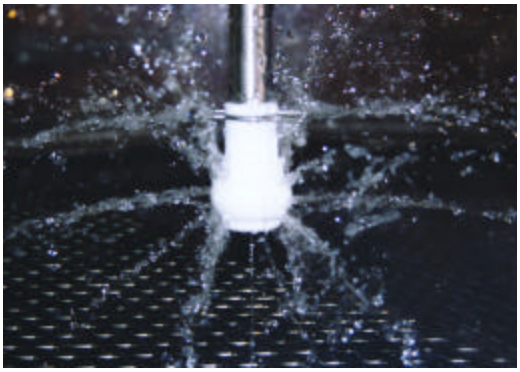

## Choose or Lose: Selecting the Right Tank-Cleaning Device for Your Application

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With the broad selection of tank cleaning devices available today, the thought of manually cleaning a tank, mixer, duct, or other vessel should be a thing of the past. Unfortunately, reports surface too often of injuries and even asphyxiation deaths from workers entering tanks for cleaning. What is most disturbing about this is the fact that there are commonly available, inexpensive products that can prevent these situations.

Automated tank washing processes can be adapted to virtually any equipment configuration, large or small, simple or complex, easy or difficult. With at least a dozen manufacturers of such devices, there is no shortage of equipment choices. The most difficult question in many situations is simply, "What will work best for my application?"

For purposes of this article, we will limit our scope to evaluating individual tank washing devices, and how they are used. We will examine both static and rotating devices, as are commonly available from a large group of manufacturers. Full CIP systems and how they are configured are beyond what we can cover in this type of venue. We will consider various types of cleaning situations, requirements of different tank sizes and configurations and the spectrum of tank washers available.

Let's begin the process by describing cleaning functions in a way that we can use throughout the discussion. For convenience's sake, here are three 'classes' of cleaning that present different challenges. The term 'soil' describes any material that we want to clean from the affected surfaces.

**Class I:** Here the soil is simply a liquid residue or light powder that does not adhere aggressively to the surface. Cleaning is simply a matter of rinsing the surface with a solution that washes away the soil and possibly disinfects the interior. Spray impact does not contribute significantly to the process. An example of this would be a tank used to hold milk.

**Class II:** This is a slightly more difficult situation where the soil does not rinse away as easily, but can be dissolved by the cleaning solution. Spray impact helps move the process along.

Over time and with enough liquid, the surfaces will come clean. An example of this would be a tank that held molasses or white glue. It doesn't wash off easily, but water will soften it and wash it away.

**Class III:** Here is the most difficult situation where the soil does not dissolve in the cleaning liquid. The cleaning process depends on the impact of the spray and washing action of the liquid to break up and carry away the soil. An example of this would be a tank that held a powder that does not dissolve in water. Any caking on the walls needs to be blasted off and washed away with enough force to keep the soil moving.

Of course, there are infinite variations between these three designations based on the application. Nonetheless, these should help as you evaluate your own specific needs. The sizes and configurations of tank washers make them particularly suited to cover specific portions of the spectrum. Choosing an inadequate design can cause obvious problems, but making a choice that is overkill can be costly in purchase price and ongoing liquid consumption.

A. Major design groups

While there are dozens of tank washer designs from various manufacturers, for the most part they can be separated into three general classifications:

- **Static**—Single or cluster nozzles designed to cover large areas without rotating.
- **Free spinning reaction heads**—Rotating heads powered by the reaction force of tangentially directed sprays.
- **Mechanically driven**—Units driven by liquid pressure or external power using gear drives for controlled pattern rotation.

There are a variety of designs within each class, each with its own advantages and disadvantages. No single design works best for every application. Benefits balance drawbacks and there are performance tradeoffs at every turn. Your best position is to understand each of these and make an effective choice for your specific needs. Below are the primary considerations for the major design classes. There are exceptions to every generalization, but this information applies in the widest range of cases.

**STATIC TANK WASHERS**

The simplest and generally least expensive tank washers are nozzle heads that do not rotate, but provide wide coverage through the use of a cluster of individual orifices or slots. They come in a variety of sizes and shapes and can be further grouped into sub classifications.

**1. Spray Balls**—These use a hollow shell, shaped like a small pumpkin, with a large group of small holes to form many small solid stream sprays when the head is pressurized. In some cases there can be slots around the "equator" that send out a fan of spray in combination with the small holes.

**Best applications:** Class I and possibly light Class II cleaning with smaller tanks, usually smaller than 10' in diameter. The design adapts well to specialized and directional coverage requirements given its ability to concentrate spray wherever it's needed. It can mount in any position since it has no rotating parts.

**Drawbacks:**

- The tank surface where the spray hits is a very small portion of the inside surface, and it receives all the impact. The balance depends on wash-down action.
- Small orifices clog easily, forming voids in the spray. Also, spray balls frequently become the "system strainer" by trapping debris. Make sure you install them where they can be cleaned out easily or use very clean liquid supply. Otherwise they gradually fill with junk carried by the liquid and drastically reduce their effectiveness.

**2. Cluster Full Cones**—Here a group of full cone nozzles are mounted on a central hub that acts as a common liquid supply. The sprays overlap so there is a cloud of droplets to provide very complete coverage. Flow rates range from less than 10 gpm up to several hundred gpm, so the size range is huge.

**Best applications:** Class I and possibly light Class II cleaning with smaller tanks, usually smaller than 8-10' in diameter. In most cases smaller tanks are better, as impact falls off quickly as the spray travels from the orifice. With larger tanks, the impact is minimal, but the coverage is complete. If the application demands a gentle spray, this is the first choice.

**Drawbacks**

- In most applications, a gentle spray is undesirable due to the low impact. However, if the tank is small enough, the impact can still be effective.
- The total flow rate of the head is typically divided among 13 or as many as 21 individual nozzles. Thus, the orifices might be small enough to clog if the liquid supply is not clean. Think in terms of the individual nozzle capacity rather than the total when you're sizing a strainer.

## FREE SPINNING REACTION HEADS

This classification is the largest and most varied. Reaction powered rotating tank washers are available from at least a dozen manufacturers. They range from tiny heads less than 1" in diameter to huge units that spray hundreds of gallons per minute. When making a selection, a number of considerations apply to the whole variety:

**Best applications:** All classes of cleaning, especially I and II. Class III is also possible if the impact requirement is not huge. Given the variety of designs, free spinning heads can handle

everything from a bucket to a tank 40' in diameter. Still, note that spray impact falls off quickly as distance increases.

**Drawbacks:**

- Anything that rotates has the potential to jam. Choose carefully based on the quality of your water and the nature of the application.
- Some only work well when mounted straight down. Others work in any mounting orientation. Be careful to check before purchasing.
- You must control the feed pressure, otherwise the spray head can rotate so fast that it interferes with effective spraying. High speeds cause small droplets to form that do not carry as far or impact as much as large droplets. Frequently 30 to 40 psi is the useful upper limit.

Overall, when looking at a specific design and matching it to an application, think through its particular features with the following points as your guide:

**Flow Rate:** It is difficult to give universal guidelines for how much liquid it takes to wash a tank since conditions vary widely. Suggestions range from .2 to .5 gallons per minute per square foot of internal tank surface. If there are few obstructions so the spray can propagate easily, and the tank is not too large, the lower end is adequate. For more difficult installations or aggressive soil, a higher flow rate may be required. Higher flow units normally produce larger droplets that carry over greater distances and hit with more impact.

**Spray Distance:** Make sure the unit you are considering has sufficient power to project the spray far enough to work satisfactorily in your application. Remember:

- Impact falls off quickly as the distance from the nozzle increases. A specific tank washer may wet the walls of a large tank, but may not have sufficient impact to strip the soil.
- Since effectiveness does not always increase with pressure, test your application carefully to find how high you can go before impact is lost from excessive spinning or atomization.
- There is no standard for impact or cleaning power, so information from one manufacturer will not necessarily relate to another. Only your experience will give you valid information for comparison.

**Material of Construction:** Almost all designs are either made from stainless steel or plastic, primarily PTFE (Teflon® using DuPont's name) but a few others like PVDF and polypropylene are also available.

- All-stainless steel units are very durable and can be subjected to extreme temperature ranges. The main drawback is ensuring that you have an appropriate grade, if your environment is particularly corrosive. Units in exotic materials are very expensive.
- All-plastic units are becoming more common. They tend to be inexpensive, especially those made from injection molded PVDF. All-PTFE units are an excellent choice for the most corrosive applications. While inexpensive, they are disposable since they cannot be reconditioned.

- Stainless steel with plastic bearing inserts is a good compromise. This can be disassembled easily and the inexpensive plastic inserts replaced as they wear.

**Nozzle Design:** Tank washers have an amazing variety of nozzle and orifice designs:

- "Cat Eye" flat fans offer a wide spray for complete coverage combined with large free passages that resist clogging. A tank washer can give 360° coverage with only 3 or 4 orifices. This style of orifice is the most common for standard flat fan nozzles used in countless other cleaning applications.
- Deflectors offer many of the same characteristics as "cat eye" orifices, but are less common.
- Solid streams maximize impact but sacrifice coverage. Cleaning between the streams depends on wash-down and may create internal stripes if the soil is difficult to remove. If there are lots of small holes to fill in gaps clogging problems may occur.
- Slot orifices offer good coverage, however they can accumulate debris and form voids in the spray. Make sure you have clean water or a good strainer.
- Count the number of orifices. In most cases, the fewer, the better. Larger orifices produce larger droplets and higher impact. Larger orifices also clog less.

**Coverage:** Most tank washers offer 360° coverage to wash the entire interior of the vessel. However, there are a variety of spray angles that concentrate the spray in a specific direction. Look at each application carefully and don't use more coverage than you really need. If you only need to wash below the head, use a design that only sprays down. Otherwise you are wasting your cleaning power on parts that don't need it.

**Bearing configuration:** Anything that rotates has to have a bearing. Since this is a critical aspect of tank washer construction, it deserves special thought:

- All stainless steel bearings are durable, resistant to temperature extremes, and do not allow for static electricity build-up. They also spin easily which can make speed hard to control. If you are working in a corrosive environment, make sure you know what material the balls are. Frequently manufacturers use a harder grade of stainless for longer life that is not as corrosion resistant. Check to make sure the unit will spin if you plan on mounting it sideways or upside down.
- Plastic bearings, primarily PTFE, when combined with other stainless steel components, offer a good compromise. They normally limit the rotational speed, at least until they begin to wear and loosen. Under high pressure or high temperature situations the PTFE can deform, leading to bearing failure. Some manufacturers offer special materials for such applications.
- Tank washer bearings leak. This happens with all models and actually helps flush and lubricate the bearing. When wear advances to the point where there is excessive mechanical play between the components, it's time for maintenance.

## MECHANICAL OR GEAR-DRIVEN DESIGNS

These are the "bigger hammers" of the tank washer product spectrum. These units use a small group of nozzles, usually solid streams, to sweep the interior of the vessel following a gear driven path. They are the most powerful and can clean the largest vessels, but this comes with a tradeoff of higher cost and mechanical complexity.

Looking at the product offering in this design class, there is a huge range of sizes, flow rates, operating pressures, and characteristics. Given the cost of such units, it is worth spending some time making a thorough evaluation.

**Best applications:** Class I cleaning for very large tanks. Class II or III cleaning in the most difficult situations, or where the sheer size of the vessel demands the most extreme solution. Spray radiai of 40 to 50 feet are possible. For smaller tanks where the soil is difficult to remove, this may be the only practical method.

**Drawbacks:**

- Gear driven units wash using a specific pattern that eventually covers the entire interior of the tank. While this is very thorough, it takes a long time to complete the task. With each revolution they typically advance 5° to 10° so they need 40 to 80 or more turns to make a complete circle. Cleaning may require even more than one circle. Shortening the time will leave areas that are not hit directly by the spray. Yet, if a light wash is all that's required, an incomplete cycle may be enough.
- Water quality becomes a greater concern where there is a more sophisticated mechanism. Debris or abrasive products in the liquid can stall or cause premature wear on the moving parts. Manufacturers go to great lengths to minimize the effect of this, but filtration is still recommended. Some models are more tolerant than others, but it is difficult to get objective information without direct experience.
- Most units give 360° coverage. There are very few units that only spray one direction.

When looking at a specific design and matching it to an application, think through the particular features with the following points as your guide:

**Nozzle count:** Units are available with 1 to 6 solid stream nozzles, with 2 and 4 the most common. The total flow of the unit is divided among all the nozzles.

- Adding nozzles gives more coverage with each rotation so the interior is swept completely in less time.
- Fewer nozzles concentrate the cleaning power and increase spray distance for a given flow rate. The streams are heavier and have higher impact when not divided among too many orifices.

**Operating pressure:** Gear driven units can run at anything from normal water line pressure to 20,000 psi. Obviously no single design covers that whole range. You need to look at your needs and consider how far you must go to get the job done.

- Each design specifies an operating range. The low end is the amount to make it move and the high end is the maximum speed the mechanism can withstand. With too much pressure the unit may rotate too fast and wear out too quickly.
- While higher pressure cleans better, it takes a lot of horsepower to provide an adequate volume of water for that level. A small high-pressure head that sprays 20 gpm at 10,000 psi has to have a 200 hp pump behind it. Even 35 gpm at 1,000 psi takes 30 hp. Make sure you have the pumping capacity before you consider entering the pressure stratosphere.

**"Lance" designs:** Some manufacturers offer versions called lances where the main drive mechanism stays outside the tank and only the actual washing head extends inside on a pipe.

- When size is critical, a lance can keep the diameter to a minimum to allow insertion through an opening too small for a self-contained unit.
- The insertion distance is limited by overall lance length. If there are a large variety of tank sizes, this can be a drawback.
- For explosive atmospheres or high purity installations such as pharmaceuticals, many users like to keep as much of the mechanism as possible outside the tank.
- If you need to operate at a wide range of pressures, a lance can give independent control of the rotation speed regardless of the liquid pressure.
- The power source on a lance is either the spray liquid or an external drive mechanism using an electric, hydraulic or compressed air motor to provide the rotation force. This provides flexibility for the installation but requires an additional connection to the unit.

**Lubrication:** Some units have sections of the mechanism sealed and packed in oil or grease. This protects more complex gear trains and minimizes wear. While this was more typical in years past, there are some units currently available that still use this approach or have it as an option. The main drawback is the potential for contamination if the washing medium breaks through the seal and the grease leaks into the process. On the upside, a sealed unit can help when using poor quality water since the water flows through less of the mechanism. With the development of more sophisticated materials, most tank washers are now are lubricated only by the washing medium. Well-designed units direct the flow through the internal passages to keep them flushed with fresh supplies of liquid so no sediment or debris accumulates.

**Serviceability:** As a piece of mechanical equipment with moving parts, a tank washer requires maintenance. With most you have the option of returning them to the manufacturer or doing the work yourself. Since the mechanisms vary in complexity between manufacturers, this is something to keep in mind. You can always ask to see the service manuals before you buy.

## HYBRID DESIGNS

There are a few tank washers that resist classification into one of the three groups. Since they are usually unique to one manufacturer it's difficult to go into much depth without giving a sales pitch. If you carefully study the literature you receive from various manufacturers, you may find

models with attributes that fall between the groups. Given the number of units on the market, there is little reason to believe that you can't get exactly what you want within practical limits. The key point is to shop around and discuss the matter with people you trust.

## General Considerations and Practices

Regardless of the tank washer design you choose, some considerations are universal. These suggestions are exactly that: suggestions. Nothing is absolute. Nothing works every time for every application. Think through these approaches and decide what sounds best for your specific installations:

### Location and Mounting

In most cases, tank washers work best when mounted one-third of the way down from the top of the tank. This uses gravity to assist in the cleaning process as the cleaning solution washes down the walls. Depending on the diameter, more than one may be needed.

- If there are internal obstructions such as agitators or mixing paddles, more than one will be required to make sure there are no shadows where the spray is blocked. If possible, it helps to run the agitator during the cleaning cycle.
- If the tank is very tall such as a silo, it will help to have more than one tank washer operating at different levels.
- If the tank is horizontal and long but must be washed from only one location, a horizontal lance can help the spray reach into the ends.

Most washing takes place by inserting the tank washer through a spud or other access point.

- For portable washing applications, simply attach the tank washer to the end of a pipe and feed it with a hose. Just be careful not to bang the head on the spud or tank wall.
- For permanent installations, it is best to attach the tank washer to a pipe with a connection or flange that mates with the spud. Make sure that the material and washer design you use is appropriate for contact with the product should that occur between washing cycles.
- More sophisticated units offer retractable mechanisms that can insert and withdraw the lance for cleaning and operating cycles. Though expensive, this is the best in automated solutions.

If contamination is a concern, there are units designed specifically for critical installations such as dairy, food or pharmaceutical use.

- Most "sanitary" tank washers are the static spray ball variety or smaller free spinning units. More complex mechanisms offer too many potential sources of contamination in these applications.
- True "sanitary" tank washers need to conform to extensive design and mounting requirements to ensure that they do not retain either product or washing solutions after cleaning and operating cycles.

- For the most complete analysis on the topic, 3-A offers a new standard (just adopted officially in November, 1998) for tank washer designs. Ask a potential nozzle supplier if their unit is certified to 3-A Standard 78-00 for tank washers. This is the most sophisticated standard currently available.
- For this application there are also specific piping and mounting requirements that are addressed in the 3-A standard.

**The Cleaning Process**

Each cleaning situation is different. Washing a tank can be as simple as a water rinse or as complex as high pressure blasting with solvents that must be collected and incinerated. If you are not sure how to approach a new application, here is one method with many applications:

- Water pre-rinse, using your lowest quality water. This wets down the interior and removes any loose soil.
- First washing rinse, using a hot alkaline cleaning solution such as 1% sodium hydroxide.
- Water rinse to wash out the alkaline cleaner. This can be re-used next time for the pre-rinse cycle.
- Second washing rinse using an acid solution to neutralize any alkaline residue and make sure no scale is left behind from hard water. Shocking the soil from one end of the pH scale to the other also helps break it down.
- Final rinse with clean water. It can contain any specific agents you want to leave in the tank prior to the next operating cycle.
- There are a number of chemical companies that can help you select the best cleaning agents for your specific needs and equipment.
- Consider this carefully to make sure you are not creating hazardous wastes from the cleaning process that will require special treatment.

**Portable Cleaning vs. CIP**

Once you have studied your applications and chosen the appropriate tank washing nozzles, you now have the choice of either moving the tank washer from tank to tank or creating a CIP (clean in place) installation, by mounting it in one place where it will be turned on for each cleaning cycle.

Portable tank washing approaches work the best in the following situations:

- The tanks are close together so they can be washed from a central point.
- Sufficient water or cleaning chemical is available and handy. Even more important, you have a place for the used solution to drain.
- Cleaning cycles are infrequent.
- There aren't many tanks.

- You have adequate maintenance staff to get out and do the job.

Some plants have facilitated portable washing with carts that can be wheeled or driven around carrying the necessary chemicals, pumps and even water. Something like this coupled with a selection of tank washing nozzles is a practical way of moving around to cover all your applications with minimal manpower.

On the other hand, the broad selection of tank washing nozzles and their economical pricing is making permanent installation more and more attractive. The thought of turning a valve or pushing a button from a console to wash one or a group of tanks certainly has its appeal. Such CIP systems can be configured to wash an entire production line. A CIP system can be as simple as a mounted tank washer connected to a water supply pipe. Or, it can be highly sophisticated with automated controls to ensure that product is never contaminated with cleaning solution. Use the same analysis to select a tank-washing nozzle for CIP use that you would for any application. There are many engineering companies that can help you design a system with whatever level of complexity is required for your needs.

**Cleaning Validation**

The move from manual cleaning to a tank-washing nozzle requires a way to determine that your equipment is clean enough that it will not contaminate product.

Some products contaminate more easily than others. A bin that holds black plastic pellets for an injection molding machine can be cleaned two or three times a year with little chance of contamination other than a pencil or hardhat falling in. On the other hand, if that same bin is having the black pellets washed out and replaced with white, a few that stay behind can get carried into the white pellets and spoil many critical parts.

While that is an extreme example, the same could apply to a tank that holds two colors of paint or two different pharmaceutical products. Contamination in such a case could spoil the product or even be deadly.

The question is how to validate the cleaning process to ensure that the tank washer you have selected is doing its job. This is particularly critical if you are using an automated process where there will be no day-to-day inspection of the washing operation. To make things more complicated, if you are using a tank washer that rotates, there has to be a way to verify that it is indeed rotating, since this is critical to the cleaning process.

Verifying that soil has been removed can be accomplished in a number of ways depending on the degree of tolerable contamination. Two critical examples include dairy and pharmaceutical applications. A common dairy method is to take bacterial cultures using swabs following very defined procedures. This indicates whether disinfection has been sufficient to reach accepted levels. In pharmaceutical applications, tanks can be coated with proteins or other substances that

fluoresce under UV light. Inspection using this method shows any weakness to the washing process.

If your validation process also demands verification that the unit is turning, the sophisticated method is to insert a pressure sensor into the wall of the tank that can measure the changes in pressure on its surface as the spray passes by. There should be regular undulations in the measurement at the same frequency of the nozzle's rotation. A cruder method would be to listen through the wall of the tank using a stethoscope or similar device for the same pulsations.

These examples are at the high end of the spectrum. In less critical applications, you can verify cleaning and mechanical performance through regular inspection. Remember, any loss of vigilance in your inspection regimen could result in a contaminated batch of product. Tank washers, like most things in life, are not foolproof or infallibly reliable.

In conclusion, while not the silver bullet for every situation, tank-washing nozzles fill an important role for cleaning all manner of product handling equipment. When used properly with careful analysis and engineering, they can perform even the most critical operations easily and economically. In the process, your maintenance personnel stay outside the confined spaces, away from potentially harmful chemical contact.

For more information on automated tank washers, or to request a **free catalogue**, please contact:

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