

*A Guide to Tank Wash Nozzle Selection:
What Information is Necessary to Make the Best Choice?*

**Christine Pagcatipunan
Spraying Systems Co.
North Ave. At Schmale Rd.
Wheaton, IL 60189**

ABSTRACT

The popularity of automated tank washing systems has led to innovations in spray technologies particularly in the area of tank washing nozzles. Proper selection of an appropriate tank wash nozzle to effectively clean a tank vessel requires collaboration between the process plant personnel and the tank wash equipment manufacturer. Cleaning objectives are specific to a manufacturing process and must be established by plant personnel. Knowing the characteristics of the product residue left behind, the kind of cleaning solution needed, and the type of flow design to be used are important considerations. A variety of nozzles are available today and understanding spray nozzle performance is a key element in determining which tank wash nozzle is best to use. Such factors as flow rate, spray impact, spray coverage, and installation all affect how clean the tank vessel will be. This discussion will provide useful guidelines on how to select a tank wash nozzle that integrates knowledge of tank wash nozzle performance with a plant's specific cleaning needs.

The Process of Selecting a Tank Wash Nozzle

Input From

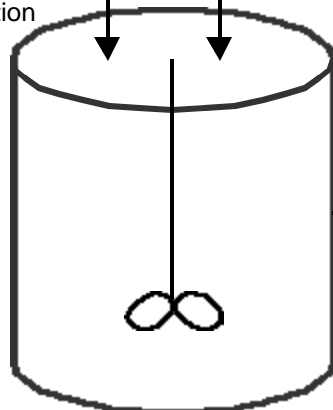
Process Plant Personnel

What is the product residue?
What is the temperature of the product residue?
What cleaning solution is needed?
What is the reason for cleaning?
What flow design is used?
What are the tank dimensions?
What is the size and location of the porthole opening?
What equipment is available?

Input From

Tank Wash Equipment Manufacturer

What are the basics of spray nozzle performance?
How do flow rate, spray impact, spray pattern, and spray coverage affect the cleaning efficiency?
What is available in spray nozzle technology, including the nozzles available and any accessories needed?



*Output From
Collaboration*

Which tank wash nozzle can fit the specific requirements?
What material should be used?
How should the unit be installed?

*Final
Selected
Product*

The best tank wash nozzle selected for the automated tank washing system.

Introduction

Process plants are now realizing the numerous benefits obtained from installing highly efficient automated tank washing systems to their cleaning processes. Just as washers and dryers replaced the old way of manually washing clothes and hanging them to dry, automated tank washing systems are replacing manual cleaning in industrial applications. Instead of sending workers into a vessel to clean it, installing automated tank washing nozzles can cut down on maintenance time and the workers are freed to work on other projects. This in turn will cut costs and keep workers from being injured especially when cleaning very large vessels. It also takes away the hassle of obtaining Vessel Entry Permit # 29 CFR Part 1910.146 that is required for entry of any tank per OSHA.

As the shift from manual cleaning to automated cleaning is becoming increasingly popular, tank wash nozzle manufacturers are continuously looking for new ways of modifying their existing products to clean tanks more efficiently. Several types of nozzles are available such as stationary, fluid-driven, and motor-driven nozzles that utilize various technologies to adapt to different cleaning objectives.

The primary objective of any tank cleaning project is to design a system that will clean, maintain, and sanitize equipment at appropriate levels to prevent malfunctions or contamination that would alter the safety, identity, strength, quality, or purity of the finished product. Each tank cleaning application is unique. Tank wash nozzles that are appropriate for one application may not be appropriate for another. Certain questions *(See Chart on The Process of Selecting a Tank Wash Nozzle on previous page)* can be asked as a guide to ensure that the best automated tank washing solution is selected. The process of selecting a tank wash nozzle requires knowledge obtained from the process plant personnel and the tank wash equipment manufacturer. Together, they can collaborate to find the best automated tank washing solution to meet the specific cleaning objectives.

Understanding the Cleaning Objectives

Identifying Product Residue and the Type of Cleaning Solution Needed

The tank vessel to be cleaned usually contains a product residue. A product residue is defined as any material that was left behind which should be washed away before another batch of product arrives. Residues can come in different forms, including:

- Residue that does not stick to the surface and can therefore be cleaned easily.
- Residue that does not wash away quickly but can be dissolved by the cleaning liquid.
- Residue that does not dissolve by the cleaning liquid but relies heavily on the spray impact to break up the residue and wash it away.

Each process plant manufactures a different product and requires various types of cleaning. Once the product residue is known, it is important to find a cleaning solution that will accomplish the job. The cleaning solution will react with the product residue in certain ways, either merely physically washing it away or dissolving it. It is important to know the temperature of the cleaning liquid, as this affects nozzle choice. Additionally, sometimes the tank will have a higher surrounding temperature when the product residue is contacted by the cleaning solution. This also affects the choice of nozzle, as it's important to ensure that the nozzle will still operate effectively at the higher resultant temperature of the vessel.

Cleaning Objectives

Each process plant should have a specific objective in cleaning. This will depend on the type of residue that was left behind and how it needs to be cleaned.

Rinsing involves removing the majority of previous product with water.

Cleaning will loosen and remove product residue by means of water and a cleaning agent.

Sanitizing. Application of sanitizing agents to all surfaces, per chemical supplier instructions, occurs during this stage. Micro-organisms are killed to an acceptable level.

Disinfecting kills 100% of most bacteria, not spores.

Sterilizing destroys or eliminates all forms of life.

The objectives for cleaning are important in tank wash nozzle selection because a tank that needs to

be thoroughly cleaned will require a different nozzle with more impact than one that requires only light rinsing. Also a rinsing application will use less water than a thorough cleaning will.

Flow Design

System flow design can take either of two forms:

Total loss:

This is when the cleaning liquid is used once and then discharged. In practice, this type of design is only applicable when cleaning is infrequent or very small volumes of liquid are needed. An advantage of this type of flow design is that it prevents cross contamination from cleaning liquids.

Partial or total recovery:

This is when the final rinse liquid is recovered and a water make up rate is determined for reuse. This recirculation cleaning system will be more contaminated than the total loss flow design. However, an advantage is a reduction in water and chemical costs.

Cycle Time

What is the minimum duration of the cleaning cycle? In many cases, more effective cleaning can be achieved by extending the time of a stage. Here's a look at four of the typical cleaning stages

- 1) **Pre-Rinse.** This stage typically removes 90% of the soil. Tests should be run during this stage to determine if debris and gross soil is being removed in the first cycle.
- 2) **Cleaning.** It is important to know how long the chemical needs to be in contact with the vessel walls during the cleaning cycle. Water temperature and spray impact are also important factors in the duration of this cycle.
- 3) **Post-Rinse.** During this stage, suspended residue and cleaning agents are removed. Rinse time should be adjusted so that no residue remains. Actual cycle time may be determined by nozzle selection, as tank wash nozzles utilizing solid streams must complete a pre-determined number of nozzle revolutions to complete one cycle. Depending on the corrosiveness of the cleaning agents used, a cold-water rinse may be recommended.

The Basics of Spray Nozzle Performance

Flow Rate

Nozzles provide a specific flow rate at a given pressure. In choosing a tank wash nozzle, it is advisable to use the least amount of flow rate that still adheres to the cleaning objectives. Using the least amount of flow rate reduces the amount of liquid needed, reduces the amount of effluent to be disposed of, and reduces overall energy costs.

👍 **Rule of thumb:** If there is uncertainty as to how much flow is required, a rule of thumb is to work on a *minimum* of 0.2 gal/min/ft² (7 liters/min/m²) of vessel internal surface area. A *good* working figure is 0.4 gal/min/ft² (15 liters/min/m²).

Spray Impact

Spray impact is the impingement force of a spray onto the target surface. There are no firm guidelines on how much impact is needed to clean a vessel. Many vessels require little impact force, relying on chemical action, water temperature, and rinse down provided by the nozzle. Other applications require some level of mechanized force, from increasing the flow rate at a given pressure to high-pressure solid streams for aggressive cleaning.

👍 **Rule of thumb:** In generating extra impact, increasing flow rate is more effective than increasing pressure. Doubling pressure gives approximately 40% more impact; doubling flow will increase impact up to 100%.

Spray Pattern

Spray nozzles are designed to distribute liquid in a controlled pattern with various defined characteristics. The patterns commonly used in tank washing applications are full cone, flat fan, and solid stream sprays.

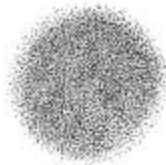
Solid Stream: This pattern is created when liquid leaves a round orifice in a circular pattern.



Flat Spray: This pattern is produced when a solid stream exits an elliptical orifice forming a thin elliptical “cat’s eye” shape



Full cone: An internal vane in the full cone nozzle causes some of the entering liquid to swirl and mix with non-spinning liquid. The mixed liquid exits the orifice in a conical pattern.



👍 **Rule of thumb:** With equal operating conditions, solid streams provide the greatest impact, followed by flat sprays and full cone sprays.

Greatest Impact:
Solid > Flat > Full Cone Sprays

Spray Coverage

Tank wash nozzles have specific spray coverages such as 360°, 180° up, 270° down, etc. This determines which part of the vessel the nozzle spray will cover.



180° up

180° down

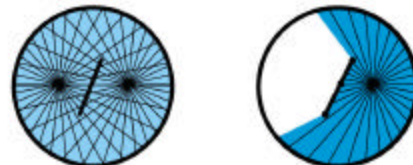
270° up

270° down

360°

Choosing the right spray coverage is important. A process plant should not use more coverage than is needed for this will result in more cleaning liquid being used than is necessary. If the vessel only needs cleaning on the bottom and the sides but not the top, then it would be wise to use a nozzle with a spray angle of 270° down.

Shadowing is a term used to define when a spray cannot directly reach part of the vessel because of an internal obstruction. This obstruction can be a mixer, agitator, or filling tube for example. The problem is to clean both the shadowed area and the obstruction itself. In cases where one nozzle cannot cover the entire internal surface, multiple nozzles are used.

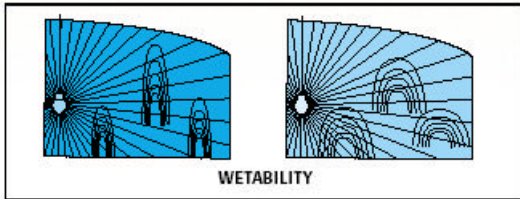


Spray Distance

Spray distance, sometimes referred to as “throw”, is defined as the distance between the spray exiting the nozzle orifice to the spray hitting the target surface. The spray coming from the nozzle should extend long enough to reach the walls of the tank vessel. Just because the spray reaches the tank surface, does not mean it can clean the heavily soiled areas. The spray loses impact the farther away it gets from the nozzle. Therefore, enough pressure should be supplied to the nozzle so that the cleaning liquid will be sprayed with enough impact and spray distance. Most nozzle manufacturers will specify the diameter of a tank vessel that the spray of the nozzle will reach in order to effectively clean the tank internal surface.

Water Quality and Chemicals

The water supply needs to be evaluated for any potential problems, such as dissolved solids or suspended particulate, which may interfere with the cleaning process. In some cases a chemical additive will increase wettability, and hence spread the spray onto the vessel wall by reducing the surface tension of the sprayed liquid. Bridging (the tendency of liquid to form streams and droplets rather than a continuous film) is also reduced.



Types of Tank Wash Nozzles Available

Tank wash nozzle manufacturers are always looking for better ways to improve nozzle designs and tailor them to a customer's specific needs. There is no one nozzle type that can be used for every application. Each nozzle type has advantages and disadvantages. It is essential to understand these differences and figure out which type suits your application. The five main types of tank wash nozzle available today are:

Fixed Spray (Stationary) Tank Washing Nozzles

Fixed spray nozzles stay in position while spraying. There are two types available, the classic spray ball with holes around it and a fixed multiple spray nozzle assembly. These nozzles are ideal for gentle washing or rinsing of an entire vessel.



Advantages: simplicity of design, reliability (no moving parts), wide range of spray coverage.
Disadvantages: low impact, small free passage, and high liquid use.

Fluid-Driven (Reactionary Force) Tank Washing Nozzles

These nozzles use the reactionary force of the fluid leaving the nozzle orifice to rotate the nozzles. For improved cleaning, some nozzles are available with solid stream or flat fan spray patterns for gentle rinsing. They are offered in a variety of spray coverages. Some are constructed of Teflon for chemical resistance and some have sanitary connections.



Fluid-Driven (Constant Speed) Tank Washing Nozzles

These types of nozzles use the momentum of the liquid flow to drive the nozzle's spray head while constant rotating speed is maintained. Unlike conventional fluid driven nozzles, these nozzles increase their cleaning impact as the fluid pressure increases. The controlled rotational speed makes these nozzles useful for tank cleaning, sanitizing, and foaming applications.



High Pressure (Motor-Driven) Tank Washers

These tank washers have a separate motor for driving the nozzle assembly. Both the liquid pressure for cleaning and the rotational speed are fully independent to optimize both the pressure and time needed to complete the cleaning process.



Advantages: high impact, reduces amount of liquid needed for cleaning process, lightweight and portable.

Fluid-Driven (Turbine) Tank Washing Nozzles

This type of nozzle utilizes fluid to spin a turbine, which in turn powers a gear set. This allows the nozzle assembly to rotate as the hub revolves around its central axis. Generally, two to four solid stream sprays rotate around the hub as the nozzles turn to provide complete coverage. These nozzles are used for high-impact cleaning in large vessels.



Choosing the Best Tank Wash Nozzle

After the process plant personnel gives details about their process and their cleaning objectives and the tank wash equipment manufacturers share their expertise in tank wash nozzle technology, they will collaborate and discuss their options.

Material Selection

Most tank wash nozzles are constructed of stainless steel, but some are made of plastic material such as PTFE (Teflon) or PVDF (Kynar). Stainless steel tank washers are very durable and can handle very high temperatures. Some stainless steel nozzles have internal plastic parts, making these units easier to disassemble and the plastic parts easier to replace. In choosing the material of construction for a nozzle, make sure that the liquid sprayed is compatible by knowing the properties of the liquid. Sometimes the liquid is being sprayed at a higher temperature than a nozzle is capable of. In this case, a different nozzle should be selected, one with a higher temperature rating. In cases where a corrosive chemical attacks stainless steel material, Teflon nozzles can be used.

Installation

It should be determined whether the tank wash unit will be permanently positioned or removed between cleaning cycles. The location and size of the port

opening should also be known as well as the tank dimensions. If the tank vessel is very tall, additional nozzles can be positioned at different levels. Most rotating nozzles work best if positioned down. If the nozzle needs to be positioned horizontally, the process plant personnel should check with the tank wash equipment manufacturer to make sure that the selected nozzle will indeed rotate in the horizontal position.

Final Selection

The final selection should be the best nozzle choice for the automated tank washing system that meets the objectives of the product manufacturer. In addition, accessories can be added to the tank washing system. Filters are needed to ensure that the liquid can pass through the tank wash nozzle. If the liquid is not filtered, there is a potential for clogging and the cleaning efficiency of the nozzle is reduced.

Repeatable Cleaning

To provide consistent cleaning results, the following is recommended:

- ***Establish and verify*** that required cleaning is being conducted in a repeatable and effective manner
- ***Document procedures*** for cleaning and record operating parameters so that every cleaning cycle can be identical
- ***Procedures*** should include how often cleaning is to be conducted. If time between cleaning cycles is exceeded, additional instructions for longer cleaning cycles may be considered.
- ***Maintenance*** of tank cleaning equipment is an important part of reliability of the tank cleaning system. Tank wash nozzles should be visually checked to ensure nozzles are not clogged and that reactionary type nozzles spin freely. Filters should be cleaned and screens should be replaced on a regular basis.

Conclusion

In choosing a tank wash nozzle, remember that not all applications are the same and a nozzle appropriate for one application may not be appropriate for another. Therefore, it is important to understand what types of tank wash nozzles are available and how these nozzles function. The plant process personnel must also relay as much information and details about their cleaning process. This includes their specific cleaning objectives. This is very important in finding which tank wash nozzle will make the cleaning process more effective and efficient.

References

- (1) A Guide to Safe and Effective Tank Cleaning. Spraying Systems CO., Catalog No.15, 2001.
- (2) Tank Wash Handbook Spraying Systems Co., UK, Handbook G523