

How to Design and Install a Wheel Wash

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Introduction

Quarries, ready-mix plants, construction sites and other industrial facilities have become the targets of new regulations designed to prevent track-out of mud, dust and dirt on to public roads. These regulations have been developed primarily in response to Federal EPA actions that have designated many metropolitan areas as “non-attainment” for their failure to comply with air quality standards for fine particulate. Fine particulate, known as PM10 and fine respirable particulate, PM2.5, are now regarded as the number one health hazard in urban environments. These particles are so small that they become lodged in the aveoli of the lungs where they can cause or aggravate a variety of respiratory diseases including asthma, emphysema and lung cancer.

Local governments in non-attainment areas are forced to take draconian measures to comply with fine particulate standards or face the loss of federal highway funds. As a result, cities like Los Angeles and Phoenix, have or are in the process of adopting rules that require affected facilities to install wheel washes. The South Coast Air Quality Management District (SCAQMD) in California, for example, has recently passed Rule 1157 that will mandate the use of rumble grates and tire washes.

In other areas of the country, encroaching residential and commercial development around industrial sites has led to an increased demand for wheel washes. Many companies, particularly stone quarries, have installed wheel washes in order to get out in front of regulation and demonstrate their willingness to be good neighbors. Other facilities are forced into compliance through fines and litigation.

Faced with state and local governments under the threat of federal action and a public unwilling to tolerate any pollution, companies need to take a hard look at how best to respond. Because the costs of pollution control equipment are difficult to recover, affected facilities have a real incentive to develop affordable and effective technology to prevent carryout.

Wheel Wash Design

There are basically four types of wheel washes. These are:

1. Flooded basins
2. Countercurrent channel
3. Low pressure inundation, and
4. High pressure cleaning.

All of these will do an effective job of cleaning tires if they are properly designed, operated and maintained.

1. Flooded Basins

Basin style washes are the simplest in design. They consist of a shallow basin long enough to permit at least one tire rotation through it. Typical basin washes are 20 to 60 ft. in length. The bottom of the basin may be



equipped with rumble strips to improve tire agitation. For best performance, fresh make-up water should be supplied to flush dirty water from the basin for collection and treatment. The main advantages of a basin style wash are:

- a. Low cost
- b. No nozzles required
- c. Continuous operation, no automation required
- d. Trucks do not get wet

Their disadvantages include:

- a. Basin requires daily cleaning for optimum performance
- b. Do not wash mud flaps or wheel wells where dirt can accumulate
- c. Require large land area (>1000 sq. ft.)

2. Countercurrent Channel Washes

The countercurrent channel design consists of long, shallow inclined channels for left and right side tires. Water continuously flushes the channel countercurrent to the direction of traffic. Dirty water drains to a sump where it is collected for disposal or treatment. Channel washes require a great deal of space. A typical channel wash may be 100-300 ft. long requiring 1500 to 4500 sq. ft. of space. Channels can include rumble strips or other texture to agitate or open tire treads.



The advantages of a channel wash are:

- a. Low cost
- b. No nozzles required
- c. Continuous operation, no automation required
- d. Trucks do not get wet

Their disadvantages include:

- a. Requires daily cleaning for optimum performance
- b. Do not wash mud flaps or wheel wells where dirt can accumulate
- c. Require large land areas (>1500 sq. ft.)

3. Low Pressure Inundation Washes

Inundation washes are designed to clean the tires, mudflaps, and undercarriage using large amounts of low pressure water. Water consumption may range from 1000 to 3000 gallons per truck depending on the size of the trucks and duration of the spray cycle. These washes generally use multiple pumps capable of handling dirty water and, because of the high water consumption rate, require a large reservoir.

A typical inundation wash uses sprays directed at the truck from the sides and bottom and may be



combined with a rumble grate. Inundation washes operate intermittently and use one or more sensors to detect when trucks enter and exit the wash zone. The wash zone is located over a catch basin that directs dirty water into a reservoir where it can be collected and treated.

The main advantages of an inundation wash are:

- a. Wash tires, mud flaps and undercarriage
- b. Require small area (<800 sq. ft. excluding reservoir)

Their disadvantages include:

- a. High water consumption (>1000 gallons per truck)
- b. Spray nozzles can plug or wear out if water is dirty.
- c. Requires sensor and controls for auto operation.
- d. May remove lube oils and greases from undercarriage

4. High Pressure Cleaning Washes

High pressure cleaning washes use water at pressures in excess of 150 psi to promote cleaning efficiency and reduce water consumption. Water consumption may range from 40 to 100 gallons per truck depending on the speed of the truck through the wash zone. They are designed to wash tires and mud flaps and are usually not used to wash the undercarriage because sprays designed to shoot up under the truck may obscure the driver's vision.

A typical high pressure system consists of a 150 to 200 gpm pump, surge tank and two or more vertical spray nozzle manifolds that are sufficiently separated to permit at least one full tire revolution. High pressure systems require cleaner water because the abrasive effects of sediment wear pumps and nozzles out more quickly.



The main advantages of a high pressure cleaning wash are:

- a. Washes tires and mud flaps
- b. Require small area (<500 sq. ft.)
- c. Low water consumption

Their disadvantages include:

- a. Spray nozzles can plug or wear out if water is dirty.
- b. Requires sensor and controls for auto operation.

Sensors for Automatic Operation

Basin and channel type washes are designed to operate continuously and require no automation. Low pressure inundation and high pressure cleaning washes are designed to operate intermittently in order to conserve water and reduce wear and tear on equipment.

For stationary wheel washes, an in-ground magnetic induction loop is preferred. This is the same type of sensor used to activate traffic signals. It consists of an approximate 4' x 8' loop of braided wire that establishes a magnetic field at the entrance of the wash zone. When this field is perturbed by a large metal object, like a truck, the sensor activates the spray nozzles. A second sensor at the exit can be used to turn nozzles off but it is more common to use a single loop in conjunction with an adjustable time delay to control the duration of the wash cycle. The main advantage of the magnetic loop is that it requires no maintenance and is extremely reliable. Because it is placed in the pavement it cannot be damaged or vandalized.



Sensor for automatic operation

For portable washes, there are two basic types of electronic sensors, electric “eyes” and proximity switches. Electric “eyes” use a transmitter and receiver to establish a beam of light. Spray nozzles are activated when the beam is broken by a passing truck. When the beam is re-established after the truck exits the wash zone, nozzles are switched off. While these detectors are highly reliable, they require periodic cleaning and maintenance. The receiver and transmitter also need adjustment to keep the beam targeted. And, like any above ground sensor, they are susceptible to accidental damage or vandalism.

Proximity switches, the kind of switch that opens your supermarket door, also use focused beams of light but combine the transmitter and receiver into a single unit which substantially reduces the requirement for cleaning and maintenance. They are very reliable but can also be damaged or vandalized.

Either type can work well but care should be taken when locating the detector. If it is installed too close to the wash zone, mist from the spray nozzles may interfere with the beam and cause the system to run on. Sensors should be located in protected positions and armored or set in concrete to protect them.

Locating a Wheel Wash

The two most important considerations when deciding where to install a wheel wash are:

1. Distance from the exit of the plant and
2. Proximity to water and drainage

Locating the wheel wash as far a possible from the plant exit will help tires to dry before trucks leave the plant. If possible, the wheel wash should be set back at least 1500 feet. Although tires may appear clean, trucks track water out of the wash and onto the pavement. When this water evaporates, a residue of very fine dust is left on the road surface that can be re-entrained by passing traffic. Because the finest particles are the best light-scatterers, the haze over the road appears out of all proportion to the tiny amount of the dust that is actually in the air – especially at sunrise and sunset.

Many plants have scales located at the exit with less than 100 ft. of paved surface before trucks go on the road. At construction sites, there is often no paved surface and trucks often exit over a bed of “rip rap” at the curb. In either case, the residue left by “clean” trucks has to be swept or flushed from the road. A wet vacuum sweeper is the preferred method of



Water tracked from the wash can dry and leave fine silt behind that becomes airborne

removing silt and uses spray nozzles in front of the brooms to prevent emissions. An alternative to a wet vacuum is flushing where men with hoses or mobile tankers with spray nozzles are used to wash silt off the road.

Proximity to water and drainage is another important factor. At large quarries with more than 500 trucks per day, for example, an inundation wash that uses 1000 gallons per truck is going to require 500,000 gallons daily. Even a pressure wash at 100 gallons per truck is going to need 50,000 gallons a day. Whether large plant or small, the wheel wash has to drain somewhere. Since it is easier to pump fresh water to the wheel wash than it is to drain dirty water from it, try to locate the wash close to a retention pond. If no pond exists, the wheel wash will require the construction of a 3-5,000 cu. ft. settlement pit. Portable plants and construction sites rarely have access to a pond or pit and have to use a temporary collection basin. This could be as simple as a precast concrete sump or as sophisticated as a dewatering bin that uses a liner and filter.



Truckers are reluctant to use washes that obscure their vision or wet their windows

exit. Moreover, truckers should not be allowed to trim their loads on clean paved surface when it can aggravate trackout.

Try to take advantage of the topography. If there is a long incline up to a scale, for example, this might be an ideal location for a channel wash where wash water flows countercurrent to the direction of traffic. Locating the wash where there is natural drainage to a sump or pond can save a great deal of money.

Recycling Water



Water drains into a settlement pit where it is collected for treatment and re-circulation to the wheel wash

Another important factor to consider in locating a wheel wash is traffic pattern. One of the biggest problems are truckers who try to bypass the wash. Consequently, truck traffic must be funneled into the wheel wash using concrete blocks or other barricades. Likewise, traffic from unpaved areas on the site must be prevented from entering the paved road leading from the wash to the



Tankers equipped with flushing nozzles are used to clean silt from pavement

Stormwater regulations in most parts of the country require that no water be discharged without collection and treatment. Recycling dirty water can easily triple the cost of a wheel wash. Large stationary quarries are fortunate in that they generally have large retention ponds they can use to recirculate water to the wheel wash. However, construction sites, recycling plants and other smaller facilities do not.

In the absence of a retention pond, stationary plants have to construct and install a sump or settlement pit to collect dirty water. Their size depends primarily on the number of trucks washed in a day and they are often equipped with one or more weirs that allow “clean” water to overflow into a sump where it can be recirculated. Many washes employ

pumps that can handle this muddy water but using it to wash tires can aggravate silt carryout.

If the water requires filtration, there are two basic options - bag and sand filters. Bag filters are relatively inexpensive and are available in configurations that use two or more bags so that they can be changed while the filter is on line. Bag filters, however, require periodic replacement and can significantly increase maintenance costs. Sand filters are also high capacity filters but they can be back-flushed to keep them clean. While more expensive than bag filters, maintenance requirements are much lower.

Portable plants and construction sites can use “dewatering” bins to collect and filter water. These are usually 30 or 40 cu. yd. roll-off containers fitted with a mesh liner and filter. The liner is used to keep the filter away from the walls and promote flow through it. The filter should be porous enough to allow a sufficiently high water flow but fine enough to capture the bulk of the dirt. A typical filter of this type will generally remove any particles over 130 – 150 microns in diameter. Dewatering bins are suitable for sites handling less than 50 trucks a day unless they are used in parallel so that one can be cleaned while another is in service. There are several companies that sell or rent dewatering bins and can also be contracted to provide regular maintenance.



“Clean” water overflow wier and oil skimmer

Factors Affecting Cleaning Efficiency

Of all the factors that affect the performance of a wheel wash, the speed of the truck through the wash zone is by far the most important. The slower the truck speed, the better the cleaning. A speed of 5 mph through the wash is generally considered the slowest practical rate. Unfortunately, most truckers are in a rush to get out on the road and tire washes often incorporate speed bumps or rumble strips to slow them down.



Speed bumps help to slow trucks down

rather than blast dirt from tires. In contrast, the efficiency of high pressure wheel washes is less dependent on water flow rates and rely more on targeted sprays to dislodge material from the tire.

Finally, the amount and type of mud and dirt on the truck affects performance. Most stationary plants, like stone quarries, generally have a stable unpaved

Secondly, the volume and pressure of water are important determinants of cleaning efficiency. The performance of basin and channel washes that do not use spray to wash tires are directly proportional to the volume of water used per truck – the more the better. The performance of low pressure inundation washes is also highly dependent on the volume of water used per truck since spray pressures are usually low enough that sprayed water is used to rinse



Rumble grates help dislodge stones from tire treads but require frequent cleaning

route through the plant, while trucks at construction sites are more likely to have wheel wells and mud flaps fouled with dirt. Mud and dirt that contains a lot of clay or reactive material like lime or cement can solidify into very hard deposits that are extremely difficult to remove.

Rumble grates can significantly improve cleaning efficiencies by agitating the tires and flexing their treads to help dislodge material. Concrete or asphalt rumble strips can improve agitation but do not possess a sharp edge that causes treads to deform and flex. While rumble grates can be effective they become quickly fouled with compacted debris and require frequent cleaning or flushing to keep them in good operating condition.

Portable Wheel Washes

Many wheel wash installations are temporary and require portable equipment. While there are several styles all feature one or more skid mounted pumps and portable spray manifolds. Only low pressure inundation and high pressure cleaning washes are suitable for portable applications. Some sites may permit use of a basin that can be demolished or abandoned in lieu of a temporary wash.

High pressure washes using vertical spray manifolds are quite compact and can be housed in a trailer along with a surge tank that can be towed from site to site. Low pressure inundation washes utilize a portable spray frame that is placed onto the ground. The spray frame may or may not use a catch basin depending upon its design and application. Because a retention pond or settlement pit is often not available or feasible, some portable washes include a dewatering box or concrete basin to collect and recirculate dirty water. At sites where silt carryout is a problem or when pumps need to be protected from abrasive solids, a portable filter and other solids handling equipment may be required.

Costs

To keep costs down, determine how clean trucks have to be. If mud flaps and undercarriages do not contribute to the problem, there is no reason to clean them. Setting the wheel wash as far from the exit of the plant as possible can go a long way to simplifying its design and maintenance. To avoid the high costs of collecting and recirculating clean water, it may be more cost-effective to use "dirty" water to wash tires and operate a vacuum sweeper to clean silt from the road. In climates where water is scarce or in cities where it is expensive, the lower water consumption of a high pressure wash can help control costs over the longer term. Some states, like Texas, provide tax exemptions or rebates for the installation of control measures.

The costs of a basin or channel wash can range from a low of about \$10,000 up to as much as \$150,000 depending primarily on the volume of truck traffic and cleaning efficiency required. Small facilities with less than 50 trucks a day may be able to get by with a simple basin that is cleaned and flushed daily. Larger plants handling 500 trucks a day located adjacent to residential or commercial property will require a substantially higher investment.

Commercial tire washes range in price from about \$20,000 to \$60,000 for an automated pump system with spray manifolds and frame. These costs, however, do not include any site preparation or water treatment. Inundation washes may require the construction of a large settlement pit as a reservoir in addition to a concrete pad to support the spray frame and basin. This can add another \$70,000 to \$100,000 to the project. High pressure washes have a smaller footprint but still require a level concrete pad and some means of water collection and treatment that can add significantly to its cost.

Finally and most importantly, institute control measures that will insure that truckers use the wash properly. Erecting concrete barricades to funnel traffic into the wash zone and using speed bumps or rumble grates to slow them down will help you to get your money's worth from your investment.