An Overview of Sweeping Equipment Technology,

The following information was written by the editorial staff of *American Sweeper* magazine to further the understanding of various types of sweeping technology. The intent is to assist sweeping industry professionals to reach a better understanding of the major types of sweeping equipment historically and currently in use in the American road sweeping marketplace.

Historical Overview

Since its inception, sweeping has been used to remove what might be termed 'cosmetic debris' from roadways and other paved surfaces. General consensus was that if a street looked clean, it *was* clean. Recently, however, sweeping has undergone significant reappraisal by the US Environmental Protection Agency (EPA), as well as by municipal entities and others throughout the country.

Recent studies have shown that more than 50% of heavy metals and other serious pollutants are attached to particles which measure 60 microns in size and smaller (as a comparison, a human hair measures approximately 70 microns in width), *even though particles of this size compose a relatively insignificant amount of the total weight and volume of a typical sweeper's hopper load*. It has been confirmed that even though a street may look clean (before or after being swept), there may still be a significant loading of small-micron, pollution-laden debris on it. Additionally, from an environmental standpoint, it is exactly this formerly inconsequential material which is now considered most important to remove. Increased emphasis, by the EPA and others, is now being placed upon the removal of small-micron debris.

If allowed to accumulate, these pollution-laden small-micron particles pose a significant environmental concern. When they run off into stormwater system because of rainfall, they are called 'total suspended solids' (TSS). During dry weather, when they get pounded into the air by passing cars, or blown into the air by wind, they are called 'fugitive dust' or 'PM-10s.' Either way, these particles pose an environmental challenge: According to EPA estimates, 30,000 people in the US are killed each year by pollutants attached to small-micron dust particles, and 1,000,000 more sustain serious lung impairment. Unfortunately, for pollutants such as zinc, which tend to become dissolved in water, there is not even any way to filter them out of our water systems. Because they remain in solution with the water once dissolved, even sophisticated catchbasin filters are of no avail.

Removing this 'non-point source' pollution, along with the traditional larger debris, has become the newest challenge to sweeping technology. On the following pages are brief overviews of most of the sweeping equipment currently available, as well as examples of their usage and applicability.

Mechanical Broom Sweepers

Mechanical broom sweepers may be likened to cleaning with a broom and a dustpan. This type of sweeper was the first to see widespread use on America's roadways. For years, mechanical broom sweepers were the only machines used for road sweeping by municipalities, departments of transportation and other road sweeping management agencies.

Typically, these machines have a 'main broom' that runs transversely – from one side of the sweeper to the other – such that the broom bristles contact the paved surface the full width of the sweeper unit. The broom rotates in a clockwise fashion when viewed from the left side of the vehicle, and collected debris is swept onto a conveyor belt of some type for transfer to a containment hopper.

The sweepers may or may not be outfitted with a 'gutter broom' on one or both sides of the sweeper. Gutter brooms are relatively small (typically 36 to 50 inches in width), are located to the left, right, or both sides of the sweeper, and are primarily used to transfer debris from the gutterline into the path of the main broom. Even though mechanical sweepers are usually outfitted with a series of water spray nozzles, because of the way they sweep they still tend to create a substantial amount of dust in dry weather. They also leave a 'slurry' of small-micron particles in their wake, mixed in with the water left on the pavement from the dust suppression system.

In recent times, it has been recognized that modern air sweepers have many advantages over mechanicals for general road sweeping usage. One reason is that mechanical sweepers merely give the illusion of leaving a clean pavement surface. Although large debris is removed by mechanical broom sweepers, they are virtually ineffective at removing particles 60 microns and smaller. Studies have shown that, from an environmental standpoint, mechanical broom sweepers may actually have a negative effect in terms of small micron pickup. This is because the action of the broom tends to break larger particles down into smaller ones. Then, because debris pickup is via an elevator rather than involving any type of air/suction action, a significant amount of small micron particles are left on the pavement's surface.

Advantages: Mechanical broom sweepers remain the standard for sweeping extremely heavy or packed-down material such as road millings. The type of sweeping where mechanical broom sweepers still are necessary also includes 'spring cleanup' in snowbelt areas of the US where a large amount of sand and other abrasives are put down for traction in the winter.

Disadvantages: A mechanical sweeper is not effective where environmental concerns exist about stormwater pollution or fugitive dust. Also, mechanical sweepers are significantly more expensive to maintain than comparable air sweepers, due to having so many moving parts (including continuous pavement contact by main broom and mechanical movement by the elevator system). Because of vast improvement in the last few years, air-based sweepers are now better suited for most types of general road sweeping.

Vacuum Sweepers

Vacuum sweepers may be compared to an open loop, household vacuum system. An engine powers a fan, which creates vacuum/suction. Typically, there is a suction intake inlet on one side of the sweeping head. After dropping large debris into the hopper, the 'used,' dirty air is exhausted back out into the atmosphere. Instead of an air blast that transfers to the vacuum opening, vacuum sweepers employ some type of broom system to brush debris toward the vacuum opening in one side of the head.

One reason vacuum sweepers became popular was the recognition that the majority of debris, especially the heavy material, collects within 36 inches of the curbline. Vacuum sweepers are designed to do an effective job of cleaning within that area. Vacuum sweepers are sold as being the 'best of both worlds,' because they utilize a broom to transfer debris and air to pick up the collected debris. However, this was before the concerns of the Clean Air and Clean Water Acts.

Given current concerns, it appears that vacuum sweepers may actually be the *worst* of both worlds: Their transfer brooms are smaller, and thus have less digging power to pick up packed-down material. Because of their narrower suction head and intake tubes, they tend to leave much of the small-micron material in place, except for under their (typically) 24 to 36-inch direct suction path. Small-micron particles, the biggest pollution-carriers, tend to be distributed further away from the curb than heavier debris. These are major factors contributing to the decline in favor of vacuum sweeping technology.

Even though they typically use water-based dust suppression systems, all but the latest technology vacuum sweepers (see information on the new small particle filtration sweepers, later in this essay) continually exhaust a high level of particulates into the atmosphere. As a result of studies by the EPA and others, it is now known that these are pollutant-laden particles which pose a quantifiable hazard to human health and safety.

Advantages: Thorough cleaning near the curb line. Less dust created than with mechanical broom sweepers. Fewer moving and wear parts than mechanical sweepers

Disadvantages: Because suction nozzle must be located on one side or the other of the sweeping head, vacuum sweepers cannot operate with both gutter brooms working. Generally don't provide efficient cleaning across the entire sweeping width, just nearby the intake area. Smaller suction tubes than on regenerative air sweepers (generally a maximum of 8 inches wide vs. regenerative air intake and blast tubes that are as wide as 14 inches). As a result, vacuum sweepers can't handle heavy debris as well as either mechanical broom or regenerative air sweepers.

Regenerative Air Sweepers

Although vacuum sweepers are still marketed, the regenerative air system is becoming widely viewed as having a number of advantages: cleaning a wider path, being more effective at removing small particles, and limiting the amount of dust-laden air that is exhausted back into the atmosphere. Generally speaking, regenerative air systems are more environmentally friendly than vacuum or mechanical broom sweepers. Several factors contribute to this.

Regenerative air sweepers employ a closed loop, 'cyclonic effect,' to do their cleaning. Like a vacuum sweeper, there is a similar vacuum inlet located on one side of the sweeping head. Unlike vacuum machines, however, regenerative air sweepers constantly recirculate (regenerate) their air supply internally. To accomplish this, the recirculating air is blasted into the sweeping head on the side opposite the pickup, or inlet, tube. Essentially, the air 'blasts' down onto the pavement on one side of the head, travels across the width of the head (gathering debris with it as it goes), then travels up the pickup hose on the other side with the debris. Manufacturers design their sweeping heads to swirl the air, so it will retain the collected debris within the airstream as it moves from the blast side of the head to the intake side.

Today, as the importance of cleaning the entire road width is becoming widely recognized, vacuum sweepers are being supplanted by the 'blast and suction effect' of regenerative air sweeping technology. Because of the way they operate, regenerative air sweepers are recognized as providing a more thorough cleaning action – even though a vacuum system may be able to boast a greater airflow per horsepower. Because they employ an air movement across the entire width of the sweeping head, regenerative air sweepers tend to do a better job of cleaning over the entire width of the pavement surface covered.

The amount of pollutant-laden air exhausted by a regenerative air-based sweeper is typically much less than with a vacuum sweeper. Because of this, and the fact that regenerative-based machines also tend to pick up the small micron particles across the entire sweeping head, regenerative air sweepers are currently gaining status as the best choice where either air quality or stormwater runoff are concerns. They are also very versatile, since they can handle material from leaves and light paper to heavy construction cleanup.

The blast-and-pickup cycle also makes these machines more effective at picking up heavy debris, since the blast is able to dislodge heavier materials and propel them into the airflow. Regenerative air sweepers are also able to support larger intake tubes, so larger debris may be removed without clogging. This is especially important when sweeping material such as leaves. As a result, today's regenerative air sweepers are able to supplant mechanical broom sweepers for all but the most challenging applications. In most applications, they represent a more comprehensive choice than do vacuum sweepers.

Regenerative Air Sweepers, *continued*

Regenerative air sweepers are suitable for most everyday road sweeping needs, and also cost significantly less to maintain. For these reasons, regenerative air sweeping equipment is often specified by US governmental agencies which are involved in paying for all or a portion of the cost of sweeping equipment being purchased. In some instances where the government has underwritten the cost of regenerative air sweepers, it has been reported that a stipulation has been included requiring that the current mechanical broom sweeper being used must be destroyed by drilling a hole in its engine(s).

Advantages: The regenerative air system is considered to be the best all around, multipurpose sweeper. Can clean a wide range of debris in a large variety of situations. Works very well under routine street maintenance-type operations, for cities or contractors with routine cleaning programs. Air system makes them better for leaves than mechanical broom sweepers, and their larger intake hoses and wider sweeping head make them better than vacuum sweepers for leaves. Fewer moving and wear parts than mechanical sweepers. Can be used to clean catch basins by adding hand hose. Multipurpose machine.

Disadvantages: Even with broom-in-head options, they generally can't handle millings, spring cleanup and other extremely heavy duty applications as well as mechanical sweepers. They use water for dust suppression and exhaust some amount of small micron particulates into the atmosphere.

New Technology: Small-Micron Surface Cleaners

A challenge to the environmental dominance of regenerative air sweepers has been mounted by a new technology that sweeps without using water, and which employs a sophisticated filtration system for dust containment. This new technology of dry sweepers is typified by Schwarze Industries' much heralded EV-series machines that have been called the "first-ever *pavement cleaners.*" Although the Schwarze EV-series machines are vacuum sweepers, they feature an innovative system to assure cleaning the full width of the sweeping head. The greatest difference, however, is that the machines also employ a multi-patented, self-cleaning filtration system that can filter 'dust' output down to 2.5 microns (PM-2.5). The filters are poly-based, so are not harmed by operation in wet weather (a bypass is employed).

The level of small particle filtration attained by the Schwarze EV-series machines cannot currently be approached by any other sweeping system. Traditional water sprays merely dissolve the small-micron particles, along with their associated attached pollutants, and this 'polluted slurry' is left on the pavement, filling the cracks.

New Technology Small-Micron Surface Cleaners, *continued*

Unlike standard sweepers to date, with the EV-series' technology no water is employed for dust suppression. The water sprays used by standard sweepers to 'suppress' dust (i.e., small-micron particles) don't do enough to actually control or remove it. The problem with water-based dust suppression is that it tends to dissolve the small micron particles, along with their associated attached pollutants, and this 'slurry' is left filling the cracks in the pavement.

With the new generation of EV-series machines, an advanced, self-cleaning filtration system is relied upon to capture the small-micron material. This represents a vast improvement over previous sweeping equipment since, with all other sweeper types, a significant portion of the small-micron 'dust' material is dissolved in the water sprays of the sweepers' dust suppression system. Although vacuum-based, tests show that the new EV-series' sweeping technology surpasses even that of regenerative air sweepers in terms of total, and environmental, cleaning ability. Models are available which even filter the in-cab air supply for operator safety in cleaning toxic, pavement-based wastes.

Advantages: Thorough small-micron cleaning as small as 2.5 microns. Toxic, recyclable and reusable materials can be picked up without wetting, and securely offloaded. Operator can be protected from breathing potentially hazardous small-micron material.

Disadvantages: Current disadvantages include a slow transporting speed of around 25 mph between jobs. The machines carry a higher cost, although the manufacturer claims this is largely offset by cost savings due to not using water: less rust, no need to fill sweeper with water, less frequent dumping, no pumps or other components for water usage, etc. Also, the current machines are not suitable for some types of municipal curb-and-gutter configurations.

We invite your questions and comments:

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