Summary

This session discusses the advantages and disadvantages of the most common spray application methods for organic coatings. These include:

- Conventional air atomizing spray
- Air-assisted airless
- Airless
- High volume, low-pressure turbine
- Electrostatic (various)
- Dip
- Heated
- Plural Component
- Robots and Reciprocators

Session 5-110

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CONVENTIONAL AIR ATOMIZED SPRAY

The conventional air atomizing spray gun was the first method ever used to spray-apply paint and coating materials, and it is still the most widely used spray gun in use today. It has a great deal of appeal for spray painters because of operator control. Basically, the function of the air atomizing spray gun is to use compressed air to disperse coating material into small droplets and to propel the droplets toward a target.

Where used

♦ Fabricators and repair shops
♦ Quality furniture and cabinet manufacturers and refinishes
♦ Contract and custom coaters
♦ Do-it-yourself handyman

Typical Application Pressure

- Typical air-spray pressure for syphon and pressure spray       40 to 60 psi
- Typical fluid pressure for pressure spray                      5 to 15 psi
## Conventional Air Atomized Spray

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>♦ Low equipment cost</td>
<td>♦ Uses high volume of air</td>
</tr>
<tr>
<td>♦ Low maintenance</td>
<td>♦ Develops excessive spray dust and overspray fog</td>
</tr>
<tr>
<td>♦ Excellent material atomization</td>
<td>♦ Does not adapt to high-volume material output</td>
</tr>
<tr>
<td>♦ Excellent operator control</td>
<td>♦ Low transfer efficiencies</td>
</tr>
<tr>
<td>♦ Quick color change capabilities</td>
<td></td>
</tr>
<tr>
<td>♦ Coating can be applied by syphon or under pressure</td>
<td></td>
</tr>
</tbody>
</table>
CONVENTIONAL AIR ATOMIZING SPRAY

Air Pressure
40 - 80 psi

Fluid Pressure
10 - 20 psi

Compressed Air
EFFECT OF FLUID FLOW RATE ON TRANSFER EFFICIENCY

Strive for the lowest fluid flow rate that will do the job
Air-assisted airless spray combines compressed air with hydraulic pressure to atomize the coating material into finer droplets than is achieved with pure airless spray. With the compressed air-assist, the normal airless hydraulic pressure can be reduced by 50% or more, which allows the operator to have more control with improved application results.

**Where Used**

- High-volume furniture production and cabinet manufacturers.
- Maintenance coatings.
- Military contractors.
- Where improved transfer efficiency is required.

**Typical Application Pressure**

- Fluid  
  800-1500 psi
- Air  
  10 psi
## Air-Assisted Airless Spray

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆ Low coating usage</td>
<td>◆ High maintenance</td>
</tr>
<tr>
<td>◆ Fair-good operator control on air pressure</td>
<td>◆ Expensive fluid tips</td>
</tr>
<tr>
<td>◆ Few runs and sags</td>
<td>◆ Poor operator control on fluid pressure</td>
</tr>
<tr>
<td>◆ Good atomization</td>
<td>◆ Not appropriate for fine finishing</td>
</tr>
</tbody>
</table>
AIR CAP FOR
AIR-ASSISTED AIRLESS SPRAY GUN

Shaping Air

Fluid

Shaping Air
AIR-ASSISTED AIRLESS SPRAY

Orifice = 0.011 — 0.018 inches

Fluid Pressure 300 — 1000 psi

Compressor

Shaping Air Pressure <10 — 20 psi

Strainer
Airless atomization of paint and coating material is accomplished by hydraulic pressures. It does not directly use compressed air to atomize the fluid. Pressure is applied to the fluid with hydraulic pumps. Depending on the solids and viscosity of the fluid, pressure will range between 500 and 4,000 psi.

As the paint or coating material is forced through a small diameter orifice in the spray gun tip, it is atomized into small particles coupled with high-velocity, and the particles are carried to the target.

Where Used

- Commercial and maintenance painters
- Rail and marine, structural steel fabricators
- High-volume production lines
- Application of viscous undercoatings and elastomers
- For large, relatively uncomplicated surfaces (buildings, steel structures, ships, roof coatings, and insulations).

Typical Application Pressure

- Medium viscosity metal primer requires 1,600 to 3,000 psi.
## AIRLESS SPRAY

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆ Low air usage</td>
<td>◆ Expensive fluid tips</td>
</tr>
<tr>
<td>◆ High-volume material output</td>
<td>◆ High maintenance</td>
</tr>
<tr>
<td>◆ Limited overspray fog</td>
<td>◆ Difficult to blend sprayed coating material</td>
</tr>
<tr>
<td>◆ Large spray patterns</td>
<td>◆ Minimum operator control during application</td>
</tr>
<tr>
<td>◆ Application of heavy viscous coatings</td>
<td>◆ Not for intricate finishing</td>
</tr>
<tr>
<td>◆ Excellent for large surfaces</td>
<td>◆ Not for high-quality appearance items</td>
</tr>
<tr>
<td>◆ Good transfer efficiency on large surfaces</td>
<td>◆ Can cause injuries to operator if not used with adequate caution</td>
</tr>
</tbody>
</table>
AIRLESS SPRAY

Orifice = 0.011 — 0.018 inches

Fluid Pressure 1,000 — 3,000 ps

Compressor
Injection in the skin is a serious traumatic injury. IT IS IMPORTANT TO TREAT THE INJURY SURGICALLY AS SOON AS POSSIBLE. Do not delay treatment to research toxicity. Toxicity is a concern with some exotic coatings injected directly into the bloodstream.

Consultation with a plastic surgeon or a reconstructive hand surgeon may be advisable.

The seriousness of the wound depends on where the injury is on the body, whether the substance hit something on its way in and deflected causing more damage, and many other variables including skin microflora residing in the paint or gun which are blasted into the wound. If the injected paint contains acrylic latex and titanium dioxide that damage the tissue's resistance to infection, bacterial growth will flourish. The treatment that doctors recommend for an injection injury to the hand includes immediate decompression of the closed vascular compartments of the hand to release the underlying tissue distended by the injected paint, judicious wound debridement, and immediate antibiotic treatment.
HIGH-VOLUME, LOW-PRESSURE SPRAY (TURBINE)

The turbine low-pressure spray equipment is a totally self-contained unit. It does not require compressed air for operation. A high-speed turbine generates the high volume of air used during spray operation. The air is heated by the turbine to approximately 110°F, and this temperature is consistent, regardless of the temperature of the surrounding air.

The principle is to atomize the coating material at low air pressure and propel the atomized droplets to the object at low velocity, utilizing the high-volume air supply.

Where Used

- High-solids coating applications
- Small parts production line operations
- Will meet EPA transfer efficiency requirements (pending approval)
# HIGH-VOLUME, LOW-PRESSURE SPRAY (TURBINE)

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆ Low blowback and spray fog</td>
<td>◆ High initial cost</td>
</tr>
<tr>
<td>◆ Good transfer efficiency</td>
<td>◆ Slower application speed (controversial)</td>
</tr>
<tr>
<td>◆ Will apply high-viscosity high-solids coatings</td>
<td>◆ Does not finely atomize some high-solids coating materials (controversial)</td>
</tr>
<tr>
<td>◆ Portable</td>
<td>◆ High cost for turbine maintenance</td>
</tr>
<tr>
<td>◆ Easy to clean</td>
<td>◆ Requires operator training</td>
</tr>
<tr>
<td>◆ Can use up to 4 guns per turbine</td>
<td>◆ Still relatively new on the market</td>
</tr>
<tr>
<td>◆ Can be used for intricate parts</td>
<td></td>
</tr>
<tr>
<td>◆ Good operator controls on the gun</td>
<td></td>
</tr>
</tbody>
</table>
Definition of High Volume, Low Pressure (HVLP)

South Coast AQMD, Rule 1124 Defines:

High Volume Low Pressure (HLVP) spray is a spray system which is operated at an air pressure at the gun of between 0.1 and 10.0 psig and at a fluid pressure of 50.0 psig.
HIGH VOLUME LOW PRESSURE AIR SPRAY

Large Diameter Hose

Air Pressure 0.1 – 10 psi

Fluid Pressure 10 - 20 psi
THE PRINCIPAL OF THE TURBINE

MOTOR

OUTSIDE AIR

AIR

TURBINE

LOW PRESSURE HIGH VOLUME AIR
GAS LAW RELATING PRESSURE TO VOLUME

\[ P_1 V_1 = P_2 V_2 \]
PRINCIPLE OF MULTICOMPONENT MIXING

Static Mixer

Manifold

Component A

Metering Valves

Component B

Solvent

Solvent Shut-off
Electrostatic application of paint and coating materials is based on the simple law of physics that dissimilar electrical charges attract. An electrical circuit is formed by converting 110 volts alternating current through a high-voltage power supply of negative 60,000 to 80,000 volt, producing low ampage direct current.

The electrostatic principle can be applied to all methods of spray application:

- Air atomizing
- Airless
- Air-assisted airless

The negative potential (voltage) is transmitted through an electrical cable to the spray gun equipped with an electrode that charges the atomized paint.

Providing the object to be coated is properly grounded, the atomized paint that would normally bypass the object is now attracted to the object and contributes to the final overall coating application.

All paints and coating materials have potential for electrostatic application. However, conventional coating formulations may require some modification to improve on the electrical properties.

The electrostatic method of applying paint and coating materials lends itself to other types of equipment:

- Reciprocating rotating disk
- High-speed turbo bells
Electrostatic disk and bell applications are proven methods for high output production conveyor lines where several hundred parts of similar geometry are to be painted. The coating material is fed to the Disk or Bell where it is negatively charged and centrifugally spun out by high-speed rotation into a predetermined field where a conveyorized line carries the objects through the field. A properly engineered system could process several thousand square feet of finished surface area per hour.

The majority of electrostatic spray installations are used to coat metallic surfaces that are conductive. There are, however, systems used to coat non-conductive surfaces:

- wood,
- plastic,
- and composites.

Prior to painting, non-conductive surfaces must be pretreated with either a chemical salt or a coating that will create the necessary electrical attraction; then it can be processed in the same way as conventional conductive objects.

Where Used

- Outdoor patio furniture, metal office furniture
- Tubular and wire products
- Contract custom coaters
- Miscellaneous metal parts for all industries
- Military contractors
- Wood gun stock and miscellaneous wood furniture (after special conductive treatments have been applied)
## Electrostatic Applications

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆ Coating wrap on edge of parts</td>
<td>◆ High equipment and maintenance cost</td>
</tr>
<tr>
<td>◆ Material savings through improved transfer efficiency</td>
<td>◆ Parts hangers and hooks must be conductive, requiring frequent cleaning</td>
</tr>
<tr>
<td>◆ High production output ideally adapts to automation</td>
<td>◆ Automated lines must be adapted to long runs of similarly shaped parts</td>
</tr>
<tr>
<td>◆ Close pack of parts on conveyor line desirable</td>
<td>◆ Will not properly coat recessed areas</td>
</tr>
<tr>
<td>◆ Reduced manpower requirement</td>
<td>◆ Wrap is not always as good as expected</td>
</tr>
<tr>
<td>◆ Lower spray booth air velocity (60 ft/min)</td>
<td></td>
</tr>
<tr>
<td>◆ Can be used with solvent-based and water-based coatings</td>
<td></td>
</tr>
</tbody>
</table>
### ELECTROSTATIC APPLICATIONS

<table>
<thead>
<tr>
<th>Advantages (condt)</th>
<th>Disadvantages (condt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>◦ Recognized by EPA for its improved transfer efficiency</td>
<td>◦ Faraday Cage affects coating of corners, cavities, etc.</td>
</tr>
<tr>
<td>◦ Can be used with wide range of application processes; air-atomized spray, airless, air-assisted airless, disk and bells</td>
<td>◦ Very difficult to ensure a good ground on small parts</td>
</tr>
<tr>
<td>◦ Disks and bells can achieve transfer efficiencies greater than 90%</td>
<td>◦ Beware of arcs in the presence of solvent fumes</td>
</tr>
<tr>
<td></td>
<td>◦ Painters are wary of electrostatic shocks</td>
</tr>
<tr>
<td></td>
<td>◦ Painters must be properly trained</td>
</tr>
<tr>
<td></td>
<td>◦ Isolation stand required when applying water-based coatings</td>
</tr>
<tr>
<td></td>
<td>◦ Transfer efficiency does not always meet expectations</td>
</tr>
<tr>
<td></td>
<td>◦ Special precautions required to</td>
</tr>
</tbody>
</table>
ELECTROSTATIC SPRAY
(Conventional Air Atomizing)

Positive Charge
Plastic Shield

Air Pressure 40 — 80 psi

Fluid Pressure 10 - 20 psi

Power Cable

65 — 75 KV
FARADAY CAGE
ELECTROSTATIC SPRAY
(Conventional Air Atomizing Water-Based Coating)

Positive Charge
Plastic Shield

Fluid Pressure
10 — 20psi

Air Pressure
40 — 80psi

Power Cable

Power Supply

65 — 75 KV
## ELECTROSTATIC TURBOBELLS & DISKS

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomizes water-borne and high solids coatings into micro-fine particles</td>
<td>Not for manual applications</td>
</tr>
<tr>
<td>Very high transfer efficiencies (&gt;90%)</td>
<td>Not for short runs of multiple geometries</td>
</tr>
<tr>
<td>Turbine rotational speed: 10,000-50,000 rpm</td>
<td></td>
</tr>
<tr>
<td>Choice of cup or disc spray head</td>
<td></td>
</tr>
<tr>
<td>Quick color changing capabilities</td>
<td></td>
</tr>
<tr>
<td>Electrostatic charge up to 100KV</td>
<td></td>
</tr>
<tr>
<td>Excellent film thickness control</td>
<td></td>
</tr>
<tr>
<td>Excellent for large, automated production lines</td>
<td></td>
</tr>
<tr>
<td>Programmable operations can independently control rotational speed, fluid flow, shaping air, and voltage</td>
<td></td>
</tr>
</tbody>
</table>
LEAFING AND NON-LEAFING ALUMINUM PIGMENT
CONVEYOR
FOR ELECTROSTATIC
ROTARY DISC

Part being coated, Suspended by Conveyor

Coating spun out by disc

Conveyor

Rotating Disc
Flow coating is a process in which the paint or coating material is flowed over an object, completely covering the surface.

Commercially designed flow coating equipment has a liquid reservoir and recirculating pumping system. The coating material is pumped from the reservoir through the flow coating nozzle or outlets, where the parts are conveyorized through the coating material. After being coated, the parts proceed into a solvent vapor-laden chamber where the coating material is collected and returned to the reservoir. It is in the solvent-laden chamber that the coating material levels itself on the surface of the part.

Because flow coating is so dependent on solvent vapor, this process has given way to other more efficient coating processes.

Where Used

- Automotive and appliance industries
- Heavy industry with high production output
## Advantages
- High-transfer efficiency greater than 90%
- High-volume production output
- Used on many parts and sub-assemblies
- Coating gets into recesses and other inaccessible areas

## Disadvantages
- High solvent demand
- Primer or shop coat only
- Sensitive to coating formulation
- Not for decorative finish
- Can produce runs and sags
Dip applications of coating materials are utilized throughout the finishing community. The applications range from simple basket dipping of large numbers of small parts into a tank of coating material, to highly sophisticated conveyorized production lines where immersion and withdrawal speeds are controlled as the parts enter and exit a well-monitored tank of coating material. Such a process will coat parts with identical coating thicknesses and provide an identical appearance.

Where Used

♦ Paint brush handles
♦ Toilet seats
♦ Wood and metal furniture
♦ Miscellaneous wood and metal parts
♦ Large metal castings
DIP COATING APPLICATIONS

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>♦ Uniform coating</td>
<td>♦ Coating material must be closely monitored</td>
</tr>
<tr>
<td>♦ Maximum transfer efficiency &gt; 90%</td>
<td>♦ Adapt to unique part configuration</td>
</tr>
<tr>
<td>♦ Cost effective</td>
<td>♦ Parts hanging is critical</td>
</tr>
<tr>
<td>♦ Can coat recesses and inaccessible areas</td>
<td>♦ Withdrawal rate is critical</td>
</tr>
<tr>
<td>♦ Can use solvent-borne or water-based coatings</td>
<td>♦ Drag-out can be high if not controlled</td>
</tr>
<tr>
<td></td>
<td>♦ Not intended for decorative finishes</td>
</tr>
<tr>
<td></td>
<td>♦ Not recommended for short production runs</td>
</tr>
<tr>
<td></td>
<td>♦ Not for multiple colors</td>
</tr>
<tr>
<td></td>
<td>♦ Not for high-solids coatings</td>
</tr>
<tr>
<td></td>
<td>♦ Not for two-component coatings</td>
</tr>
</tbody>
</table>
The programmable robot is the latest addition to automating the application of paint and coating materials.

Ultimately, the robot will replace the hand-spray operator; however, it is the skill of the hand-spray operator that is used to program the robot.

A hand-held manipulator is moved through the application sequence by the spray operator simulating the actual motion required to spray paint an object. The initial recorded program may be refined to achieve maximum efficiency prior to implementation.

It is important to recognize the limitations of the program and allow for hand-spray touchup or supplement to completely spray a difficult geometry.

Where Used

- Automotive and aircraft parts
- Farm machinery and equipment
- Wood products
- Miscellaneous metal parts and subassemblies
- Camouflage pattern painting
<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>◆ Consistent, uniform coatings from one part to the next</td>
<td>◆ High initial cost</td>
</tr>
<tr>
<td>◆ Coating application conserves manpower</td>
<td>◆ Not recommended for short runs of dissimilar parts</td>
</tr>
<tr>
<td>◆ Adaptable to all methods of spray equipment</td>
<td>◆ Some limitation on quality of applied coating</td>
</tr>
<tr>
<td>◆ Predictable results regardless of the season</td>
<td>◆ Requires skilled personnel to program</td>
</tr>
<tr>
<td>◆ Less solvent required to reduce coating viscosity</td>
<td>◆ High maintenance costs</td>
</tr>
<tr>
<td>◆ Can be used in combination with all types of spray equipment</td>
<td>◆ Must control coating viscosity and temperature of application</td>
</tr>
<tr>
<td>◆ Excellent for coating the same configuration thousands of times</td>
<td>◆ Not recommended for premixed, two-component coatings</td>
</tr>
</tbody>
</table>
The hot spray paint method has been used for many years, and is adaptable to any spray system. Now more than ever, higher solids VOC-compliant coatings will perform more satisfactorily when heat is used to reduce application viscosity.

Coating manufacturers usually standardize viscosity measurements at 77°, which is considered to be ambient room temperature. When heated to between 110° and 120°F, the viscosity of an average pigmented alkyd enamel will decrease by 25% to 30% below the established standard.

Hot spray paint heaters are usually located between the source of the paint supply and the spray gun. The heaters are thermostatically controlled to maintain constant paint temperatures. Hot spray systems can be designed to either recirculate the coating material from the heater to the spray gun and return to the heater, or to go through the heater and dead-end at the spray gun.

Where Used

- Wood furniture and cabinet manufacturers
- Machine tool manufacturers
- Implement and farm machinery
- Over the road semitrucks and trailers
Advantages

- Omit solvent additions for viscosity reduction
- Constant application viscosity regardless of ambient temp. and weather conditions
- High film build with fewer coats
- Improved leveling, smoother surfaces
- Potential for improved transfer efficiency
- Several designs available
- Can be used in conjunction with most types of spray equipment
- Different designs available

Disadvantages

- Additional maintenance and equipment costs
- Fast solvent flash-off can develop pinhole and solvent entrapment if coating is applied too heavily
- Additional fluid hose to spray gun for recirculating
- Will use more paint
- Not recommended for premixed two-component coatings
- Not intended for water-based coatings
IN-LINE HEATING

Heater

Recirculating Fluid

Pressure Pot or Reservoir
PRINCIPLE OF
MULTI-COMPONENT MIXING

Manifold → Static Mixer

Component A → Metering Valves → Component B

Solvent Shut-off → Solvent