Transfer Efficiency

The Concept of Transfer Efficiency

What Is Transfer Efficiency?

Put very simply, the *transfer efficiency* of a spray finishing process means the amount of material that adheres to the target compared to the amount of material that was sprayed through the applicator toward the target. Transfer efficiency is expressed as a percentage, as in “under these testing conditions, this HVLP spray finishing process is 60 percent transfer efficient”, or “the addition of electrostatics made the spray finishing process 90 percent more efficient”.

Transfer efficiency is critical to the spray finishing industry from both a cost and a regulatory standpoint. Although transfer efficiency is a relatively simple concept, it can lead to considerable confusion (or even deception) if it is not clearly understood. To serve your customers well, you need to know more about transfer efficiency and how it is used in the industry, beyond its simple definition.

Transfer efficiency is usually expressed as the percentage of the weight of solids sprayed versus the weight of solids gained by the target. As an example, 60 percent transfer efficiency means that 60 percent of the weight of the solids in the material that was sprayed actually reached the target. The balance of 40 percent was lost to the spray booth or other areas during the spray finishing process.

Figure 1 on the next page illustrates the concept of transfer efficiency by showing the amount of material reaching the target as only a portion of the total amount of material that is sprayed. The material that is lost as over spray is both a regulatory problem and a cost overrun for the manufacturer, as you will learn later in this module.

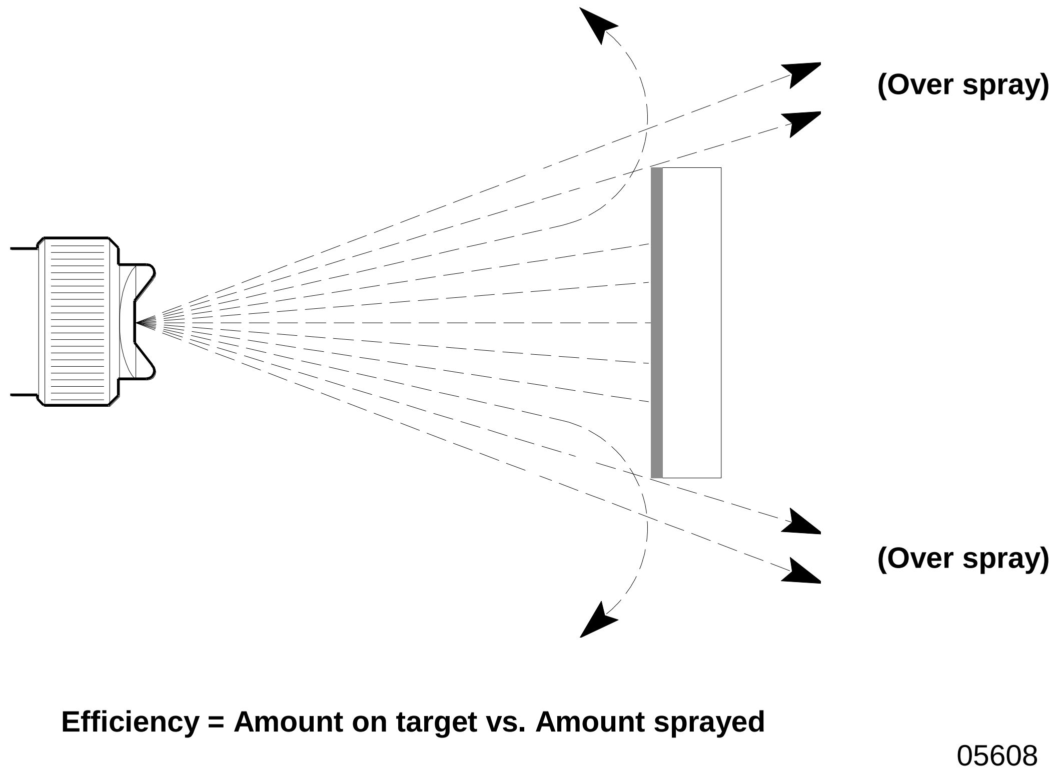

Figure 1 Transfer Efficiency Illustrated

Expressed mathematically, transfer efficiency is the net amount of material deposited on a part divided by the total material sprayed. A simple formula for calculating transfer efficiency is expressed below in Figure 2. The necessary inputs for using this formula can be obtained by measuring the amount of material sprayed and the amount of material on the part.

Ws = Weight of material sprayed
Wp = Weight of material on the part

T.E. = Wp/Ws x 100

Figure 2 A Simple Formula for Calculating Transfer Efficiency

The amount of material sprayed can be measured with a totalizing flow meter or by monitoring the weight of the material supply before and after spraying. The amount of material on the part can be measured by weighing the part before and after spraying. However, the measurement will be inaccurate if a significant amount of solvent evaporated before the sprayed part was weighed.

An alternate, more accurate method for calculating transfer efficiency is expressed below in Figure 3. The inputs for this formula require that you measure the amount of sprayed material, weigh the part before and after spraying and drying, and know the percentage of solids in the material.

$$\frac{\text{Weight of solid material the part gains}}{\text{Weight of wet material sprayed X Percent solids of the fluid}}$$

Figure 3 Alternate Formula for Calculating Transfer Efficiency

Both of these methods of calculating transfer efficiency determine how much material reached the part compared to how much was lost to the surrounding environment. Obviously, when a greater percentage of material adheres to the target, less material is needed to achieve the desired film thickness. This means the operator reduces the emissions of chemicals into the air and lowers the costs for materials and cleanup. Therefore, improved transfer efficiency is a major objective for the spray finishing industry.

Factors Impacting Transfer Efficiency

If optimal transfer efficiency is a key objective in spray finishing, how can it be improved? To improve transfer efficiency, you need to control the factors that influence the efficiency of the transfer of material to the target.

The primary spray finishing conditions that impact transfer efficiency are:

- **Substrate** (target or part) **characteristics,** such as size and shape
- **Operator variability**
- **Atomization and spray finishing methods**
- **Equipment characteristics,** including the balance of fluid pressure and air pressure
- **Air conditions in the spray booth**, such as humidity, temperature, and air velocity
- Others (such as the **electrical conditions** of the equipment, target, operator, and spray booth; **material characteristics** such as viscosity and conductivity; and when using electrostatics, the **electrode voltage and position** in the spray pattern)

These spray finishing conditions can be complex and difficult to measure and control. Yet, to perform a valid, accurate test of transfer efficiency, spray finishing conditions must be specified and controlled. Operator variability alone can account for a 20, 50, or even 100 percent difference in transfer efficiency.

To accurately measure the transfer efficiency of a specific spray finishing process, you need to do the following:

1. Specify in advance the spray finishing parameters you will use, including production rate, material type, finish quality, and atomization method.
2. Weight the parts before spray finishing and record their weight.
3. Measure the weight (or volume) of the material container, fully charged, before beginning the test.
4. Coat the parts as required, using the same method of application to be used in product production.
5. Measure the weight (or volume) of the material container after spray finishing.
6. Cure the parts completely.
7. Weigh the coated parts to determine their weight gain after finishing and record the weight increase.
8. Determine the weight solids of the material, either by measuring or by obtaining the data from the material supplier, and calculate the dry weight of the solids sprayed.
9. Use the formula (presented in Figure 3) to calculate transfer efficiency.

Note that when you are using a totalizing flow meter, you can eliminate steps 3 and 5 above

Controlling Costs Through Transfer Efficiency Improvements

Costs Associated with Spray Finishing

The costs associated with spray finishing processes include expenses for:

- Coatings
- Filters
- Conveyers
- Operator cleanliness
- Booth maintenance
- Maintenance of walls and floors
- Sludge removal

In addition to regulating air quality, the EPA also regulates the storing, transport, and disposal of the hazardous materials produced by the spray finishing industry. These requirements represent additional costs to the manufacturer. For example, the manufacturer must remove sludge from the water it uses for clean-up, as well as determine if its sludge wastes (materials and solvents) are hazardous. Users of materials and solvents must also keep accurate records of the waste materials they discard.

If the company contracts for waste removal, it must select a properly permitted disposal firm to trans- port, treat, store, or dispose of hazardous waste. Finally, the company's records must detail the contents of the materials it transports or disposes of (whether the company disposes of hazardous waste independently or through a contractor). All of these requirements represent additional costs that can be reduced through more efficient spray finishing processes.

Helping Customers Reduce Costs

As a representative of Graco, part of the service you provide should be to help customers reduce their costs through transfer efficiency improvements. For example, you can assist them in:

- Choosing alternate materials having fewer VOCs
- Altering the spray finishing process by using electrostatics or other methods with higher transfer efficiencies
- Limiting sludge to reduce sludge removal expenses
- Improving operator techniques to realize maximum efficiency from equipment

In the spray finishing industry, improved transfer efficiency is always a worthwhile objective, from both a regulatory and a cost-savings standpoint.