(page.19-21)

Search for Body Painting Friendly to the Environment

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○ Trends in Environmental Measures Related to Painting: VOC Regulations

Currently, volatile organic compounds (VOCs) have been attracting attention as an environmental problem caused by painting. VOCs refer to toluene, xylene and other volatile organic substances present in thinners and other solvent type paints. These substances have been used widely in various industries due to their ideal characteristics as solvents (such as paints and adhesives) and detergents. However, it has been pointed out that VOCs are responsible for the depletion of the ozone layer, and cause photo-chemical smog and allergies. The PRTR Act*1 came into force in April 2001, which obligates all manufacturers to report the amounts used of some specific chemical substances. Still, this Act does not regulate the amounts used or emitted of these substances. Accordingly, the revision of the Air Pollution Prevention Act in May 2006 is designed to force businesses emitting VOCs to report their VOC emitting quantities to prefectural governors; and observe relevant emission standards.

○ Measures and Efforts to Reduce VOCs

A radical measure to reduce VOC emissions, used for some SUS and AL cars, is to do without the painting of body outer plates. However, painting is indispensable for steel vehicles, as well as express train cars and U.S.-bound LRVs for which appearance matters. Less drastic measures to reduce VOC emissions include:

1) Change of Paint Types

At present, solvent type paints are generally used for body painting, due to their excellent quality regarding workability and finish (the smoothness of paint film). Containing 450 to 780 g/l of VOCs, however, these paints are less advantageous in terms of environmental impact, compared to the paints presented below. Accordingly, VOC emissions can be reduced by replacing solvent type paints with environmentally friendly ones as shown below.

(1) High Solid Paints (VOC: 300 to 450 g/l)

Paint ingredients are roughly divided into solids that form a film after drying, and a solvent that evaporates during drying. High solid paints refer to paints that contain relatively large proportions of solids. Since these paints contain only small proportions (15 to 25%) of evaporating solvent, they contribute to reducing environmental burdens on air. Our company uses high solid paints (all made in the U.S.) e.g. for the body outer plates of U.S.-bound low-floor vehicles. As shown in Table 1, the amount used of high solid paints is smaller than that of general paints, because of the former's higher solid proportions. However, high solid paints are disadvantageous in some aspects: they are costlier than general paints (even considering their higher solid proportions), and tend to yield a poor finish due to the smaller proportions of thinner.

(2) Water Paints (VOC: 20 to 180 g/l)

While general paints are diluted by solvent, water paints are diluted by water. Though most water paints contain organic solvents, their proportions are far smaller than those for solvent type paints. Water paints therefore are superior to solvent type paints in terms of environment-friendliness and safety. However, these paints have not been used widely due to some disadvantages: being subject to the influence of humidity and temperature, they have a poor quality regarding drying. Also, it is difficult to form a uniform film using a water paint; this causes some problems in securing the smoothness of the film.

At present, our company uses water paints for soundproofing to paint the interiors of U.S.-bound LRVs. This is because finish is not important in painting covered areas, and also because in this application, a sufficiently long interval between painting and the next process can be secured for drying. We intend to expand the use of water paints, starting from immediately applicable vehicle surfaces.

(3) Powder Paints (VOC: 0 g/l)

Powder paints are used in the form of powders, and hence do not contain any organic solvents, water or other volatile ingredients. A powder paint is applied to the surface of an object, and molten in a baking oven to form a paint film. This paint is superior to any other paint regarding environment-friendliness: it contains neither an organic solvent that pollutes the air, nor water that pollutes the water in drainage.

Our company has used powder paints for the interior parts of vehicles manufactured for Kowloon-Canton Railway Corporation (KCRC), Hong Kong. However, it is difficult to ensure a good finish by using a powder paint. Also, use of the paint requires special spray guns and drying ovens. In addition, a special booth is necessary to recover, for reuse, the part of a powder paint that failed to be applied to an object, though this possibility of reuse itself represents an advantage.

2) Change of Painting Methods (Improvement of Adhesion Efficiency)

Another conceivable measure is to change painting methods to improve adhesion efficiency (the ratio of the volume of adhered paint as compared to that of sprayed paint). The part of paint mist that failed to adhere to the surface of an object accumulates (e.g. on booth walls) and causes the adhesion of foreign matters to the painted surfaces. Accordingly, improving adhesion efficiency is important not only in reducing the volume of applied paint, but also in improving painting quality. Our company uses the four painting methods discussed below. Adhesion efficiency varies according to the painting method used.

(1) Air Spray

This is the most popular painting method, involving the spraying of a paint that has been atomized using compressed air. While this method can ensure a good finish, its adhesion efficiency is bad due to the scattering of a large proportion of paint mist (theoretical adhesion efficiency: 30 to 40%).

(2) Airless Spray

This painting method involves applying a pressure of about 10 MPa to a paint, and releasing this paint into the air to atomize it via a sudden pressure change. While the adhesion efficiency of this method is good (about 1.5 times that of the air spray method, with a theoretical efficiency of 50 to 60%), it is not suitable for high-quality or touch-up painting due to large mist particle sizes. Our company uses the airless spray method widely, e.g. for the primer painting (for rust proofing) of bodies and parts; and the top coating of underframes, bogie frames and other portions for which finish quality is not important. The method is not suitable for body top coating due to its poor finish quality compared to the air spray method, but it is effective in reducing the volume of applied paint due to its higher adhesion efficiency.

(3) Low-pressure Spray

The low-pressure atomizing spray method represents an improvement of the conventional air spray method regarding adhesion efficiency. This method increases the adhesion efficiency (to a theoretical value of 55 to 60%) by reducing the flow rate of air in the area near the object to be painted, and thereby controlling the air-induced scattering of paint particles.

To improve finish, we use low-pressure spray guns for the finishing of VTA body outer plates. This has resulted not only in improved finish, but also in the reduced volume of applied paint, as shown in Table 2.

(4) Static Spray (Static Air Atomization)

The static spray equipment is designed to improve paint adhesion efficiency. It charges an atomized paint with a minus static electricity, to have the paint attached efficiently to a grounded object via electrical attraction (theoretical adhesion efficiency: 50 to 60%).

Automatic painting equipment of this type has been introduced at our new painting plant inaugurated in May 2004. It has contributed to improving both the finish and the adhesion efficiency (see Table 2).

For each type of painting equipment (except the airless spray), adhesion efficiency can be improved by decreasing the pressure of air used for paint spray, and thus reducing the proportion of spray rebounded by the painted object. To achieve a high quality finish, however, it is necessary to reduce the paint particle size by increasing the air pressure. Accordingly, it is important to determine the optimal painting conditions by balancing these conflicting requirements.

When using a low-pressure spray gun, the distance between the painting equipment and the painted object (gun distance) must be shortened as far as possible: taking too long a distance will reduce particle speed, causing problems with adhesion. When introducing this gun for painting VTAs, we found difficulties in changing workers' consciousness in this respect: accustomed to the use of conventional spray guns, they had a preconception that having short gun distance would make the film too thick and liable to sagging. Also, workers had to master a different gun (arm) movement to maintain a short gun distance. This shows that workers must be retrained sufficiently to make the most of new painting equipment.

3) Reduction of the Volumes of Mixed Paints

A two-liquid paint, made by mixing a main agent with a hardening agent, cannot be used after the elapse of a certain usable time; the unused part of the paint must be disposed after this time. Accordingly, it is important to reduce the volume of surplus paint by limiting the volumes of mixed paints to the required minimums for the area to be painted.

4) Reduction of the Volumes of Procured Paints

A paint toned for top coating cannot be used for vehicles other than those for which it was originally intended. Also, hardeners and thinners can be used only during a certain season, for they have their respective usable temperatures. Accordingly, it will prove effective to reduce the difference between the purchased and used amounts of paint by accurately predicting the amount to be used.

5) Maintenance of Painting Equipment

Our new body painting plant, inaugurated in May 2004, has activated charcoal absorption equipment designed to reduce VOCs emitted from painting booths. To make the most of this equipment, it is necessary to inspect it periodically, and replace activated coal according to the results of inspection. (The inspection involves measuring odor concentrations upstream and downstream of the activated charcoal. Replacement is done if the treatment efficiency has been found to be lower than 90%.)

○ Future Efforts

Painting has a large potential impact on worker health and on the environment. Also, reduction of the amount of applied paint is an important task not only from the standpoint of environmental conservation, but also in terms of cost reduction. To reduce environmental burdens, we will strive to reduce unnecessary paint in the course of routine painting; use appropriate painting methods; promote the use of high solid paints; and expand the applications of water based paints.

* PRTR Act: refers to a legal system to control specific chemical substances potentially harmful to human health and ecosystems. Under this system, businesses determine the amounts of these substances which have been emitted to the environment from, or transported out of, their establishments; and report them to the authorities. The authorities compile and publish data obtained from the report.