More productivity, less pollution

Power and productivity are fitting by-words for ABB's paint system activity

Hubert Labourdette

Paint application is a difficult industrial process but it is an area that ABB has much experience in. Over the years, the company's paint system activity, has developed a range of solutions for industrial paint shops that help improve overall productivity and quality. Automotive and general industry customers use these solutions for the surface finishing of cars, mobile phones, marine engines and cranes for example.

However, many paints contain organic solvents that are hazardous to human health and the environment. As companies are under pressure to reduce emissions and decrease their operating costs, optimized products, solutions and services are the order of the day. A crucial area of optimization is the paint booth and one that ABB has successfully tackled with the development of an air recirculation system combined with a state of the art energy saving process. This solution is described in the following article.

Paint application is a difficult industrial process, which has to face many demanding challenges simultaneously. For example:

- *Top-class paint finishing quality must be achieved* by spraying the object in a well controlled air environment, ie, in a paint booth with the correct temperature, air speed and hygrometry, and with the absence of dust.
- *There should be little or no waste.* Paint and solvent can be saved by using ABB paint robots and atomizers.
- *The exposure of operators to solvents should be avoided* to protect their health.
- *Energy should be saved.* The energy used represents between 25 and 30 percent of the paint application process cost.
- *It must be in line with environmental regulations.* This is now possible when using solvent paint thanks to Volatile Organic Component (VOC) treatment and to energy savings.

ABB has already addressed the paint material savings challenge with its cartridge bell system [1] and the majority of automotive carmakers are now equipped with it. A new paint robot generation 1, launched in 2006, dramatically reduces human activity in polluted areas by enabling a fully robotized process.

Paint booth optimization

The paint booth process is illustrated in 2. An air make up unit (1) processes fresh air from the outside and controls its temperature, humidity and dust content. This fully controlled air is brought to the roof of the booth (2) at a constant vertical speed. It picks up solvent and paint during the spraying operation (3). A washing process is achieved through the venturi (4), where water mixed with paint material waste is sent to the waste treatment tank (5), and air mixed with solvent is blown through a chimney to the outside (6).

This type of process is very costly in terms of energy as large quantities of outside air (many hundreds of thousands of cubic meters per hour) need to be treated. Additionally, the mix of air and solvent which is rejected into the atmosphere no longer complies with environmental rules. These reasons alone are a compelling argument for paint booth optimization.

The ABB solution

To solve all these issues simultaneously, ABB has developed an air recirculation system combined with a state-of-the-art energy saving process in the paint booth. This solution combines air recirculation, solvent disposal and energy saving and is fully compliant with environmental regulations. It can only be applied in fully robotized areas. Since the launch of ABB's new paint robot generation this happens to be more and more common in paint shops.

1 A new paint robot generation

2 Paint booth process

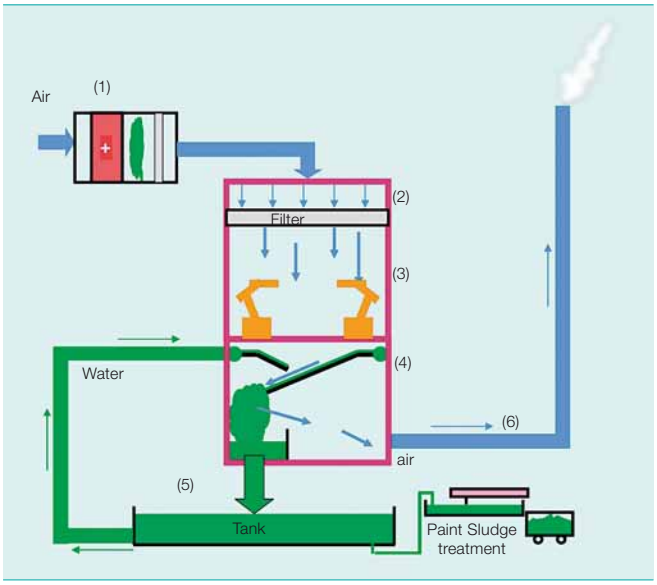


ABB has developed an air recirculation system combined with a state-of-the-art energy saving process in the paint booth. This solution combines air recirculation, solvent disposal and energy saving and is fully compliant with environmental regulations.

Recirculation

The paint booth air recirculation process is shown in 3. After the washing stage (4), the polluted air is not vented outside. Instead, it is 90 percent recycled in the booth after it has been treated in (8). This recirculation system not only allows air reutilization, but the solvent concentration in the booth has a ratio that is in line with full optimization of the solvent burning process. Solvent concentration in the booth is monitored and maintained within safe limits. A specific air duct extracts 10 percent of the air flow and sends it to a Regenerative Thermal Oxidizer (RTO) (7). This extraction is counterbalanced by a small flow of air from the outside (1).

This process is very stable with very little influence from outside conditions. However, it requires a very efficient washing process (4) and a well specified dust filter.

Regenerative Thermal Oxidizer (RTO)

A regenerative process is used to treat the solvent in which burning is achieved at 800 °C. Thanks to the recirculation process, the air is solvent saturated. It goes through a high temperature ceramic chamber 4, where its temperature is raised to 780 °C after which it enters a combustion chamber. An auto-combustion phenomenon occurs at this temperature level, fully eliminating the solvents. This solvent-free air flow – with a temperature of 835 °C – is then sent through a second ceramic chamber where it is cooled to + 60 °C before being vented to the outside.

With the exception of the start-up phase, the amount of energy consumed by this system is close to zero, and thermal efficiency is close to 95 percent.

The air flow is periodically inverted to increase the ceramic temperature. With the exception of the start-up phase, the amount of energy consumed by this system is close to zero, and thermal efficiency is close to 95 percent. The process fully conforms to environmental laws in application in almost all countries.

Energy and water savings

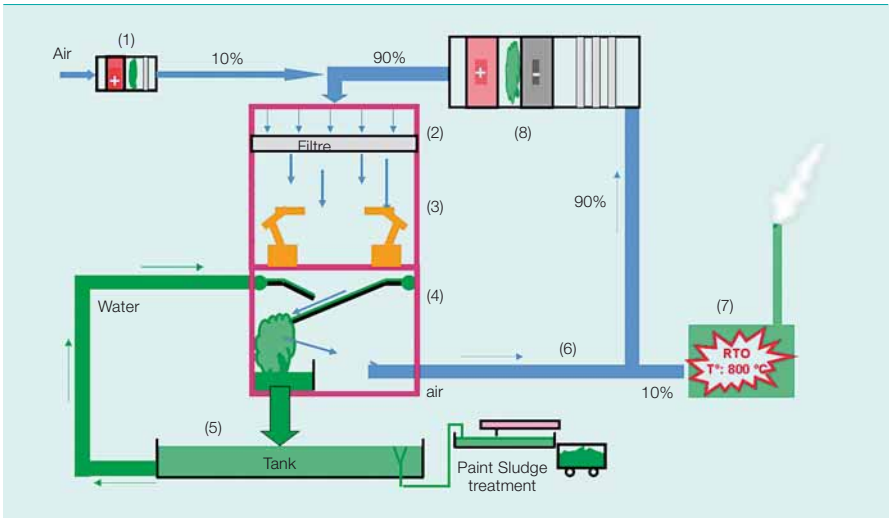
The paragraphs above have shown that solvents can be eliminated without additional energy. Another significant source of savings is in the outside air conditioning process 3 (1). Compared to a traditional scheme, ABB's process reduces the quantity of fresh air used – and hence the energy consumed – by a factor of 10! However, it requires the introduction of new equipment 3 (8). A more detailed illustration of the recirculation process is shown in 5. This entire concept has been optimized with energy savings in mind. After the washing step (A), the air humidity is too high and therefore cannot be reintroduced directly into the booth (C). Instead, it must be dried by condensation.

After a dust filtration stage, the air temperature is decreased to 14°C (B) to condense the water after which it is immediately increased to 19 °C. To reach an optimal level deemed necessary to achieve good paint application, the temperature of the air is increased by a further 2 °C by passing it through a fan. At the condensation stage, all water is collected and returned to the washing equipment. This approach creates a closed-loop system for the water, resulting in significant savings. Compare this to the traditional process, where a mixture of water and air is blown out, while fresh water is used in the washing equipment.

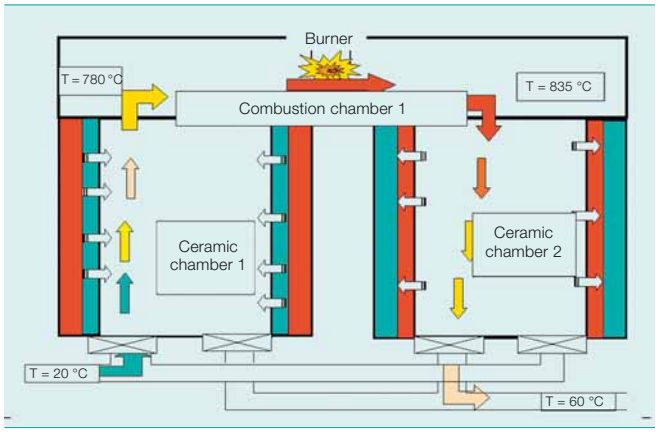
At the condensation stage, all water is collected and returned to the washing equipment, creating a closed-loop system for the water, and resulting in significant savings.

A cooling system is directly connected to the air treatment unit. It is used for the first step of air cooling, but as with all such systems, it generates a significant amount of heat. However, rather than creating a problem, this heat is utilized for

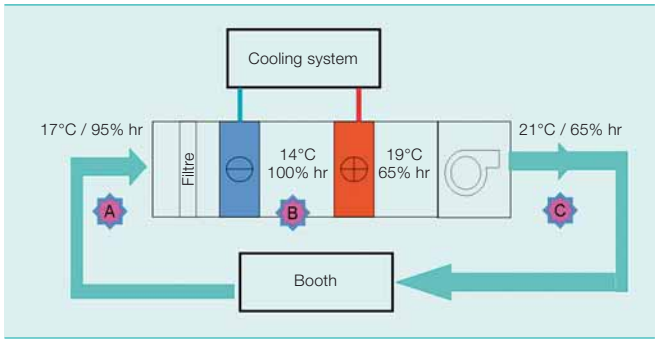
3 Paint process with air preheater and regenerative thermal oxidation (RTO) reduction equipment



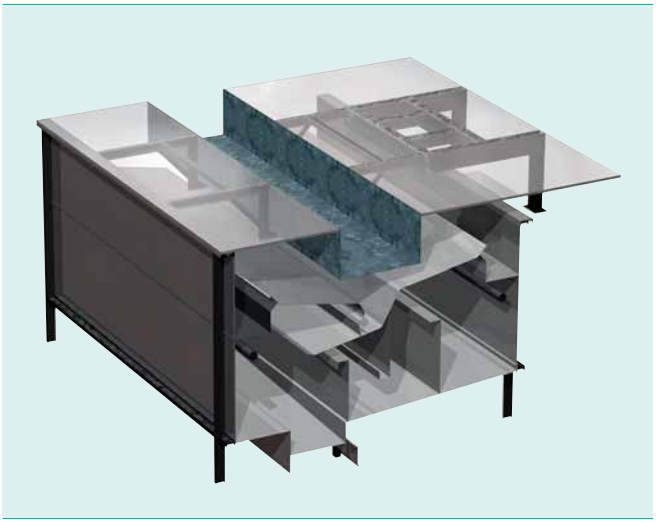
4 Air circulation chamber



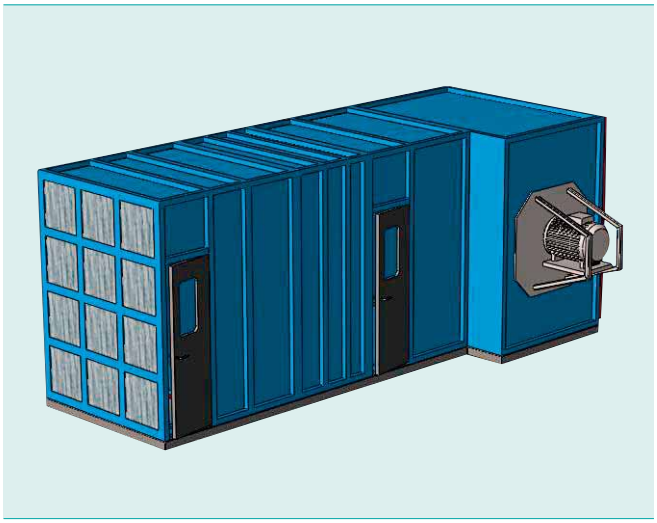
5 Air heating and cooling system



6 Compact and transportable air washing equipment



7 Compact and transportable air treatment unit and cooling equipment



the second step of air heating. The result is low energy consumption.

System implementation

ABB's air recirculation system can not only be implemented in new factories but it can also be used to improve the performance of existing ones. The latter case, however, creates an additional challenge in that all modifications, including start-up and commissioning, have to be successfully implemented during the two or three weeks of normal shutdown (ie, summer and Christmas holiday period). To achieve this, ABB has successfully developed a modular equipment range based on a plug and produce approach, 6 and 7.

Almost all elements of this range include products from other ABB divisions (PLC, drives, instrumentation etc.) and they provide a good overview of the ABB equipment portfolio. They are pre-assembled in a temporary structure close to the existing paint shop. As soon as production shuts down, the old equipment is partially disassembled and the new modules are then integrated into the paint line.

Customer benefits

The system offers very stable application conditions independent of outside weather variations, which results in a significant quality improvement. A new installation is very compact and requires a much smaller footprint than that of an older line, and it is fully compliant with environmental regulations. Substantial energy savings approaching 30 percent are realized when compared with existing lines. This represents a nine percent reduction in the total annual operating cost of the paint process.

Customers benefit from the very high level of engineering expertise acquired by ABB engineers in paint application from the many installations around the world. This experience is necessary to accurately define a complete system. Additional benefits are generated by using a fully robotized process without any manual paint application, an area in which ABB is the world leader.

Substantial energy savings approaching 30 percent are realized when compared with existing lines. This represents a 9 percent reduction in the total annual operating cost of the paint process.

Paint savings, the complementary challenge

The recirculation system requires a fully robotized process which produces further savings, ie, it reduces paint consumption (and thus cost) and hence environmental impact. Robots equipped with a state of art ABB paint atomizer increase transfer efficiency (defined as paint quantity used on a part divided by total quantity of paint used). In addition, the paint process is monitored by a sophisticated program, which accurately tracks all paint process related parameters as well as the paint pattern on the car.

The robot is now mandatory not only to achieve paint savings but also to avoid operator contact with very dangerous chemical substances Title.

This unique solution from ABB increases productivity and saves energy with less pollution.

Hubert Labourdette
Global Lead Center for Paint Process Automation
Saint Ouen l'Aumône, France
hubert.labourdette@fr.abb.com

Reference

[1] **Yoshida, Osamu**, "More colors, less waste – ABB Cartridge Paint System: Cutting costs and reducing environmental impact", ABB Review Issue 1 2006, pages 43–46.