Don't Blow It!

How to Choose the Correct Air Compressor for Use with Waterborne Paints in the Auto Body Industry

By Dan Hanley and Daniel Williams

The rules of engagement are a little more strict with waterborne paint than they are with solventborne.
- Nick Bartoszek, Sherwin-Williams Automotive Finishes

Knowledge is power.
- Sir Francis Bacon

Introduction

Since 2009, Bay Area auto body repair and paint shops, production paint shops, fleet repair paint shops, new car dealer paint shops, and truck body and trailer painting facilities[1] have been subject to the Bay Area Air Quality Management District's (BAAQMD) amended Regulation 8, Rule 45, which "limits the emission of volatile organic compounds from the finishing or refinishing of motor vehicles, mobile equipment, and their parts and components."[2]

BAAQMD defines volatile organic compounds (VOCs), as "any organic compounds [with some exceptions] that would be emitted during use, application, curing or drying of a solvent or surface coating."[3] Since VOCs are present in virtually all paint traditionally used in the auto industry, shops throughout the Bay Area have been forced to switch to VOC-free waterborne paint. Many shops, however, have not changed their air compression equipment to accommodate this paint, and are consequentially losing money and time due to inefficiencies caused by their mismatched equipment.

The following paper will explain how to choose an air compression system for use with VOC-free waterborne paint, and is written to address specific needs within the auto body industry.

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[1] State of California. Bay Area Air Quality Management District. *Compliance Tips for Automotive Refinishing Shop.* San Francisco, CA: Bay Area Air Quality Management District, 2009. Print.

[2] State of California. Bay Area Air Quality Management District. *Regulation 8, Organic Compounds, Rule 45, Motor Vehicle And Mobile Equipment Coating Operations.* San Francisco, CA: Bay Area Air Quality Management District, 2009.

[3] Ibid.

Background: Regulation 8, Rule 45; VOCs; and Waterborne Paints

Faced with growing evidence asserting the dangers of VOC use in various industrial processes, the California Air Resources Board (CARB) began encouraging local air quality districts to adopt stricter VOC regulations in 2005. The South Coast Air Quality Management District was the first Californian district to implement this standard into law, but most Northern California districts have now followed suit. BAAQMD amended its air quality standard governing organic compounds and motor vehicle coating operations (Regulation 8, Rule 45) on October 1, 2009 to limit the use of most traditional solvent-based paints, as well as various other industrial compounds.

Regulation 8, Rule 45

According to BAAQMD's Regulation 8, Rule 45, any entity which uses more than thirty gallons of automotive coating per year—including primer and clear coats—is required to obtain a permit to operate from the Air District and comply with the laws regarding VOC use and limits.[4] In addition, shops cannot posses any non-compliant coatings after October 1, 2009.[5]

> " ...waterbourne paints are typically thinner, cleaner, and more viscous."

VOCs

The term "volatile organic compound" refers to any of the hundreds of carbon-containing chemicals that are gases at room temperature (excluding inorganic carbon-containing gases such as carbon dioxide and carbon monoxide).[6] VOCs are present in virtually all industrial products, from underarm deodorant to cleaning fluid. Unfortunately, many individual compounds are linked to air pollution and illness in animals and humans.

VOCs form ozone, the primary component of smog, by reacting with airborne chemicals in the presence of sunlight.[7] While upper-atmosphere ozone is beneficial—it blocks harmful ultraviolet rays from reaching the earth's surface—ground-level ozone is considered toxic by the EPA, and linked to chest pain, coughing, throat irritation, and congestion. It can also worsen bronchitis, emphysema, and asthma.[8]

Finally, many VOCs used in auto painting applications are also known or suspected to cause cancer in humans, including benzene, toluene, and xylene.[9]

Waterborne Paints

Waterborne paints for use in the auto industry are not new—they have been used in Europe for many years and are applied to most new cars at the factory by auto makers—however, they differ substantially from their solvent-based counterparts: waterborne paints are typically thinner, leaner, and more viscous. As a result, these paints require different application equipment than their solvent-based counterparts, as well as additional operator concern for the climate in which they are sprayed:

> *...if I bring a painter off the street who has never sprayed it, he's going to have to go through every season because temperature and humidity changes will come into play. So it might take a new painter a little longer to get acclimated to your climate or work environment spraying waterborne versus solvent. He's not going to just come in and boom, get the clearcoat and basecoat and learn the mixing system and ratios, etc.*[10]

According to author Michael LaGault, as published in *Body Shop* magazine, "comparing waterborne paint to solvent-borne paint is like comparing apples to oranges".[11] LeGault cites the additional drying time required by waterborne paints as a crucial difference,

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[4] Ibid. 1

[5] State of California. Bay Area Air Quality Management District. *BAAQMD Automotive Coatings Presentation.* By Jeremy Kimball, Senior AQ Inspector. Bay Area Air Quality Management District, 2 Mar. 2010. Web. 1 June 2010.

[6] Indoor Environment Department of the Lawrence Berkeley National Laboratory. "Indoor Volatile Organic Compounds (VOCs) and Health." *Indoor Air Quality Scientific Findings Resource Bank*. Lawrence Berkeley National Laboratory, 2010. Web. 02 June 2010.

[7] United States Environmental Protection Agency. "Ground-level Ozone." *US Environmental Protection Agency*. US EPA, 7 Jan. 2010. Web. 02 June 2010.

[8] Ibid.

[9] United States Environmental Protection Agency. "Auto Paint Chemicals." *US Environmental Protection Agency*. US EPA, 5 Jan. 2010. Web. 02 June 2010.

[10] Anderson, Michael. "Converting a Body Shop to Waterborne Paint: What to Expect." *BodyShop Business - The Body Shop Reference: Technical Notes, Events, Products*. Body Shop Business, 9 Feb. 2010. Web. 02 June 2010.

[11] LeGault, Michael. "Waterborne Basecoat Under the Microscope." *Body Shop* Aug. 2008. Business Information Group, Aug. 2008. Web. 2 June 2010.

and explains the mechanism involved as follows:

> *...as a rule, given similar conditions, waterborne paints do not dry as quickly as paints made with an organic solvent carrier. The reason for this difference is explained by the difference in the vapor pressure of water versus that of organic solvents. The evaporation of a liquid is dependent on its vapor pressure. The higher the vapor pressure of a liquid at a given temperature, the greater the tendency of the molecules to "escape" the surface and enter the atmosphere. Organic solvents such as ketone or acetone have a much higher vapor pressure than water, which is one reason they are called "volatile" organic compounds and are easily detected by the human nose.*[12]

According to LeGault, using the proper air moving equipment is the primary determinant of an operator's success when using waterborne paints:

> *The bottom line is that shops converting from solvent-borne to waterborne paints may need to invest in air moving equipment to achieve similar drying times and productivity.*[13]

How to Choose the Correct Air Compressor for Use with Waterborne Paints in the Auto Body Industry

Refinishing auto paint to match factory color and quality is auto body shop customers' first priority. For shop owners and managers, doing the job correctly the first time to maximize profit is their top concern. Compressed air has always played a key role in the process, and is even more important when using waterborne paint—operators cannot afford to allow excess moisture from compressed air to enter their spray. Additionally, waterborne paints typically need additional air to successfully atomize their paint particles due to their typically higher viscosity compared to solvent-based paints. The first step, then, in choosing the correct air compressor for use with waterborne paints is to determine the most appropriately-matched method of compression.

Piston vs. Rotary Screw Compressors

For the most part, piston compressors—devices which compress air using a piston and crankshaft—are acceptable when supplying compressed air for solvent-based applications. The inherent weaknesses of these systems, however, make them unacceptable for efficient use with waterborne paint.

Piston compressors rely on intake and exhaust valves in their motors. As these valves wear, their integrity becomes compromised and they can introduce contamination (in the form of oil and fuel) into the output stream from other parts of the system.[14]

Waterborne paints tend to be less forgiving of these contaminants than their solvent-based counterparts, and perform poorly in their presence.

Rotary screw compressors, which compress air by forcing it through tightly-spaced screws, are a better match for waterborne paints due to their resistance to contamination. Since they do not have the same system of valves, pistons, rings, and connecting rods[15] as their piston-driven components, rotary-screw compressors are less subject to internal contamination; their output is consequentially "cleaner" than that of a piston-driver compressor, and hence more appropriate for use with waterborne paint.

Many operators will also find the lower maintenance requirements of rotary screw systems advantageous by comparison to their piston-driven counterparts:

> *The only significant moving parts in a screw compressor are the male and female rotors. There are no valves, pistons, rings, or connecting rods that require regular maintenance. With the elimination of the pistons, rings and valves, annual maintenance costs are also reduced on screw machines. ... When comparing screw compressors and reciprocating* [piston] *machines, it is important to consider maintenance costs into the overall project cost.*[16]

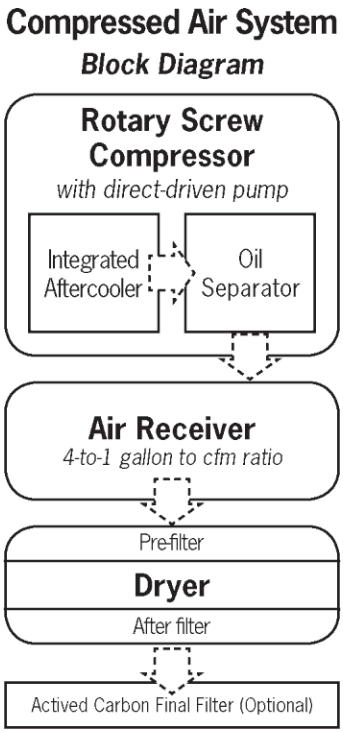
[12] Ibid.

[13] Ibid.

[14] Sullivan, Ed. "When Compressed Air Is Crucial." *Compressed Air Best Practices* Sept. 2007: 45-47. Print.

[15] Bruce, J. Trent. *Screw Compressors: A Comparison of Applications and Features to Conventional Types of Machines*. Rep. Calgary, Alberta, Canada: Toromont Process Systems. Print.

[16] Ibid. 15



Heat and condensation are additional considerations in choosing between piston-driven and rotary screw compressors. Piston-driven compressors generate substantial heat as they operate, which in turn produces condensation. This moisture, when introduced into the compressor's output stream via ambient air input, will further degrade the performance of waterborne paint—particularly if combined with particulate contamination from the imperfect seals of a piston-based unit.

Finally, rotary screw compressors are inherently quieter than their piston-driven counterparts and able to operate continuously, as opposed to piston-driven units, which are typically rated for 50% duty cycles.

Additional Features

When choosing a rotary screw compressor, look for certain features that, while not present on all units, can make critical differences in the quality of the work they produce. An integrated aftercooler (which removes bulk condensate from the compressor's output) and an oil separator (look for a unit which reduces oil carryover to less two parts per million) will contribute to profitability by eliminating moisture and contaminants from the compressor's output. An energy-efficient direct-driven pump will reduce electricity consumption (and consequentially lower operating costs). Be aware that most low-cost rotary screw compressors in the five-to-ten horsepower range do not include these features.

Choosing an Air Receiver: Bigger is Better

A properly-sized air receiver is essential to maximizing quality when using waterborne paints. As with any air compressor, a rotary screw unit requires a receiver with a capacity above the unit's maximum mean air consumption to act as a buffer and storage medium—for waterborne paint spraying applications, a 4-to-1 ratio of gallons to cubic feet per minute (cfm) is desirable to ensure sufficient air storage to allow the compressor to cycle efficiently.

Please note that this recommendation is higher than the gallon-per-cfm capacity sometimes recommended for industrial applications—in addition to offering gains in compressor cycling efficiency, a large receiver will reduce moisture in the system's output, thus improving its effectiveness when used with waterborne paint:

> *If it's of sufficient capacity, the air in the receiver can cool once the compressor has been shut off. It's the process of compressing the air (friction between the air molecules) that generates the heat. As the air in the receiver cools, it reduces the capacity for holding moisture, and eventually the temperature in the receiver will reach the dew point where more water is dropped from the compressed air than would be the case if the air stayed hot. Less water in the compressed air means fewer problems to deal with downstream. If it were us, we'd have… the largest practical air receiver possible for our compressor system.*[17]

Dryers: Refrigerated and Desiccant

In addition to a properly-sized receiver to ensure that air is sufficiently dry for use with waterborne paints, a quality dryer (downstream of the compressor and receiver) will further dry the air, eradicating virtually all moisture from the compressor's output.

A refrigerated dryer, which removes moisture from the compressed air stream with a heat-exchanger (similar to a home refrigerator), will eradicate virtually all moisture when used in conjunction with proper filtration: a pre-filter placed before the dryer captures bulk moisture and contamination as it enters, and an after-filter placed immediately after the dryer ensures that no remaining particulate matter passes into the final airstream.

For even more demanding applications, a desiccant dryer can be used in place of a refrigerated unit—desiccant dryers remove moisture from air by passing it through a chamber filled with porous desiccant tablets (typically activated alumina or silica gel) which absorb moisture into millions of tiny pores on their surfaces.

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[17] Wade, William. "Receivers: Air Tanks for Your Compressor." *About Air Compressors. Help in Understanding and Using Compressed Air*. Web. 07 June 2010.

As the desiccant is wetted, various schemes (dependant on dryer model) are used to re-dry it within the system. Desiccant dryers, while more effective than their refrigerated counterparts, are typically unnecessary for use in auto body spraying applications, but should be considered if additional drying is required.

Finally, to ensure that the minimum possible level of contamination is present in your compressor's output, consider an activated carbon final filter to remove residual oil vapor that may be present.

Mind Your Filters

Although a rotary screw compressor with a properly-sized receiver and dryer will provide substantially cleaner air than a piston-driven unit, proper air filtration is still necessary to ensure top-notch results when using waterborne paints—air within the system must be filtered to remove moisture and atmospheric contaminants. Filters will be included in various stages of the compression process depending on your particular model of compressor; pay particular attention to their state, and change them at your system's manufacturer's recommended intervals. Soiled or otherwise compromised filters can quickly ruin a paintjob, robbing you of time and profit.

Additional filtration at the point-of-use—in this case, your facility's spray guns—may provide additional benefits, as well: any internal moisture or corrosion in your system's lines will be filtered out of your gun before it can contaminate its output or the unit itself.

Additional Considerations

The ideal air compression system for use in the auto body industry is a carefully selected combination of components designed to provide the clean, dry air necessary for top-notch results with waterborne paints. But the system is more than the sum of its individual parts: to maintain profitability and spray consistent coats over time, all systems (regardless as to quality) must be properly sized to their application and adequately maintained.

Determining Horsepower Requirements

In determining the horsepower (hp) needed for your spray applications, the first places to consult are the manufacturers' requirements for your spray guns and your paint equipment distributor. A single spray gun application may only require a five horsepower rotary screw compressor system with clean and dry air, but your facility's paint drying system must be taken into account, as well.

If you use an air venturi system to dry paint in your facility, you will require additional compressed air depending on the amount of air movement you need to achieve the desired drying: the amount of air required is directly proportional to the number of air venturis used in the booth. Although faster drying times can be achieved, it is important to remember that using an air venturi is expensive: generating compressed air requires a considerable amount of electricity. More cost-effective methods, such as cross-ventilation, ceiling fans, infrared drying, and air blowers, should be considered in lieu of an air venturi system (provided the longer drying times inherent to the methods are acceptable). If your application demands drying by air venturi, you might consider adding an inline heater before the venturi—heat can have a dramatic effect on drying time.

> " ...consider a compressed air system as a long-term investment: don't buy the cheapest system available!"

A Word about Maintenance

The final, and most important, advice for shop owners using waterborne paint in the auto finishing industry is to consider a compressed air system as a long-term investment: don't buy the cheapest system available! When examining a compressor system's lifecycle costs, the initial capital investment is minimal compared to the electricity and maintenance costs that will add up over the years. Invest in a system that is reliable, efficient, and maintenance-friendly.

In doing your research, it is important to evaluate the maintenance plans available from your local compressed air providers. Compressor systems must be serviced at least once a year in a single-shift operation, and all filters must be inspected for moisture and changed at regular intervals based on their manufacturer's specifications. While auto paint and equipment distributors may be able to sell compressor equipment, they typically do not have factory-trained technicians to perform service and repairs.

Remember that when you contact a provider for information about your compressed air system, you are paying for a service, and (ideally) beginning a lasting and mutually-beneficial relationship. Don't be afraid to ask questions. Augmenting or replacing your older air compressor (and related devices) is an expensive proposition, and while a rotary screw compressor boasts substantially lower maintenance requirements than a comparable piston system, no solution is foolproof. Ask your provider about the maintenance requirements particular to your system, and follow his or her advice.

Conclusion

The Bay Area Air Quality Management District's amended Regulation 8, Rule 45, which limits the emission of volatile organic compounds from finishes used in the auto industry (and various similar laws in other jurisdictions), obviously has profound and lasting implications for shop owners and operators. Profitability does not have to be one of them. By matching quality waterborne paints with an air compression system appropriate for their use, operators in California (and anywhere waterborne paint is used) can maximize their operation's efficiency and profitability, all while turning out top-notch work.

Understanding the differences between waterborne and solvent-based paint as they pertain to your air compression equipment can make the difference between an inadequate and a great paint job. While changing your system to better accommodate a new kind of paint may represent a short-term financial hardship to your organization, remember that the long-term benefits of a properly-matched system vastly outweigh the initial cash outlay. Top-quality results speak for themselves, and organizations able to provide them will survive and flourish despite changing times.

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