PAINT BOOTH PRESSURE LEVELS

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Much thought has been given to paint booth pressures. Usually this discussion centers around whether the booth is under a negative or positive pressure. Some discussions insist that the booth be held at a positive pressure relative to the outside so that dirt and debris cannot enter the painting chamber and soil the object being painted. This is a serious consideration in booth design and is generally solved by having very good seals on the doors and completely caulking the panels. Others insist the booth be at a negative pressure relative to the outside. This prevents emissions and VOCs from entering the room adjacent to the spraying chamber. Once again, having very good seals on the doors and caulking the panels solve this problem.

This discussion generally assumes that the paint booth is a place that is at a uniform pressure level. This is not true and the science of balancing paint booths, especially so-called "big rooms" is easy to understand.

In order for air to move a pressure difference must exist from one end of the booth to the other. In a draw-thru booth (Figure 1) the pressure at the entrance will be near zero, and it will get progressively more negative as it approaches the filter bank and exhaust fan. One may think of the spraying chamber as a section of ductwork, since it is completely enclosed.

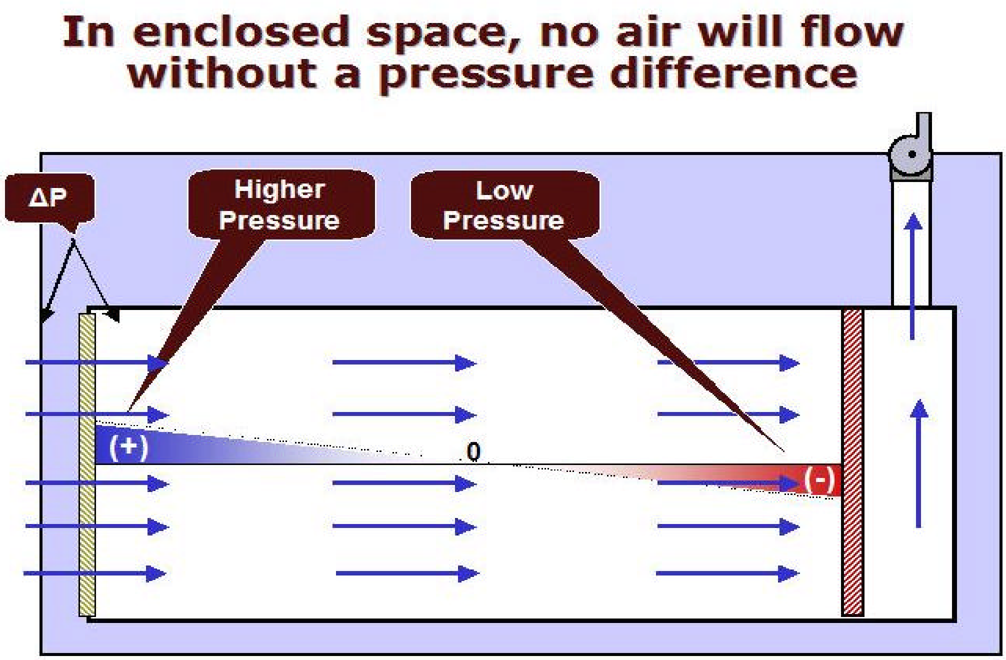

Figure 1 – Pressure Difference

Notice the gradation of pressure as the air moves from one end to the other. If the room pressure were to be measured relative to the outside area at the center of the booth, you would find that the pressure would be different at the end of the booth nearest the exhaust filters.

Notice that in the draw-thru system (Figure 2), the air is drawn through a filter door or wall. This is usually the product entry door because it has sufficient area to allow for good filtration. It is an important addition to a booth to add a filter door (as opposed to using an open front booth) because air carrying dust and dirt particles is filtered prior to entering the painting chamber removing most of the cause of imperfections.

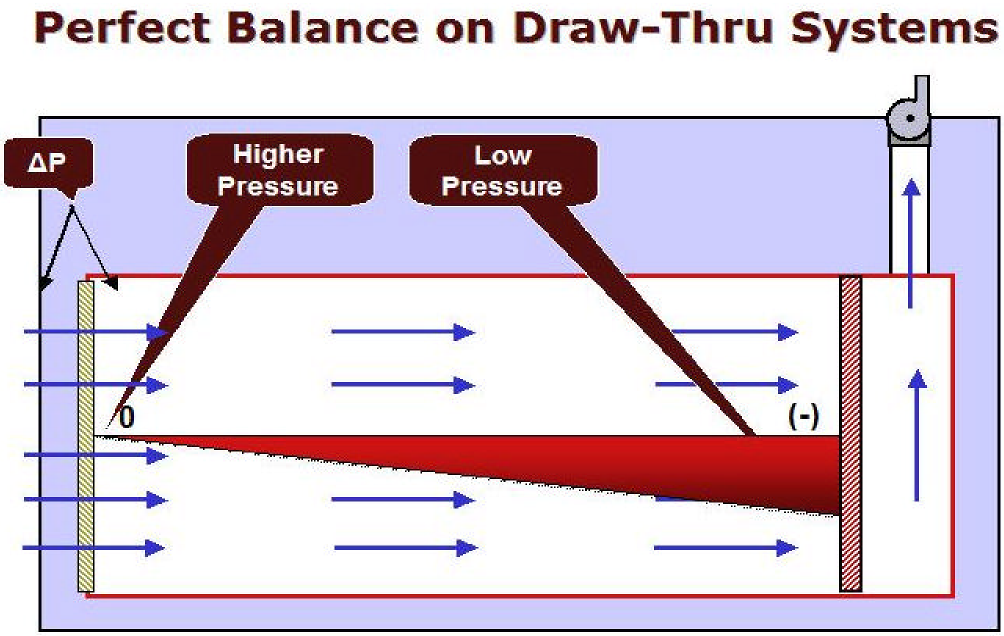

Figure 2 – Draw-Thru Balance

PRESSURIZED SYSTEMS

In pressurized systems an air replacement system consisting of a fan and maybe a heater system adds replacement air directly to the booth in lieu of drawing the air thru a filter door. These systems are difficult to balance, but once the fundamentals are understood the balancing is very simple. Let us look at a system that is incorrectly balanced (Figure 3).

In this system, more air enters the booth than is allowed to leave. When the air systems are first turned on, the suction from the exhaust tries to evacuate the room, but in time the surplus air builds up pressure in the middle of the booth causing a cloud to form. Air is a compressible fluid and will just “bunch up” at the point of interference. This cloud is invisible until the painter starts his painting operation. Then the air is colored with paint and the cloud is very visible (See Figure 3).

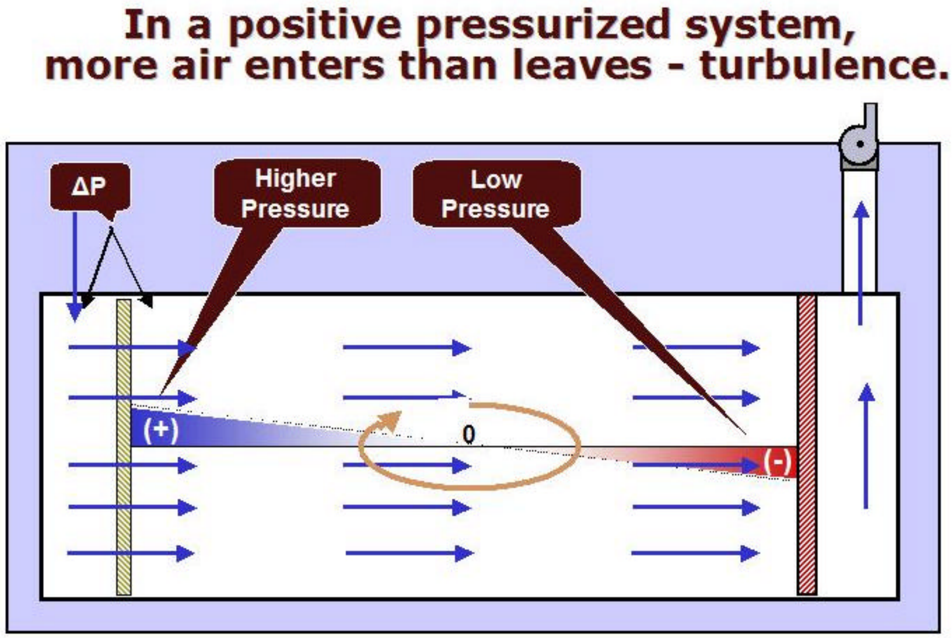

Figure 3 – Pressurized with Turbulence

Turbulence is also obvious when using a small handheld velometer. Since the meter is a vane type device, air entering from one side causes the vane and its needle to move to the appropriate place on the scale. When air enters from both sides such as at a location of turbulence, the needle and vane oscillate and it is difficult to get a reading on the meter that is stable.

In any case, turbulence is one of the worst things that can happen to a painter. It causes all manner of blemishes in the paint from thinly applied paint to overspray and dirt inclusions, to low visibility. Turbulence will show up as paint overspray on the walls and lamps of the paint booth, on the floor, and on the painter himself. It makes the working conditions very difficult and the chances of customer dissatisfaction very likely.

Looking at a well-balanced system (Figure 4), the booth is at a negative pressure (relative to the outside) from the time the fresh filtered air enters the booth until it leaves through the exhaust filters. This is the same pressure profile as the draw-thru system. It is as if the exhaust fan were reaching out to the zero point of pressure in the booth and gathering the air, while the supply fan is pushing the air just enough to move it to the zero point of pressure in the booth.

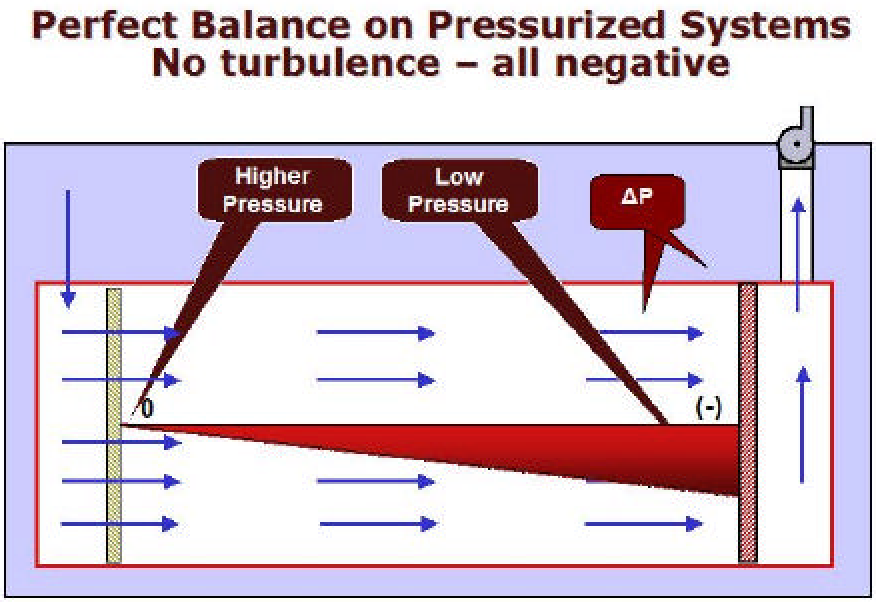

Figure 4 – Pressurized and Balanced

It is best to design a booth to move the zero point of pressure in the painting chamber to the intake filter section of the booth. In this manner the fan reaches out to the filters and pulls the air through them into the booth. This is the same principle used in the draw-thru system.

SO MUCH FOR THEORY!

What about actual practice? When the "perfectly balanced" environment of a spray booth is disturbed by the object to be painted as well as by a painter and spray apparatus, the perfect booth also changes. This is natural, obeying physical laws.

The most noticeable thing that happens is the filters become soiled with paint and particulates. This fact of life is a sign that the paint booth is functioning correctly. If the opposite were true, the paint booth would be greatly out of balance and paint and particulate would soil the object and the floor or walls. As the filters become clogged, the exhaust fan sees a greater resistance to flow and moves less air. The intake fan is less likely to see a change to its resistance and continues to supply the same volume of air.

The effect is the zero point of pressure in the booth starts to migrate toward the center of the booth. Wherever this zero point is located a cloud of paint will be seen when the painter is working at that location. A velometer will also be helpful in demonstrating this effect. To move the zero point back to the intake of the booth, the exhaust fan must run at a faster rate to compensate for the increased static pressure.

The practical way of doing this is to install a variable speed drive system (VFD) on the fan and connect it to a sensor and a controller that measures the room static pressure and adjusts the fan speed accordingly. It is not important where the sensor is located since the gradation of pressure is essentially linear and if a pressure of -.03" is held at the center of the booth, the same good results can be had by holding the pressure to -.05" nearer the exhaust filters.

The object itself introduces challenges that can frustrate a painter at times. But painters are clever creatures and by experimenting with their stance and the location of the spray they can overcome most of the negative effects of the object interferences. Mostly, these effects show up in turbulence and the overspray causes a soiled area on the object to be painted. By choosing the method of applying paint, much of these effects can be mitigated. The painter may find that by spraying from back to front works better than the opposite way. Perhaps re-orienting the object will modify the turbulence to the point that it is not a problem.

Balancing a booth can be a difficult job unless the technician understands the principles of air movement and pressure gradients. Once armed with these principles, the job is less an art than a science.