Holistic Approach to Designing a Blast Containment Ventilation System Layout

By Russell Roden, Atlantic Design, Inc. | calladi.com

When planning the optimal layout for ventilation and dust control, the complete flow path of the ventilated air — from intake start to final exhaust — must be considered. Many layouts do not provide for the air flow needed to protect blasting personnel or the area surrounding the blast containment from excessive dust exposure. If all the inlet and exhaust pressure drops are not taken into account, the system will be underpowered and will not deliver the required air flow. Following is a description of a typical abrasive containment area and the flow and pressure considerations for making the ventilation and containment system work successfully.

Typical ventilation systems for blast containments are low-pressure and are measured in inches of water gauge (in wg). While there are a number of different instruments for measuring gauge pressure, the classic U-tube manometer, which uses gravity and water to measure low pressures, is commonly used in the design of ventilation systems. The U-tube manometer is essentially a small tube, between 3/8- and 1/4-inch diameter, formed into a tall U shape (up to about 36 inches in height) with the uprights on the U approximately 2 inches apart.

Proper ventilation and dust control is crucial for protecting the blasting personnel and the area surrounding the blast containment from excessive dust exposure.
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To measure gauge pressure, the U-tube manometer is held in a vertical configuration and the tubes are half-filled with water. One tube is connected to a low positive or negative pressure, and the other is left open to the atmosphere. The pressure causes a difference in elevation, measured in inches, between the two columns in the manometer.

For additional reference, 1psi = 27.7 in wg and 1-inch mercury = 13.6 in wg. These values are at standard atmospheric conditions but will suffice for typical blast projects.

System pressure, not including any dynamic or velocity pressure, is usually called the static pressure. This is essentially the difference between the atmospheric pressure and the positive or negative pressure inside the ducting or containment. The overall total system pressure is called the system static pressure.

A normal ventilation system will have both negative and positive pressure over the course of the total air-flow path. Blast containment arrangements typically use a single fan for ventilation systems, so having enough power at the fan is crucial. Centrifugal fans, like the ones used on portable dust collectors in the blasting industry, allow the air flow to increase or decrease in direct inverse relation to the system pressure. Less pressure means more flow and vice versa.

All the power required for containment ventilation systems is generated from the dust collector fan.

This can be covered in more detail in future articles, but suffice it to say that the flow will adjust to the amount of power the fan has. If the fan is underpowered for the task at hand, then the air flow will drop until the system pressure is in equilibrium with the fan pressure — the system static pressure. This is why system parameters such as the filter differential pressure may look normal while the system is operating way below the required air flow.

The designer of a blast containment ventilation and dust-control layout must take into account many factors to ensure that the system will operate properly. First, the size of the containment system must be considered. Then a flow layout must be determined to provide adequate air flow for that containment size and identify how the air will flow through the containment area to protect the blast personnel.

There are two main types of air flow used in blast containments: cross-flow and down-flow. Most containments use cross-flow. While this article does not explain how to determine the amount of air flow required, it should be noted that, for most containments, air flow within the containment area needs to be directed to the blaster work area, using internal ducting or duct fans or other means in order to receive maximum benefit from the ventilation system.

On many occasions, we have seen containment air-flow calculations that only take the containment area, ducting, and dust collector into consideration. As we mentioned previously, the only motive force for the air flow in typical blast ventilation systems is the dust collector fan, and if the fan pressure required is underestimated, then the desired air flow will not be achieved. To accurately determine the total system pressure, all the areas of pressure drop — or drag — must be included. This means that the pressure to move the air through the containment area, ducting and dust collector system as well as the pressure drop to get the air moving into the containment area and to exhaust the air out of the fan must be included. Failing to consider all the different and various places where the pressure drag occurs will result in an incomplete process total. Sample pressure drop areas are listed below:

- Acceleration of the static air in the atmosphere into the air intake of the containment area,
- The drop through the containment inlet opening,
- The drop as the air goes through the containment area,
- The reacceleration of the air flow in the containment into the outlet opening,
- The pressure drop through the flexible ducting between the containment area and the dust collector inlet,
- The pressure drop through the twists and turns inside the dust collector,
- The pressure drop to pass the air through the filters,
- The pressure drop to gather the air from the filter housing into the clean air ducting,
- Acceleration and fan pressure drops,
- The fan exhaust pressure drop,
- The pressure drop to get the air from the fan exhaust reintroduced back into the atmosphere.


For optimal ventilation, the complete flow path of the air, from the intake start to the final exhaust, including all of the pressure drop points, must be considered.

While this is not an all-encompassing list, it serves as a good sample of the various areas that need to be considered for air-flow drag. The sum total of these air-flow resistance points can be significant.

Below are some of the most common — but often overlooked — areas where significant pressure drop can occur.

- **Intake air**. Often, when designers calculate air flow and intake, they fail to take into account the pressure drop required to get the air into the containment area. While each project is different, a standard number used for layouts can be about 2 in wg.

- **Pressure drop** through the filters. Many times, the actual pressure drop of dirty or used filters is more than expected when the collector is running at full flow. This can be from incorrect collector design, incorrect filters and also a malfunctioning or improperly designed filter cleaning system.

- **Exhaust back pressure**. One of the most underestimated air-flow obstructions is the blower exhaust outlet. As stated, the motive force for the air to be exhausted from the blower and returned to the atmosphere is produced by the fan. Most portable dust collectors on the market today do not have any exhaust enhancements, such as an evasé, which can actually capture some of the exhaust pressure, and almost all have flow-restricting exhaust screens, which further impede the air flow. To make matters worse, most system overall-pressure-monitoring gauges stop at the inlet to the blower, and the exhaust-positive pressure-flow restriction hasn't been taken into account. This final pressure drag can be as much as 10-20 percent of the system total.

- **Undersized ducting**. A portable dust collector should use the largest diameter duct possible, keeping within standard air-flow conditions, and the duct should be as straight and as smooth as possible. Using undersized ducting or not having enough ducts will decrease air flow and increase system air-drag pressure to the point that the system may not even be capable of meeting air-flow requirements.

For a truly full-flow air ventilation system, the layout must be considered as a whole to achieve the desired air flow. Failure to take this holistic approach will always result in inadequate air flow and unnecessarily expose the blaster and the environment surrounding the containment area to fine particles that should have been captured by the ventilation and dust collection system. Depending on the filter media used in the collector and the ducting size and layout, typical blast containment ventilation systems can easily approach 15 in wg total static pressure or more. Contractors and users of portable dust collectors for their blast containment ventilation need to do their homework and ensure that the total air-flow path with the associated flow-drag values are included in all system pressure calculations. Failure to do so will result in an unsafe working environment both inside and outside the containment area.

ABOUT THE AUTHOR

Russell Roden, Atlantic Design, Inc.

Russell Roden graduated from the University of Houston with a degree in Mechanical Engineering in 1984 and has worked in the Blasting and Coating industry ever since. In 1997 he founded Atlantic Design, Inc. where he has secured several patents and set new innovation, quality, and safety standards for Abrasive Blasting Equipment in a worldwide market.

Atlantic Design, Inc.

1.866.CallADI
410.335.1400
callADI.com

info@calladi.com
11505 Pocomoke Court
Baltimore, Maryland 21220