Dust collection systems are designed to capture airborne dust from bulk solids processes, such as conveying, mixing, blending, and packaging, and convey the dust to a dust collector for filtration, containment, and safe disposal. A properly engineered dust collection system can significantly reduce in-plant dust contamination levels, minimizing worker exposure to respirable dust and explosion hazards from combustible dust accumulation. Under certain circumstances, however, a dust collection system can actually contribute to in-plant dust contamination levels by reintroducing collected dust back into the workspace (called reverse contamination). Reverse contamination can be caused by either atmospheric conditions outside the plant or by how the dust collection and HVAC systems are configured to operate.

Atmospheric conditions outside the plant

Sometimes a dust collection system that discharges its filtered exhaust air outside the building can cause contamination problems inside the building while the system is shut off. Wind passing over and around a building creates pressure differences between the outside and inside of the building. On the windward (or upwind) side of the building, this typically creates a positive outside pressure, meaning the air pressure outside the building is higher than the air pressure inside the building. If the dust collection system’s exhaust fan discharge is in the positive-pressure wind zone, higher-pressure outside air can flow backward through the discharge and into the dust collector when the exhaust fan is shut off. This can disturb dust on the dirty side of the dust collector’s filters and carry the dust back through the system’s ductwork and dust capture hoods into the workspace. If the dust is toxic, this can cause a serious contamination problem.

Installing a powered shutoff damper in the clean-air duct and interlocking it to close when the exhaust fan is shut down will minimize this backflow.

Alternatively, you can keep the dust collection system’s exhaust fan operating at a lower speed rather than shutting it off. This will maintain positive inside pressure at the exhaust fan discharge and minimize the potential for outside air flowing backward through the dust collection system.

Dust collection and HVAC system operation

Having the technical knowledge to design a dust collection system doesn’t provide you with the whole picture of your plant’s airflow. To ensure that your dust collection and HVAC systems don’t reintroduce collected dust into the workspace or draw contaminated plant air into adjacent office space, you need to understand all the factors affecting airflow inside your plant. The following are some common plant airflow problems that can lead to reverse contamination:

Recycled exhaust air. Some dust collection systems return (or recycle) the clean dust collection airstream back to the workspace rather than exhausting it outside the building. This can save energy and eliminate the cost of a make-up air system (which draws in outside air to replace the dust collection air exhausted to the outside). However, recycling dust collection exhaust air is allowed only when certain precautions are taken. Many environmental health and safety specialists recommend against recycling exhaust air back into the plant if the dust captured by the dust collection system contains carcinogens or contaminants of unknown toxicity. In other cases, final filters, such as HEPA filters, on the clean-air side of the dust collector are sufficient to ensure that the recycled exhaust air is free of contamination from possible dust collector filter leakage or bypass. Additional requirements for recycling exhaust air for dust collection systems handling combustible dust are explained in NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.

Pulse-jet cleaning systems. Most dust collectors today incorporate a compressed-air pulse-jet filter cleaning system to periodically remove accumulated dust from the filters. Operating this cleaning system with the dust collection system’s exhaust fan shut down will pressurize the dust collector and the inlet ductwork, forcing dust out of the dust capture hoods and back into the workspace. You can prevent this by interlocking the pulse-jet filter cleaning system with the dust collection system’s exhaust fan so the filters can’t be cleaned when the exhaust fan is off.

Negative office-space pressure. Plant office space is also subject to dust contamination. A plant’s office space typically has its own HVAC system for heating and cooling but is connected by corridors to the manufacturing area. When the office space is unoccupied and the office temperature is raised in the summer or lowered in the winter to save energy, the air pressure in the office space may become negative or neutral relative to the manufacturing area. This can allow airborne contaminants from manufacturing processes to enter the office space.
Office space should always be under positive pressure with respect to the plant’s manufacturing area.

To ensure that these or other airflow problems don’t cause reverse contamination in your plant, involve plant production, maintenance, and health and safety personnel in your dust collection system’s design process and get their approval of the design before construction begins. Their input can help to improve your dust collection system’s performance and ensure the safety of your plant’s workers. For more information about dust collection system design, see the requirements listed in the 2015 edition of NFPA 91: Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids.¹

References

John A. Constance, PE (jac@engcollab.com), a consulting engineer at The Engineers Collaborative, has more than 30 years experience designing, engineering, and troubleshooting dust control and industrial air systems for bulk solids processing and handling industries.

The Engineers Collaborative
Canandaigua, NY
215-300-9563
www.engcollab.com