Podium Session 120
Engineering Controls – Lessons from Design and Practice
Wednesday, June 20, 2012, 1:30 PM – 4:10 PM
Papers CS-120-01 – CS-120-08

CS-120-01
Using Prevention through Design Principles at a Plastics Extrusion Facility to Improve Ventilation and Reduce Noise and Ergonomic Stressors
E. Pullen, Clariant Corp., Charlotte, NC.
Situation/Problem: The "Masterbatches" business unit at Clariant provides custom coloring for plastics by mixing pigments and resins, then extruding and cutting into pellets. Old style pelletizers and air wipes have been high noise sources. When hot plastic emerges from the die head, local exhaust is used to capture off-gassing vapors. Separate local exhaust ventilation is used to capture pigment dust from weighing, blending and material transfer. The process included heaving lifting and repetitive motions. The older Masterbatches equipment was difficult and expensive to retrofit to reduce noise levels. Existing ventilation systems were not properly designed to adequately collect dust and vapors.
Resolution: When the Illinois site decided to redesign the total layout of the production area, they implemented best design practices to bring noise levels to the lowest possible level, to minimize the escape of dust from each part of the operation and to reduce ergonomic stressors.
Results: The new production area has reduced noise levels and created a much cleaner work area by minimizing dust generation through tight process connections. Vapors and dust are also collected efficiently at the source by the proper design of the new ventilation system. Ergonomic stressors have been reduced by the layout of the operation and the use of pneumatic conveyors for moving resin materials and better design for handling bags of pigments.

Lessons Learned: Our Industrial Hygiene group has done routine IH surveys, provided training and conducted periodic audits of the facilities. As a result, when the timing and capital was available to make the changes to the production area, the facility management and engineers were knowledgeable about what aspects of their operation needed improvement. What they have learned from this implementation process will help save the other facilities time and money when they are able to upgrade their equipment.

CS-120-02
Health/Odor Design Criteria Development for Assessing Exhaust Impacts at Fresh Air Intakes and Sensitive Locations
J. Reifschneider, R. Petersen, CPP, Inc., Fort Collins, CO.
Situation/Problem: Concentration predictions from physical modeling or mathematical methods by themselves are not useful for examining exhaust stack designs unless some minimum acceptable concentration, or design criterion, is specified. This presentation will provide a methodology for developing minimum acceptable design criterion values which can be used for assessing exhaust impacts at fresh air intakes and sensitive locations.
Resolution: There are generally two types of design criteria. The first is concentration relative to mass emission rates for sources with distinct chemicals emitted at mass emission rates which
can be estimated or quantified. Such sources include chemical, radiological and biological fume hoods, boilers and certain chemicals of diesel combustion. The second type of criteria is dilution-based, which is typically used for sources with complex chemical composition which cannot be quantified but for which odor data is available in terms of dilution. Diesel, kitchen and animal exhausts have dilution-based odor criteria.

**Results:** The criteria are developed using NAAQS, ACGIH®, AIHA® and other appropriate agencies or studies to establish health and odor limits. The ideal exhaust design minimizes chemical concentrations at all air intake and sensitive receptor locations to levels below the concentration limit for each substance potentially emitted. The concentration limit is typically expressed in terms of a health limit and odor threshold.

**Lessons Learned:** This presentation will provide a discussion on how concentration levels at air intakes and other sensitive location can be estimated and then subsequently compared to the health/odor design criterion. The presentation will also include discussions about the probability of exceeding the design criterion and real risk of adverse exposure.

**CS-120-03**

**Specialized Engineering Controls for Hexavalent Chromium and Cobalt in Metal Manufacturing**

L. Verdier, Shaw Environmental, Inc., Cincinnati, OH; S. Fischer, Haynes International, Kokomo, IN.

**Situation/Problem:** Manufacturing corrosion-resistant and high-temperature alloys, involves grinding, cutting, melting, welding, and other hot processes with alloys that contain nickel, chromium, cobalt, and other metals. These processes produce airborne concentrations of metal dust and fume, including hexavalent chromium and cobalt, which exceeded occupational exposure limits at some processes. Use of ventilation systems based on conventional designs did not always provide the degree of control required to reduce exposures below occupational exposure limits.

**Resolution:** Improving performance of local exhaust ventilation systems and other engineering controls involved:

- Verification of the system’s performance meeting design specifications.
- Modification or adjustment of the system to improve performance. Modifications were based on published research on experimental design modifications and/or observations/measurements of the existing system’s shortcomings.
- Replacement of the existing system with a new design based on lessons learned from the previous-generation system.
- Design a unique local exhaust ventilation system to fit the process requirements.

**Results:** Reduction of airborne concentrations of hexavalent chromium and cobalt of up to 80 percent were achieved with a combination of engineering controls (primarily local exhaust ventilation) and process control changes.

**Lessons Learned:** Successful design and implementation of engineering and process controls involved a collaboration of production management, process engineers, plant engineers, employees, and industrial hygiene. Feedback and buy-in from production personnel and employees was valuable in modification and re-design of the systems.

**CS-120-04**

**Industrial Hygiene Verification Study for a Contained Filter Dryer at a Pharmaceutical Chemical Pilot Plant**

A. Yoshida, R. Prodans, Abbott Laboratories, Abbott Park, IL.

**Situation/Problem:** The installation of a contained filter dryer at a R&D pharmaceutical chemical pilot plant required an industrial hygiene verification study be conducted to determine exposure potential and verify adequacy of engineering containment before equipment could be placed in use. Active pharmaceutical ingredients of varying potency are manufactured at the facility. Containment was designed to control exposures for potent and/or highly hazardous compounds, those considered to have an exposure limit of 10 μg/m³ or less.

**Resolution:** The study incorporated isolator test protocols established by the International Society for Pharmaceutical Engineering (ISPE) for assessing containment performance of equipment while utilizing lactose as the surrogate for active pharmaceutical ingredients. Samples were collected during process activities to determine source concentrations generated at
containment and transfer points. Personal exposures were measured at the task level to determine Estimated Time Weighted Averages (ETWAs) and compared against the design criteria. Surface swab samples were also collected to evaluate the potential for surface contamination.

**Results:** Personal concentrations were measured at or below 0.35 μg/m³. Area concentrations measured during process activities were less than 0.3 μg/m³ and were at or below 0.5 μg/m³ during cleaning. Measurable surface concentrations were detected on swab samples indicating the potential for material to be transferred to other surfaces.

**Lessons Learned:** Equipment design demonstrated achievable exposure containment at or below the design target of 0.5 μg/m³. Measured sample concentrations could continue to be further reduced by improving operator knowledge of equipment, operating and containment techniques. Industrial hygiene monitoring during active manufacturing will continue to be conducted to gather additional exposure data.

**CS-120-05**

**The Application of a Positive Displacement Ventilation Protocol in an Industrial Precious Metal Refining Facility**

W. Mele, D. Hall, Chemistry & Industrial Hygiene, Inc., Wheat Ridge, CO; C. Ellwood, AOEH, LLC, Black Hawk, CO.

**Situation/Problem:** An industrial hygiene and engineering assessment of a precious metals refinery operation was conducted for the purposes of identifying point sources of airborne silver and determining an estimate of the percent contribution of these point sources to overall ambient and/or employee exposures. The original exhaust system controls included local exhaust systems and turbulent flow general dilution exhaust, but employee exposures were determined to be at or above the MSHA PEL for silver dust and fume.

**Resolution:** A preferred general ventilation protocol was to introduce make-up air to the space along both the east and west walls of the refinery at a low velocity, and slightly lower temperature than the room air, and to draw exhaust air at various locations through the roof utilizing individual power roof ventilators. It was suggested that this “positive displacement ventilation” protocol would greatly enhance the ability of the general dilution ventilation system to capture contaminants and remove them by relying on the thermal plumes of the various contaminant sources to carry contaminants to the rooftop by their natural buoyancy, while gently lifting the total room air volume from below in a piston-like positive displacement exhaust pattern.

**Results:** The displacement ventilation protocol was successful in reducing employee silver exposures to below the MSHA PEL. Furthermore it was demonstrated that the airborne concentration of silver dust and fume increased in concentration as the increase in distance from the floor of the refinery.

**Lessons Learned:** Increasing the volume of exhaust and make-up air to the space is not the major contributor in controlling airborne contamination but rather the method of introduction of air and the control of the airflow patterns within the space is crucial.

**CS-120-06**

**Reducing Airborne Exposures and Community Nuisance Odors at a Foundry**

G. Croteau, University of Washington, Seattle, WA.

**Situation/Problem:** A foundry specializing in brass and aluminum castings received numerous nuisance odor complaints from residential neighbors shortly after starting operations at a new facility. The primary odor constituents were phenol and naphthalene; two odorous compounds released from the binder system during the casting process.

**Resolution:** Nuisance odor conditions were reduced in the short term through work practices, and on a permanent basis through process changes. Work practices introduced immediately included pouring during favorable atmospheric conditions and waiting until the castings cooled before the molds were broken down and the cast parts removed. Process changes included the use of a new binder system and the utilization of dilution ventilation. Design parameters presented in the ACGIH® Ventilation Manual were used to determine the air exchange rate and exhaust stack design. Process change effects were assessed by monitoring for phenol and naphthalene.

**Results:** Work practices provided for some
reduction in odor complaints but did not completely eliminate community nuisance odor conditions. The new sand casting binder system was found to effectively reduce odorous emissions, resulting in a ten-fold decrease in phenol and naphthalene concentrations within the facility. The ventilation system, comprised of two blowers exhausting a total of 40,000 cubic feet per minute of air from the building at a height of 50 feet above ground level, provided for a more effective dispersion of odorous compounds. Odor complaints declined substantially after these changes were made allowing employees and management to focus on production.

**Lessons Learned:** Carefully consider health, safety and environmental issues when relocating a facility:
- General ventilation can be effective for reducing worker exposure levels.
- General ventilation is more effective if targeted to a specific area.
- Substitution should always be considered.

**CS-120-07**
**Occupational Exposure Controls: IH Meets CSI**
T. Morris, Morris Innovative IH&S Solutions, Cincinnati, OH.

**Situation:** Substitution, engineering and PPE all have a role in exposure control with engineering considered the “gold standard.” Controls can sometimes be impossible (substitution) or expensive (LEV) to implement and their effectiveness can be quite variable. The key to effective exposure control is thorough exposure assessment, achieved mainly by exposure monitoring. Controls, especially capital intensive ones, are directed at the perceived “driving” exposure(s) but follow-up assessments sometimes find no change or an increase in workers’ exposures resulting in frustration and possible credibility issues.

**Resolution:** Exposure monitoring does not necessarily identify tasks/factors associated with significant exposures. Observation and documentation of workers’ tasks are a valuable adjunct to exposure monitoring but are not always done. “Minor” workplace activities/factors are often missed or ignored because they are thought to not affect exposures (bag breaking v. empty bag disposal). These “incomplete” exposure assessments are partially responsible for the poor outcome of some exposure control efforts. Exposure data coupled with workplace analyses can identify cheap, simple and inexpensive (CSI) exposure controls that can be as (or more) effective as expensive advanced methods.

**Results:** Exposure monitoring and workplace analyses were used to develop effective CSI controls at diverse industries, especially when compared to the engineering methods considered. Case studies include a happy (clean) room where Freon 11 exposures 1.6x the OEL were reduced 81% and saved money, “English muffin” Co exposures were reduced 47% and foundry Cd/Pb exposures >OELs were reduced to ND/background for $0.

**Lessons Learned:** Controls (for chemical or physical agents) implemented based on perceived “driving” exposures do not always achieve expected results. At industries as diverse as pharma to foundries, observation and assessment of worker activities plus exposure monitoring led to effective cheap, simple and inexpensive methods that should be the starting point for our exposure control efforts.

**CS-120-08**
**So, You Want to Renovate Your Anatomy Labs and Morgue? Lessons Learned 5 Years Post-lab Renovation**
J. Whitlock, Wright State University, Dayton, OH.

**Situation/Problem:** Anatomy, Nursing, and Medical students and faculty working in older facilities with high levels of formaldehyde during lab, class room instruction, and donor preparation.

**Resolution:** Money is limited but how to convince administrators of the “safety factor” of formaldehyde exposures while training current students to recognize hazards from known exposures.

**Results:** A newly, expanded facility with modern equipment and amenities featuring flexible labs and proper ventilation.