Two Energy Efficiency Measures for "Constant Air Volume Exhaust Systems": Damper and Variable Speed Drive

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Laboratory exhaust systems provide the required pressure difference for the fume hood operation and prevent toxic contamination of the building and its' surroundings. Since all fume hood and exhaust devices are seldom used simultaneously at full capacity, there are opportunities to conserve energy and to decrease the system capacity. In the past 20 years, most energy efficiency studies have been focused on the HVAC and fume hoods Variable volume fume hood systems and heat recovery systems have significantly decreased HVAC energy consumption in laboratory buildings.

Researchers have also tried to reduce system sizes using system diversity factors. One researcher compared the actual laboratory exhaust airflow and the design exhaust airflow in an industrial research laboratory building, which had 56 constant-exhaust fume hoods. The investigation found that the actual laboratory exhaust airflow varied from 21% to 43% of the design value during typical working days. The laboratory exhaust airflow was measured continuously, for over a month, in three laboratory buildings where VAV fume hoods were used. They found that the laboratory exhaust airflow varied from 31% to 57% of the design airflow in building 1, 29% to 53% in building 2, and 45% to 70% in building 3. However, engineers have to size the exhaust system using the conventional value to ensure system reliability during its lifetime, since the maximum laboratory exhaust airflow may change from year to year. When a conventional "constant air volume exhaust system" is designed, significant amounts of makeup air are used to maintain "constant stack exit velocity", regardless of the type of fume hoods in laboratories. Consequently, unnecessary fan power is used.

Two energy efficiency measures have been developed to reduce the fan power of the conventional "constant air volume exhaust system". The damper measure adds a modulation damper in the main exhaust air duct and static pressure at the inlet or outlet of the exhaust air fan. The fume hood static pressure is controlled via the modulation

damper, while the fan inlet or the outlet static pressure is controlled via the make-up air damper. The damper measure can potentially reduce exhaust fan power by up to 15%. The Variable Speed Drive (VSD) measure adds a variable speed drive to the fan motor and a static pressure sensor to the outlet of the stack. The fume hood static pressure is controlled via the make-up air damper. The stack inlet or outlet static pressure is controlled by the VSD. The VSD measure can potentially reduce fan power by up to 60%. The annual exhaust fan energy savings depends on the exhaust airflow patterns and the exhaust system duct layout.