9. Industrial Air Handling

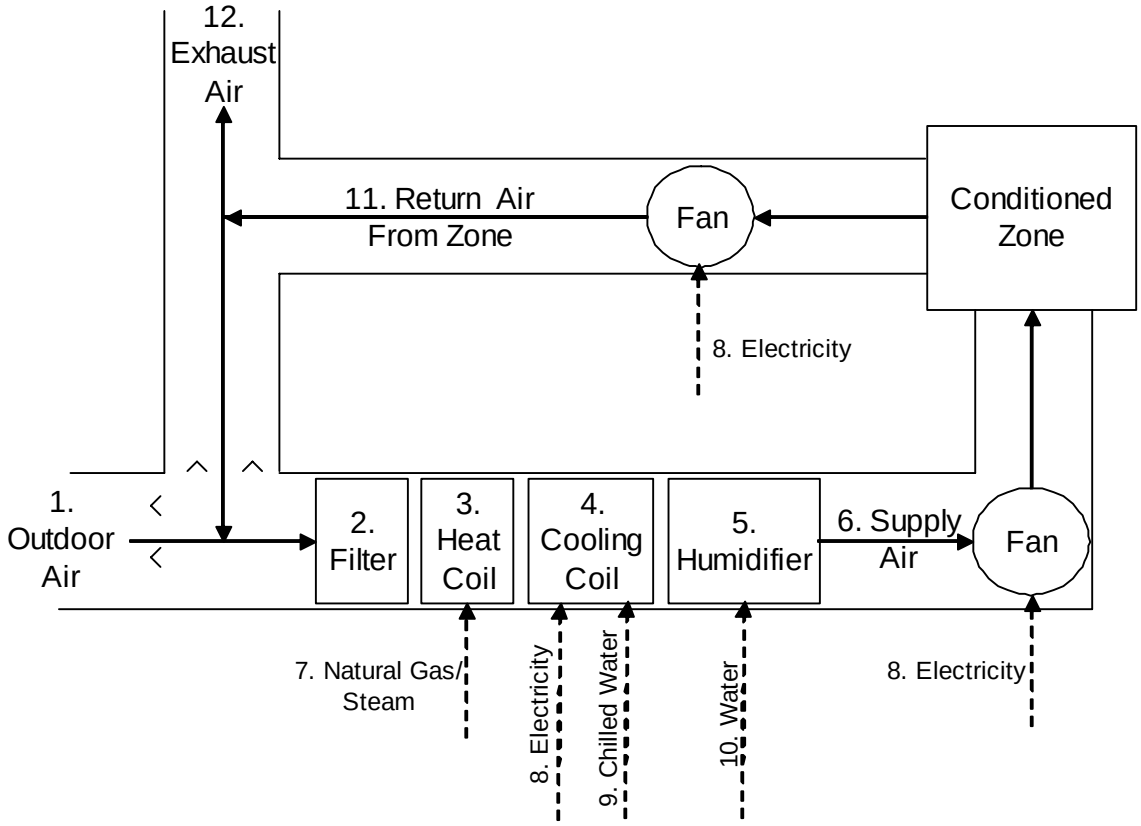

Figure 9.1 – Industrial air handling system

Many parts of industrial facilities are designed to maintain the environment within acceptable limits of temperature, humidity, and pollutants. In the food industry, for example, air pollutants are kept at the lowest possible level in order to keep the product from becoming contaminated. By legislation, office areas must also be kept within maximum allowable levels of contaminants to ensure the well being of occupants.

AIR HANDLING SYSTEM OVERVIEW (REFER TO FIGURE 9.1 ABOVE)
The primary functions of an industrial air handling system are to heat, cool, and clean the air, humidify or dehumidify it, and provide ventilation. Commercial and industrial systems can be configured in several different ways; Figure 9.1 illustrates a general case.

Here's how an industrial air handling system works: Outside air (1) and return air (11) from the conditioned zone[24] mix in order to maintain allowable levels of impurities and to keep energy usage to a minimum. Outside air is introduced into the system to keep the zone well ventilated and maintain good indoor air quality (IAQ). The mixed air subsequently passes through a filter (2) before it is heated or cooled. A heating fluid,

[24] According to McQuiston et al., a zone is a conditioned space under the control of a single thermostat.

commonly hot water or steam, must be supplied to the heating coil (3). The water can be heated using a water heater or steam can be used with a heat exchanger[25]. A cold fluid, usually a liquid or a mixture of liquid and vapor, must also be supplied to the cooling coil (4). Pumps are used to circulate the heating and cooling fluids through the system. A humidifier (5) can be used to keep the supply air (6) from being too dry. Spraying atomized particles of water or steam to the supply air before it is delivered to the conditioned zone usually does this.

Ventilation brings outside air into a specific zone, thus protecting the area from unacceptable levels of contaminants and odors. Carbon monoxide (CO) and carbon dioxide (CO_2) levels also must be kept low in order to maintain the comfort and safety of the area's occupants. Measuring CO_2 levels within a zone can point to incorrect ventilation rates. The Environmental Protection Agency (EPA) recommends that CO_2 be limited to 1,000 ppm[26] in areas where occupants have continuous exposure. The presence of high amounts of CO_2 in a space can cause discomfort (headaches, shortness of breath, and nausea). CO is a toxic gas, and levels lower than 15 ppm are recommended. Other gases such as sulfur oxides and nitrous oxides also can be found in conditioned zones. To ensure the health and safety of occupants, maximum allowable levels of these gases must also be observed.

ENERGY SAVINGS OPPORTUNITIES AND RELATED BEST PRACTICES

There have been changes to the codes and standards governing IAQ. The increased ventilation rates demanded by these new codes have, in turn, triggered an increase in energy consumption. Maintenance is a primary concern for companies dealing with ventilation-related projects. However, best practice projects in this area should be considered as they can generate significant energy savings. Some of these important projects are described below.

Correct Level of Ventilation

As mentioned, ventilation is an important function of an industrial air handling system. With proper ventilation, comfort can be assured, and, more importantly, health risks can be greatly minimized. Carbon dioxide is a byproduct of our metabolism, which makes it difficult (if not possible) to control its production. Carbon monoxide, however, is a byproduct of incomplete fuel combustion and smoke from tobacco products. It is possible to greatly control its production in the workplace. For example, repairing improperly vented furnace chimneys or leaky water heaters will reduce contaminants and improve air quality.

The best way of making sure that CO_2 and CO levels are not above recommended allowances is to check ventilation systems within the plant. To check whether contaminated air is being captured and circulated, make sure that outside air intakes are not located close to loading docks or areas where cars can be parked. Check indoor equipment to verify that it's functioning properly.

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[25] Information on steam and water heaters is provided in the steam and the process heating sections respectively.

[26] Parts Per Million—ppm.

Excessive Ventilation

Excessive ventilation will not improve the comfort level of occupants in a zone, but it will increase energy usage since any extra outside air must be conditioned and delivered to the zone. Therefore, the ventilation rates of the air handling system should be well calibrated to keep indoor air quality as close to acceptable limits as possible. Refer to ASHRAE[27] Standard 62 for detailed information on recommended ventilation and contaminants rates.

Outside air dampers should be adjusted regularly to ensure the functionality of the system. Outside air intakes should also be adjusted to accommodate changes to the number of occupants in a particular zone. With modern technology, it is also possible to control the amount of outside air used based on the time of day or number of occupants in a given zone.

Economizers

An air-side economizer cycle (or economizer) is a process of using cold outside air to reduce the cooling load within a conditioned zone. This cycle consists of a strategic sequence of damper controls that supply cold air (typically around 55-65°F) directly to the zone when the system is in cooling mode. In some cases, it is less efficient to dehumidify cold air than it would be to run the system without the economizer cycle. Therefore, the economizer cycle should be controlled with enthalpy sensors that are a combination of temperature- and humidity-sensing elements. Air-side economizers can, in many instances, be easily installed into existing systems and should be considered in most facilities.

Motors

Premium efficiency motors and variable frequency drives can be used on motors powering fans and pumps. Best practices related to these topics are further explained in the motors section of this document.

Programmable Thermostats

It's easy to install a programmable thermostat in an office area, and doing so can save energy. A programmable thermostat is basically a combination clock and thermostat that manipulates the temperature of a zone depending on the time of day.

Thermostats should also be set at the highest and lowest comfortable temperatures during the cooling and the heating season, respectively. It is estimated[28] that 90% of occupants, if they are appropriately attired for the season, will be comfortable if the temperature

[27] American Society of Heating, Refrigerating and Air-Conditioning Engineers – ASHRAE: www.ashrae.org.

[28] McQuiston, F.C., Parker, J.D., and Spitler, J.D., Heating, Ventilating, and Air Conditioning: Analysis and Design, Willey & Sons, 5th ed.,2000.

ranges[29] from 68° to 75°F during the winter and from about 79°F to 84°F during the summer.

Air Distribution

Air distribution can play a key role in the efficient operation of any ventilation system, since well-placed terminals and return devices can reduce the amount of air that needs to be distributed. Normally the quantity of outside air and/or supply air used can be decreased if the supply air is distributed near the work area.

Improved air distribution and air exhaust also can greatly enhance areas where humidity is a problem. Humidity levels in a food processing plant are generally high because of the large amount of water required by the process. Many plants circulate and condition the air from the entire zone, even though the source of the high humidity is confined to a small area of the zone. In such cases, the load on the air handling system can be significantly reduced by collecting the moist air at the source and exhausting it. The same principal could be used to help alleviate odors and smoke.

Destratification Fans

If an area has poor air circulation, the temperature near the ceiling can be much different than the temperature at floor level. This phenomenon is known as stratification of air temperature. Stratification in heated zones causes inefficiency because the thermostat (which is often at floor level) senses lower temperatures than if the room were not stratified. Thus the thermostat signals the need for heat, increasing the average temperature, whereas all that is needed is to move the warm air near the ceiling towards the floor. In addition, conduction losses through insulation are significantly reduced since the high temperatures around the ceiling are reduced.

Low-speed ceiling fans, or destratification fans, can be installed in heated zones to increase the movement of hot air from the ceiling towards the floor, reducing the amount of heat required to provide the desired comfort level.

Radiant Heating

Radiant systems emit directional heat that is transferred directly to surfaces and bodies but not to the air as in a forced air system. Radiant heating systems provide savings because they maintain comfort level without heating the entire space, they decrease stratification, and combustion efficiency tends to be better than conventional heating systems.

Building Insulation

Insulation is an effective way of mitigating heat loss. Well-insulated walls and ceilings will reduce heat gain during the summer and reduce heat loss during the winter. Selecting the correct insulation is important, as different areas may need different types of insulation material. Walls and ceilings should be insulated and protected from moisture

[29] Ranges used for low air speed: ≤30 fpm and 50% relative humidity.

and air leakage. Vapor barriers should be installed on the insulation to protect it from moisture. As with insulation in industrial equipment, the harsh environment can weaken the integrity of the insulating material. Therefore, existing insulation should be checked and fixed if necessary. Keep in mind that different construction types require different insulation materials, and the amount of insulation needed can impact its cost effectiveness.

Air Leaks

It is virtually impossible to have a perfectly sealed building. However, air leaks, which occur in corners, doors (walk-through, garage, docks, etc.), and windows, should be kept at a minimum. This problem is also found between conditioned and unconditioned areas of a facility. Most of the time, solving an air leak problem is simple. Make sure that cracks around doors, windows, and corners are well caulked, and use curtains or doors between conditioned and unconditioned areas.

Heat Recovery from Exhaust Air

All heat exhausted from the plant should be considered for recovery. In most industrial facilities, equipment like air and refrigeration compressors generate heat that can be recuperated and ducted to heated zones, effectively reducing the load on the air handling equipment. In cases where the air is not sufficiently clean for direct use in the space, heat exchangers can be used to transfer the energy to cleaner air.

RESOURCES

Printed Material

Aro, T. and Koivula, K., Learning from Experiences With Industrial Ventilation, CADDET, Sittard, Netherlands, 1993.

ASHRAE Standard 62, Ventilation for Acceptable Indoor Air Quality.

McQuiston, F.C., Parker, J.D., and Spitler, J.D., Heating, Ventilating, and Air Conditioning: Analysis and Design, Willey & Sons, 5th ed., 2000.

Wulfinghoff, D.R., Energy Efficiency Manual, Energy Institute, MD, 1999.

On-Line Tools

U.S. Department of Energy
Energy Efficiency and Renewable Energy
- Energy Savers: www.eere.energy.gov/consumerinfo/energy_savers
- Energy Matters: www.oit.doe.gov/bestpractices/energymatters/energy_matters.shtml
- Building Technologies Program: www.eere.energy.gov/buildings
  - Information Resources : www.eere.energy.gov/buildings/info/publications.html

Energy Information Bridge: www.osti.gov/bridge

Oak Ridge National Laboratory (ORNL)—Buildings Technology Center
- Building Envelopes Program: http://www.ornl.gov/sci/roofs+walls/
  - Insulation Fact Sheet: www.ornl.gov/sci/roofs+walls/insulation/ins_01.html
  - ZIP-Code Insulation Program : www.ornl.gov/~roofs/Zip/ZipHome.html

Simply Insulate: www.simplyinsulate.com
www.simplyinsulate.com/howmuch.html

Organizations

American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): www.ashrae.org

The Carbon Trust: www.thecarbontrust.co.uk/energy

Iowa State University Industrial Assessment Center (IAC): (515) 294-3080 or www.me.iastate.edu/iac

North American Insulation Manufacturers Association (NAIMA): www.naima.org