Ventilation In The Workplace

Adequate ventilation in any workplace is essential for good health and productivity. A well-designed and efficient ventilation system has many benefits, including:

1. reducing exposure to airborne hazardous substances thereby preventing work-related illness, absenteeism and turnover;
2. preventing the accumulation of heat in the workplace thereby preventing heat stroke and heat exhaustion;
3. reducing time and money spent on inspection and cleaning of raw materials, semi-finished products and final products when dust, oil, organic solvents and other airborne substances are kept to a minimum;
4. reducing costs for electricity;
5. increasing productivity when the working environment is comfortable and well-adapted to the needs of the workers.

A number of low-cost measures can improve ventilation and improve the working environment. The environment in a factory can improve drastically when natural air flow is used efficiently. Simple changes of the location of ventilators, electric fans and exhaust hoods, or rearranging the location of workplaces will bring about a comfortable working environment without any extra costs. Here are some more suggestions:

1. Determine the problem:
    i. is the problem caused by a single source of heat?
    ii. is there airborne contamination from a single point?
    iii. is the problem more general?
2. Consider alternative solutions which are best adapted to the enterprise and see which one is best;
3. Observe a similar improvement in another enterprise or workplace and get advice;
4. Try the idea first on a small-scale to see how it works, then make small but continuous improvements.

Improve Production Procedures to Minimize the Need for SpecialVentilation

Consider the following basic steps for improving the working environment in your enterprise:

1. remove or isolate heat sources and processes which use hazardous substances;
2. replace dangerous substances with less dangerous ones. For example, soap and caustic soda can replace organic solvents and water-soluble paint can replace paint using an organic thinner. Organic solvents often are more expensive and dangerous;
3. use only the necessary amounts of hazardous substances and keep only the necessary amount in a small container at the workstation;
4. use appropriate sized brushes, pans, spray guns and nozzles;
5. use lids or covers on containers to prevent hazardous substances from evaporating; cover machines and conveyors to reduce evaporation and control the amount of dust in the air;
6. label containers with the name and nature of the substance inside to provide workers with necessary information and to prevent misuse, damage to worker health or the product or the loss of raw materials;
7. avoid using production processes which require special ventilation systems. A change in the process is often less expensive than constructing a ventilation system.

Protect the Workplace from Outside Heat

It is far more economical to protect the workplace from outside heat than trying to cool down a heated workplace. Outside heat enters by sunlight or its reflection, hot air or heat from hot roofs and walls.

Here are some suggestions for how to protect the workplace from outside heat:

1. plant trees, bushes, flowers and grass to shade the workplace and shield it from external dust;
2. construct water reservoirs or ponds around the enterprise to promote cool breezes. Stock the pond with breeding fish to prevent the growth of mosquitos. The water can also be used in support of extinguishing fire;
3. use shades, canopies, louvers and screens to reduce heat from solar radiation and its reflection;
4. paint the outside surfaces of roofs and walls in light colours and make their surface smooth so that they reflect sunlight;
5. put insulation under roofs or on walls to help prevent the penetration of coldness in cold areas.

Use Natural Ventilation

The design of workstations should take advantage of natural ventilation before costly artificial ventilation systems are installed. Some ways of doing this include:

1. locate workstations where the worker can take advantage of a strong natural air flow by avoiding doing work in corners or places surrounded by walls, partitions or equipment;
2. place hot machines and facilities where hot air can rise and escape easily to the outside;
3. open doors and windows or create new openings to increase cross-ventilation;
4. use ceiling fans and windows in higher positions to push hot air out as it rises. A chimney has no power source but can ventilate smoke efficiently;
5. remove partitions or other obstacles which may disrupt airflow;
6. close windows near ventilation inlets or provide partitions around hoods if there are cross winds, since drafts from open windows can disrupt ventilation flow.

Use Push-Type and Pull-Type Ventilation Properly

There are two types of ventilation using electric powered fans: push-type and pull-type ventilation. The combined use of push-type and pull-type ventilation can increase greatly the efficiency of ventilation. Here are some tips:

1. use push-type ventilation to provide a strong air flow which can reach a distant place. Use push-type ventilation if there is no risk of scattering airborne contaminants. The fan can be moved easily to re-direct the air flow;
2. use pull-type ventilation to collect vented substances. Use it if there is a risk of airborne hazardous substances being scattered. The distance between the source of the contamination and the inlet of the pull-type ventilator to its exhaust duct must be no more than one metre. Suction power decreases exponentially as distance increases and is therefore weaker as one moves further from the opening;
3. a combination of push-pull ventilation is the most efficient form of ventilation, although it can be costly to set up. Push-pull ventilation means hoods of push-type and pull-type ventilation are facing each other. This method overcomes the weaknesses of separate push-type and pull-type ventilation. Push-pull ventilation can provide strong air flow to distant places without spreading contaminants. The capacity of the exhaust fan must be bigger than that of the pushing fan or contaminants will be spread throughout the workplace. Usually the capacity of an exhaust fan must be 5 to 15 times larger than that of a pushing fan;
4. place sources of heat or sources of airborne hazardous substances close to exhaust ventilation to ensure sufficient airflow for their removal;
5. use a special type of push-pull ventilation, such as an air-curtain, when it is necessary to isolate hot air from the workplace.

Increase the Efficiency of an Exhaust Ventilation System by Equipping it with Hoods and Flanges

This technique saves on electricity and decreases the necessity of replacing fan motors. Using hoods and flanges is an efficient way to overcome weak points of pull-type ventilation systems. Hoods and flanges increase the efficiency of ventilation by limiting air flow from unnecessary directions.

1. use enclosing type hoods if the airborne substances are very harmful or if the area to be ventilated is narrow. Using transparent plastic or glass board on the front of the hood allows workers to see inside the hood;
2. use flanges to increase the power of pull-type ventilation by up to 25%. To get efficient ventilation, the width of a flange must be a maximum 15 cm or the same length as the diameter of the duct;
3. provide shutters or curtains on exhaust ducts or hood inlets and close them when the ducts or hoods are not in use. Increase the efficiency of ventilation by narrowing unnecessary parts of the inlet with a shutter door or curtain;
4. use enclosing types of hoods if airborne substances are hazardous or if the area to be ventilated is narrow;
5. use open-type hoods properly so that flying particles go directly into the hood. Close windows near ventilation inlets or place partitions around hoods.

Use Shields, Dividers and Barriers to Block Heat Radiation and Increase Ventilation Efficiency

Shields, dividers and barriers can prevent heat transfer from radiation and hot air. These devices increase ventilation system efficiency and can save money spent on electricity and on buying powerful electric fans. Here are some suggestions on how to use them:

1. reflect radiated heat by using shields, dividers and barriers with a smooth and light-coloured surface facing the heat source;
2. use absorbent shields, dividers or barriers if workers must work in a hot area adjacent to a strong heat source. These block heat radiation without reflecting heat back onto the worker;
3. use the opposite side of the shields, dividers and barriers for storing tools and other devices if the isolating boards are not subject to overheating;
4. equip shields and dividers with wheels so they can be moved easily.

Consider the Ventilation When Deciding Where to Place Work Stations

Even if work stations are equipped with expensive and efficient ventilation systems, improper placement of a work station may can compromise the system's ability. Involve workers in the process of placing workstations. Workers need to be informed why the placement of work stations is important and how they can best position themselves to take advantage of both natural and mechanical ventilation. This single measure will help reduce the cost of ventilation systems and the cost of electricity.

1. consider the location of workers and sources of airborne hazardous substances or heat and consider the direction of airflow when positioning workstations;
2. place fans for push ventilation behind or beside workers so that contaminants or heated air are never blown toward the workers;
3. consider other workers working near the workstation. Push-type ventilation can cause secondary pollution exposing people at surrounding workstations to contaminants or hot air;
4. use enclosed hoods to ensure that a worker's breathing area is not between the source of a contaminant and a collection hood;
5. place hoods above heat sources, not beside them;

6. close windows near ventilation inlets or provide partitions around hoods to prevent the effect of cross winds;
7. use hoods to capture flying particles.

Prevent the Disruption of Airflow

Obstacles to air flow can prevent the removal of airborne hazardous substances and hot air. To prevent this negative effect:

1. remove any small partitions or piles of semi-finished products that can disrupt airflow or change its direction;
2. remove large obstacles since air flow may not be able to circulate over them, thereby creating a back current. Airborne hazardous substances and hot air carried by the air flow may simply return, contaminating workers;
3. move the workstation to a place without obstacles. If the workstation cannot be moved, position a fan so that the airflow goes through the air space between the worker and the wall;
4. avoid placing objects in front of exhaust hood inlets as it disrupts the air flowing into the hood.

Consider the Characteristics of Hazardous Substances

Knowledge of the physical characteristics of hazardous substances can help in selecting an effective ventilation method. Upward ventilation is not effective for substances heavier than air but it is effective for substances lighter than air (vapour less than 10,000 parts per million).

1. use downward or horizontal ventilation if substances are heavier than air (most high concentrations of organic solvent gases are heavier than air. Upward ventilation will therefore, not be effective);
2. check carefully the oxygen level in confined spaces such as tanks, pits, ship holds, caissons and tunnels. If a worker enters a confined space with an oxygen level of less than 10% (normal level is 21%) the worker will lose consciousness quickly and probably die within 10 minutes. Masks supplying air with sufficient oxygen, such as air-line respirators, must be worn in low oxygen environments.

Provide Periodic Maintenance for the Ventilation System

Periodic maintenance and cleaning of ventilation systems is essential. Have a ventilation specialist check the capture velocity of exhaust ventilation when its efficiency is in doubt. Appropriate maintenance provides the following benefits:

1. prevent secondary emission of dust by keeping floors and machine surfaces clean;
2. prevent accumulation of dust;
3. prevent dust and other contaminants from escaping in the system by detecting and repairing holes in ventilation ducts and hoods;
4. maintain sufficient airflow by repairing or replacing broken fans;
5. reduce repair costs when problems are located and repaired at an early stage;
6. maintain maximum effective ventilation by keeping ventilation ducts clean which also increases the strength of the airflow.

Use Personal Protective Equipment (PPE) as the Last Solution

PPE is not an inexpensive solution. It needs to be properly maintained and cannot always prevent exposure completely. PPE is uncomfortable and it can be difficult to ensure that workers use it. Consider other solutions before ordering PPE. If, however, other solutions are not feasible or their

effect is not adequate, make sure that PPE is selected according to its purpose and ease of use. For example, masks with dust filters should be used to protect the worker from inhaling dust while masks with specific chemical gas filters should be selected and used for organic solvents.

1. use personal protective equipment properly and keep it clean;
2. change periodically filters on masks following the manufacturer's recommendation.

Checklist for Adequate Ventilation

How to use the checklist

1. Ask the manager any questions you have. You should learn about the main products and production methods, the number of workers (male and female), the hours of work (including breaks and overtime) and any important labour problems.

2. Define the work area to be checked. In the case of a small enterprise the whole production area can be checked. In the case of a larger enterprise, particular work areas can be defined for separate checking.

3. Read through the checklist and spend a few minutes walking around the work area before starting to check.

4. Read each item carefully. Look for a way to apply the measure. If necessary, ask the manager or workers questions. If the measure has already been applied or it is not needed, mark NO under "Do you propose action?" If you think the measure would be worth while, mark YES. Use the space under REMARKS to put a description of your suggestion or its location.

5. After you have finished, look again at the items you have marked YES. Choose a few where the benefits seem likely to be the most important. Mark PRIORITY for these items.

6. Before finishing, make sure that for each item you have marked either NO or YES, and that for some items marked YES you have marked PRIORITY.

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1. Heat sources are removed or isolated from the workplace.
   Do you propose action?
   Yes No Priority
   Remarks_____

2. Processes using hazardous substances are removed from the workplace.
   Do you propose action?
   Yes No Priority
   Remarks_____

3. Dangerous substances are replaced with less dangerous ones.
   Do you propose action?
   Yes No Priority
   Remarks_____

4. Handling unnecessary amounts of hazardous substances is avoided by having only a one-day supply at the workstation.
   Do you propose action?
   Yes No Priority
   Remarks_____

5. Adequate size brushes, pans, spray guns and nozzles are used.
Do you propose action?
Yes No Priority
Remarks_____

6. Containers with lids and covers are used to avoid evaporation of hazardous substances.
Do you propose action?
Yes No Priority
Remarks_____

7. Hazardous substances are labelled with the name and nature of such substances.
Do you propose action?
Yes No Priority
Remarks_____

8. Production processes are used which do not require special ventilation systems.
Do you propose action?
Yes No Priority
Remarks_____

9. Trees, bushes, flowers and grass are planted near the workplace to provide shade and to protect from external dust.
Do you propose action?
Yes No Priority
Remarks_____

10. Water tanks and ponds are constructed around buildings to promote cool breezes.
Do you propose action?
Yes No Priority
Remarks_____

11. Shades, canopies, louvers and screens are used to prevent heat through solar radiation.
Do you propose action?
Yes No Priority
Remarks_____

12. The roof and outside walls are painted in light colours to reflect solar radiation.
Do you propose action?
Yes No Priority
Remarks_____

13. Insulation is used under roofs or on walls to help prevent the penetration of coldness in cold areas.
Do you propose action?
Yes No Priority
Remarks_____

14. Workstations are designed to take advantage of natural ventilation.
Do you propose action?
Yes No Priority
Remarks_____

15. Windows are opened to increase cross-ventilation.
Do you propose action?
Yes No Priority
Remarks_____

16. Ceiling fans and windows in higher positions are used to push hot air out.
Do you propose action?
Yes No Priority
Remarks_____

17. Push-type ventilation is used to get strong airflow where the airflow will not contaminate other areas.
Do you propose action?
Yes No Priority
Remarks_____

18. Push-pull ventilation is used to increase the efficiency of artificial ventilation.
Do you propose action?
Yes No Priority
Remarks_____

19. Sources of heat or airborne hazardous substances are placed close to exhaust ventilation to assure their removal.
Do you propose action?
Yes No Priority
Remarks_____

20. Hoods and flanges are used to increase the efficiency of pull-type ventilation.
Do you propose action?
Yes No Priority
Remarks_____

21. Open-type hoods are used properly.
Do you propose action?
Yes No Priority
Remarks_____

22. Exhaust ducts or hoods are provided with shutters or curtains and when not in use are closed or openings are minimal.
Do you propose action?
Yes No Priority
Remarks_____

23. Shields, dividers and walls are used to block heat radiation and to increase ventilation efficiency.
Do you propose action?
Yes No Priority
Remarks_____

24. Ventilation systems are maintained periodically.
Do you propose action?
Yes No Priority
Remarks_____

25. Personal protective equipment is used properly and kept clean.
Do you propose action?
Yes No Priority
Remarks_____

26. Filters on masks are changed periodically following the manufacturer's recommendation.
Do you propose action?
Yes No Priority
Remarks_____