Displacement Ventilation:

MASDeC October Meeting

Displacement Ventilation is Defined As:

Room Ventilation created by room air displacement, by introducing air at low level in a space at a lower air temperature than the room air.

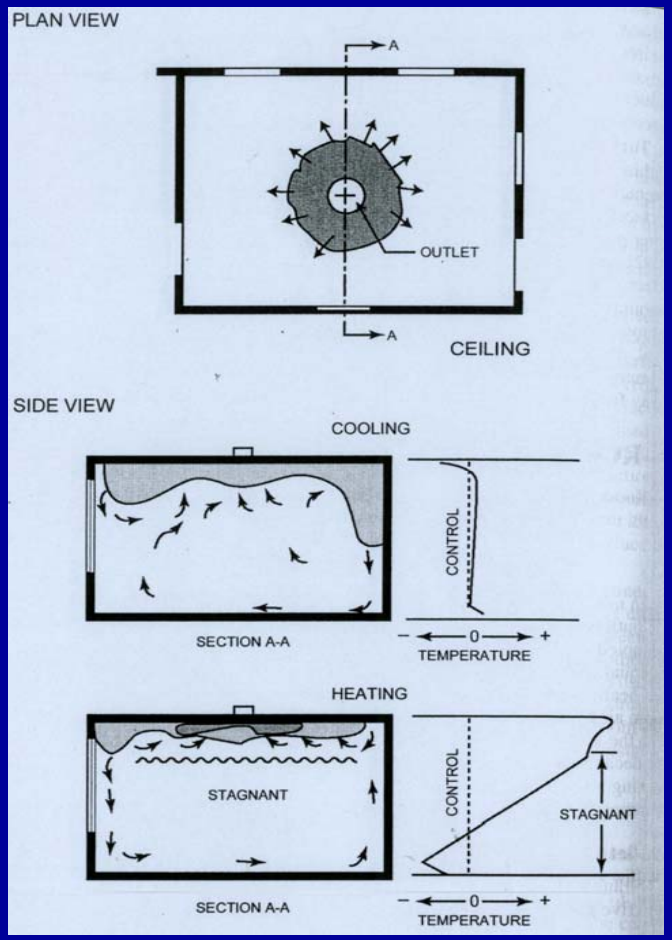
Two Harbors High School Rendering, showing DV Diffusers at base of columns.

History

- Displacement Ventilation (DV) has been used in Scandinavia over the last 20 + years.
- Recently DV has become increasing popular in the U.S.
- Originally DV was implemented for the welding industry.
- It has since been applied successfully to a variety of other types of spaces, including: Offices, Classrooms, Conference Rooms, Auditoriums, Gyms and Restaurants.

Mixing Ventilation

- This is the familiar air distribution method.
- Warm contaminated air migrates toward ceiling and mixes with incoming air.
- In heating mode, stagnant area is created in the occupied zone.
- Supply air temps may be anywhere from 55-90 deg F.



Air Temperature

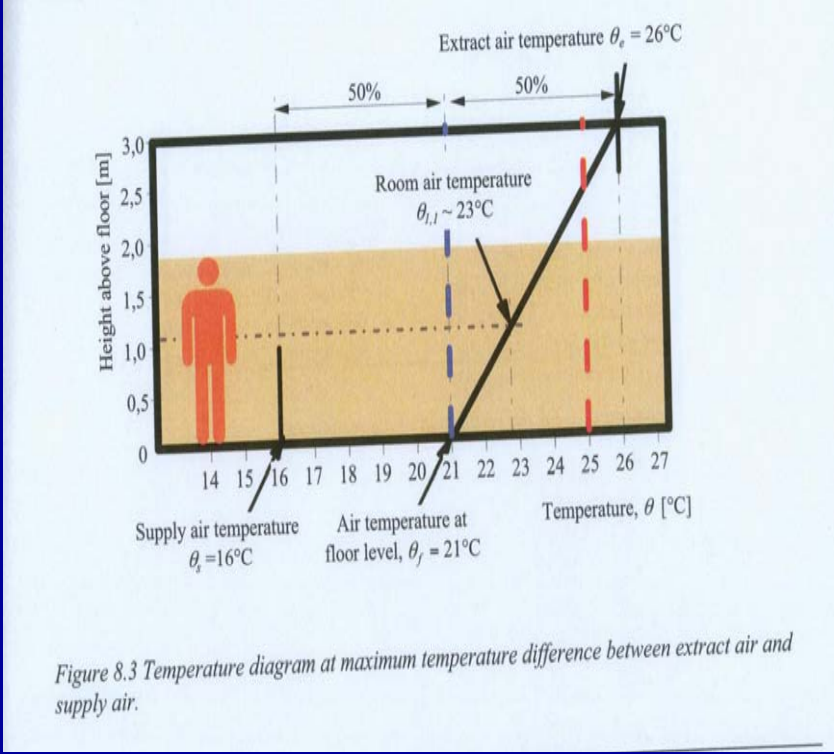


Figure 8.3 Temperature diagram at maximum temperature difference between extract air and supply air.

- Displacement Vent.
  - Room temp. 72 deg F.
  - Air is supplied between 62-67 deg F.
  - Extraction or exhaust air is 75 degrees or greater.
  - Air temp increases from the floor to the ceiling as indicated by a straight line, theoretically.

Air Flow

- Displacement Ventilation
  - Heat sources (i.e. people computers) create heat plumes.
  - Stratification zones are created in the space.
    - Upper extraction air zone.
    - Lower occupied zone.
  - Contaminates are carried out of the occupied zone and exhausted from the space at or near the high point of the room.
  - To gain the proper air flow, diffuser selection and location is critical.

Figure 3.1 Schematic illustration of the air flow that might be found in a room ventilated by displacement ventilation

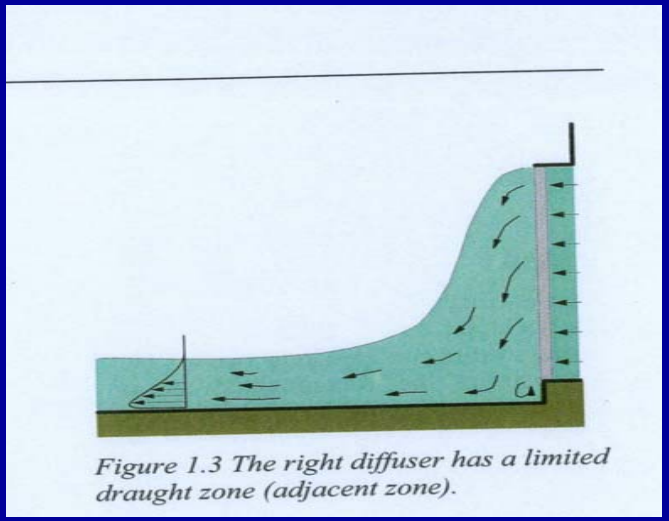
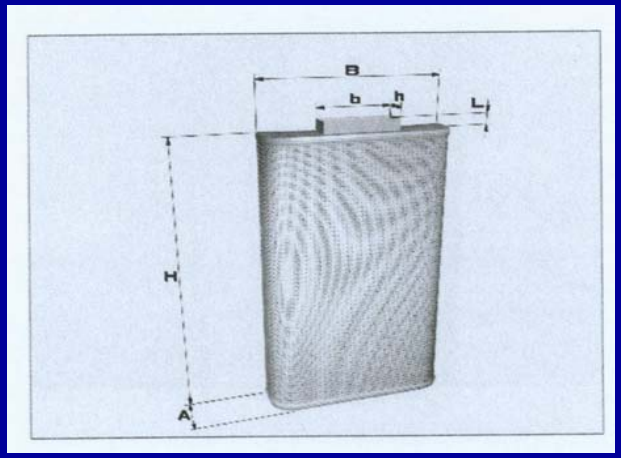


Figure 1.3 The right diffuser has a limited draught zone (adjacent zone).

Diffuser Selection

- Displacement Ventilation uses air diffusers with a large outlet area to supply air at low velocities.
- Diffuser performance is important to help reduce draft.
- Diffuser specifically designed for DV should be selected in most cases.
- Coordination of diffuser locations.
- Floor and wall space will need to be coordinated.



Indoor Air Quality (IAQ)

Figure 3.25 Thermal flow around a person may give cleaner breathing air.

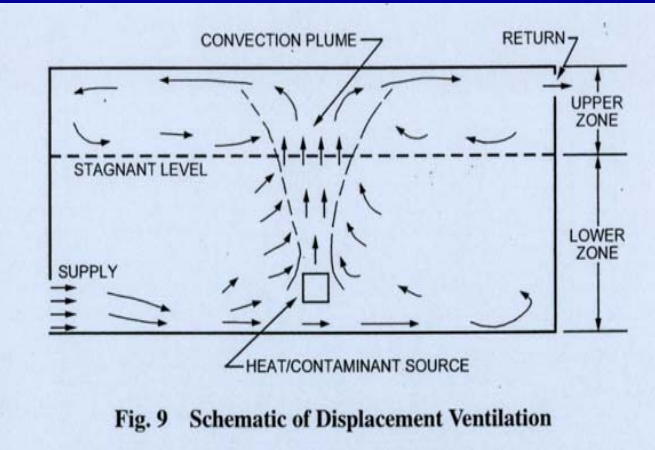
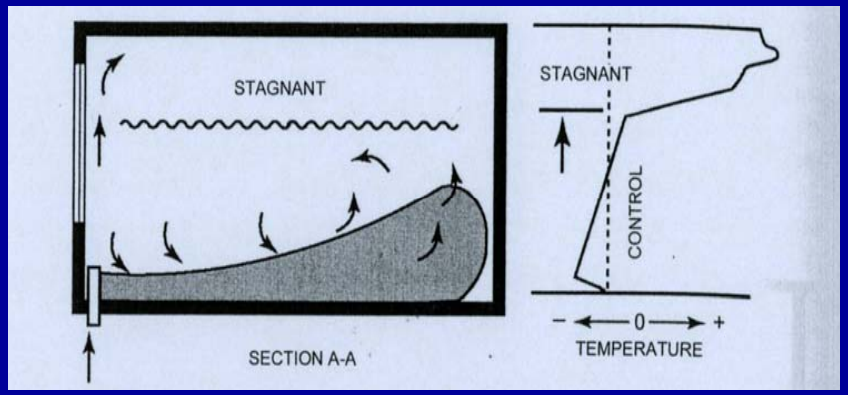


Fig. 9 Schematic of Displacement Ventilation

- Due to convective (thermal) flows with DV, contaminants will flow to the upper zone, thus DV provides better IAQ.
- Impacts on IAQ.
  - Contaminant source.
  - Contaminant location
  - Human body convection.
  - Wall surface temperature.
  - Space Height.

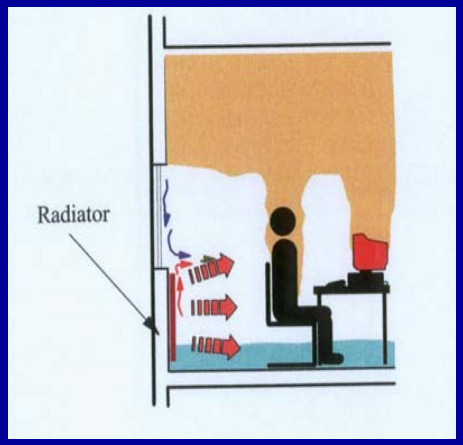
Ventilation Effectiveness (VE)

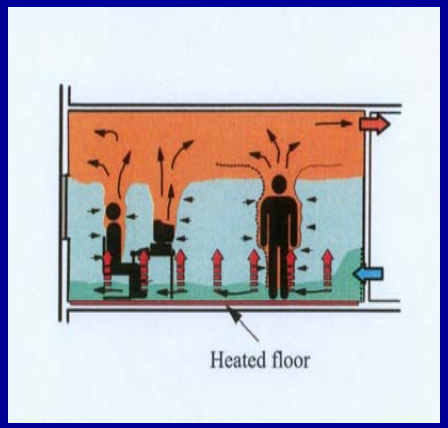


- Air change effectiveness is the ability to delivery ventilation air.
- Perfect mixing ventilation air change effectiveness equal 1.0.
- DV effectiveness has been tested to be 1.2 to 2.0, DV provides better effectiveness.

- VE is the ability of air distribution system to remove internally generated pollutants.
- Due to the return/exhaust grilles being located in the upper zone the VE of DV systems will be much better than mixing systems.
- It is possible to lower total outside air requirements and still meet code.
- It is possible to allow the greater VE to improve ventilation and possibly improve human performance.

Thermal Comfort





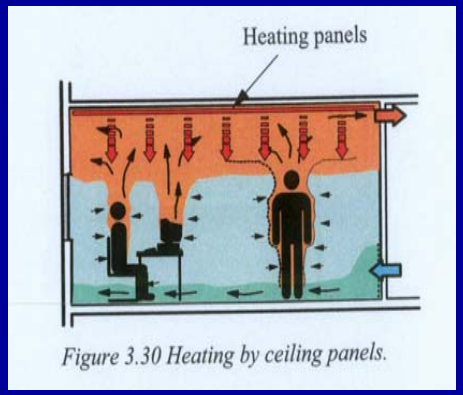


Figure 3.30 Heating by ceiling panels.

- Heating must be provided by other means due to the low supply air temp.
  - Perimeter radiation or convection.
  - Floor heat
  - Ceiling panels
- Additional Cooling
  - Fan Coil units
  - Radiant Panels or Tubes.
  - Using DV, only, can result in very high airflow.

Energy Efficiency

- Lower air flow rates for the same air quality, equates to energy saving.
- DV has more potential for free cooling (economizer) and needs less cooling energy than mixing ventilation, in moderate climates.

Cost

- First costs may be less for the mechanical ductwork, due to fewer diffusers.
- First costs for general construction may be higher, due to chase considerations.
- Secondary heating system is required, but in mild climates, it will probably be needed or evaluated for need.
- System cooling plant size may be reduced due to higher discharge temperatures.

Cloquet High School Gymnasium.

Pros & Cons

Pros:

- Better Indoor Air Quality (IAQ).
- Energy savings, higher cooling supply air temps allows use of airside economizers more frequently.
- Lower air flow rates for the same or better air quality.
- Improved acoustics, due to lower velocity air flow.
- Lower pressure loss through low velocity diffusers.

Cons:

- Contractor unfamiliarity.
- Coordination of building features and diffuser locations.
- Larger quantities of air where higher cooling loads are needed.
- DV should not be used when contaminates are heavier than air.
- Higher ceilings are better for DV systems.
- Ceiling cooling panels may be needed to supplement air systems where cooling loads are high.

Bayfield School Cafeteria – custom perforated supply diffusers.

Cloquet High School – Gymnasium exterior wall chases for DV.

Displacement Ventilation – Mock Up at Price in Winnipeg.

Mock up smoke test with DV.

Smoke test at exterior wall with “students”, warm floor cold ext. wall