

periods when the space is only partly occupied and the mechanical arrangements are inadequate for properly varying the quantity of air handled to suit.

A good arrangement is to provide apparatus for handling 30 cu. ft. of air per person per minute with provisions for recirculating any amount up to as much as two-thirds of this.

The percentage of air recirculated may be varied to suit the seasonal changes so as to conserve heat in winter and refrigeration in summer. The schools where the requirements are not so severe and it is not necessary to provide for summer conditions as much as 90 per cent of the air can be successfully recirculated. The use of ozonation for eliminating odors and for otherwise refreshing the air is advisable wherever recirculation is regularly and intensively employed (see Chapter XXIII, p. 265).

Present methods of measuring and comparing qualities of ventilation not taking into account any of the functions of the relative humidity of the air except that bearing upon effective temperature. This means that air of any temperature and relative humidity, within proper physical range, *i.e.*, below 64 deg. wet bulb, may be made to meet the comfort line by either heating or cooling without addition or deduction of moisture.

Absolutely dry air may be heated or cooled to 78 deg. and be 100 per cent perfect as far as effective temperature is concerned and still be far from desirable in its effects on the membranes of nose, throat and lungs. Such dry air is also very conducive to the increase of dustiness in the atmosphere of a room from the standpoints of dryness and electrostatic agitation.

The air washer and humidifier correct these difficulties and there should be some definition of limits for the relative humidity in the measure of ventilation.

It is not unusual to find from 1 to 2 million particles of dust per cu. ft. in the outside air surrounding city buildings and unless this is eliminated it will give dust counts in rooms equivalent to a deduction of from 5 to 20 per cent in the perfection of ventilation.

A good air washer should eliminate 80 to 90 per cent of the dust entering the intake and perhaps reduce the dust penalty in the rooms to less than one-half of the figure given. It will be seen, therefore, that air washing and humidification may improve the quality of ventilation about 10 per cent in the effective temperature department, plus another 10 per cent in the dust department, plus other improvements in the quality of ventilation by maintaining proper humidity and removing other injurious substances and odors.

Where effective temperature is controlled, according to the usual method, from the dry bulb temperature in the room there may be a wide variation in this effective temperature due to the varying amounts of moisture in the air, unless humidifying apparatus with accurate humidity control is employed. Between the condition of absolute dry air at 70 per cent and absolutely saturated air at 70 deg. there is a difference of 10 deg. in effective temperature which means an average difference of 25 per cent in the quality of ventilation. This may be taken to mean about 10 per cent on each side of the neutral point for ordinary ventilating

conditions so that the air washer and humidity should improve the ordinary ventilating plant another 10 per cent on this count.

Good dry air filters will of course serve the same purpose for cleaning the air of suspended matter, and may improve the ventilation about 10 per cent.

SCHOOLS REQUIRE SPECIAL CONSIDERATIONS

In connection with the ventilation of schools the condition in the classrooms for average winter weather is that the body heat given up to the room from the occupants is less than the heat loss from the building to the outside air so that the incoming air may be maintained at a higher temperature than that of the air surrounding the occupants. This means that the effective temperature may be controlled within 1 deg. above or below the comfort line.

Assuming that 95 per cent ventilation is required for class-rooms, that the distribution is 85 per cent and there is no deduction for dust, bacteria or odors, could have a deduction of 85 per cent of 2.5 per cent which is equivalent to about 2 per cent for CO₂. This would mean 15 cu. ft. of air per pupil per minute.

The usual requirements of state laws is 30 cu. ft. per pupil which would mean a deduction of 1 per cent for CO₂ leaving a 4 per cent deduction for effective temperature, dust, bacteria and odors.

Allowing a deduction of 2½ per cent for effective temperature there would be a possible deduction of 1½ per cent for these other items. It will depend therefore upon the quality that can be maintained for these other items as to the actual quantity of air required between 15 and 30 cu. ft. per minute per pupil.

Where intensive recirculation is employed the extent of the recirculation will depend on the quantity of CO₂, odors and other objectionable factors which can be removed from the recirculated air and also upon the ability to keep the relative humidity from rising to an undesirable point on account of the vapor given up to the air by occupants of the building.

The ventilation of school auditoriums where the occupancy of the rooms is of a relatively short duration of from 1 to 2 hours the initial air in the rooms may be relied upon to reduce the intensity of ventilation required so that from 15 to 20 cu. ft. of air per person per minute is usually sufficient. In the ventilation of hospitals the wards may be treated much the same as the class-rooms of a school with the exception that it is inadvisable to use recirculation on account of the danger of contagion.

School toilets should be separately ventilated with an air change of from 2 to 5 min. employing mechanical supply and exhaust with the exhaust in excess of the supply in order to prevent objectionable odors from diffusing into other parts of the building.

Kitchen and lunch rooms should be ventilated with about a 5 min. air change for lunch rooms and a 1 to 3 min. air change for kitchens with at least a part of the exhaust taken from the lunch rooms through the kitchen so as to keep all of the air travel towards the kitchen, thus preventing the kitchen odors from diffusing into the lunch rooms.