WHY TASK/AMBIENT CONDITIONING (TAC) SYSTEMS?

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ABSTRACT

Comfort needs for each person differ and change frequently, making them the #1 complaint. Task/ambient air conditioning will eliminate this problem by providing individuals with personal comfort control. Tests indicate that the individual can change the temperature he or she feels (the "perceived temperature") by as much as 8°C by varying the air flow. Because moving air is doing a lot of the cooling, system temperatures can be set higher to save energy. People that feel warm simply increase the air flow at their personal air terminals without affecting their neighbors. The air required to maintain space conditions can be introduced as displacement ventilation, providing cleaner air to the occupants. Tests indicate that ventilation effectiveness with displacement ventilation is 1 ½ to 2 times that of conventional systems. Results are substantial additional energy savings, especially in hot, humid climates. All this can be accomplished at lower first cost and much lower life cycle cost.

KEYWORDS: Task/ambient, personal comfort control

INTRODUCTION

Air conditioning is the #1 complaint in virtually all offices. The cause for the complaints is no mystery. People are comfortable when the heat removed is equal to the heat generated. The heat generated by individuals varies from 80 kcal/hr to 800 kcal/hr – a ratio of 10 to 1. It varies between people of different weight and metabolism, but also varies with physical activity, state of health, and state of mind. The increased metabolism from physical activity or mental excitement persists to varying degrees for periods as long as a half hour. All of these changes plus changes in levels of radiant heat from the sun and equipment and lights ideally are compensated by changes in heat removal or addition [1]. No thermostat or automatic control can accommodate these changes

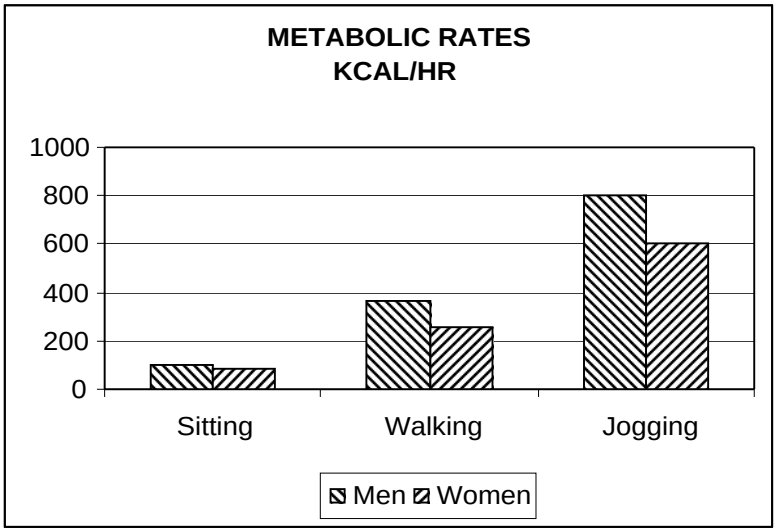

Figure 1. Metabolic rates [various sources].

since they involve individual occupants and eight personal comfort factors as shown in the following table.

Table 1. Personal comfort factors.

PERSONAL COMFORT FACTORS	
• Temperature	• Physiology
• Humidity	• Clothing
• Infrared heat	• Air quality
• Physical activity	• Air movement

TASK AIR

The aircraft and automotive industries recognized this problem long ago. Both provide for personal control by each individual primarily through control of air movement [2].

Tests conducted with thermal mannequins show that by changing the air movement by the individual, the "perceived temperature" (the temperature in still air that would add or remove the same amount of heat) can be changed by at least 5°C. In other words, at a room temperature of 26°C with moving conditioned air from 5 to 15 liters/sec, additional cooling of 3-5°C is obtained at velocities below 1 m/sec [3, 4]. This is a far lower velocity than that in cars and aircraft (which run from 2 to 3 m/sec) and meets ASHRAE recommendations in ANSI/ASHRAE 55-2004. This standard represents average settings to be preferred by most people under average conditions. It takes into account skin wetness which can only be estimated at this time. However, additional air – up to 30 liters/sec – should be available for extreme conditions (e.g., after climbing stairs or running).

Providing task air for occupants has been proven effective in various installations and tests [5]. One complication is the control of ambient conditions, since individuals can effectively shut off a part of the air supply. While modern electronic controls can answer this need, there is a simpler solution. Keep the total air supply constant and only divert a part for personal use – if not used, it reverts to control ambient conditions.

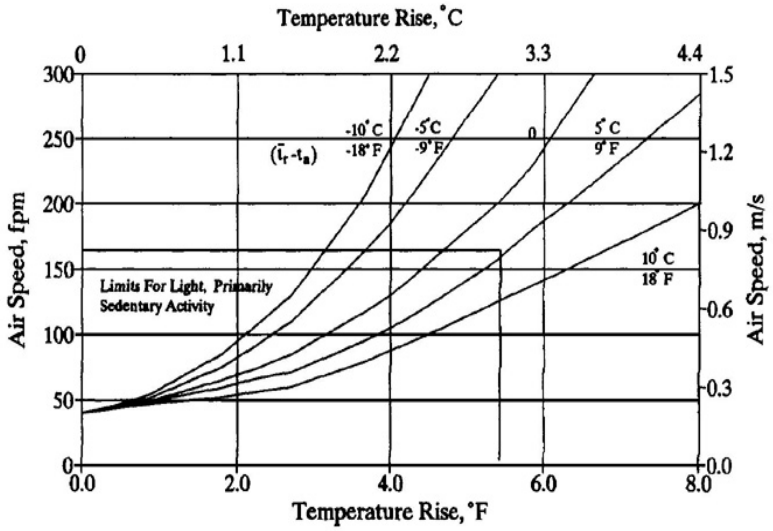

Figure 2. Air speed required to offset increased temperature. The air speed increases in the amount necessary to maintain the same total heat transfer from the skin. This figure applies to increase in temperature above those allowed in the summer comfort zone with both t_r and t_a increasing equally. The starting point of the curves at 0.2 m/s (40 fpm) corresponds to the

recommended air speed limit for the summer comfort zone at 26°C (79°F) and typical ventilation (i.e., turbulence intensity between 30% and 60%). Acceptance of the increased air speed requires occupant control of the local speed. [6, p.6]

IAQ

One of the important effects of task air is that the air at the breathing level has not yet been contaminated by extensive mixing with room air contaminated by people and equipment. If task air is combined with displacement ventilation for ambient air and with good filtration, the best possible interior air quality is achieved [7].

HUMIDITY CONTROL

The air supply for task air systems has to be above 18°C to avoid discomfort. In order to get proper humidity control, the cooling system should operate as normal with leaving air temperatures between 10°C and 12°C. Conditioned air should then be mixed in the air handler with filtered return air to get to the desired supply air temperature. This has the added advantage that no saturated air enters the space – as is generally the case with conventional systems (air leaving a cooling coil is usually saturated). This will help to prevent the formation of mold found in conventional systems.

ENERGY SAVINGS

In properly designed TAC systems the individual task supply air outlets are located near user occupants for two reasons: 1) to permit easy access by the occupant for individual control, and 2) to obtain maximum cooling effect from relatively low velocity air movement. Air required to maintain ambient space conditions can be introduced as displacement ventilation. System temperatures can be set higher to save energy. Occupants who feel warm may simply change the volume and/or direction of the airflow through their personal air terminals (without affecting their neighbors). The higher operating temperature will permit a much greater energy savings from economizer control, and lower operating cost because of the higher room temperature. Florida Power & Light indicates a savings of 14% by raising room temperature to 26°C. Because of the reduced ductwork with UFAD/TAC air distribution, there is a great reduction in fan power requirements [8].

VENTILATION EFFECTIVENESS

Tests indicate that ventilation effectiveness with “displacement ventilation” and task air is 1 ½ to 2 times that of conventional systems. Results are substantial additional energy savings, especially in hot, humid climates [9].

Underfloor air distribution (UFAD) with displacement ventilation also produces improved air quality. A Japanese study found a dramatic reduction in airborne particles with underfloor air distribution. Particle counts with underfloor supply were approximately one seventh those of conventional overhead distribution [10].

SUSTAINABILITY

When combined with UFAD, TAC with displacement ventilation can be integrated into workstation furniture. This approach permits easy, low cost reconfiguration of workspaces,

particularly in areas with high densities and churn rates. By distributing all air flow through furniture, the floor can be free of supply grilles [11].

GREEN DESIGN

TAC contributes to sustainable design by supporting elements of the LEED Green Building Rating System™, including optimizing energy performance, increased ventilation effectiveness, controllability of systems by individual operators, and satisfaction of thermal comfort requirements under ASHRAE 55-2004 [12, 6].

OPERATING CONTROLS

Operation of complex controls, even thermostats, by occupants has always been a problem. When designed with controls similar to those used by the automotive industry for many years, occupants are familiar with the use of the system, thus eliminating the need for extensive training. Users enjoy immediate response to changes in their comfort requirements without affecting other occupants, and enjoy cleaner air. The warmer ambient temperatures will keep small people (e.g., many women) happy, and the warmer people simply turn up their personal air supplies.

PRODUCTIVITY

A vast amount of material has been written about the increased productivity due to better air quality and personally adjustable controls. Since 90% of the cost of buildings are the occupants even a very small increase in productivity will pay for more than the cost of the building, including operating cost and amortization [13, 14, 15, 16].

FIRST COST

When properly coordinated with electric power, telephone, security, computer, control wiring and plumbing, first cost will be less than conventional systems (less ductwork and labor). Even greater savings come from lower life cycle costs [17].

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