

V

- Vacuum
 - cooling unit, 474
 - heating pumps, 274
 - control, 275
 - piston displacement, 276
 - heating systems, 268, 820
 - down-feed, 270
 - unit heater connection, 421
- Vacuum dryer, 734
- Valve, valves, 339
 - angle, 295, 296, 339
 - automatic, 341
 - check, 339
 - control, 296
 - expansion, 478
 - gate, 339
 - globe, 339
 - reducing pressure, 293
- Vane, vanes, 583
- Vaned outlets, 586
- Vapor, vapors
 - heating system, 820
 - unit heater connection, 421
 - pressure, 820
- Vaporizing oil burner, 213
- Velocity, 820
 - exhaust grilles, 590
 - method duct design, 606
 - pressure, 820
 - return grilles, 360, 363, 590
- Ventilation, 820
 - air conditioning units, 430
 - dairy barn, 768
 - garage, 789
 - hospitals, 684
 - natural, 751
 - general rules, 757
 - passenger bus in summer, 701
 - physiological objectives of, 65
 - railway passenger car, 697
 - ship, 842
 - State codes, 832
 - symbols for drawings, 826
 - systems, 383
 - wind forces, 751
- Ventilator, ventilators
 - control, 757
 - roof, 756
 - unit, 423
 - control, 649
- Vertical blow unit heater, 416
- Vertical openings, 124
 - sealing of, 124
- Vibration, machine, 635
- Viscous filters, 556
 - automatic, 557
 - impingement, 556
- Vitiation of air, 41
- Volume
 - control, 402
 - furnace, 179
 - specific, 818

W

- Wall, walls
 - heat flow through, 153
 - heat transfer coefficients, 99, 103, 105
 - infiltration through, 118
 - time lag of solar radiation, 154
- Warm Air
 - gravity heating system, 358
 - design procedure, 362, 364
 - furnace capacity, 367
 - installation practice, 358, 369
 - performance, 368
 - standardized units, 362, 363
 - unit carrying capacity, 365, 366, 367

Warm air (continued)

- mechanical heating system, 371
- automatic control, 375
- cooling methods, 380
- cooling system design, 381
- dampers, 375
- design procedure, 376
- duct velocities, 377
- ducts, 375
- fans, 373
- filters, 373
- furnace, 371
 - heavy duty, 379
 - selection, 378
- humidification, 379
- motors, 373
- registers and grilles, 374
- panel heating, 788, 789
- radiant heating, 788
- radiators, 218
- Washer, washers, 521
- air, 813
- Water
 - atmospheric cooling equipment, 430
 - coils, 496
 - control temperature service, 809
 - cooled
 - condenser, 480
 - unit conditioning, 434
 - corrosion treatment, 341
 - heater
 - coal-fired, 808
 - solar, 810
 - heating, 801, 805
 - make-up, 544
 - maximum, main temperature, 528
 - properties of, 472
 - supply piping, 801
 - arrangement, 802
 - thermodynamics of, 1
 - well, temperatures, 527
- Water vapor, 6
 - saturation pressure, 6
 - specific enthalpy, 7
 - specific volume, 7
- Welding, 323, 334, 336
- Wet-bulb temperature, 532, 820 (see Temperature)
- Wet return, 284, 820
- Wind, winds
 - forces, 751, 754
 - due to stack effect, 752
 - natural draft equipment, 535
 - selection of, velocity, 137
- Window, windows
 - coefficients of transmission, 115
 - leakage, 120
 - solar radiation through, 154, 155
 - ventilators, 427
- Winter
 - air conditioning system, 383
 - comfort zone, 57
 - freezing, equipment, 544
- Wound rotor motor, 673
- Wrought-iron pipe, 324
- Wrought-steel pipe, 323

X-Y-Z

- Year 'round air conditioning system, 383, 652
- Zone control, 647
- evaporative regulation, 30
- Zoning, 400
 - control, 647
 - dual duct, 402
 - multiple fans, 401
 - recording, 401
 - reheat, 401
 - separate equipment, 401
 - volume control, 402



CHAPTER 1

Thermodynamics of Air and Water Mixtures

Dry Air, Specific Enthalpy, Water Vapor, Moist Air, Dalton's Law, Humidity Ratio, Relative Humidity, Dew-Point, Enthalpy, Thermodynamic Wet-bulb Temperature, Mollier Diagram, Typical Air Conditioning Processes, Adiabatic Saturation, Psychrometric Chart, Steady Flow Energy Equation, U. S. Standard Atmosphere

THE working substance of the air conditioning engineer may be regarded, for the purpose of analysis, as a mixture of only two constituents, dry air and water. The mixture may consist of two, and possibly three distinct phases, solid, liquid and vapor. The vapor phase is conveniently referred to as *moist air* and is regarded as a mixture of *dry air* and *water vapor*.

DRY AIR

Composition. Dry air is itself a mixture of several gases, but its composition is subject to such slight variation that it may be regarded as fixed. According to *International Critical Tables*, the mol-fraction composition of dry air is given by the first column of figures in Table 1. Molecular weights are given in the second column; the last figure in the third column is the *apparent* molecular weight of the mixture; the fourth column of figures gives the ordinary weight-fraction composition.

It is well known that dry air contains other gases besides those listed in Table 1; but these are present in such minute amounts that they can be grouped together as argon. Values in the lower section of Table 1 give the approximate mol-fraction composition of what is called argon in the upper portion of the table.

In physical and chemical thermodynamics, there is a distinct advantage in using a different unit of weight, the mol, for each different substance involved. A mol of oxygen weighs 32,000 lb as a matter of definition; a mol of any other substance is a weight, in pounds, equal to its molecular weight.

Specific Volume and Density

The ratio of total volume to total weight is called *specific volume*, *v*. In the English system, volume is expressed in cubic feet and weight in pounds; hence, specific volume is expressed in cubic feet per pound. The reciprocal of specific volume, that is, weight per unit volume is called *weight density*, *d*. The unit of density is the pound per cubic foot.