



Technical Resource Center

Determining Moisture or Latent Loads

Moisture load can come from many sources, which provide the data needed to calculate the total latent load on any air conditioning or drying system. The total latent load equals the sum of applicable individual loads.

Outside design level. Bry-Air Dehumidifier performance characteristics are expressed in terms of specific humidity or grains per pound of air. To determine the outside design moisture level, use the standard design dry-bulb and wet-bulb conditions because this value measures the design total heat (wet-bulb) occurring with the highest practical dry-bulb. The design moisture level will exist when a lower dry-bulb occurs with the design wet-bulb. This condition represents the same total heat, but a higher specific humidity. The table below lists the recommended design specific humidity for various design wet-bulb temperatures. Use the standard accepted design wet-bulb for your locality.

Example: If the accepted design level for your city is 95°db (dry-bulb temperature) and 76°wb (wet-bulb temperature), this condition equals 104 gr/lb. But there will be many days when 76°wb will occur at a lower dry-bulb temperature. From the table below, the proper design specific humidity for comfort would be 115 gr/lb; for industrial work it would be 125 gr/lb. Figures below assume that these levels will be reached or exceeded on 30 percent of summer days for comfort work and 10 percent of days for process work.

Ventilation latent load. Determine the latent load equivalent to the outside air by subtracting the indoor or maintained specific humidity from the outdoor specific humidity and multiplying that amount by the pounds of outside air brought into the system.

EXAMPLE: If 1,000 cfm ventilation air is at 125 gr/lb. design and the design inside condition is 70 gr/lb., what is the ventilation latent load?

$$\frac{1000 \times (125 - 70)}{14} = 3930 \text{ gr/min or } 235,800 \text{ gr/hr.}$$

The average density of air is given as 14 cu. ft. per pound of air and is used regardless of the actual density at design conditions.

Recommended Design Outside Moisture Level

Design Outside Wet Bulb	Design Specific Humidity	
	Comfort Work	Process Work
F	(gr/lb)	(gr/lb)
81°	139	149
80°	130	143
79°	125	139
78°	120	134
77°	118	130
76°	115	125
75°	112	121
74°	108	117
73°	105	113
72°	100	109
71°	95	106
70°	90	102



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Latent Heat Dissipated by Adult Occupants

Dry Bulb Temperature	Occupants At Rest	Occupants Doing Light Physical Exertion *	Occupant Doing Heavy Physical Exertion **
F	(gr/hr)	(gr/hr)	(gr/hr)
60°	400	1300	1960
65°	530	1630	2400
70°	670	2060	2920
75°	900	2540	3450
80°	1180	3040	3950
85°	1525	3550	4450
90°	1870	4000	5000

* Examples - Waiters, dinner dancing, light factory assembly work

**Examples - Factory machine operator, continuous dancing

Evaporation from a wetted surface. Determine the amount of moisture evaporation from a pan, tank or other wetted surface into a space using the following calculations:

Where:

Gr. = moisture evaporated in grs/hr.

Vel = air velocity in F.P.M.

V_L = vapor pressure equivalent to temperature of surface water - inches of mercury.

V_A = vapor pressure equivalent to dew point temperature of air over surface - inches of mercury.

If air is moving across surface: $Gr. = 650 \times \left(1 + \frac{Vel}{230}\right) \times (V_L - V_A) \times (\text{sq ft of surface})$

If air is impacting surface: $Gr. = 1350 \times \left(1 + \frac{Vel}{250}\right) \times (V_L - V_A) \times (\text{sq ft of surface})$

Vapor Pressures of Water

Temperature Degrees F	Vapor Pressure Inches Mercury	Temperature Degrees F	Vapor Pressure Inches Mercury	Temperature Degrees F	Vapor Pressure Inches Mercury
30	0.1663	65	0.6222	100	1.933
35	0.2035	70	0.7392	110	2.60
40	0.2478	75	0.8750	120	3.45
45	0.3004	80	1.032	130	4.53
50	0.3626	85	1.213	140	5.88
55	0.4359	90	1.422	150	7.57
60	0.5218	95	1.660	160	9.65



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Miscellaneous Moisture Loads

<u>Description:</u>	<u>Load Grs/Hr:</u>
Food (Per meal)	200
Steam Table (per sq ft top)	2,000
Coffee Urn, 3 gal. steam or electric	10,000
Coffee Urn, 3 gal. gas	15,000
Coffee Urn, 5 gal. steam or electric	17,000
Coffee Urn, 5 gal. gas	26,000
Hair Dryer, electric, per helmet	2,700
Hair Dryer, gas, per helmet	4,000
Unvented gas burners (nat. or mfg. gas) per 1000 Btu. input	650

Moisture permeation. This is discussed in detail in Part Four beginning on page 8.

Moisture loads in the table above represent unvented appliances. Although personal judgment is used to determine vent or hood efficiency, the hood efficiency should never be higher than 50 percent.

Drying hygroscopic materials. The calculations shown above apply only to evaporation of free water from a surface. When hygroscopic materials are in the first stages of drying—when the surface is actually wet—the above relationship may exist. But after surface drying is complete, further drying will occur at a rate that depends on the rate of diffusion within the material; the rate varies with the degree of dryness within the material and is based on expected structural changes that occur during the drying process.

Establish the drying rate of hygroscopic materials in order to establish the hourly moisture load. Unfortunately these rates must be determined experimentally in each situation.

Usually, the desired outcome with hygroscopic drying is to improve drying rate or degree of dryness in the final product within an existing set up or with the addition of a dehumidifier. In doing so, the desired drying period is generally included with the total weight of material to be handled.

$$\text{Average drying rate} = \frac{\text{Wt. of material entering minus Wt. of material leaving}}{\text{Drying time (hrs)}}$$

One caution here: the drying period cannot be arbitrarily assumed; it must be realistic. For example, if dry air circulates in a dehumidifier and cannot dry a material to totally dry within 2 hours, and then 2 hours will be neither a possible nor a realistic desired drying time.

Storage of hygroscopic materials. When hygroscopic materials enter a dry storage space, even for a short time, they contribute a moisture load that must be absorbed by the dehumidifier. The table below lists the moisture holding capacity of various materials in equilibrium with air at the relative humidities shown. The percentages compare the moisture to the substance's totally dry weight.

If the incoming material has unknown moisture content, assume that it is in equilibrium with 60 percent rh air. In winter, the materials will likely come into a room in equilibrium with 90 percent rh air. However, in winter most other sources of rh are lower, so the summer figure (60 percent) can be used all year, unless the product loads makes up most of the entire total and the permeation load is minor by comparison.



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Regain of Hygroscopic Materials

Moisture Content Expressed in Percent of Dry Weight of the Substance at Various Relative Humidities – Temperature, 75°F.

Classification	Material	Description	Relative Humidity - Per Cent									Authority
			10	20	30	40	50	60	70	80	90	
Natural Textile Fibers	Cotton	Sea island - roving	2.5	3.7	4.6	5.5	6.6	7.9	9.5	11.5	14.1	Hartshorne
	Cotton	American - cloth	2.6	3.7	4.4	5.2	5.9	6.8	8.1	10.0	14.3	Schloesing
	Cotton	Absorbent	4.8	9.0	12.5	15.7	18.5	20.8	22.8	24.3	25.8	Fuwa
	Wool	Australian merino-skein	4.7	7.0	8.9	10.8	12.8	14.9	17.2	19.9	23.4	Hartshorne
	Silk	Raw chevennes - skein	3.2	5.5	6.9	8.0	8.9	10.2	11.9	14.3	18.8	Schloesing
	Linen	Table cloth	1.9	2.9	3.6	4.3	5.1	6.1	7.0	8.4	10.2	Atkinson
	Linen	Dry spun - yarn	3.6	5.4	6.5	7.3	8.1	8.9	9.8	11.2	13.8	Sommer
	Jute	Avg. of several grades	3.1	5.2	6.9	8.5	10.2	12.2	14.4	17.1	20.2	Storch
	Hemp	Manila & sisal - rope	2.7	4.7	6.0	7.2	8.5	9.9	11.6	13.6	15.7	Fuwa
Rayon	Viscous Nitrocellulose Cupramonium	Average skein	4.0	5.7	6.8	7.9	9.2	10.8	12.4	14.2	16.0	Robertson
	Cellulose Acetate	Fiber	0.8	1.1	1.4	1.9	2.4	3.0	3.6	4.3	5.3	Robertson
Paper	M.F.Newsprint	Wood pulp - 24% ash	2.1	3.2	4.0	4.7	5.3	6.1	7.2	8.7	10.6	U.S.B. of S.
	H.M.FWriting	Wood pulp - 3% ash	3.0	4.2	5.2	6.2	7.2	8.3	9.9	11.9	14.2	U.S.B. of S.
	White Bond	Rag -1% ash	2.4	3.7	4.7	5.5	6.5	7.5	8.8	10.8	13.2	U.S.B. of S.
	Com. Ledger	75% rag - 1% ash	3.2	4.2	5.0	5.6	6.2	6.9	8.1	10.3	13.9	U.S.B. of S.
	Kraft Wrapping	Coniferous	3.2	4.6	5.7	6.6	7.6	8.9	10.5	12.6	14.9	U.S.B. of S.
Misc. Organic Materials	Leather	Sole oak - tanned	5.0	8.5	11.2	13.6	16.0	18.3	20.6	24.0	29.2	Phelps
	Catgut	Racquet strings	4.6	7.2	8.6	10.2	12.0	14.3	17.3	19.8	21.7	Fuwa
	Glue	Hide	3.4	4.8	5.8	6.6	7.6	9.0	10.7	11.8	12.5	Fuwa
	Rubber	Solid Tire	0.11	0.21	0.32	0.44	0.54	0.66	0.76	0.88	0.99	Fuwa
	Wood	Timber (average)	3.0	4.4	5.9	7.6	9.3	11.3	14.0	17.5	22.0	Forest P.Lab.
	Soap	White	1.9	3.8	5.7	7.6	10.0	12.9	16.1	19.8	23.8	Fuwa
	Tobacco	Cigarette	5.4	8.6	11.0	13.3	16.0	19.5	25.0	33.5	50.0	Ford
Food-stuffs	White Bread		0.5	1.7	3.1	4.5	6.2	8.5	11.1	14.5	19.0	Atkinson
	Crackers		2.1	2.8	3.3	3.9	5.0	6.5	8.3	10.9	14.9	Atkinson
	Macaroni		5.1	7.4	8.8	10.2	11.7	13.7	16.2	19.0	22.1	Atkinson
	Flour		2.6	4.1	5.3	6.5	8.0	9.9	12.4	15.4	19.1	Bailey
	Starch		2.2	3.8	5.2	6.4	7.4	8.3	9.2	10.6	12.7	Atkinson
	Gelatin		0.7	1.6	2.8	3.8	4.9	6.1	7.6	9.3	11.4	Atkinson
Misc. Inorganic Materials	Asbestos Fiber	Finely divided	0.16	0.24	0.26	0.32	0.41	0.51	0.62	0.73	0.84	Fuwa
	Silica Gel		5.7	9.8	12.7	15.2	17.2	18.8	20.2	21.5	22.6	Fuwa
	Domestic Coke		0.20	0.40	0.61	0.81	1.03	1.24	1.46	1.67	1.89	Selvig
	Activated Charcoal	Steam activated	7.1	14.3	22.8	26.2	128.3	29.2	30.0	31.1	32.7	Fuwa
	Sulfuric Acid	H2SO4	33.0	41.0	47.5	52.5	57.0	61.5	67.0	73.5	82.5	Mason