Armstrong® Application of Unit Humidifiers for Direct Discharge

A survey of your requirements should be taken to determine the amount of steam needed for humidification, the number, size and type of units required, and the location of both humidifier and humidity controllers.

Sizing and Location with Natural Ventilation

These are the average industrial humidification applications with:

Room temperatures—65° to 80°F.
Relative humidities—35% to 80%.
Natural ventilation—i.e., infiltration around windows and doors.

Selection Data Required

Minimum Outdoor Temperature: For most jobs, figure 10°F above the lowest recorded temperature for your locality. The lowest temperatures are seldom encountered for more than a few hours.

- Indoor Temperature
- RH Desired
- Pressure of Steam Available for Humidification
- Number of Cubic Feet in Room
- Air Changes Per Hour: air changes taking place under average conditions exclusive of air provided for ventilation or regain of hygroscopic materials.

Rooms, 1 side exposed _____1
Rooms, 2 sides exposed _____1-1/2
Rooms, 3 or 4 sides exposed _____2
Rooms with no windows or
outside doors _____1/2 – 3/4

Typical Problem:
Design outdoor temperature _____0°F
Indoor temperature_____70°F
RH required _____40%
Air changes per hour _____2
Steam pressure available_____5 psi

Room size 400’ x 160’ with 10’ ceiling
Natural ventilation
Heated by: Unit heaters-fan on-off control

Step I: Steam required for humidification. Our room contains (400’ x 160’ x 25’) or 1,600,000 cu ft.

From the 70°F Table 38-1, read across from 0°F outside temperature to the 40% RH column where you find the figure .409 lbs of steam/hour per 1,000 cu ft of space for each air change. Then, 1,600 times .409 times 2 equals 1,309 lbs of steam/hour installed humidification capacity required.

Step II: Electric or air-controlled units. The large floor area calls for multiple humidifiers. No explosion hazard has been specified so use of air-controlled units is not required. Electric units are recommended.

Step III: Number of humidifiers for job. Divide steam required by capacity of humidifiers at steam pressure available.

Step IV: What size humidifier to use. For this example, a large number of smaller capacity units is recommended. Larger capacity units could cause condensation on the low ceiling. Also, because of the large floor area, the humidistats for fewer units would be widely spaced which could result in less accurate control than desirable.

Step V: What type humidifier to use. In this example, integral fan units are preferable to steam jet units installed in conjunction with unit heaters. Since the unit heater fans are on or off to control temperature, it follows that the humidistat may call for steam when the nearest unit heater is not running. With the low ceiling, the discharge from a steam jet humidifier might rise to the ceiling and produce condensation. Therefore, the integral fan type should be used.

Step VI: Location of humidifiers. Several patterns are possible, and actual location can usually conform with the existing steam supply and return lines to make an economical installation with a minimum of new piping.

Pounds of steam per hour, per air change for each 1,000 cu ft of space to secure desired indoor relative humidity at 70°F with various outdoor temperature (outside air 75% saturated).

Table 38-1. 70°F Humidification

Outdoor Temp.	70°F - Relative Humidity Desired Indoors - 70°F										
	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
*30	.079	.136	.194	.251	.309	.367	.424	.482	.539	.597	.654
20	.154	.212	.269	.327	.385	.441	.499	.557	.615	.672	.730
10	.204	.262	.319	.377	.434	.492	.549	.607	.665	.722	.780
0	.237	.294	.352	.409	.467	.524	.582	.639	.697	.754	.812
-10	.257	.314	.372	.430	.487	.545	.602	.660	.717	.775	.832
-20	.270	.327	.385	.442	.500	.557	.615	.672	.730	.787	.844

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In our problem of a 400' x 160' x 25' room, there would likely be steam lines along both sides of the room, and humidifiers can be located as shown in black in Figure 39-1. If the supply lines run down the center of the room the line pattern would be practical. Runouts to integral fan units in a 160' wide room would be about 20' long. If the room were only 60 or 80 feet wide, runouts need be no longer than required for actual hookup.

Step VII: Location of humidistat. This should be from 20 to 30 feet away from the humidifier and slightly to one side of the air stream from the unit. The humidistat should "see" its humidifier and be in "active" air. Do not hide it behind a post or in the channel of an H-beam. It must get a good sample of the air to control the humidity.

Sizing and Location with Forced Ventilation

Typical Jobs: Mill and sanding rooms in furniture factories. Here, the problem of selecting and installing humidifiers is much the same as previously described except for:

1. Determining the number of air changes.

2. Location of humidifiers and humidistats.

Air Changes: These can be determined from the exhaust fans' capacities. The cubic feet per hour capacity of the fans, divided by the cubic feet of space to be humidified, will give the number of air changes.

Where the capacity of fan or fans is not known, air changes can be measured with velometer readings at all open doors, elevator shafts, etc. leading to the room and with fans operating at full capacity. Your Armstrong Representative can determine air changes for you.

Humidifier Location: Bear in mind that humidifiers will have to control the humidity 24 hours a day, seven days a week during the heating season. Exhaust fans may operate only 40 hours or 80 hours per week. Thus the humidifiers and humidistats must be located for good distribution of humidity during fan-off periods as well as when the fans are operating.

Figure 39-1. Where practical, locate humidifiers to minimize piping. Locations shown in black where steam supply lines are along outer walls; in white where supply is in center of room.

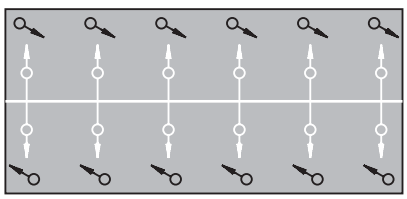
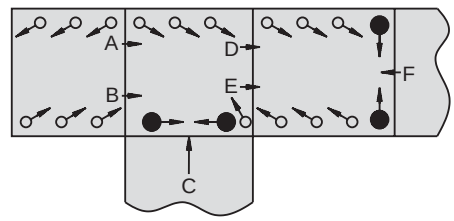


Figure 39-2. Outlines a typical requirement. Schematic layout of humidifiers in wood-working plant where exhaust fans are used. Arrows indicate air flow induced by fans. Humidifiers are sized for load conditions imposed by fan. Humidifiers are located to give uniform distribution of humidity when fans are off or when fans are running.



Pounds of steam required per hour per air change for each 1,000 cu ft of space to secure desired indoor relative humidity at 75°F with various outdoor temperatures (outside air 75% saturated).

Table 39-1. 75°F Humidification

Outdoor Temp.	75°F - Relative Humidity Desired Indoors - 75°F										
	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
*30	.129	.196	.264	.331	.399	.466	.533	.601	.668	.736	.803
20	.204	.271	.339	.406	.474	.541	.609	.676	.744	.811	.879
10	.254	.321	.389	.456	.524	.591	.659	.726	.794	.861	.929
0	.286	.354	.421	.489	.556	.624	.691	.759	.826	.894	.961
-10	.307	.374	.442	.509	.577	.644	.711	.779	.846	.914	.981
-20	.319	.387	.454	.522	.589	.657	.724	.792	.859	.927	.994

*Note: When outdoor design temperatures exceed 30°F, use Table 7-1, Page 7.

Sizing for High or Low Temperature Humidification

Where air temperatures are well above 75°F or below 70°F, it is impractical to use Tables 38-1, Page 38, or 39-1, Page 39. Humidification requirements must be figured from Table 7-1, Page 7, showing grains of water per cu ft of saturated air at various temperatures. Typical problem: How much steam per hour is required to humidify 60,000 cu ft of space with four air changes per hour to 40% RH when the air temperature is 90°F? Assume that any makeup air will come from outdoors at 0°F, 75% saturated.

90°F saturated air = 14.9 gr/cu ft saturated = 5.976 gr/cu ft at 40% RH

Outdoor air 0°F saturated = .475 gr/cu ft

75% saturated = .356 gr/cu ft

5.976 minus .356 = 5.620 grains to be added per cu ft

$$\frac{5.620 \times 1{,}000}{7{,}000} = .803 \text{ lb per M cu ft per air change}$$

NOTE: 7,000 gr = 1 lb

With four air changes in a 60,000 cu ft room, then .803 x 60 x 4, or 193 lbs steam would be required per hour. Humidifier capacity required for temperatures below 70°F is determined in exactly the same manner.

NOTE: For high temperature air in particular, air volume changes dramatically with RH. Armstrong Humid-A-ware™ Humidification Sizing and Selection Software will provide greater accuracy in humidifier sizing for these applications.

Explosion Hazard Humidification

Sizing air-operated humidifiers for areas where explosion hazard exists is done exactly as for other requirements except that they should be sized for the most severe conditions of makeup air, RH required and minimum steam pressure.

Humidifiers should be located to get the best possible dispersal and distribution of vapor in the area.

Special Purpose Industrial Applications

In some industrial operations, a stratum of high relative humidity is required in close proximity to a fast moving sheet or film of paper, thin gauge plastic, fabric, cellophane, etc. The objective may be to prevent accumulation of static electricity charges, or to prevent loss of moisture from the material. If the sheet or film is hot, as it very well might be, it tends to give up its moisture very quickly. By using steam shower humidifiers expressly adapted for this application to create a laminar zone of high humidity adjacent to the sheet, moisture loss is prevented and moisture content of the material is properly maintained.

For this application, the humidifier must be interlocked with the drive of the machine, and it is essential that the steam be discharged in a dry state, with no water droplets or liquid spray.

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