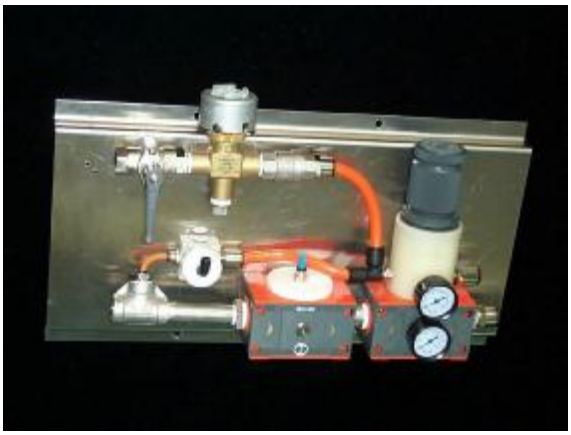
BEST A/V SYSTEMS
HUMIDIFICATION
HUMIDIFIERS

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

BEST A/V Final-Fog® System

Proportional Control Ultra-Sonic Fog Humidifier

Final-Fog® Proportional Control Ultra-Sonic Fog Humidifier



Manifold

Controller

FEATURES:

1. Produce super fine particle: D_{32} = average 8.4μm ◦
2. Suitable for places like clean-room, semi-conductor, textile plant, paper & print plant, computer room, food process & storage, library, museum, and …etc.
3. Equipped with Direct Digital Controller (DDC), Proportional Water Flow Control Valve, Pneumatic On-Off Control Valve, patented Flow-Through Auto-Proportional Differential Pressure Regulator, and Ultra Sonic Fog Nozzle, for a perfect timing control and transforming the water into the finest mist as ever. The process is having compressed air and DI/RO water both go through the patented Flow Through Auto Proportional Differential Pressure Regulator and then go into the Ultra Sonic Fog Nozzle at the same time. It keeps the supply water and compressed air always at their best condition for providing the finest mist. With the unique constructed nozzle the atomizing takes place there and produce thousands and thousands of super fine particles. These countless particles increase the total heat exchange area and hence expedite the heat transfer rate.

The mist that comes out of nozzle will drift into the air flow and mix with (absorbed by) the air quickly and evenly to increase the humidity of the airflow. The humidified airflow then go through the AHU or disperse directly into an open space where requires humidification. This is not only increasing the humidity of the airflow, but also cooling down the temperature of the airflow. So, this type of humidification is also called “cooling humidification”.

4. No maintenance costs or little: Apply stainless steel materials, DI/RO supply water, and filtered clean air to minimize the maintenance work. The only time that requires maintenance is when starting the unit after a long period of shut down. You need to clean up the unit before you use it again for securing a high quality humidification.
5. Economical effectiveness. This system is very cost effective and can save a lots of money. Such as：
   - **Simple structure - low equipments cost**：as the structure is rather simple than other type of humidifiers, so the equipment costs would be much lower than others especially when the required humidification capacity is very large.
   - **Easy to install - low labor cost:** use push-in fittings for quick and easy installation and maintenance.
   - **Less Cooling Coil load - low energy & cooling water consumption**：very cost effective especially in hot and dry environments. Because this fog system directly spray out the mist into the airflow, so when increase the air humidity it also decrease the air temperature. In this way, it reduces the cooling coil load and hence requires much less cooling water, and the cooling coil will last longer. In the long run, the cost saving on this part is huge, e.g. saving on energy, cooling coil, cooling water, …etc.
   - **Less energy consumption:** compare to Electric or Electro Humidifiers, fog system requires only 0.03kw (30w) power supply or lower, regardless how large the humidification capacity is. It also offers a safe operation by having low voltage & wattage power supply and air-pressure-actuated system.
   - **Less components - less costs in every way**：compare to Electric or Electro Humidifiers, fog system’s structure has less components:
     - **Control unit:** low voltage and wattage operation.
     - **Manifold:** fully pneumatic control; auto-differentiated air & water pressure; capable of multiple-series connection for larger capacity.

6. Proportional Control makes substantial saving on air consumption:
   - **Proportional controlled output**：able to adjust the air flow rate to water flow rate effectively, i.e. Less water required then less air would be used, and the other way around. It will save at least half of the air consumption when compares to traditional fog system or fog humidifier without real proportional control function.
   - **On-Off Controlled Output**：unable to adjust the air flow rate to the water flow rate. It takes only full capacity of compressed air regardless of water flow rate.

Especially when most of actual humidification load required is much less than the designed capacity, so often time the humidifier is working at a low level of water rate. It is not only wasting the expensive compressed air, but also affects the quality of fog. It's been tested and proved that one key factor of having the best quality fog is keeping the air pressure higher than the water pressure at a steady differential pressure ranging from 1.0 to1.5 kg/cm^2.

- **Water pressure vs. Compressed air pressure：**
  - When compressed air pressure is 1.0~1.5 kg/cm^2 higher than water pressure, the atomizing process becomes very effective and can produce very high quality fog for humidification. And Best A/V's patented and unique Flow-Through Auto Proportional Differential Pressure Regulator is made to fulfill this important task.
  - When compressed air pressure is 2 kg/cm^2 (or more) higher than water pressure, the supply air will push away the supply water; only little or no water goes into the nozzles. It is hardly to have enough fog for humidification and wastes the costly compressed air.
  - The supply water pressure should be higher than 3 kg/cm^2 and the higher the better. Because the efficiency of compressed air is in direct ratio to water pressure and the higher the water pressure the lower the consumption of compressed air.

7. Large range of capacity: ranging from 10 kg/hr to infinity; suitable for industrial or commercial building with central air conditioning control room or big open area for direct humidifying. The nozzles and manifolds are able to working at multiple-series connection, so it can add up units as many as needed with no limit.

8. Low air consumption: every 1.0 kg/hr of water for humidifying only require 0.86 Nm^3/hr of air. It's done by our patented Flow-Through Auto-Proportional Differential Pressure Regulator of Best A/V fog system. The regulator keeps the compressed air pressure at a steady differential pressure higher than water pressure (ranging from 1.0 to 1.5 kg/cm^2); and maintains these two pressures at a fixed differential pressure. This differential pressure control function is based on a very simple principle and structure. It does not require a complicate control system or special skills for installation. It uses the air effectively & efficiently and saves a huge cost on expensive compressed air. It is very easy to understand , so it saves a lot of labor hours on installation, repairing, maintenance, and operation.
9. Fixed differential pressure between Compressed air and Water: It is proved either in the lab or in the field that an effect fog system is relying on the ability in controlling the air pressure to be 1.0~1.5 kg/cm2 higher than the water pressure. When the air pressure is higher than the water pressure within this range, the water flow is at its highest rate and promising a quality fog. In order to have the finest fog system, we made a lot of efforts in designing our Flow-Through Auto-Proportional Differential Pressure Regulator. As the result, it is not only achieving in maintaining a steady differential pressure between air and water pressure, but also

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

reducing the compressed air consumption and saving costs. Below is the illustration of our Flow-Through Auto-Proportional Differential Pressure Regulator and how it works.

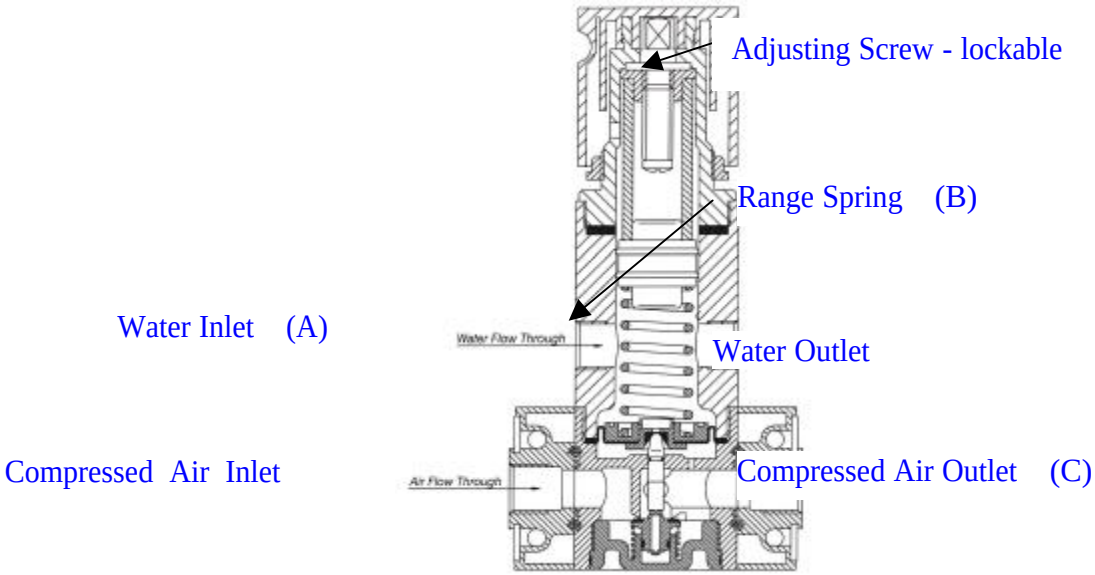


FIG. 1 Flow-Through Auto-Proportional Differential Pressure Regulator
(Auto-proportional flow control)

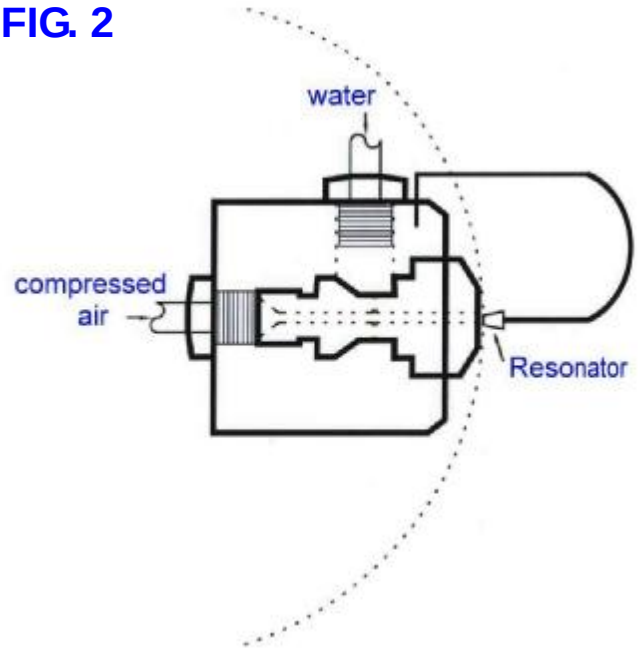
10. Rangeability (Turndown Ratio)： **50：1**
11. Adapting standardized push-in fittings and tubings: it's easy and quick in installation and disassembly and no special tools are required. Saving labor costs on installation, maintenance, and replacement.
12. Optional Supply Air Velocity On-Off Controller: when the airflow is low or not enough to absorb the fog completely, it reduces the humidifying quality and the fog will dew on the walls of air handling unit or surface of expensive equipments. Our optional Supply Air Velocity On-Off Controller will turn off the humidifier when it detects a low airflow. This device avoids the damages caused by over-wetted duct or air handling unit, such as shortened equipments life span, increased employee sick leave due to bacteria from the air-conditioning, …etc.
13. Direct Digital Controller：
    - Easy operation: applied comprehensive technology makes the operation very easy and simply.
    - With LCD Display: provides the current status clearly in plain language and on four lines.
    - Quick-Access Key System: combining push-button system and menu-guided dialog. Enable to get direct access to a specific main menu, e.g. time program, data points-parameters, alarms, plant…
    - Compatible with center control room.

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

14. Input signal: 2.0~10V or 4.0~20mA.
15. Low power consumption: 220VAC/30W.
16. Auto Self-Cleanup function whenever turns on or turns off the humidifier: when the fog system receives start-up or stop signal, the first step is pump up air through the tubing and nozzles to clean away water remains and dirt to prevent possible scale and bacteria formed inside the tubes and nozzles and enhance the life-span and efficiency of nozzles.
17. Slop-and-flat headed Resonator:
    - Unique designed and shaped to make the fog particles far more smaller and enable the air to absorb the fog completely in a very short time. It also works perfectly for a larger difference in pressure between air and water.
    - Easy to adjust the fog pattern (radian) for better fog result. By means of fastening or loosening the resonator can adjust the distance between the resonator and the outlet of nozzles and so to determine the fog pattern. The best fog pattern is shown as below FIG.3. Please see below illustrations for three different patterns:

FIG.2 shows: the resonator is too close to the outlet of the nozzle, so the fog is spraying backward and cover all over the nozzle. It creates lots of big water drops and dew on the body of nozzle and the most it affects the fog quality.

FIG. 2



Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

FIG.3 shows: the resonator is at the proper position and creates the fog pattern with the largest area and with no dew.

FIG. 3

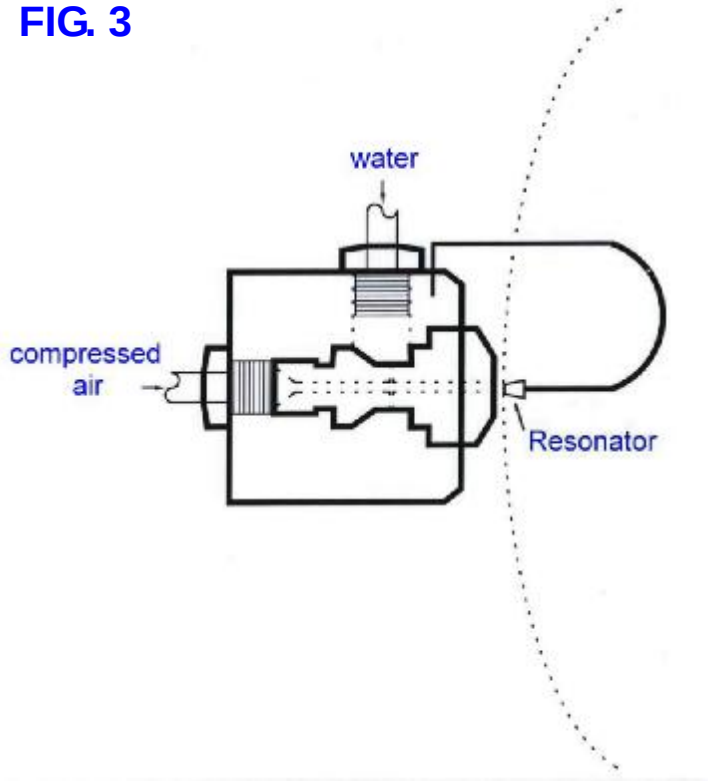
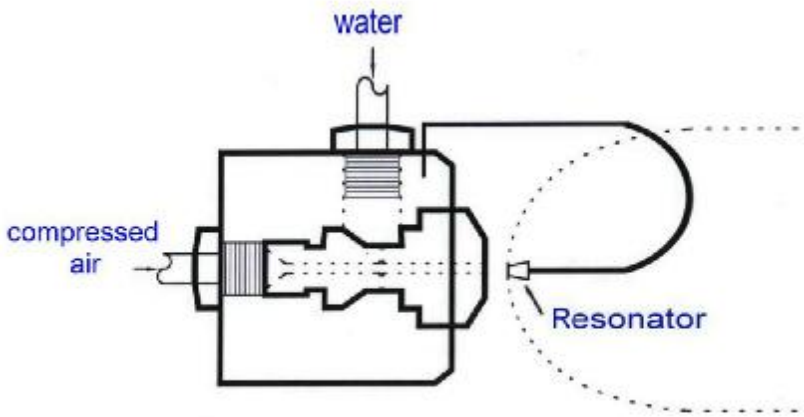


FIG.4 shows: the resonator is too far away from the outlet of the nozzle, so the fog is spraying straight forward with a narrow pattern and creating larger fog particles.

FIG. 4



Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

ULTRA-SONIC FINAL FOG NOZZLE:

1. **Body Structure:** in Stainless Steel series 300, simple structured, less parts, long life-span, no maintenance needed. The high density of stainless steel body makes it resistant to high pressure and corrosive.
2. **Operation Principles:** two modes in forming the liquid film mechanically, rim and wave mode. The resonator of Ultrasonic Final Fog Nozzle creates ultrasonic vibration and so further atomizing the mist into fine fog state.
3. **Experiment Reveals：**
   a. When Pressure of water (Pw) fixed at 3kg/cm^2 and with Pressure of air (Pa) = 3kg/cm^2, the fog pattern is a spread-out shape (about 150^o); when increase Pa = 4kg/cm^2 the fog pattern turns to 175^o; but when increase Pa above 4kg/cm^2 the fog pattern becomes 180^o; it reveals when air pressure is much higher than water pressure the fog pattern will be larger than180^o (means the fog flow spray backward). But an increase on the water pressure will detain the fog from spraying backward. It's because the nature of fog is containing two phases - liquid and vapor, and the liquid phase always has a bigger inertia force than airs, so the water always leads the flow direction. Best A/V's Final-Fog resonator is designed according to this characteristic of fog flow and shaped its resonator a flat and slop head so as to have wider spray range and smaller particles of fog and to meet the high quality demand of industries applications.
   b. In nature, when water pressure (Pw) equal to air pressure (Pa), the nozzle will get its biggest liquid flow rate; when air pressure higher than water's, water flow rate will be depressed and the other way around. But to overcome these nature forces, Best A/V System's nozzle has a special internal design which mechanically depress water flow rate when water pressure is getting higher than air's; and so water pressure will always fluctuate with air pressure and so does water flow rate to water pressure.

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

PARTS, FEATURES AND FUNCTIONS

1. Nozzle: for mixing water and compressed air for the first atomization; also as the supporting base for Slop-and-flat headed Resonator.
2. Atomization Chamber: enable the water and air having the first atomization and spray out the mist from nozzle at sonic speed.
3. Slop-and-flat headed Resonator: for the 2nd atomization taking place - when mist comes out of nozzle it then hits directly on the resonator to form the finest fog at ultrasonic speed; also for adjusting the fog patterns to have the best fog quality.
4. DDC Controller:
   - Compatible with the center control unit/room for proportional control.
   - accepts 4.0~20mA or 2.0~10VDC input signal to control on valves、E/P transducer、time scheme...etc; deliveries accurate water and air flow rate as requested.
   - With unique handling: the LCD display clearly provides the current status in plain language and on four lines. Four quick-access keys get direct access to a specific main menu.
5. Manifold for nozzles: includes Flow-Through Auto-Proportional Differential Pressure Regulator、control valves for water and air、check valve、pressure gauge.
6. Flow-Through Auto-Proportional Differential Pressure Regulator:
   - Automatically regulating the differential pressure between air and water and provides a steady environment for atomization taking place, so as to have the best quality of fog for humidification.
   - Reducing air consumption when in low water flow. An additional value for saving energy costs.
7. Control Valves:
   - Water flow control valve: a proportional control valve; accepts 3~15psi signal; automatically control the water output from 0~100%.
   - Air control valves: consist of two on-off control valves.
     - One air valve is regulating the air flow for atomization, and
     - The other is drain valve for cleaning and removing water remains in the tubing and nozzles at each time the humidifier is turn-on or turn-off. It's a self-cleaning step whenever the humidifier unit starts or stops to prevent from lime scale forming and clogged in the tubing or nozzles.

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

OPERATION PRINCIPLES

1. Compressed air travel through air tubing and go into nozzles' atomization chamber at a very high speed and pass through a very narrow path then exit and collide with the adjustable resonator head. Finally spray out at ultrasonic speed.
2. Pure water pumped into water tubing and goes into nozzles' unique designed guide paths and come into atomization chamber via two very small holes on even side of atomization chamber. Because these two holes are so small so that only very little and tiny water will pass through and at the same time also increase the water pressure for entering the atomization chamber to mix up with the high speed airflow and become a mist (moisturized air) called the first time atomization. The mist then passes through a very narrow path and exits the nozzle, then collide with the adjustable resonator head and finally spray out as the finest fog at ultrasonic speed called second atomization. The fog spray pattern can be adjusted as a vertical line or parabolic curve; adjust on the resonator screw to have the best pattern and smallest particle fog for entering the duct or air handling unit and be absorbed thoroughly by the airflow there and carry out into the spaces that needed humidification. At the second atomization, the fog particle diameter is less than 10 microns, see below FIG.5 reveals:

Average Particle Size Distribution **2001/6/21 13:46:05.4720 - 13:46:05.4980**
Valid Data Record
Material : water Lot : 1

Size (um)	% <	% in	Size (um)	% <	% in	Size (um)	% <	% in
0.287	0.01	0.01	4.56	7.92	1.86	72.33	100.00	0.00
0.330	0.02	0.01	5.23	10.72	2.80	83.06	100.00	0.00
0.378	0.05	0.03	6.01	14.45	3.73	95.37	100.00	0.00
0.435	0.11	0.05	6.90	19.38	4.93	109.51	100.00	0.00
0.499	0.20	0.09	7.92	25.66	6.28	125.74	100.00	0.00
0.573	0.32	0.13	9.10	32.80	7.15	144.38	100.00	0.00
0.658	0.43	0.10	10.44	41.00	8.19	165.79	100.00	0.00
0.755	0.47	0.05	11.99	50.46	9.46	190.37	100.00	0.00
0.867	0.53	0.05	13.77	58.94	8.48	218.59	100.00	0.00
0.996	0.67	0.14	15.81	67.47	8.53	250.98	100.00	0.00
1.14	0.78	0.11	18.16	75.06	7.59	288.20	100.00	0.00
1.31	0.93	0.14	20.85	81.64	6.59	330.92	100.00	0.00
1.51	1.11	0.18	23.94	87.07	5.42	379.98	100.00	0.00
1.73	1.35	0.25	27.49	91.24	4.17	436.31	100.00	0.00
1.99	1.68	0.33	31.56	94.41	3.17	500.98	100.00	0.00
2.28	2.05	0.36	36.24	96.68	2.28	575.26	100.00	0.00
2.62	2.55	0.50	41.61	98.38	1.69	660.54	100.00	0.00
3.01	3.36	0.81	47.78	99.53	1.15	758.46	100.00	0.00
3.46	4.46	1.11	54.86	99.93	0.41	870.89	100.00	0.00
3.97	5.96	1.50	63.00	100.00	0.07	1000.00	100.00	0.00

FIG. 5 Average Fog Particle Size Distribution
P_w=4kg/cm^2 , P_{air}=5kg/cm^2

FIG.5 shows the initial measured particle size distribution data; and use figures to

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

represent the particle size and percentage, the bigger the number the larger the particle diameter and percentage.

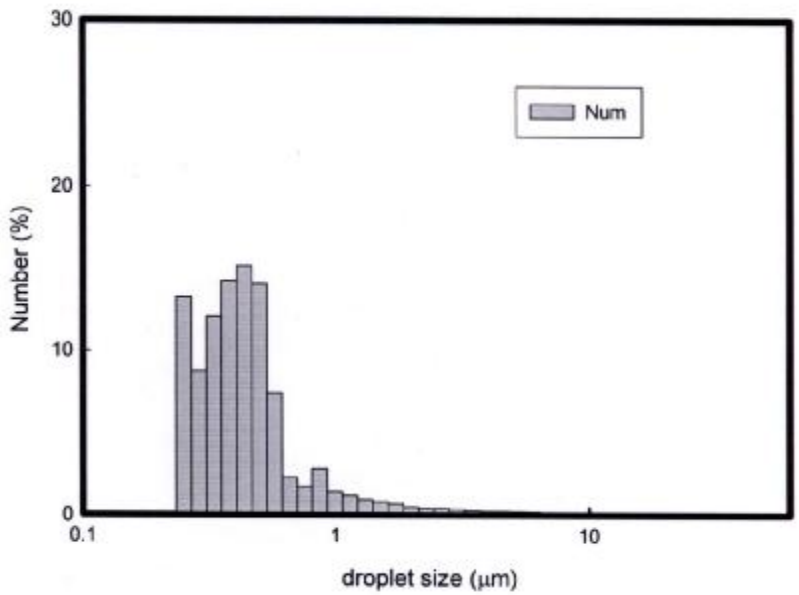
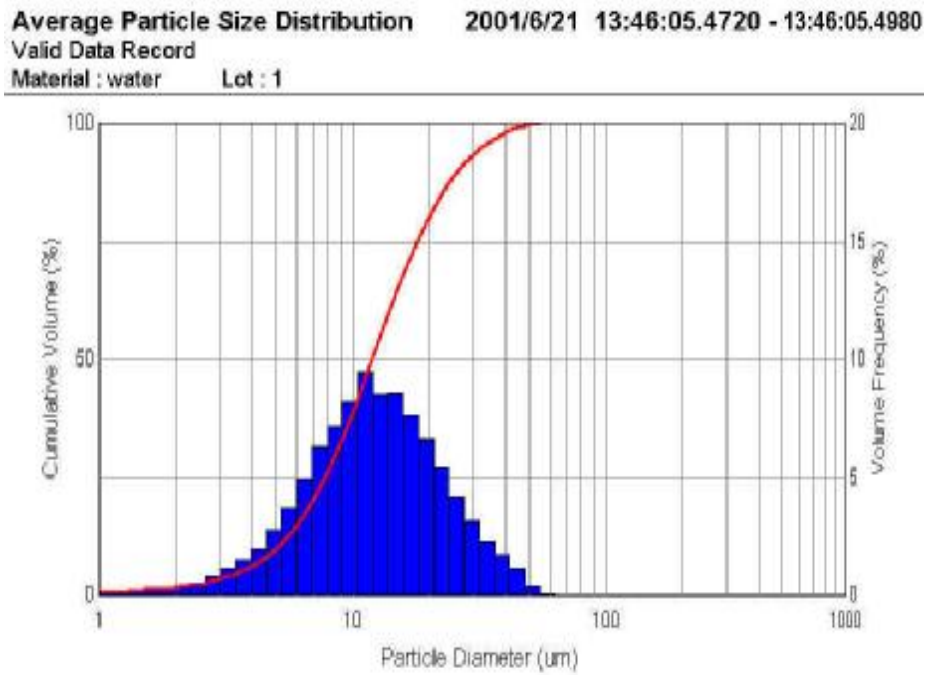


FIG. 6 Fog Particle Size & Number Distribution

P_w=4kg/cm^2 ， P_{air}=5kg/cm^2

FIG.6 shows most of the fog particle are well within the size of 0.1~1.0.



(SMD = 8.49 μm, D_v(50) = 11.9 μm)

FIG. 7 Fog Particle Size Distribution

P_w=4kg/cm^2 ， P_{air}=5kg/cm^2

FIG.7 shows D_{32} value of fog particle size distribution diagram. It tells the absorb

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

distance required for the humidification application.
D_{32} = (particle size)^3 ÷ (particle size)^2

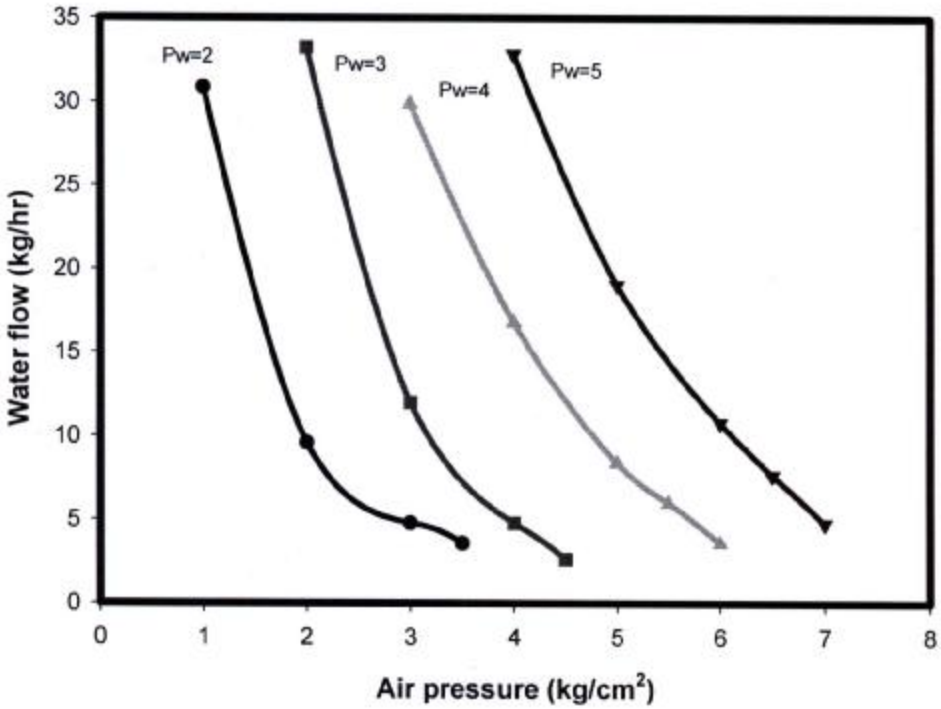


FIG. 8 Nozzle Water Flow vs. Water/Air Pressure Curve

FIG.8 shows the pressure curve of the nozzle under a given water flow rate with varied water pressure and air pressure. The test results conclude as below:

A. When water pressure is equal to air pressure: will have the biggest water flow rate, but fog quality is not good.
B. When water pressure is 1 kg/cm^{2}g higher than air pressure, will have the finest fog quality and moderate water flow rate.
C. When water pressure is 1.5 kg/cm^{2}g higher than air pressure, will have good fog quality but with very little water flow.

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

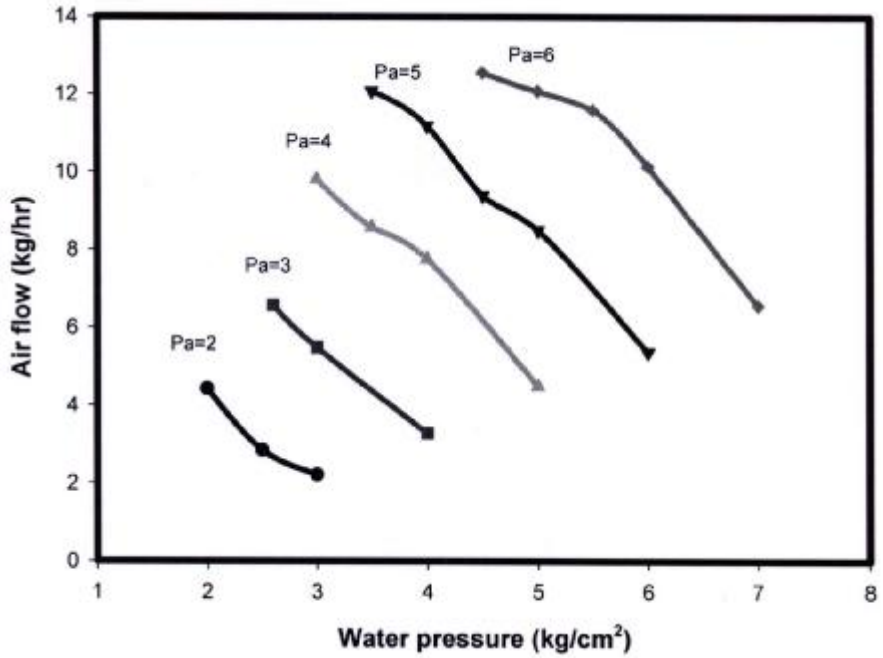


FIG. 9 Nozzle Air Flow vs. Water/Air Pressure Curve

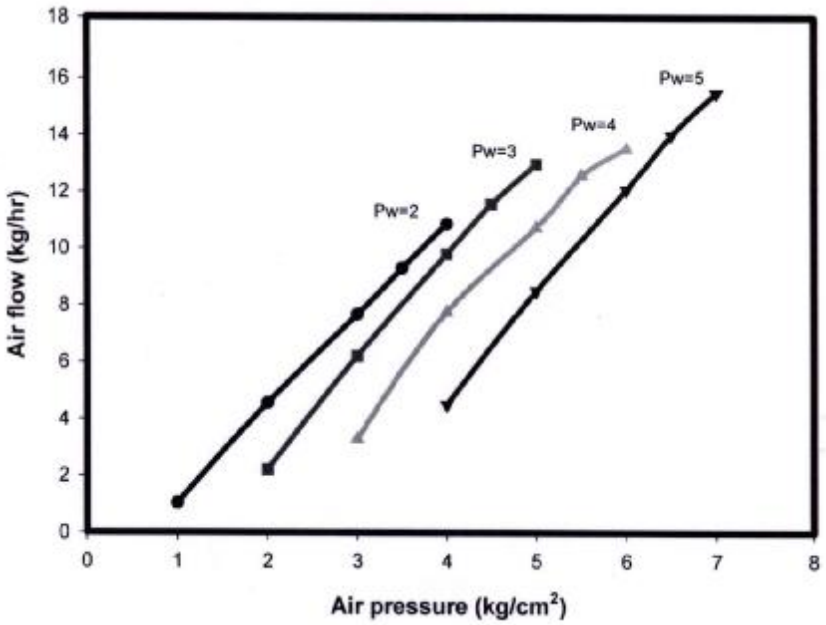


FIG. 10 Nozzle Air Pressure vs. Air Flow Curve

FIG.9 and FIG.10 show air consumption rate and water flow rates changes.

From FIG.8, 9, and 10, conclude as below:

A. The higher the water pressure, the lower the water flow rate.
B. When air pressure is 1 kg/cm^{2}g higher than water pressure, will get the best fog quality.
C. The higher the water pressure, the lower the air consumption.

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

FIG.11 Air Consumption Per Kilo Water

Unit: Liter/Hr

Water \ Air	2	3	4	5	6	6.5
2	118	1967				
3		152	1373			
4			145	976		
5				152	625	
6					193	346

Note: air unit = kg/cm^2 , water unit = kg/cm^2

FIG.12 Air Consumption Per Nozzle

Unit: Liter/Min.

Water \ Air	3 kg/cm^2	4 kg/cm^2	5 kg/cm^2	6 kg/cm^2
2 kg/cm^2	99			
3 kg/cm^2		127		
4 kg/cm^2			139	
5 kg/cm^2				156

Supply Water Requirement: city water must be filtered at least by 5*μ* filter or use RO/DI. RO/DI is recommended.

Supply Air Requirement: regular air must be filtered at least by 10*μ* air-filter.

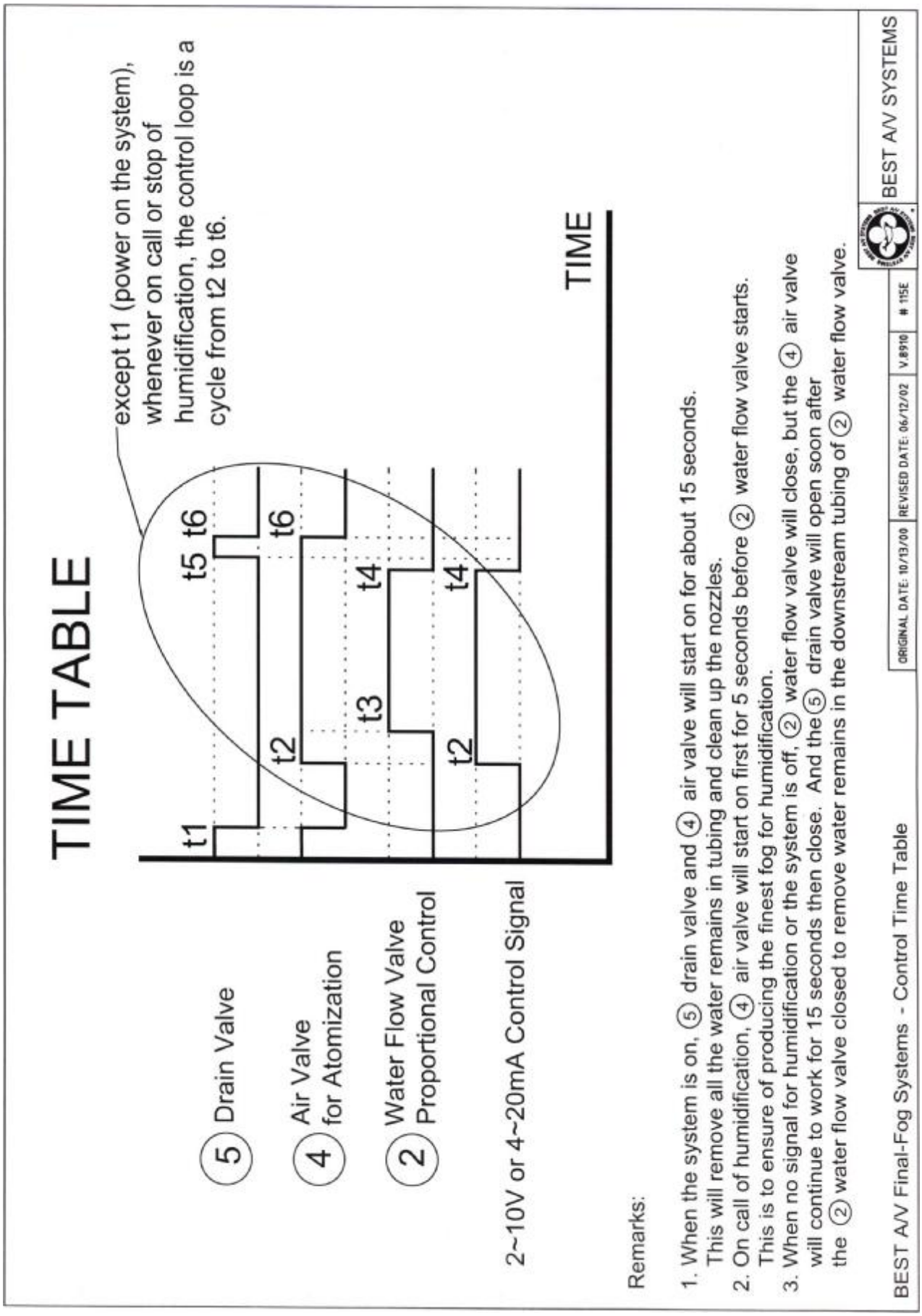
Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

OPERATING PROCEDURE

1. First turn on the main power inside the control cabinet, then from the outside of the control cabinet find the lightened switch and turn it clockwise to “1” position. The unit is then in auto-mode and will open the two valves on the manifold board for few seconds to remove any water remains in the tubing and nozzles and then the unit stays at stand-by mode.
2. When on call of humidification, the center control room sends 4.0~20mA or 2.0~10V proportional signal to start off the unit for humidification. The on-off air valve will open for few seconds, before the proportional water valve starts. The proportional water valve’s opening is depending on the need of humidification. The water flow through Flow-Through Auto-Proportional Differential Pressure Regulator, and the regulator will have the air pressure at a steady and higher pressure than water’s. Water and air come into nozzles separately and have the first atomization inside the nozzles, and when the mist (mixed air and water) come out the nozzles outlet and collide with the resonator, there the 2nd atomization taking place, and at last the fog spray out at ultra-sonic speed and with fine particle and much larger area for heat transfer. The fog is then being absorbed very fast and thoroughly by the air and increase the relative humidity of the airflow.
3. When fulfill the humidification requirement, the proportional water valve will close first, but the drain valve and air valve will continue to run for few second to remove the water remains in the tubing and nozzles before they both close at the same time.
4. Refer to above point 1 and 3, you will see that the water comes in later but goes first in operation. This unique design is to make sure of producing the smallest particle size and good quality fog for humidification.

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

FIG.13 BEST A/V Final-Fog : Control Time Table Diagram



Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

CONTROL CABINET : FEATURES AND FUNCTIONS

1. DDC controller: Direct Digital Control Unit, is programmable to be customized for specific need.
2. LCD display: User friendly. It clearly provides the current status in plain language and on four lines. Four quick-access keys for having direct access to a specific main menu.
3. Accepts 4.0~2.0mA or 2.0~10VAC.
4. Compatible with center control room. Excellent for remote control.
5. DDC controller receives signal for humidification, it then sends out order to air control valves and water control valve and have them reacting properly.
6. Proportional humidification: the E/P transducer transforms input signal 2~10V into 3~15psi output signal and to control over the proportional pneumatic control valve, so that to have proportional humidification.
7. On-off control on air: follow the application needs and provides compressed air just as needed.
8. Push-in fittings: quick and easy installation and disassembly.

Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

SPECIFICATION & SELECTION EXAMPLE

1. **Data required:**
   a. Dimension of AHU or DUCT
   b. Fresh air flow rate (inlet airflow)
   c. AHU or DUCT's supply airflow condition: relative humidity and temperature or dew point temperature (air before humidified)
   d. Desired airflow condition (room airflow): relative humidity and temperature.
   e. Supply water pressure
   f. Supply compressed air pressure
2. **Nozzle:** the max. Flow rate for per nozzle is 10 kg/hr. To determine the total of nozzles required for an application is having the humidity capacities required ÷ per nozzle capacity and then add 10%.
   For example: Total humidification needed: 150 kg/hr
   Total nozzles needed = (150 kg/hr ÷ 10 kg/hr)*1.1 = 17 nozzles
3. **Manifold:** per manifold can handle max. 25 nozzles for better fog result. If an application needs a total of 18 nozzles, then divide it by 25 and round off the figure, you get 1 for the total number of manifold required for the application.
4. **Absorb distance:** the straight distance between the nozzles to the first object the fog touch is called Absorb Distance. It allows the fog to travel and be absorbed completely and thoroughly by the air without condensate. The absorb distance is determined by the airflow velocity and required relative humidity. The higher relative humidity required, the longer the absorb distance would be. If the absorb distance is shorter than required the fog would condensate and the most it can not increase the air's relative humidity to meeting customer's need.
5. **Spacing for nozzles:** nozzles shall be evenly spaced and shall follow below spaces requirement to preventing condensate and having satisfactory humidification.
   a. Min. space between nozzles: 300 mm
   b. Min. space between nozzles and floor ground: 600 mm
   c. Min. space between nozzles and ceiling of AHU/DUCT: 400 mm
6. **Supply water:** city water must be filtered at least by 5μ filter or use RO/DI water. RO or DI water is recommended. The total required water flow rate is the sum of nozzles' flow capacity.
7. **Supply air:** regular air must be filtered at least by 10μ air-filter. The total required airflow rate is the sum of nozzles' flow capacity.
8. **Humidity capacity sizing & selection:** see below example
   a. Condition:

- AHU size: 3700mm(H) x 3000mm(W) = 3.7M x 3.0M = 11.1 M^2
- 100% fresh air (inlet airflow):100,000 m^3/hr @ -5℃db & -℃wb, see point **A** on below "Psychrometric Chart"
- Required room air condition (room airflow): @21℃& 45%RH, see point **B** on below "Psychrometric Chart"
- Preheated air condition: @27.2℃, see point **C** on below "Psychrometric Chart"
- AHU Supply airflow condition: @ 16℃, see point **D** on below "Psychrometric Chart"

Sate Point	℃db Dry Bulb	℃wb Wet Bulb	℃dp Dew Point	%RH Relative Humidity	Kg_w/kg_a Humidity Ratio	m^3/kg Specific Volume	Kj/kg Enthalpy
A	-5.00	-5.00	-4.83	100	0.00251	0.76	1.26
B	21.00	13.85	8.57	45	0.00698	0.84	38.72
C	27.20	11.92	-5.00	11.24	0.00251	0.85	33.60
D	16.00	11.85	8.57	61.58	0.00698	0.83	33.66

- Supply water pressure: 4 kg/cm^2
- Supply air pressure: 6 kg/cm^2

b. Refer to below "Psychrometric Chart", find **A point for inlet airflow** @-5℃DB & -5℃WB, and from A we get **0.00251 kg_w/kg_a** for humidity ratio and **0.76 m^3/kg_a** specific volume.

c. Refer to below "Psychrometric Chart", find **B point for Room Airflow** @21℃ @45%RH, we get **0.00698 kg_w/kg_a** for humidity ratio.

d. **The difference humidity ratio of A and B:**
= 0.00698 kg_w/kg_a - 0.00251 kg_w/kg_a = **0.00447 kg_w/kg_a**

e. **Humidity capacity required:** it's 100% fresh air flow rate divided by the average of A's and D's specific volume, then multiply by the difference of A's and B's humidity ratio, i.e.
= 100,000 m3/hr ÷ ((0.76+0.83)÷2) m^3/kg_a × 0.00447 kg_w/kg_a
= 100,000 m3/hr ÷ 0.795 m^3/kg_a × 0.00447 kg_w/kg_a
= 562.26 kg/hr

f. **Total nozzles required:** have humidity capacity divided by per nozzle's water flow rate (per nozzle water flow rate =10 kg/hr), then plus 10% nozzles
= (562.26 kg/hr ÷ 10 kg/hr) x 1.1
= 56 nozzles x 1.1 = 62 nozzles

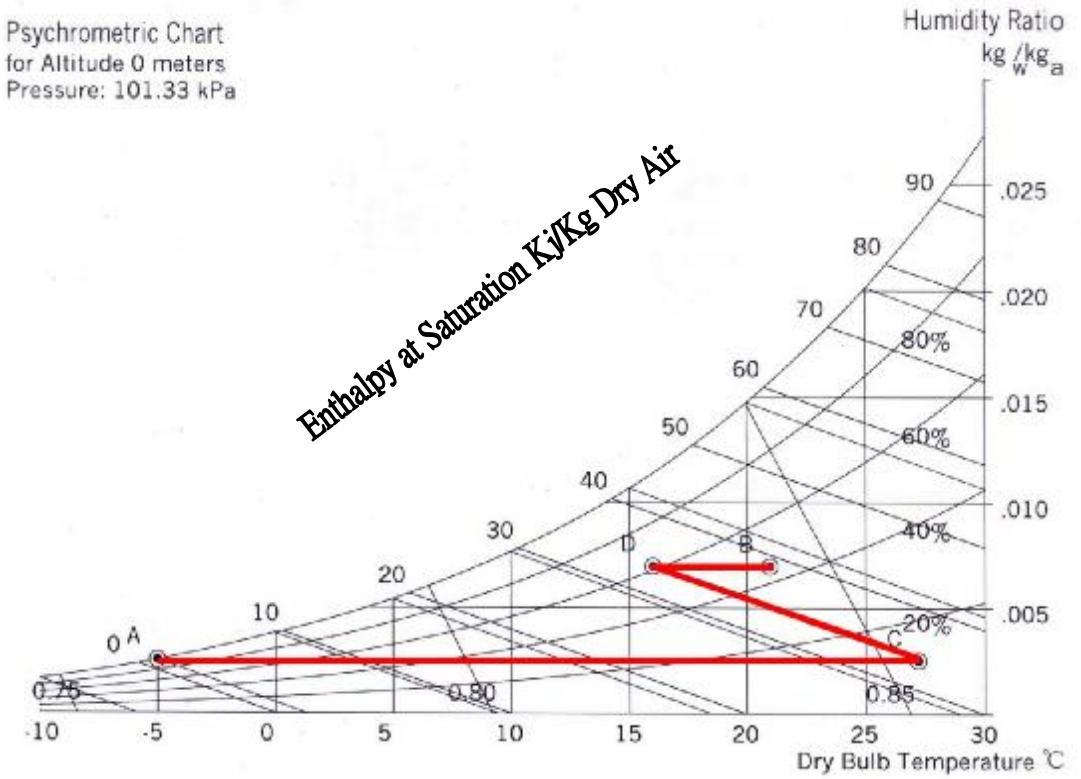
g. **Max. air consumption:** the supply water pressure is 4 kg/cm^2 , so we refer to Fig.12 and select 4 kg/cm^2 for water pressure and 5 kg/cm^2 for air pressure, we get 139 Liter/Min. and the max. compressed air needed is 62 nozzles x 139

Liter/Min.
= 8618 Liter/Min.
Note: the differential regulator automatically control and maintain the air pressure at 1 kg kg/cm^2 higher than water pressure.

h. **Absorb distance required:**

Convert the Inlet airflow velocity unit from m^3/hr to m/s
= (100,000m^3/hr÷60÷60)÷(11.1M^2)= 2.5 m/s
Refer to below diagram "Absorb Distance for Fog System", find 2.5 m/s on the left side for air velocity and from there draw a horizontal line to the right till reach with line of 61.58%RH (AHU Supply airflow relative humidity, point D on "Psychrometric Chart"). We get 1.62 M, then add 10% for absorb distance.
= 1.62 M x 1.1
= 1.78 M

Psychrometric Chart

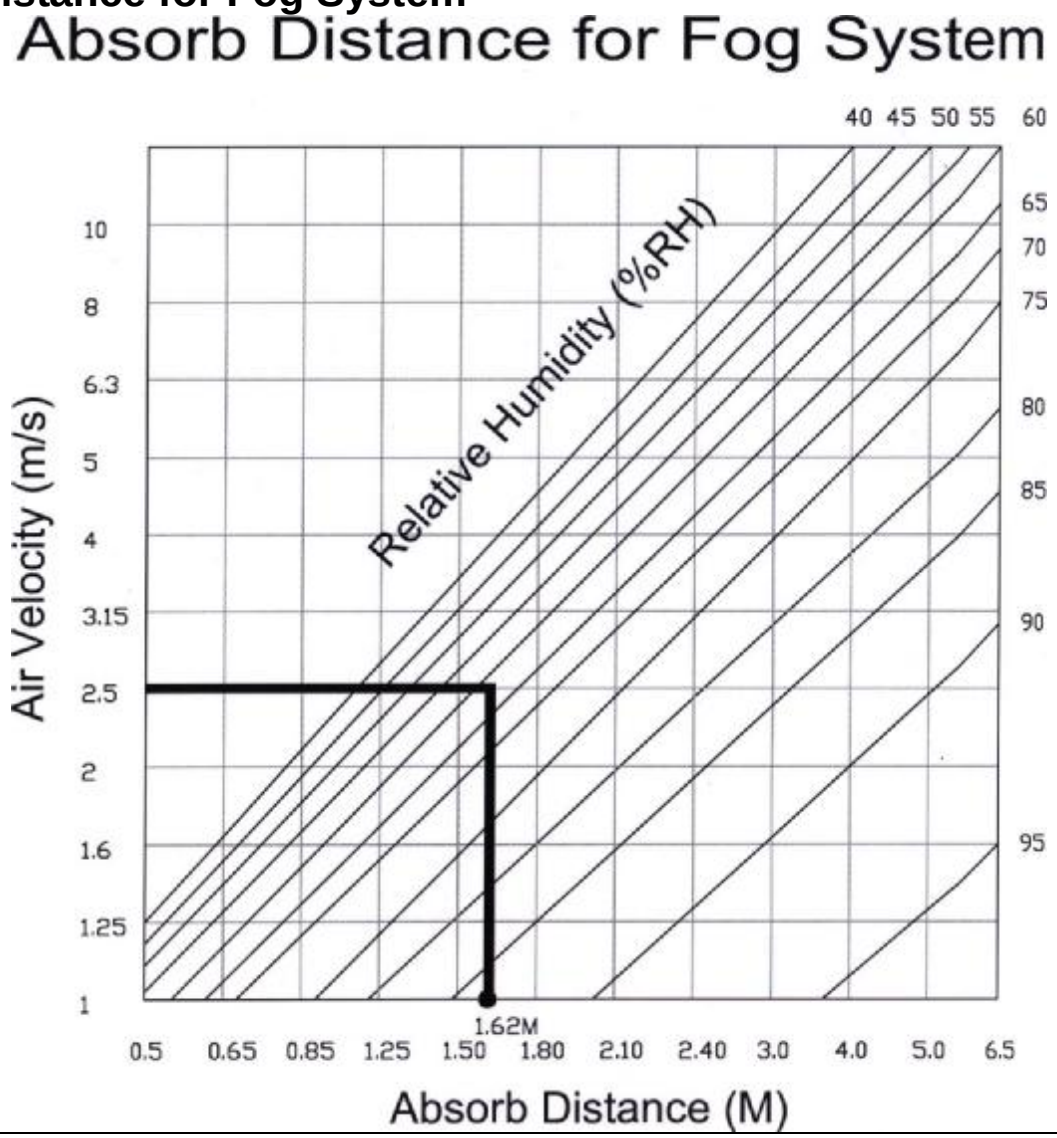


State Point Data

State Point	Dry Bulb ℃db	Wet Bulb ℃wb	Dew Point ℃dp	Relative Humidity %RH	Humidity Ratio kgw/kga	Specific Volume m^3/kg	Enthalpy kJ/kg
A	-5.00	-5.00	-4.83	100.00	0.00251	0.76	1.26
B	21.00	13.85	8.57	45.00	0.00698	0.84	38.72
C	27.20	11.92	-5.00	11.24	0.00251	0.85	33.60
D	16.00	11.85	8.57	61.58	0.00698	0.83	33.66

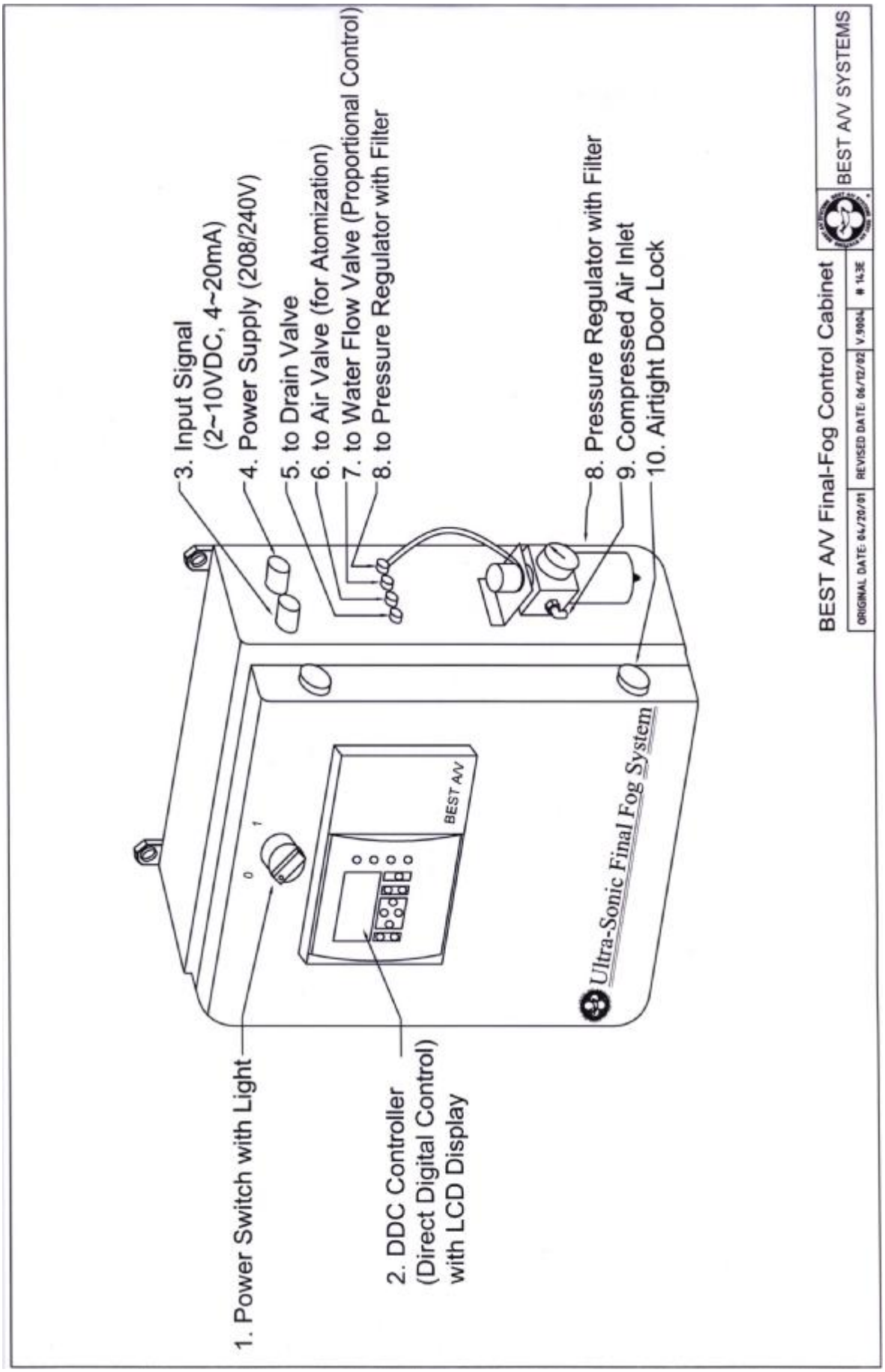
Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

Absorb Distance for Fog System



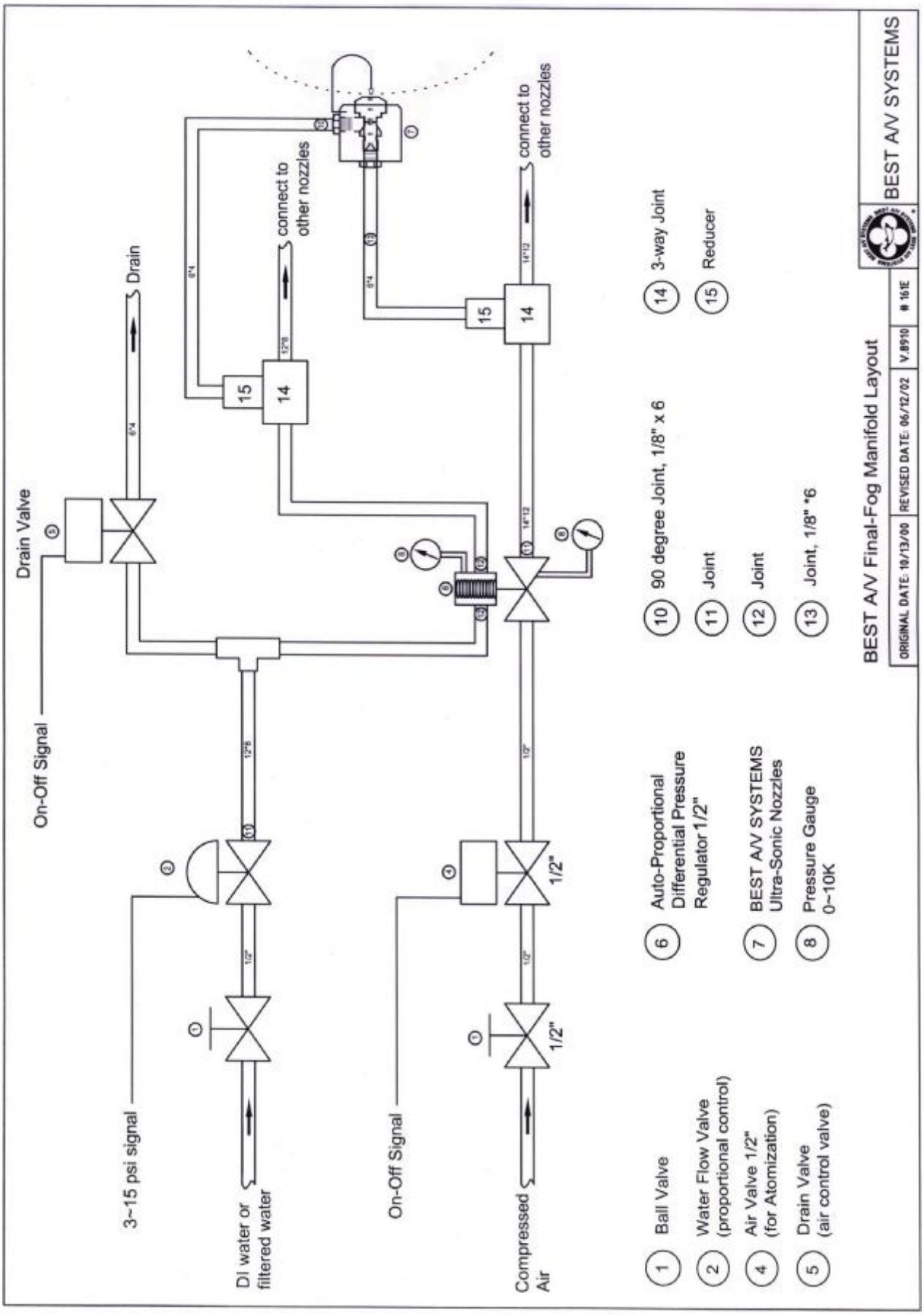
Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

FIG.14 BEST A/V FINAL-FOG : Control Cabinet



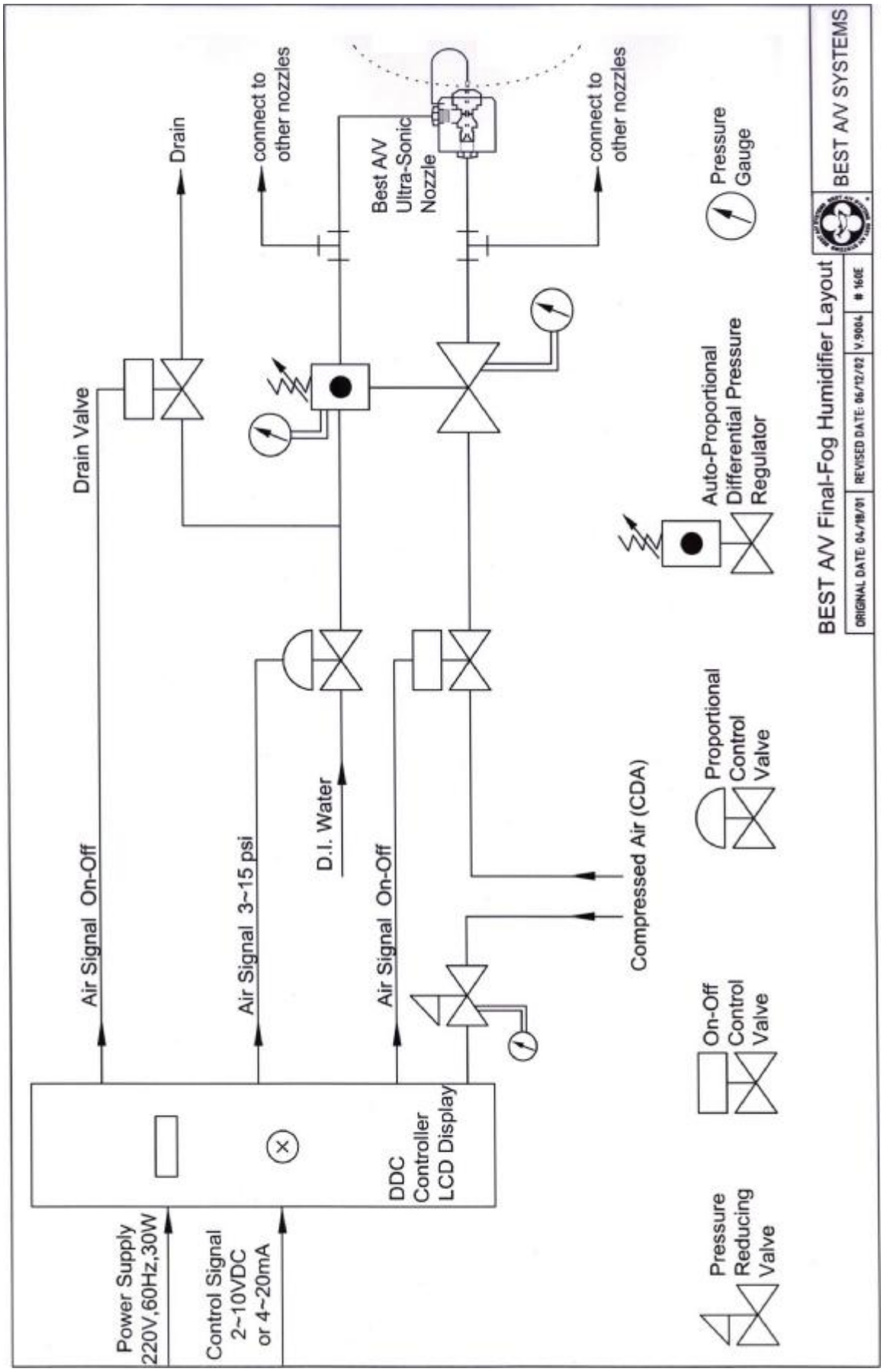
Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

FIG.15 BEST A/V FINAL-FOG : Manifold Layout



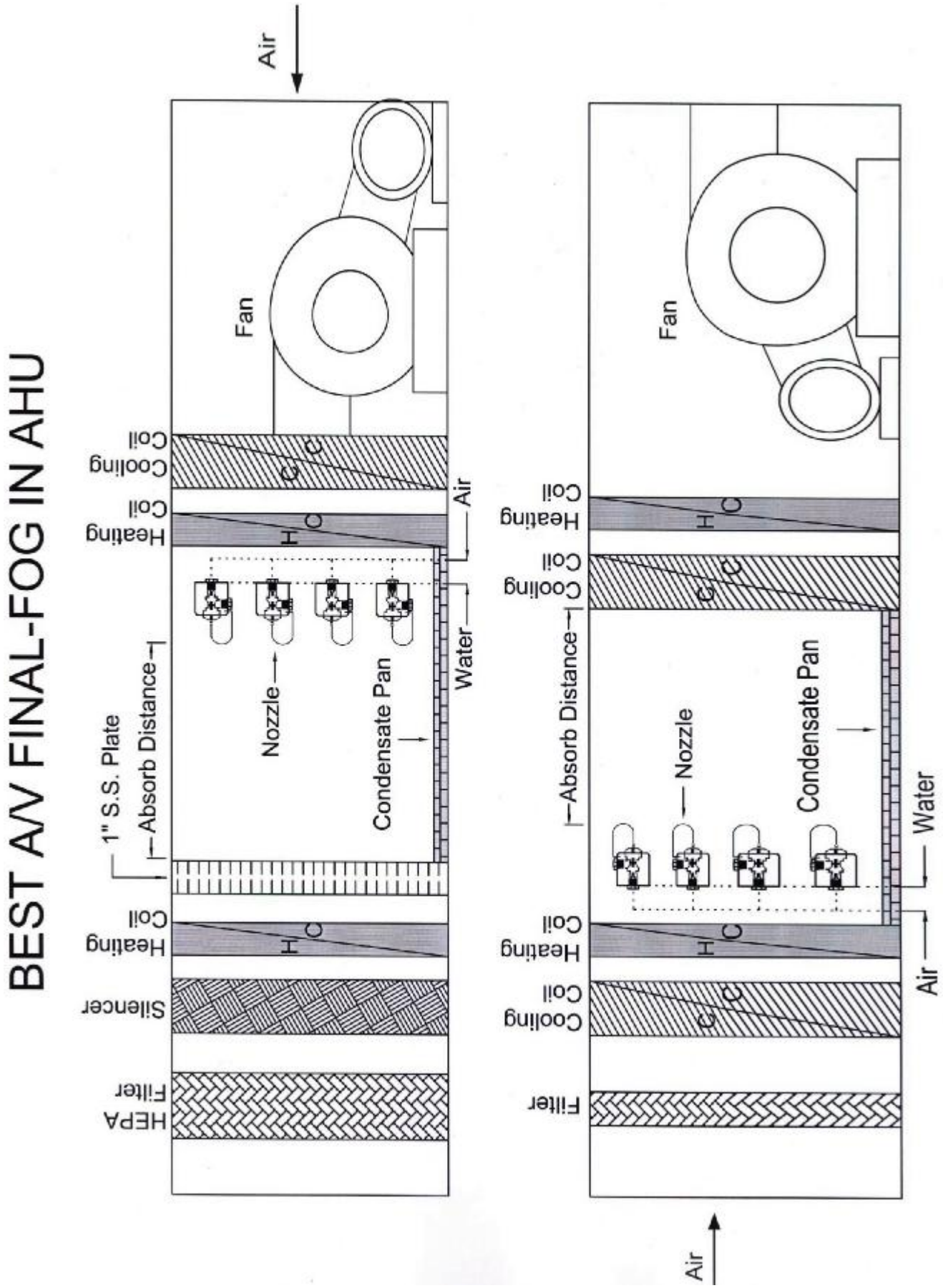
Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

FIG.16 BEST A/V FINAL-FOG HUMIDIFIER LAYOUT



Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

FIG.16 BEST A/V FINAL-FOG HUMIDIFIER IN AHU



Tel. +886-2-2657-6518
Fax. +886-2-2657-6522
E-mail: hlckeng@ms51.hinet.net

HOW TO SPECIFY FINAL-FOG SYSTEM

1. The fog system shall be with
   a. Direct Digital Controller with LCD digital display/monitor
   b. Proportional control: auto or manual control (dual control)
   c. Resonator: Slop-and-flat headed Resonator.
   d. Manifold for nozzles: includes Flow-Through Auto-Proportional Differential Pressure Regulator、control valves for water and air、check valve、pressure gauge...etc.
   e. 304 S.S. supporting bar for nozzles.
2. Shall accept 4.0~20mA or 2.0~10V input signal.
3. Shall be able to have proportional control of humidity output.
4. Fog's average particle size in SMD (D_{32}) shall be equal or less than 10 microns (10 μm).
5. All wetted parts shall be of plastic materials or corrosion-resistance materials to prevent rust.
6. Resonator shall have adjustable screw to fixing the biggest fog pattern, smallest particle size, and largest heat-transfer area for high quality and better humidification result.
7. Resonator and Nozzles shall be disassembling for cleaning and maintenance.
8. Direct Digital Controller shall
   a. Have proportional control on humidification.
   b. Have time-delay control on air and water devices.
   c. Automatically remove the water remains in the tubing and clean the nozzles whenever the fog system unit starts or stops (main power).
   d. Have push-in fittings between nozzles and manifold/s for quick installation and easy maintenance.
9. Supply water pressure shall be 2~5 kg/cm^2. And supply water shall be filtered by 5*u* filter or use RO/DI.