

KNOW YOUR

AIR ENGINEERING

SYSTEM



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1.0

OUR INTRODUCTION



1.1 GENERAL INFORMATION

- 1.1.1 **Name** : **PACK PLAST INDUSTRIES**
- 1.1.2 **H.O. Address** : F – 198,
I.P.I.A., Kota – 324005
(Rajasthan)INDIA
- 1.1.3 **Telephone** : (0744) 2422144/45, 6450875
- 1.1.4 **Fax** : (0744) 2422145
- 1.1.5 **Gram** : EXTRUSHAPE
- 1.1.6 **E-mail** : info@packplast.com
- 1.1.8 **Web Site** : www.packplast.com
- 1.1.9 **Location** : Kota is situated on Western Railway in between
Bombay and Delhi, on bank of river Chambal.
- 1.1.10 **Our Bankers** : State Bank of Bikaner and Jaipur
State Bank of India



1.2. TECHNICAL BIO – DATA

1.2.1 Technical Staff:

Name	Qualification	Experience
Mr. Atul Shourie	B.E. (Elect)	30 Years
Mr. Anuj Shourie	B. E. (Comp. Sc.)	5 Years
Mr. Manu Gupta	B.E. (Mech.)	15 Years
Mr. B. Majumdar	AIME (Mech.)	35 years
Mr. R.K. Manoja	AMIE (Mech)	35 years
Mr. S.N. Rathore	AIME (Mech.)	20 Years

Technical Advisor

Dr. D. Gupta	M.E. (Mech.), PHD	25 Years experience in Evaporative Cooling
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Marketing and Sales Team

Saurabh Shourie	MBA (Marketing and Finance)	7 Years
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1.2.2 Production Capacities

Plastic Processing:

Extrusion	500 MT/Annum
Molding	100 MT/Annum
Fabrication	200 MT/Annum

Misc. Fabrication:

700 MT/Annum

Centrifugal Fans' Range (CMH)

1,000 to 2,00,000

1.2.3 ISO 9001 – 2009

Awarded

1.2.4 Year Production Commenced

1979



1.3 RECENT EXECUTIONS

	Order Value (in Rs. Lacs)
1.3.1 Export Turn Key Job	
M/s A.I.T.C. Ltd. Bangkok	90.00
M/s Sunflag (Thailand) Ltd., Bangkok	80.00
1.3.2 The Department of Atomic Energy	
The Heavy Water Board, HWAC Project, Rawatbhata Emergency Air Decontamination System	92.00
1.3.3 RAPS (Rajasthan Atomic Power Station)	
Design, Manufacture, Supply, Erection, Testing & Commissioning of AIR WASHER	53.00
1.3.4 Hindustan Aeronautics Ltd.	
Air Ventilation System for Engine Division	68.00
1.3.5 RAPS (Rajasthan Atomic Power Station)	70.00
Supply, Fabrication, Erection & Commissioning of FDB & associated Ducting	

1.4 MANUFACTURING ACTIVITIES

Unlike other companies in India who procure parts from several manufactures
WE MANUFACTURE EACH & EVERY PART USED IN AIR ENGINEERING SYSTEM. Our list of products is also enclosed herewith.

1.5 SALES AND SERVICE FACILITIES

Our organization is very particular about after sales service. We have qualified field staff at Kota and we would always be available to provide services at short notice.



2.0

A NOTE FOR TOP MANAGEMENT



2.1 AIR ENGINEERING IN TEXTILE INDUSTRY – A NOTE

Humidification process is a must for textile industry right from yarn to weaving. Although the importance of maintenance of proper relative humidity in different section of entire process is well known to everyone from supervisor to President, it is rare that we find the proper measurement of Relative Humidity.

As is well known Humidification Process is a power guzzler. It has always been the source of Energy Conservation and a whip in hands of top management to beat engineering department. To avoid being a scapegoat the engineering department has skillfully evolved methods to show its efficiency at the cost of performance of system.

The first basic change that has been prevalent for years are locations of measurement of Relative Humidity. The wall-mounted instrument is placed in alleys where there is no heat load, thus showing desired R/H at low power consumption. **BUT THIS IS NOT THE LOCATION WHERE CONDITIONED AIR IS REQUIRED.** Proper R/H is required where the material is being processed.

Yarn manufacturing machines have length of app. 21 mtr. (70 ft.) and the heat load also varies from tail end to head. For quality product to be manufactured the R/H should be constant over entire length of machine.

All these considerations should be taken into account by management and should give free hand to engineering department to achieve these.

Only under above parameters can quality product be manufactured.

In our opinion if desired R/H levels at every stage of yarn manufacturing are provided there is no need for yarn conditioning process which involves high capital cost [Indigenous yarn conditioning equipment cost nearly Rs.50 Lacs) as also involves power wastage by way of steam induction. May it be pointed out here that these process can only add 1 to 2% moisture content in yarn, meaning if your viscous yarn has 8%, it can increase to 10% but can not increase to 13% which is standard norm. Use of Humidifiers in packing department can only achieve superficial increase in yarn moisture content. Penetration to innermost core of bobbin is not possible.

IT IS THEREFORE OF UTMOST IMPROTANCE [if quality product is desired] THAT R/H BE MEASURED AT PROCESS LEVEL AND NOT IN ALLIES.

There can be as high as 20% error in readings at these two locations. For example in post spinning if desired level is 65% RH and the wall mounted instrument in alley is showing 65% the actual R/H at machine process location may be only 55% or even less.



There are many other ways by which engineering department can mislead the production people. A simple ploy is adjusting DBT & WBT thermometer to show higher R/H increase of 10 higher WBT, which can increase R/H by 3%.

There are but many ways and it's beyond scope of this short not to cover all.

Basically its managements duty to take engineering department in confidence, have a proper rapport up to Humidification Plant operator so that proper department conditions are achieved and quality product in the mill is manufactured.

To reduce cost of Humidification/Energy Conservation expert should be called in or the Plant supplier **SHOULD BE FIRST ASKED TO SPECIFY ENERGY COST PER KG. OF YARN, INSTALLED LOAD as also ABSORBED LOAD. THE ONUS OF PROVIDING DATA UNDER PEAK LOAD OR FAOURABLE AMBIENT CONDITION SHOULD ALSO BE TO PLANT SUPPLIERS ACCOUNT.**



2.2 MODERN UTILITY SYSTEM

Modernisation is the hub of activity in every industry today. As our country is lacking in technology, our industrialists always look toward European, American or Japanese technology for up gradation.

Now although importing high productions machines is a sound idea, copying utility requirements is not.

High tech nations are mostly cold countries having very strict environment as also work conditions regulations. It is not very practical to adopt same practices in India.

In particular if we look towards utilities in textile industries we have following branches to cater to: -

1. Humidification Plants.
2. Air Compressors.
3. Lighting.
4. Waste collection etc.

Humidification Plants are the most energy consuming utility in textile industry hence we shall focus our attention to this part first: -

Textile process subjects the fibre to heating, pulling, drawing twisting etc. Which cause: -

- Breakage of fibre
- Development of static electricity.
- Generation of fluff.
- Generation of Dust & Heat.

Man and machine efficiency would get lowered if these factors were allowed to prevail. Proper Humidity levels increase strength of fibre, lower static electricity, lower heat levels by evaporation and settles the fluff and dust in the air.

Following temperature and Humidity levels are required for smooth operations:

DEPARTMENT	TEMPERATURE	HUMIDITY
BLOW ROOM	32 to 35	65 ± 5
SPINNING PREPARATORY	32 to 35	55 ± 3
SPINNING	32 to 35	60 ± 5
WEAVING PREPARATORY	32 to 35	65 ± 5
WEAVING	32 to 35	80 ± 5



Paper presented at Energy Conservation Seminar held at Kolhapur

It is observed from above table that nowhere the temperature levels are below 30°C. Hence we should keep in mind that textile industry does not require Air Conditioning with reference to temperature, Evaporative Air Cooling due to Humidification process is generally sufficient to manage the temperature conditions. Relative Humidity is the core parameter, which is desired round the year. Hence this aspect should be critically followed.

It can be mentioned here that Hybrid Cooling using heat exchanger in tendon with cooling tower can reduce temperature by 2-3°C if Human comfort angle is to be considered.

In Modern Mills it is found that huge energy is wasted in controlling temperature. We tend to forget that the imported machines are specified to run at 20 °C because ambient conditions at machine origin may go below even zero °C. Hence they try to keep their energy bill to lowest levels by keeping, minimum temperatures required for textile process. Following table gives energy consumption in Humidification and Air conditioning: (U/Kg)

PROCESS	MODERN MILLS	PARTIALLY MODERN MILLS
HUMIDIFICATION	1.07	0.54
TEMPERATURE CONDITIONING	1.29	N.A.
TOTAL	2.36	0.54

It is obvious here that partially modern mill stand to gain 1.82 U/kg.

For a 25,000 spindle unit the saving can be translated to Rs.60,000 per day @ Rs. 3.5/Unit. An annual saving of approximately Rs.2 crore can be envisaged.

All microprocessor based machines can work easily up to 35°C hence there is no limitations from production side. If finer counts are desired for export purposes, it is basically the production machine, which must be most modern rather than utilities.

Partially modern utilities can achieve the perfection in conditions required in work hall. For very rough yarn even the old conventional system of utilities can be adopted where U/kg is only 0.24.

In short, when a spinning unit project is undertaken more stress should be laid on textile machines for production of end product. Utilities should be kept at conventional type or maximum partially modern type.



We may specify conventional, partially modern and Modern utilities as under: -

Conventional Utilities:

Under this head we have those utilities where auto controls are not available. The Return Air filtration system is limited to stationary V filters. Waste collection systems etc. are not included. Air washers are of old design having metal parts and totally dependent on work skill of manpower. Temperature inside depends on ambient conditions.

Partially Modern Utilities:

Condition in these utilities, controls of humidity is achieved by Humidistat and Air Flow quantity. Dampers are manually operated. Instead of V filters, low Energy consuming scrubber system is used. Water treatment is adopted. Plastic parts are used in Air Washer for long life and efficient working. Temperature inside depends on ambient conditions.

Modern Utilities:

The modern utilities totally depend on Auto Controls. In addition to control of Humidity, temperature controls are also available. Air Washer has chilled water. The air mixing is by auto-controlled dampers. Fluff control is by Rotary Air Filters and total waste collection system in all departments is adopted.

The energy consumption in different set up is as under: (U/kg. for 40 count yarn production)

S. No.	Utilities	Modern Mill	Partially Modern	Conventional
1.	Air conditioning extra for cooling	1.29	N.A.	N.A.
2.	Humidification	1.07	0.54	0.29
3.	Air Compressor	0.43	0.27	0.04
4.	Lighting	0.16	0.21	0.15
5.	Waste Collection & others	0.69	N.A.	N.A.
	Total 1 to 5	3.64	1.02	0.48

It is obvious from above that Modern Mill Utilities is not at all beneficial for any common count yarn production-spinning unit. The very high-energy cost can only be absorbed by spinning units manufacturing very fine, very costly grade yarn. The Chief Executive Officer, project consultants should always ask vendors to submit energy profile of utilities being procured.

In present competitive market only those companies can survive who are energy conscious.



3.0

O U R S Y S T E M S



3.1 AIR HUMIDIFICATION SYSTEM

Where air is to be conditioned with primary consideration of levels of Relative Humidity in department Humidification Plants are installed.

Following industries require these plants:

1. Textile Industries
2. Tobacco
3. Bakeries
4. Fruit vegetable temperature storage
5. Breweries

The system essentially is dependent on **Evaporative Cooling**. Air with low R/H is passed through Spray Chamber having water at WBT **No change in Enthalpy is** [wet bulb temperature] envisaged. To control the system Fresh Air, Return Air and Exhaust Air Dampers are provided. The temperature in department always remains above WBT.

A cut view showing basic inputs of Air Washer are enclosed.

Mist Eliminators are provided in path of exiting air to entrap large particles of water as also remove dust/fiber and clean the air.

Enclosed data sheet gives parameters required to design Humidification Plant.



3.1.1 REQUIRED DATA FOR HUMIDIFICATION PLANT DESIGN

Machine Loadkw
Load Factorkw
Lighting Load
Type of Roof
False Ceiling Yes/No.
False Ceiling InsulationThickness in mm with insulating material

Space to be contioned
Lengthmeters
Widthmeters
Heightmeters

Material of wall
Thickness of plaster on wallmm
Doors & Windowsmm
OccupancyPersons

Outside amblient conditions
A. Summer(Max.)
Dry bulb temp. °C
Wet bulb temp. °C
B. Winter (Min.)
Dry bulb temp °C
Wet bulb temp. °C

RH required inside%±

Plan of space to be conditioned may be enclosed with dimensions and lay out of machines



3.1.2 GENERAL INFORMATION REQUIRED FOR SUBMITTING QUOTATION

Site
Town
Nearest City
Approach
Communication Tel :
 Fax :
 STD Code:
Manufacturing Activity
Capacity
Ambient Condition DBT WBT
Summer
Winter
Input power (Electrical) available at site

DATA TO BE PROVIDED FOR DESIGNING THE H&V PLANT

	Blow Room	Preparatory	Ring Frame	Finishing
Length (m)				
Width (m)	-	-	-	-
Area (m ²)	-	-	-	-
Height (m)	-	-	-	-
Volume (m ³)	-	-	-	-
Machine Load	-	-	-	-
HP	-	-	-	-
KW				
Lighting Load (KW)	-	-	-	-
Occupancy	-	-	-	-
Type of Roofing	-	-	-	-
False Ceiling	-	-	-	-
RH Required inside the working space	-	-	-	-



3.2 AIR VENTILATION SYSTEM

Ventilation is one of the primary requirements in industries viz. chemical, paints, pharma and varnishes or other similar category industry. Ventilation may also be required for other area based on needed nature.

Normal ventilation for area of general use may be sufficient through natural means only i.e. without use of any exhaust or ventilation system. On the contrary for areas used for special purpose viz. Chemical industries, Pharmaceutical, Paints & Varnish industries, etc.

Proper ventilation may only be achieved through properly designed ventilation system (Forced Draught Ventilation System) so that the need is fulfilled with reasonable minimum capital as well running expenses.

An over capacity designed system may disrupt the work and a lower capacity designed system would not fulfill the requirement. The purpose of Force Draught Ventilation System is to remove foul air, fumes from the working area.

A Forced Draught Ventilation System may require having any or all of the following components (Items) depending upon the nature of need:

- 1. Fan** Of requisite flow capacity and operating pressure.
- 2. Ducts** For removal of foul air/fumes in a controlled manner without their spreading in the working space.
- 3. Filters** To arrest/entrap the suspended particles from the air.

Depending upon the nature of need the system is to be properly designed and the required components are carefully selected keeping the following aspects in view:

- Type of anticorrosive protection needed.
- Type of filtration system required.

Ventilation is sometimes not given the due importance and the result is low production and hazardous working environment.

Mainly in the following process areas proper and well-balanced ventilation is indispensable:

- 1) Chemical
- 2) Pharma
- 3) Paint & Varnishes
- 4) Metal Finishing
- 5) Casting
- 6) Glass
- 7) Forging
- 8) Plastics



3.3 SELF CONTAINED PACKAGE TYPE SYSTEM

Sometimes it becomes quite expensive to have a conventional type H & V Plant when the air quantity to be handled is in the range of 35,000 CMH to 75000 CMH only due to much civil work being involved. In such cases the most suitable substitute is SELF CONTAINED PACKAGE TYPE HUMIDIFICATION PLANT.

The other ADDED ADVANTAGE WITH SELF CONTAINED HUMIDIFICATION PLANT IS THAT IT CAN BE SHIFTED FROM ONE PLACE TO ANOTHER. The only civil work involved is construction of plat -form for Humidification Plant.

We at **PACK PLAST** have designed and developed “SELF CONTAINED PACKAGE TYPE HUMIDIFICATION PLANT” which has no parallel to it.

Plant Housing is made out of suitable size MS angles, MS sheet etc. duly coated with rubber paint inside and painted on outside. Rest components excluding RETURN AIR, FAN & MOTOR and also AFS are as that of conventional type Humidification & Ventilation Plants. The plant would be provided with Electrical Panel consisting of main switched, starter of standard make. The plant would also be provided with watertight bulkhead fittings, light control switches and 3 pins 5 amp. Socket suitable for operation on 230 V, 50 Hz, and Single-phase supply.



3.4 AUTO RETURN AIR CLEANSER

In every Textile Industry Humidification or Air Conditioning System requires a proper air filtration device so as to have circulation of clean air in the department.

One of the major menaces in textile industry airflow system is fluff. Fluff / lint suspended in air is a normal feature in almost all textile units, which do not filter return air properly.

Although requisite air flow is a must for textile units to maintain relative humidity the efficiency of air flow system is not, in most of the cases, given due consideration. In most Units the airflow efficiency is **NOT EVEN 50%** (based on our experience at various units), thereby resulting in wastage of capital investment as well as energy, not to talk of poor end product quality.

When we talk of air circulation we mean supply or fresh air, which mixes with return air coming from department and entering Humidification Plant. This air then flows and diffuses in the department through ducts. The blockade in air passage (i.e. return air duct) caused due to deposition of fluff on filter media is most probably ignored and under the conditions availability of air quantity is drastically reduced. Axial Flow Fans consume same or higher energy for reduced air quantity resulting in huge energy losses.

With due consideration to this problem and inherent draw backs related to Rotary Air Filter and Stationary “V” filter we at **PACK PLAST** after sufficient R & D exercise have developed **AUTO RETURN AIR CLEANSER** which over comes the problems related with Rotary Air Filter and “V” Type Stationary Filter.

Our **Auto Return Air Cleanser** (ARAC) is a properly designed & balanced device to automatically remove fluff at a slow and continuous rate, so that fluff is not converted into small particles, which may mix in the air.

The ARAC is simple in mechanism which offers long trouble free service eliminating the complex fluff problem and minimize the energy wastage due to filter choking partially or fully.



It has been observed that energy consumption increases, to the tune of 30-40% with respect to rated consumption if filter media is unclean.

For example a 50,000 CMH capacity plant, (having 10 HP S/A Fan and 7.5 HP R/A Fan) can waste energy worth Rs. 1,00,000 approx. per annum if it is run with choked R.A. filter. Also the required conditions in department may not be maintained with set parameters.

3.4.1 COMPARISON CHART

AUTO RETURN AIR CLEANSER	ROTARY AIR FILTER	STATIONARY “V” FILTER
Power consumption very low	Power consumption high	Nil
Needs hardly 1 feet depth	Needs very large space.	Needs at least 3 ft. depth
Simple rotary drive.	Complex drive	N.A.
Can be installed in old existing return air plenum	Very difficult to install.	Can be installed in old existing return air plenum.
Easy to install	Large area required.	Easy to install.
	Installation is complex	
Low capital cost	Very high capital cost.	Very low capital cost.
Low operational cost. Rs.15 per day on date	High operational cost. More than Rs. 400 per day on date.	Very high operational cost as it requires continuous manpower for cleaning. Not the least cost effective
Almost no maintenance	Regular maintenance	Manpower is required to clean. Hence continuous maintenance.
Automatic continuous cleaning	Automatic continuous fine cleaning	Human factor creeps in.
No load on return air fan.	No load on return air fan.	If filter unclean return air fan over loaded.
Maximum Air availability	Maximum air availability	Human factor creeps in.
Pay back period is approx. 10-12 months with consideration on loaded motor.	Additional running cost involved.	N.A.



3.5 ENERGY CONSERVATION IN FAN OPERATION

3.5.1 AUTO CONTROL OF FAN MOTORS

The design of Humidification Plant is mostly based on peak load parameters. The peak conditions in Humidification Plant case do not persist for more than 20-30 days during the year. During remaining period fan & pump energy may be saved to a considerably high extent. Even the day and night temperature variations may add to the energy saving.

We at **PACK PLAST** through continuous efforts have developed a system, which takes care automatically of the relevant parameters pertaining to maintenance of required humidity in the work halls (khata) of textile industries and energy saved amounts to approx. 30-40%.

The system mainly comprises of: -

Variable frequency drive with compatible **sensor, transmitter, controller** to run motor At speeds proportional to air quantity requirement in work hall (khata) depending upon humidity conditions.

As per fan law even a reduction of 10% in RPM causes a saving of around 30% in HP.

According to yearly air quantity requirement (based on in depth study of collected datas) we have arrived at the following DUTY CYCLE including safety factor:

<u>CFM</u>	<u>MONTH/YEAR</u>	<u>DUTY CYCLE</u>	<u>REMARK</u>
100%	2	$\frac{2}{10} \times 100 = 16.6\%$	Due to drop in static pressure beyond desired limit reduction of fan motor speed is not feasible below 80%
80%	10	$\frac{10}{12} \times 100 = 83.3\%$	

The following sample of calculation regarding energy conservation with incorporation of Energy Conservation System may clarify the economic viability details for a plant of 56000 CMH capacity having: -

1 Nos. 12.5 HP motor for supply air	= 12.5 HP
1 Nos. 10 HP motors for return air	= <u>10.0 HP</u>
Total	= <u>22.5 HP</u>



We can very easily find out the WEIGHTED HP (which is actual required HP based on duty cycle) as follows:

<u>%age Air Requirement</u>	<u>Duty Cycle</u>	<u>Required HP</u>	<u>Weighted HP</u>
100%	16.6%	22.5	$22.5 \times \frac{16.6}{100} = 3.74 \text{ HP}$
80%	83.3%	5	$5 \times \frac{83.3}{100} = 4.17 \text{ HP}$
			Total = 7.91 HP
			Say 8 HP

Conclusion:

1. Total HP of fan motors for Plant (designed) 22.5 HP
2. Total required HP with Energy Conservation System incorporated. 8 HP

Saving 14.5 HP
% age saving 64.4 %

2. Appreciable energy conservation in case of water circulating pumps would also occur by controlling the running of pumps through HUMIDISTAT in conjunction with suitable device.

Thus it is quite evident that the capital cost incurred for provision of ENERGY CONSERVATION SYSTEM is paid back with in a period of 12 to 18 months (Depending upon the running hours and prevailing cost of electrical energy)

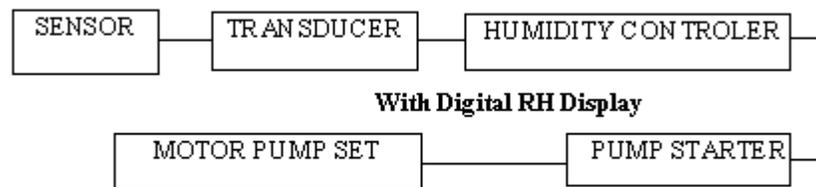


3.5.2 AUTO CONTROL OF WATER CIRCULATING PUMPS

Based on our experience we have concluded that in almost all cases the pumps are unnecessarily running in spite of the fact that the RH conditions inside work area do not warrant for the same. This is because to stop and run pumps manually every now and then is not practical.

To avoid this wasteful running and energy consumption we have developed Automatic control system for of pumps, a package comprising of Electronic Humidity controller which in conjunction with properly matched sensors, transducers etc. Automatically CUTS-OFF or CUTS-IN the pumps as per RH requirement in the work area. Due care has also been taken to avoid inching operation of pumps. It is worth mentioning that inching of pumps is quite dangerous for the life of pumps itself.

OUR CONTROL PACKAGE HAS ALREADY BEEN TRIED OUT SUCCESSFULLY IN SEVERAL TEXTILE INDUSTRIES



SCHEMATIC DIAGRAM



3.6 HYBRID AIR CONDITIONING SYSTEM

3.6.1 INTRODUCTION

Air conditioning systems using mechanical refrigeration have high initial cost and consumes significant amount of energy. A cheaper system of cooling is **Evaporative Cooling** used extensively in hot and arid climates. However, this process has its own limitations that it **cannot be used effectively if the wet bulb depression is low** (Wet bulb temperature is high).

It has therefore been considered that an economical system, involving both mechanical refrigeration and evaporative cooling may be evolved to cater to Indian conditions consuming less power and providing the same indoor conditions as in refrigerated air conditioning..

A DBT of 32°C ($\pm 2^\circ\text{C}$) and relative Humidity of 50-75% in different section of textile industry can be achieved by above combination.

3.6.2 SYSTEM EXPLANATION

A two stage hybrid air conditioning system consists of a first stage of a **dry surface type indirect evaporative cooling system** and a second stage of **chilled water spray system**.

Cooling of air by chilled water spray using a refrigerated air conditioning system is a costly and energy consuming system. The cost of refrigerated cooling system comes to about 1.00 kW per TR (50 Kcal/min or 3.5 kW of cooling).

Pre cooling inlet air using cold water from cooling tower does not consume that much power. Power required to pre cool air will depend on ambient wet bulb temperature however, under worst climatic conditions (say 29°C WBT) the power requirement may be 300 Watt per TR of heat removed from air in pre cooler as compared to 1 kW/TR for refrigerated air-conditioning. At lower wet bulb temperature the power requirement will be still lower as has been shown subsequently.

3.6.3 INDIRECT EVAPORATIVE COOLING [COOLING TOWER/COIL SYSTEM]

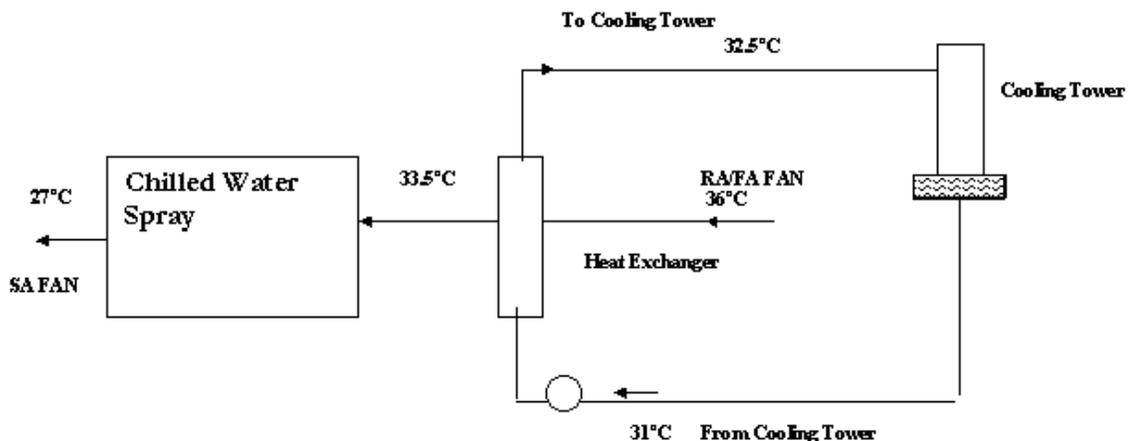
Combination of a cooling tower or other evaporative water cooler with a water to air heat exchanger and water circulating pump is indirect evaporative cooling system. Water is pumped from the reservoir of the cooling tower to the coil and return to the upper distribution header of



the tower. The re – circulated water is evaporatively cooled to within a few degrees of the wet bulb temperature as it flows over the wetted surfaces of the cooling tower. As the cooled water flows through the tubes of the coil it picks up heat from the conditioned return air. The temperature of the water increases and the supply air is pre cooled sensibly. Over all cooling effectiveness may range between 55% to 75%.

$$\epsilon = 100 \frac{(T1-T2)}{T1-T^*}$$

T1 = Temp of entering air
T2 = Temperature of leaving air
T* = Outside wet bulb temperature of air.



HYBRID AIR CONDITIONING SYSTEM

3.6.4 TWO STAGE HYBRID AIR CONDITIONING SYSTEM

When the indirect evaporative cooler is placed in series (upstream) with a conventional refrigerated system, it reduces the sensible heat load on refrigeration system. Energy required for the indirect cooling stage includes the pump and cooling tower fan as well as some additional fan energy to overcome resistance in the supply air system due to heat exchanger. The energy consumed by indirect evaporative cooling stage is much less than the energy saved from



reducing the load on refrigeration system. As a result, the overall energy consumption of the system will reduce. Another saving could result from the reduction in size of the refrigeration equipment required. Indirect evaporative cooling may also reduce the total time the refrigeration equipment must be operated during a year.

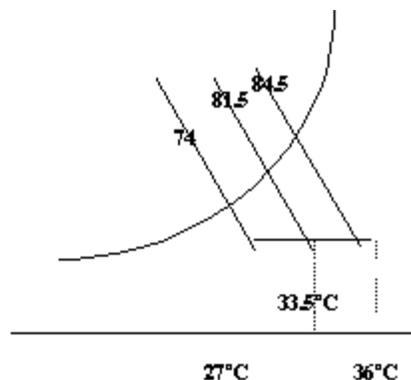
It has been found that the load on chilled water system can be reduced by pre cooling of air, thereby reducing the power consumption by more than 30% during the period of worst ambient conditions.

3.6.5 ILLUSTRATIVE EXAMPLE

In textile industry say Ring Frame, the maximum conditions, to be maintained with energy conservation consideration are 55% RH and 35°C DBT. The quantity of supply air is say 3,40,000 m³/hr at 27°C. The outside wet bulb temperature is as high as 29°C.

As the outside air WBT is 29°C, chilled water spray has to be used. All return air has to be used and fresh air dampers have to be kept closed. The return air temperature will be 35 to 36°C after RA fan. In a conventional chilled water spray system, the load on refrigeration plant would be :

$$\begin{aligned} &= (3,40,000/0.9) \times (84.5 - 74) \text{ KJ/hr} \\ &= 1101.8 \text{ KJ/sec} \\ &= 315 \text{ TR} \end{aligned}$$



TWO STAGE SYSTEM WITH AMBIENT WBT = 29 C

An hybrid system will pre cool the air in indirect evaporative cooling stage first and then in refrigerated spray chamber. At an ambient WBT of 29°C, the water from cooling tower pump at a temperature of about 31°C will be available at Heat Exchanger inlet. The outlet water temperature will be about 32.5°C. Air coming at 36°C to Heat exchanger can be cooled to 33.5°C in the heat exchanger (heat exchanger efficiency at a low of 55.5%) The heat load transferred to pre cooler

$$\begin{aligned} &= (3,40,000/0.9) (84.5 - 81.5) \\ &= 314.8 \text{ KJ/Sec} \\ &= 90 \text{ TR} \end{aligned}$$



The heat load coming on chilled water spray with pre cooled air

$$\begin{aligned} &= (3,40,000/0.9) (81.5-74) \\ &= 787 \text{ KJ/Sec} \\ &= 225 \text{ TR} \end{aligned}$$

Reduction in refrigeration load on spray chamber = $90/315 = 29\%$

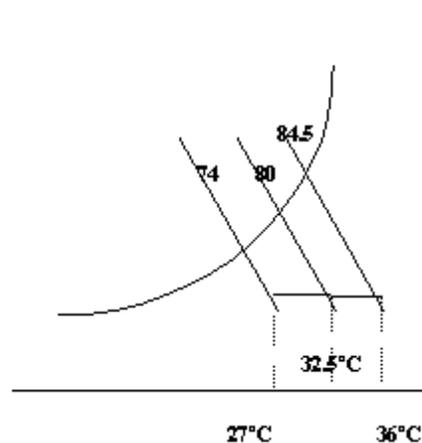
Reduction in power consumption on chilled water system = 90 kW

Power consumption in indirect evaporative cooling system pump and fan = 15 kW

Net energy saving = $90 - 15 = 75 \text{ kW}$

= Rs.6300.00 per day @ Rs. 3.50 per kW

In case the wet bulb temperature falls to 28°C on a favorable day or in the night, the temperature of water from cooling tower will be 30°C and air off the heat exchanger will be at a temperature of 32.5°C. Load shared by indirect pre cooling stage will be



TWO STAGE SYSTEM WITH AMBIENT WBT = 28 C

$$= (3,40,000/0.9) (84.5-80)$$

$$= 473 \text{ KJ/Sec}$$

$$= 135 \text{ TR}$$

Load on refrigeration system

$$= (3,40,000/0.9) (80-74)$$

$$= 629.7 \text{ KJ/Sec}$$

$$= 180 \text{ TR}$$

Reduction on refrigeration load = 42.8%

saving on energy consumption on refrigeration system = 135 kW

Energy consumption by indirect pre cooler = 15 kW

Net energy saving = $(135-15) \text{ kW}$

= Rs.10080.00 per day @ Rs.3.50 per kW



At a particular place the WBT goes on changing with time on a day it is maximum in after noon between 1.00 to 2.00 P.M. and minimum at about 5.00 A.M. This diurnal variation has to be considered for such a system where energy consumption has such a great dependence on wet bulb temp. A daily average saving can be assured as :

$$= \frac{1}{2}(120+75) = 97.5 \text{ kW}$$

=Rs. 8190.00 per day

=Rs. 16,38,000 p.a. considering 200 days for which refrigeration system is in operation

This saving will further increase as the ambient conditions improve with season and for a favourable ambient wet bulb temperature for 3-4 months during March, April, Oct in a year, the savings could be far more than as shown above. May be if the wet bulb temperatures are 26/27°C, the refrigeration load could be reduced to zero with such a system for these months. Any textile unit will have a minimum of 8 to 10 such air conditioning towers and annual saving on power consumption for air conditioning would be 1.5 corers or more.

3.6.6 CONCLUSION

A hybrid air conditioning system will yield the same indoor design conditions as a refrigerated air conditioning system as the second stage comprises of the refrigeration stage. The initial cost incurred on first indirect evaporative cooling stage is also compensated by reduction in the size of the refrigeration plant as its load is partially transferred on the first stage. The first stage cools the air evaporate and hence consumes less power as compared to the refrigeration plant and so the hybrid system is more power efficient as compared to the refrigerated air conditioning.



3.7 ENERGY CONSERVATION WITH HYBRID NOZZLES

The main power guzzlers in any Humidification Plant are equipment used for Air discharge and spray system.

Air quantity and spray load is calculated for peak demand conditions. However these conditions exist only for a period of 20-25 days in a year of 365 days which means for 90% of year excess air and water quantity is circulated.

The second major consideration is system efficiency. In this case system efficiency (barring human errors) is Air Washer efficiency. In a case study following results were observed:

SAT WFF(%)	DRY BULB TEMP LEAVING SPRAYS	SUPPLY AIR TEMP RISE	ROOM DRY – BULB TEMP AT 55% RH
100	75	19	94
95	76	17.6	93.6
90	77	16.2	93.2
85	78	14.7	92.7
80	79	13.3	92.3

SUPPLY AIR TEMP RISE	SUPPLY AIR QUANTITY	% saturations efficiency
19	102,400	100
17.6	110,600	95
16.2	120,000	90
14.7	132,300	85
13.3	146,200	80

From above it is easily understood that huge air quantity wastage occurs for operation in narrow range of 75 to 95%. Hence it is **MUST THAT NO AIR WASHER OPERATES BELOW 95% efficiency.**

To achieve highest air washer efficiency control over mist generations is of utmost importance. But this again is easier said than done.

On practical side with best of filtration, fluff will go into air washer causing nozzle chocking and ultimately lowering air washer efficiency.



At **PACK PLAST**, we have developed system, which will use only fresh water [the quantity required for evaporation] there by completely avoiding tank water. With this method chocking of nozzle is totally avoided which in turn means:

- No Nozzle clearing
- No Tank cleaning

However, for air washing the Mist Eliminators will be drenched by flooding Nozzles.

The Nozzle set up is again divided in circuits for optimum use. As soon as ambient conditions improve part circuit will be cut off to keep saturation efficiency at 95% and not over saturating the air.

In best of organization this system can reduce up to 20% power consumption:



3.8 FANLESS COOLING TOWER

3.8.1 SALIENT FEATURES OF FANLESS COOLING TOWER

1. The cooling tower may be installed at floor level. The only reservation is that the height of water basin should be high enough to match the water circulating pump suction.
2. The water is sprayed through a specially balanced spray system inside the cooling tower to create negative pressure (vacuum) sufficient enough to get air induced automatically for cooling the water sprayed.
3. Airflow into the cooling tower is possible from all the four sides and as such wind direction has no effect on the performance.
4. All parts are made out of PVC/Plastic, which is non-biodegradable and has very long life. Nut-bolts used are also galvanized iron or brass to make them corrosion free.
5. The tower is almost maintenance free and needs only periodic cleaning.
6. No painting is needed.
7. Due to working on negative pressure (vacuum) the possibility of wastage of water due to escaping out of the cooling tower is almost eliminated.
8. Most energy efficient as no fan is required.
9. Efficiency of cooling tower does not decrease due to clogging of fills (In finless C.T. no fills are required)
10. Efficiency of cooling tower performance does not fall due to ageing.



3.8.2 COMPARISON CHART

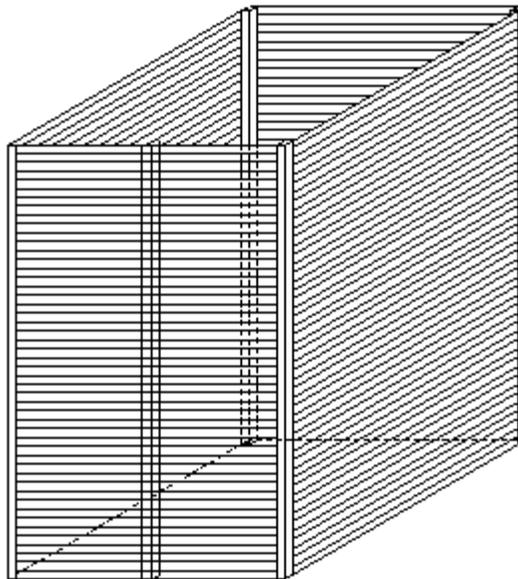
S. No.	F.R.P. Cooling Tower	Splash Type Cooling Tower	Vacuum Draft Jet Cooling Tower
1.	Bottle Type shape	Rectangular or Square Shape	Rectangular or Square Shape
2.	Fan Mounted on the top of the tower, which is completely free from problems encountered with belt & gear, drives.	Fan mounted either on the top or on the side.	Fan less.
3.	Power consumed to run the fan increases the operating cost of cooling tower. A 5HP Fan Motor consumes electricity costing approx. Rs. 64,000/- per annum @ Rs.3=00/ unit	Power consumption is nearly same as compared to that of F.R.P.	This is the most advantageous because no power consumption for fan driving.
4.	Air inlet from the bottom of the tower and exit from the top of the tower. Water and airflow is parallel but in opposite directions.	Water and Air Flow is perpendicular to each other so resistance to air flow.	Due to jet action vacuum is created around the spray and as a result, an air current starts to flow automatically.
5.	Packing/Fills: - a. PVC Fill Sheets are used to improve water air contact time. b. Clogging occurs which affects the efficiency of the tower.	PVC Splash bars are used to improve air water contact time. In this type, there is no clogging but maintenance is required to clean the fungus from splash bars.	No fills used still heat exchange is optimum. No fills/splash bars, hence no maintenance on this point.



S. No.	F.R.P. Cooling Tower	Splash Type Cooling Tower	Vacuum Draft Jet Cooling Tower
6.	Noise Generation	Noise Generation	Noise Generation almost NIL
7.	Water Loss is More	Water loss is still More	Minimum Water Loss
8.	High Maintenance Cost increases the Operating Cost	High Maintenance Cost increases the Operating Cost	It is an almost Zero Maintenance Tower
9.	<p>Life expectancy & Maintenance:</p> <p>Fills: Average life is approximately 5 years.</p> <p>Regular & rigorous cleaning is required.</p> <p>Fan & Motor: Regular maintenance is required because motor remains always in humid conditions.</p> <p>Louvers: Cleaning is required</p>	<p>Splash Bar: Average life is 7 to 10 years.</p> <p>Regular & rigorous cleaning is required.</p> <p>Fan, Motor & Gear Drive/ Belts: Regular maintenance is required.</p> <p>Cleaning is required</p>	<p>No such maintenance is needed.</p> <p>No such maintenance is involved.</p> <p>Only Cleaning is required.</p>



3.8.3 ISOMETRIC SKETCH OF FANLESS COOLING TOWER (WITH OUT PLUMBING & BASIN)





3.9 A STUDY ON MAINTENANCE OF VARIOUS AIR SYSTEMS

Textile Industry in general requires only two utilities.

- Humidification Plants.
- Air Compressors.

Out of these two, Air Compressor being single unit utility requires less attention than Humidification Plants.

Humidification Plants have varied parameters as under:-

3.9.1 AIR FILTRATION

It is of utmost importance that Air taken in to Air Washer is clean. This aspect of Humidification Plants is given very little consideration, though our study shows that this parameter should be paid maximum attention from maintenance point of view. If the entering air is clean.

- Louvers shall be always clean hence no air distribution problem will arise.
- Tank water will be clean so less load on water filtration and clean nozzle will give good mist generation.
- Air Washer Piping, pump impeller will not be choked thereby giving long life at low energy consumption.
- Eliminators will remain clean thereby giving better mist separation efficiency at low energy cost.
- Supply Air Duct and Diffusers will not corrode due to better mist separation efficiency of eliminators.

The above points clearly favor a very good Air Filtration System should be used to have high Air Washer efficiency, though the A/W efficiency formula does not have this parameter at all.

$$\text{A/W Efficiency} = \frac{T_{\text{DBT}} - T_{\text{A/W}}}{T_{\text{DBT}} - T_{\text{WBT}}}$$



Depending on system used the recommended maintenance is as under:

Stationary V Filter	Every Shift
Auto Fluff Scrubber	Once 15 days
Rotary Air Filter	

Note: We have also studied Air Filtration methods. The paper can be supplied on request.

3.9.2 AIR DISTRIBUTION:

This component of Humidification Plant mainly distributes the air entering the Air Washer. This is important from point of view of increasing saturation efficiency. Many Humidification Plants do not provide this component, as visibly it has no function. But in reality the efficiency of system can go down as much as 20-30%.

The main Air Distribution systems involve:

1. Louvers
2. Perforated Sheets
3. W shaped baffle plates.

Of the above Louvers give best air distribution at lowest pressure drop.

Maintenance should be done every 15 days

3.9.3 AIR WASHER:

This component consists of:

- 3.1 Air Washer Pump and Piping
- 3.2 Nozzles for Mist creation
- 3.3 Water Filter
- 3.4 Tank

3.9.4 AIR WASHER PUMP & PIPING:

Always used high efficiency pumps and piping system. Usually the pump efficiency can go down to even in good companies 15-20%.

Due to commercial interventions pump and piping selection takes a beating. Normally even a technocrat considers pump and piping as objects of low technical consideration having almost fixed efficiency. Following comparison will show the actual conditions:



Maintenance of pump and piping should be done every month. But more attention should be paid to water treatment/cleanliness. Water filtration system should be good made out of stainless steel.

In ordinary case

Pump Maintenance	Every month
Header Blow	Every 3 month
Raiser Blow	Every month along with nozzle cleaning.
Tank Blow	Every month

If good filtration and water treatment is done:

Pump Maintenance	Every 3 month
Header Blow	Every 6 month
Raiser Blow	Every 3 month
Tank Blow	Every 3 month

3.9.5 NOZZLES FOR MIST CREATION

These are the crucial component responsible for actual mist generation. Nowadays many good types of Nozzles are available. The main criteria should be low maintenance at high mist generation.

The non-clog type nozzle requires less maintenance at good mist generation. The orifice should be of hard material preferably S.S. Nozzle maintenance is must every month.

The most important is the orifice size. While cleaning the nozzles the orifice should be checked for its diameter and shape.

Too large a diameter or oblong shaped orifice will not give proper mist formation.

3.9.6 WATER FILTRATION SYSTEM

In Humidification Plants water for Humidification of air is re-circulated. In coming air carries fluff dust etc. that is washed in Air Washer by circulating water. Hence the foreign particle content of water goes on increasing water is filtered so that pump does not suck in these dust & lint particle thereby causing choking in pump, pipe line and nozzles.

The filtration system comprises of: -

1. Stationary Water Filter Screen.
2. Rotary Water Filter

For obvious reasons the filter screen should be of stainless steel. The stationary filters should be two banks so that fresh filter can first be insisted before removing choked filter for cleaning.



MAINTENANCE SCHEDULE

Water Filter Screen should be cleaned every week.

3.9.7 TANK

Due to evaporation dissolved contents in water goes on increasing, if cleaning or blow down is not affected these dissolved salts shall accumulate in pipeline and nozzle.

MAINTENANCE SCHEDULE

Blow Down	Every 15 days
Tank cleaning	Every six months

3.9.8 MIST ELIMINATORS

Mist Eliminator has a two-fold function.

- To eliminate water droplets from air.
- To clean the air.

These functions can only be performed by Eliminators if they are in clean state. Hence cleanliness of eliminators is essential. Choked eliminator shall also cause excessive pressure drop across then. Which will increase overall power consumption of plant.

The best type of eliminators are these which will eliminate water droplets at minimum pressure drop, i.e. having a profile without notches. They should also be installed in such a manner which facilitates easy cleaning. Two of most suitable profiles are as under:

MAINTENANCE SCHEDULE

In theoretical practice eliminator should always in cleaned state so as to have maximum separation efficiency and remove dust from air.

Installation of flooding nozzles at top is a good method to keep eliminators clean.

MAINTENANCE SCHEDULE

With flooding nozzles installed	Once in 3 months
Without Flooding Nozzles	Once a week



4.0

SPARES FOR AIR SYSTEMS



4.1 AIR DUCT

4.1.1 PURPOSE OF DUCTING

The proper distribution of air to the conditioned space at desired Blow and induction is one of the most important factors to maintain desired conditions. The quantity of air required must be available in proportion to heat dissipation in the work hall. This can be accomplished with the help of **GOOD DUCTING**.

4.1.2. DEAL DUCT SYSTEM

An ideal duct system must have no friction and shock losses, the total pressure (the sum of the static and velocity pressures should be the same every where along the duct independent of the changes in the cross-sectional areas of the duct. But in actual practice the losses do exist and may only be minimized to the lowest possible extent. These losses depend on.

1. Air Velocity
2. Duct Size
3. Interior surface finish
4. Length of Duct
5. Leakages

The system should also be within prescribed limits of sound level.

4.1.3 HEAT GAIN OR LOSS, LEAKAGE AND ALLOWANCE FOR LEAKAGE

Varying any of the above parameters from set values also varies the losses in the air duct. These losses play very important role in determining the size of the fan, angle of blades, motor rating etc. in an air system whether it be an air conditioning, Humidification & Ventilation, or Comfort Cooling or Forced Draft Ventilation Plant.

Whenever the air inside the duct is at a temperature other than the air surrounding the duct heat flows into or out of the duct (based on temperature gradient) Hence the load calculation should take into account an appropriate allowance for this heat gain or loss. Poor workmanship in metal/sheet joints may cause leakages in the air duct.



A leakage into unconditioned space is a total loss. It is estimated (based on various studies) that in ordinary ducting following minimum allowance has to be made as a percentage of both room sensible heat and latent heat: -

As recommended by experts in the field: -

Long Duct	10%
Medium Duct	5%

These are Percentages for low velocity systems. In high velocity systems the losses amount to the extent, just not tolerable.

4.1.4 PVC LINED DUCT/PVC DUCT WITH FRP

In order to minimize these losses, **FOR THE FIRST TIME IN THE COUNTRY** a superior choice in Air Ducts i.e. PVC LINED DUCT or PVC Duct having FRP coating is available.

We with our expertise at **PACK PLAST** have successfully developed PVC Duct or PVC Lined Duct. Earlier these were manufactured out of G.I./Aluminium sheets only without PVC Lining, which had following drawbacks: -

1. They were prone to high corrosion due to being in continuous contact with very high RH air all the time. This weakness was a sort of menace in industries located in coastal areas and in chemical industries
2. The G.I./Aluminium duct design had to be done with a consideration of availability of sheet sizes and limitations for bending etc.

The above problems of sheet fabrication have almost been eliminated with our PVC/FRP Ducts or PVC Lined Ducts.



4.1.5 ADVANTAGES

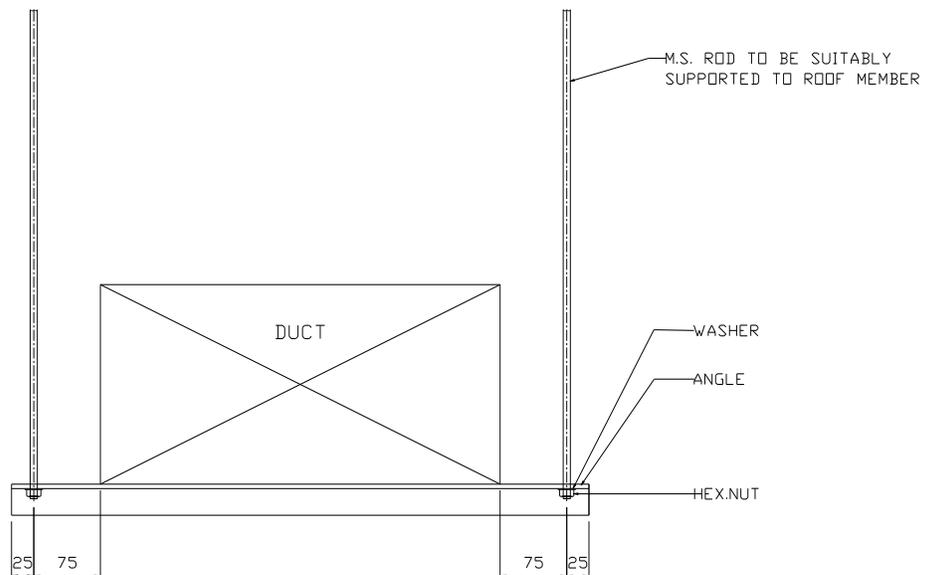
- Unaffected by moisture and moving air.
- Airflow with minimum resistance to be overcome.
- Higher strength due to double layer formation i.e. G.I. Or Aluminium + PVC Lining.
- Good sound dampening.
- Surface of the duct, coming into contact of moist air is of PVC having smooth finish which is unaffected by dampness.
- Far better efficiency of Air Delivery System.
- Leakage free as leakage through one layer is neutralized by other layer.
- Most Cost Effective.
- Fire Retardant.
- Less heat gain or loss, as PVC Lining also acts as an additional layer of insulating media.



ANNEXURE - (D-2)

INSTALLATION OF DUCT & HANGING ARRANGEMENT

ANNEX NO. D-2



NOTE

- 1) THE DUCT SUPPORT SHALL BE SPACED <1200 mm.
- 2) ALL HANGING MATERIAL WOULD BE ZINC/CADIUM PLATED OR Al/Bi COATED.



ANNEXURE - (D-3)

JOINTING OF SHEET METAL



I A Grooved Seam



I B Standing Seam



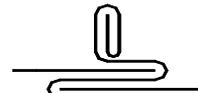
I C S-Slip



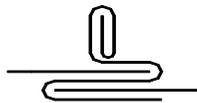
I D Drive Slip



I E End Slip



I F Bar Slip



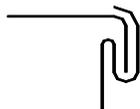
I G Reinforced Bar Slip



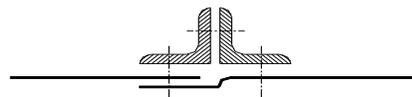
I H Pocket Slip



I J Double Seam



I K Pittsburgh Seam



I L Angle Connection



**RECOMMENDED CONSTRUCTION FOR RECTANGULAR SHEET METAL DUCTS
Low Pressure Systems**

DUCT DIMENSION	MATERIAL GAGE				RECOMMENDED CONSTRUCTION * Transverse joints, Bracing and Reinforcing
	Steel U.S. Gage		Aluminium B & S Gage		
	Duct	Slip	Duct	Slip	
Up to 24	24	24	22	20	Packet slip or Bar-S slips spaced not more than eight feet apart.
24 to 30	24	24	22	20	Packet slip or Bar-S slips spaced not more than four feet apart.
31 to 60	22	22	20	18	
61 to 72	20	20	18	16	Reinforced packet slip or reinforced Bar-S, spaced not more than four feet apart. 1½" x 1½" diagonal angle reinforcing ‡ or 1½" x 1½" x 1/8" girth angle reinforcing ‡ located midway between joints.
73 to 90	20	20	18	16	Reinforced pocket slip † or reinforced Bar-S slip † spaced not more than four feet apart. 1½" x 1½" x 1/8" diagonal angle reinforcing † or 1½" x 1½" x 1/8" " girth angle reinforcing ‡ located midway between joints. 1¼" x 1/8" band iron stay bracing for duct width 73" to 90".
91 and up	18	20	16	16	Reinforced pocket slip † or reinforced Bar-S slip † spaced not more than four feet apart. 1½" x 1½" x 1/8" diagonal angle reinforcing ‡ or 1½" x 1½" x 1/8" " girth angle reinforcing ‡ located midway between joints. 1¼" x 1/8" band iron stay bracing for duct width 91" to 120". 1¼" x 1/8" band iron stay bracing spaced 48" apart for duct widths 121" and up.

*All ducts over 18" in either dimension are cross-broken, except those to which rigid board insulation is applied or area of duct where outlet or duct connection is to be installed. Duct seams are either Pittsburgh lock seam or longitudinal seam.

† Reinforce joint with 1¼" x 1/8" band iron.

‡ Angles are attached to duct by tack welding, steel metal screws or rivets on 6" centers.



SCOPE OF WORK

Insulated supply air duct, supply fabricate, erect, commission and testing duct manufacture from G.I. Sheet having thickness as under:

<u>Size of Duct</u>	<u>Thickness</u>
Up to 600 mm	24 G
600 to 750 mm	24 G
775 to 1500 mm	22 G
1525 to 1800 mm	20 G
1825 to 2250 mm	18 G
62275 and above	

The frame angle would be as under:

<u>Size of Duct</u>	<u>MS Angle</u>
Up to 600 mm	Not used
600 to 750 mm	Pocket slip & Bar slip
775 to 1500 mm	Pocket slip & Bar slip
1525 to 1800 mm	40x40x3 mm thick
1825 to 2250 mm	40x40x3 mm thick
62275 and above	40x40x3 mm thick

Accessories used:

- Black Japan paint on existing of duct
- Support for branch duct 10 mm.
- For Packing
- Between MS Frame thermo Cole foam 6 mm
- Nut bolts.
- Red oxide paint on all MS parts.
- Insulation of False ceiling as per your specification.
- Chickens wire mesh 26 G Hessian cloth.



4.2 AIR TIGHT DOORS

Air Tight Door is a must for any Air Handling System whether it is a Humidification Plant or Air Conditioning Plant to avoid leakage of conditioned air.

The Air Tight Door should also be sufficiently strong to face the air pressure and also to bear the stresses. The operation of Air Tight Doors should also be smooth.

We at **PACK PLAST** are manufacturing properly desired Air Tight Doors.

The frame is made out of MS angle 50x50x5 mm; the MS Sheet used is 1.6 mm thick (16G) with reinforcement strips. The door is provided with pin & bush type heavy duty hardened hinges and robust locking arrangement.

The size of the door is as per customer specification (common size is 800 x 1800 mm).

Our range of Air Tight Doors is: -

1. Double Jacketed with Glass Wool Insulation and door rubber gasket.
2. Single frame without insulation but with door rubber gasket.

These are supplied duly good quality paint finish.



4.3 AIR WASHER PIPING

Air Washer Piping is the network to install Nozzles for spray system.

The division of face area of Air Washer should be in such a manner that there is no Dry Air by pass. For this purpose the Spray cone formation area of Nozzle should be known. Based on this area and overlap of 20-25% the air washer piping is designed.

The piping consists of:

- Suction pipe of pump.
- Discharge Pipe of pump.
- Headers.
- Risers.

It is always advisable to have one-size larger pipes at suction so as to avoid any air trap.

The risers are designed keeping view the total cross section area matching the header cross-section area. Similarly the total nozzle area should match the each riser area. The entire above system is called BANK.

Air Washer usually have 1 or 2 BANKS. But in special cases even 3 banks are installed.

The air washer piping can be of G.I. or Plastic.

Both have advantages and disadvantages. Where G.I. has corrosive character the plastic pipe is breakable.

Air washer piping also has suction and discharge valves as also water make up connection and over flow/drain assembly.



4.4 AIR FANS – AXIAL FLOW & CENTRIFUGAL:

Axial Flow Fans are made out of Aluminium casted hub and blades. The blades are of variable angle to facilitate power saving in good reasons.

Axial Flow Fans are manufactured with numerous profile blades as also number of blades right from TWO BLADES to 10 BLADES.

The primary consideration is quantity of air as also total pressure delivered.

Here we may emphasize that to place order for fan it is not just air quantity specification sufficient. It is essential to consider total system resistance, which is requested to be over come by fan. In most of cases the pressure is specified on adhoc basis, which causes massive energy loss.

The system resistances are:

Air Filter
Damper
Perforated Sheet/ Louvers
Spray System
Mist Eliminators
Duct Size and length

PRECAUTIONS FOR INSTALLATION

The fan is supplied after proper balancing but due to transportation constraints the same is dispatched in knocked down condition.

Proper care is to be taken for assembling and mounting of the fan on the driving shaft as mentioned below: -

6. Check the impeller bore i.e. the impeller must slide on the driving shaft neither too tight nor loose, shaft key also must fit properly in driving shaft & fan impeller.
7. The blades on the impeller should invariably be fixed matching the numbers marked on the impeller blade holes and fan blades.
8. First the blades to be loosely tightened and then after adjusting the angle of blades equally with the help of bewail protector the nuts may be fully tightened.



The second nut having a grub screw should be tightened fully and locked in position with tightening of the grub screw.

An alien key is also provided for the purpose.

9. The complete fan and impeller assembly should then be mounted on the driving shaft and checked for any deficiency by rotating the same with hand.
10. The fan is now ready for commissioning. However it should be observed for few minutes for any undue vibration, which may occur due to improper assembly.

In case any deficiency is observed the matter may be referred to us for advice on remedial measures or assistance. FAN SHOULD NOT BE RUN UNDER SUCH CASE.

IT IS A MUST TO RETIGHTEN THE FAN BLADE NUTS AFTER A RUN OF ABOUT 3 TO 4 DAYS, AS DUE TO ANY REASON THE NUTS MAY GET SOMEWHAT LOOSE.

A **Centrifugal Fan** is a mechanical device for moving air or other gases. It has a fan wheel composed of a number of fan blades, or ribs, mounted around a hub. As shown in Figure 1, the hub turns on a driveshaft that passes through the fan housing. The gas enters from the side of the fan wheel, turns 90 degrees and accelerates due to centrifugal force as it flows over the fan blades and exits the fan housing.

Centrifugal Fans can generate pressure rises in the gas stream. Accordingly, they are well-suited for industrial processes and air pollution control systems. They are also common in central heating/cooling systems.



Contents

- 1 Fan components
 - 1.1 Types of drive mechanisms
 - 1.1.1 Direct drive
 - 1.1.2 Belt drive
 - 1.1.3 Variable drive
 - 1.2 Fan dampers
 - 1.3 Fan ribs
 - 1.3.1 Forward-curved blades
 - 1.3.2 Backward-curved blades
 - 1.3.3 Straight radial blades
- 2 Centrifugal fan ratings
- 3 Air Movement and Control Association (AMCA)
- 4 See also
- 5 References
- 6 External links

Fan components

The major components of a typical centrifugal fan include the fan wheel, fan housing, drive mechanism, and inlet and/or outlet dampers.

Types of drive mechanisms

The fan drive determines the speed of the fan wheel (impeller) and the extent to which this speed can be varied. There are three basic types of fan drives.^[1]



Direct drive

The fan wheel can be linked directly to the shaft of an electric motor. This means that the fan wheel speed is identical to the motor's rotational speed. With this type of fan drive mechanism, the fan speed cannot be varied unless the motor speed is adjustable.

Belt Drive

Belt driven fans use multiple belts that rotate in a set of sheaves mounted on the motor shaft and the fan wheel shaft.

This type of drive mechanism is depicted in figure 2. The belts transmit the mechanical energy from the motor to the fan.

The fan wheel speed depends upon the ratio of the diameter of the motor sheave to the diameter of the fan wheel sheave and can be obtained from this equation:^[1]

$$rpm_{fan} = rpm_{motor} \left(\frac{D_{motor}}{D_{fan}} \right)$$

where:

rpm_{fan} = fan wheel speed, revolutions per minute

rpm_{motor} = motor nameplate speed, revolutions per minute

D_{motor} = diameter of the motor sheave

D_{fan} = diameter of the fan wheel sheave

Fan wheel speeds in belt-driven fans are fixed unless the belts slip. Belt slippage can reduce the fan wheel speed several hundred revolutions per minute (rpm).



Variable drive

Variable drive fans use hydraulic or magnetic couplings (between the fan wheel shaft and the motor shaft) that allow control of the fan wheel speed independent of the motor speed. The fan speed controls are often integrated into automated systems to maintain the desired fan wheel speed.^[1]

An alternate method of varying the fan speed is by use of an electronic variable-speed drive which controls the speed of the motor driving the fan. This offers better overall energy efficiency at reduced speeds than mechanical couplings.

Fan Dampers

Fan dampers are used to control gas flow into and out of the centrifugal fan. They may be installed on the inlet side or on the outlet side of the fan, or both. Dampers on the outlet side impose a flow resistance that is used to control gas flow. Dampers on the inlet side are designed to control gas flow and to change how the gas enters the fan wheel.

Inlet dampers reduce fan energy usage due to their ability to affect the airflow pattern into the fan.^[1]

Fan Ribs

The fan wheel consists of a hub on which a number of fan blades are attached. The fan blades on the hub can be arranged in three different ways: forward-curved, backward-curved or radial.^[1]

Forward – Curved blades

Forward-curved blades, as in Figure 3(a), use blades that curve in the direction of the fan wheel's rotation. These are especially sensitive to particulates. Forward-curved blades are for high flow, low pressure applications.



Backward – Curved Blades

Backward-curved blades, as in Figure 3(b), use blades that curve against the direction of the fan wheel's rotation. These types of fan wheels are used in fans designed to handle gas streams with relatively low particulate loadings because they are prone to solids build-up. Backward-curved fans are more energy efficient than radial blade fans. Backward curved blades are used for high pressure, low flow applications.

Straight Radial Blades

Radial fan blades, as in Figure 3(c), extend straight out from the hub. A radial blade fan wheel is often used on particulate-laden gas streams because it is the least sensitive to solids build-up on the blades.

Air Movement and Control Association (AMCA)

The centrifugal fan performance tables provide the fan RPM and power requirements for the given CFM and static pressure at standard air density. When the centrifugal fan performance is not at standard conditions, the performance must be converted to standard conditions before entering the performance tables. Centrifugal fans rated by the Air Movement and Control Association (AMCA) are tested in laboratories with test setups that simulate installations that are typical for that type of fan. Usually they are tested and rated as one of four standard installation types as designated in AMCA Standard 210.[2]

AMCA Standard 210 defines uniform methods for conducting laboratory tests on housed fans to determine airflow rate, pressure, power and efficiency, at a given speed of rotation. The purpose of AMCA Standard 210 is to define exact procedures and conditions of fan testing so that ratings provided by various manufacturers are on the same basis and may be compared. For this reason, fans must be rated in SCFM.



4.5 DAMPERS

Dampers are one of the most important parts of air conditioning/Humidification System. But in actual practice, these are not considered so. In most of the organisations striving for energy conservation, dampers are not given due weight age.

The desired conditions in Plant area can only be achieved, if mixture of fresh air and return air is maintained properly. This function can only be achieved if the dampers are working efficiently. Especially in winter season fresh air required is minimum, otherwise heaters have to be incorporated to maintain temperature inside the plant, thereby increasing cost of energy.

The Dampers are used for two important functions in the air handling autocrats

1. To control and mix outdoor and return air
2. To control air quantities handled by the fan

DAMPERS are manufactured with a window having number of blades. The blades are connected through suitable linkage for operation to control the air quantity.

We with our team of Technical Experts here at **PACK PLAST** manufacture dampers in PVC as also in aluminum and GI.

Dampers are designed to control flow of air and may be operated manually or by electricity or by compressed air depending on service conditions, they are known as the single or multiple blade type.

PVC Dampers do not rust and have very long life. The leakage also is restricted up to 6-7%.

The single action damper is used in locations where the damper is either fully open or fully closed. A double acting damper is used where control of airflow is required. This arrangement is superior since the airflow is throttled more or less in proportion to the blade position, whereas



the single action type damper tends to divert the air and does little or no throttling until the blades are nearly closed.

PVC dampers as well as Aluminium dampers are almost **airtight**. To make Aluminium damper airtight each blade edge is provided with sealing rubber gasket. However, there is leakage of 3%.

In case of Aluminium dampers the operation may be through simple hand lever or it may be gear driven as per choice of the customer and source of operation i.e. manually or electrically or by compressed air.

Gear drive enables infinite variation in closing/opening of dampers.

The size of the dampers is as per customer's requirement/specifications.

MATERIAL SPECIFICATION:

- **PVC DAMPERS: Blades** made of Extruded PVC, operating system M.S. Frame, M.S. Angle.
- **ALUMINIUM DAMPERS:** Blades made of extruded Aluminium, operating system of Nylon gears, Frame Aluminium channel or M.S.

GI dampers – Blades 18 G Frame 16 G GI Sheet.

4.6 DIFFUSERS/GRILLS

In every air distribution system the air is to be uniformly distributed in the area for which it is meant through air ducts.

This distribution of air may be through diffusers or through grills, however in Industries where direct blow of air is not desired and the main requirement is to maintain proper desired conditions, the diffusers are suitable and where direct blow of air is needed air grills may be used.

The diffusers and grills were mostly manufactured out of G.I. Sheet and exceptionally out of aluminum sheet. The uses of G.I. Sheet or aluminum sheet due to being corrosion prone are almost out dated.



We at **PACK PLAST** manufacture diffusers/grills out of PVC.

PVC being corrosion free and bio undegradable has very long life span.

The PVC diffusers or grills are manufactured as per customer's requirement.

The PVC diffusers and grills are manufactured in many configurations such as:

1. Square
2. Rectangular
3. Circular
4. Step In
5. Step Out
6. Single Leaf
7. Double leaf

Attention should be paid to following technical parameter of diffuser:

1. Air Direction
2. Air velocity
3. Blow
4. Drop
5. Spread

4.7 FALSE CEILING

Providing and fixing false ceiling with Bison/Phenotherm/AC Sheet/Gypsum Board and thermal insulation with 50mm thick glass wool of 24 Kg/m³ density where required complete with suspension system consisting of 35x25x1.6 mm thick aluminum main tees, 25x25x1.6 mm aluminum cross tees, 25x25x1.6 mm thick aluminum wall angles, 6mm dia MS Rod suspenders, fixing clips for ceiling panels etc. complete in all respects inclusive of all accessories for small areas. For large areas the semi-corrugated sheet should be supported on lightweight joist. [4.5 Kg.Rmtr.]



FALSE CEILING:

Providing, fabricating and suspending in position to true horizontal line false ceiling as per given design in 6 mm thick AC preferred sheet.

- Coat of Red Oxide primer over M.S. material.
- Two coat of enamel paint to M.S. Material.
- Two coat of oil bond distemper on A.C. Sheet.
- False Ceiling frame fabricated out of M.S. JOIST 5.5/6 Kg/meter weight 65 mm including hanging, securing with Nuts & Bolts to true alignment.

4.7.1 FALSE CEILING INSULATION:

Resin bonded insulated fiberglass, Make Khinco/UP Twiga Make only.

Density 24 Kgs/m³

Thickness – 50 mm

Overlap – 100 mm

4.7.2 VAPOUR BARRIER

LD Polythene bag having weight 20 gm/sq.ft.

Adhesive tap for over lapping. However, looking at five hazards in textile industry, we recommend use of PVC bags [self extinguishing prophesy] instead of LD Polyethylene.

Another full proof option is to have GI cladding over vapor barrier.

4.8 FIBER REINFORCED POLYESTER

Fiber Reinforced Polyester technology has gained wide acceptance for casting, surface coating, electrical application, chemical resistances, heat resistance, filament winding etc. The main Raw Materials used are:

1. Polyester Resin
2. Catalyst
3. Accelerator
4. Reinforcing Materials
5. Inert Fillers
6. Separating Agents
7. Colours

The main application methods are:

1. Hand Lay up
2. Filament Winding
3. Dough Mixing
4. SMC
5. Casting applications



As regards your requirement of large circular tanks, we would request that following additional care should be taken in glass roving method (which is part of filament winding method)

- THAT angle of winding should be such to impart maximum mechanical strength.
- THAT combination of helical, longitudinal and circumferential winding should be adopted.
- THAT as glass content is high it is not very resistant to corrosion and wet conditions, therefore coating of resin followed by mat should be the inner core of tank.
- THAT even the outer surface should be finished with extra resin.
- THAT the resin used should be isophthalic resin with following properties: -

1. Lower viscosity (3.5 poise)
2. Excellent wetting properties
3. **Specific gravity – 1.1**
4. Acid value – 22 mg. KOH/g
5. Volatile content – 41%
6. Water absorption < 0.16% (at 25°C after 24 hrs.)

- THAT the unidirectional roving should have following properties

Glass content % weight	70
Specific Gravity	2.0
Tensile Strength	1,20,000 lbs/in ²
Young's Modulus	4 x 10 ⁶ lb/in ²
Impact Strength	50 ft – lb

4.9 FLOODING NOZZLES

Usually the function of mist eliminator is consideration to be only to entrap moisture particles so as to avoid carry over in duct and thereby to department.

But another important function of eliminator is to prevent dust particles to reach department. Contaminated Air get washed in spray and eliminated in mist eliminators therefore this enclosure is called AIR WASHER.

To help mist etc. mentors eliminator, dust, fiber it is essential that the eliminator plate is always wet. Only the wet surface of eliminator plate can entrap dust and fluff.

To keep eliminator plates wet it is essential to install flooding nozzles.

These nozzles are to work at 0.5 Kg/cm² pressure and the output should be 1 gpm approximately. The spacing of nozzles depends upon type of eliminators used,



4.10 LAGGING OF STEAM PIPES, VESSELS, TANKS FOR THERMAL INSULATION

The thermal energy has a tendency to flow from the area which is at high temperature to the area having lower temperature resulting in thermal losses and are directly depending upon: -

4.10.1 THE TEMPERATURE GRADIENT:

In other words the higher the temperature than the surrounding temperature join the thermal losses go on increasing drastically and also develop totally undesirable stresses.

4.10.2 SURFACE AREA AVAILABLE FOR DISSIPATION

The thermal losses are directly proportional to the surface area. These thermal losses not only cause financial loss but also adversely affect the call of the day for Energy Conservation.

These losses also affect the performance of the related equipments and end product quality in turn.

The thermal losses may not be totally eliminated, as no man made thing is 100% efficient. However these can be minimized based on techno commercial grounds.

Of course application & selection of insulating material would depend upon: -

1. Economics
2. Temperature Gradient
3. Technical Requirements

The insulating property of the material also depends on thickness, density etc.

After thorough analysis (theoretically as well as field studies) the use of mineral wool for lagging of steam pipes, vessels & tanks still today is found to be a viable choice.

Most of the technocrats are not clear about the use of mineral wool properly to have satisfactory results.

Some of the related points are: -Cleanliness of the surface whose insulation is to be done.

It is to mention that this is necessary to avoid future corrosion and also to have proper contact of insulating material with the hot surface.

Mechanical strength The mineral wool is a loose material and has to be reinforced so that it stays in desired position.

Cladding It prevents damage from outside and fly off of mineral wool fibers.



Cladding also serves the purpose of protection from radiation of heat.

Based on all above the proper specifications for insulation for steam pipes etc. are:

- a) To clean all surfaces of pipelines/Tanks/Equipments by means of wire brush to remove dirty particles, mill scale and sticky foreign materials.
- b) Making the mattresses with Loose Mineral wool of required density with help of one side 24 Swg. X 3/4" G.I. wire mesh. The said mattresses will be wrapped around the pipeline and stitched with 22 Swg. Lacing wire circumferentially and horizontally.
- c) To bind tightly mattresses with 24 Swg. G.I. wire netting and protect with 24 Swg. Aluminium Sheet on piping and 22 Swg. Aluminium sheet on equipments/Tanks secured in position by means of self-tapping screws with sufficient over lapping between joints.

- d) Density of Mineral Wool 150 Kg./Cubic Meter

50 mm thick	3500 sq.ft.	51=50
100 mm thick	3500 sq.ft.	65=70
150 mm thick	3500 sq.ft.	79=00

- (e) The thickness may be selected as per technical requirement.

It may thus be safely concluded that the use of MINERAL WOOL for lagging of steam pipes, vessels, tanks etc. is a better choice if not the best.

4.11 LOUVERS

Louvers basically are contours for allowing inlet air free of large foreign substances, and uniform spread of air over entire face area of Air Washer. Other important utilities of louvers are in providing shade without restricting airflow i.e. it is a structure, which is very important from VENTILATION point of view. Louvers also provide obstruction to rain, so that rainwater does not enter the work place and check water splash from spray chamber in case of Humidification Plant.

Louvers are made out of many raw materials, the one raw material PVC was not used earlier. We with our team of technical experts here at **PACK PLAST** have now successfully developed louvers and its fixing accessories in PVC.



PVC a versatile material has many advantages as enumerated below:

1. PVC products have pleasing colors and appearance hence have better aesthetic look and is unbreakable.
2. PVC products are no corrosive hence are better suited than G.I. (which is corrosive) in Humidification/Air conditioning plants. This being non biogradable has very long life.
3. PVC is unaffected by most of the chemicals & gases.
4. PVC can be extruded in any profile. This is also free from insect/algid attack, hence is far better than wood.
5. The length of PVC Louvers is kept approx. 700 mm (width being 125 mm approx.) To have proper strength and ease of maintenance. However the window size may be of any dimensions, as the window is equally divided in sections to accommodate the louvers of approx. 700 mm length. G.A. Drawing for fixing louvers in H&V Plants is also enclosed. For Cooling Towers the width of louvers is 170 mm approx.
6. No inspection door is required as the louvers are very easy to remove out of the slots and fitting back is also quite easy.

From the above we can easily evaluate that PVC is better than all earlier materials used for manufacture of LOUVERS.

THE PROVISION OF PVC LOUVERS IS MORE COST EFFECTIVE IN COMPARISON OF PERFORATED SHEET, AS THE DIFFERENCE IN COST IS MARGINAL CONSIDERING THE BETTER PERFORMANCE & EASE OF MAINTENANCE.

Looking at above it is clear that even the vertical members (which have slots to accommodate Louvers) should also be manufactured out of PVC material, which is non-corrosive.

The following comparison between Perforated Sheet Louvers (The General arrangement drawing for PVC Louvers enclosed) would make the matter technically clear:

We may thus very safely conclude that PVC Louvers are better suited than G.I. Louvers and Perforated Sheet whether G.I. or PVC



4.12 MIST ELIMINATORS

Mist Eliminators have been developed to meet out the requirements of various industries where elimination of mist from humid air is necessary to prevent droplets of mist carryover to the working area as also to remove dust particles from humid air.

Earlier the eliminators were manufactured out of G.I./Aluminium Sheet and had the following draw back.

1. They were prone to high corrosion due to being in continuous contact of moist air. This problem was faced more in industries located in coastal areas or chemical industries due to high TDS in water/environment.
2. Intricate designs for eliminators were not incorporated in spite of better efficiency of mist elimination due to limitations in sheet metal working. Accordingly the performance of sheet metal eliminators had been too far from desired norms.

These problems have almost been overcome due to advent of plastic era.

Now it is possible to incorporate any type of intricate design. A good design must fulfill the following:

- Less pressure drop and better efficiency of mist elimination at desired/designed air velocity.
- Higher the efficiency lesser the losses i.e. lower consumption of energy for driving the air through. The cost of energy required to drive air through eliminators is directly proportional to; pressure drop across eliminators.
- The eliminators must be compatible with higher operating velocities also. In the airflow cycle fan performance plays a vital role i.e. higher the velocity the smaller is the over all size of the plant which means lower capital investment.
- Due to better profile dust elimination is better thereby being more compatible to air washing operation.



With consideration of the above requirements we the **PACK PLAST INDUSTRIES**, KOTA are the pioneers in developing successfully PVC Mist Eliminators of various designs. [G.A. Drawing is also enclosed].

1. **F – 4 Type:** This Type of Eliminators are used in industry to prevent moisture carry over, it has a very intricate design which permits low-pressure drops. But they may be used where the height of Air Washer is not more than 2 meters. Up to this height these Eliminators work very efficiently. The Pitch kept for this type of Eliminators is 25mm Holding Blocks used for fixing these at such distances are also available. These Eliminators due to design restriction are used mostly for comfort cooling. In textile industry these Eliminators are not installed due to the notch getting choked up by fluff. Thereby causing water carry over.
2. **F – 6 Type:** These Eliminators can be used up to any height in industry. Practical trials have been carried out for height up to 4.8 meters. The design of these is broad base, i.e. against width of 170 mm for F- 4 type these come in width of approx. 245 mm. This gives it better protection against warping. The design also results in **minimum pressure drop**. They can be used at a pitch of 30 mm hence cost wise they are equal to F - 4 type. Special Holding Blocks have been developed to give them an equal pitch. As there is **no notch in these eliminators their use in Textile Industry is most logical**.
3. **F – 8 (4 Pass Small):** The width of eliminator is only around 160 mm and need much less space to install. These are most suited where the initial cost is to be kept low such as comfort cooling of Auditorium, Small Hotel, and Picture Hall etc. They have to be used at a pitch of 25 mm.
4. **F – 10 (4 Pass Medium):** The flat notch design makes it better than F-4 but not as good as F-6. However, the spacing of eliminator can be kept at 30 mm
5. **F – 12 (6 Pass):** The width of eliminator is appreciably more i.e. approx. 265 mm which make it suitable for use in plants consisting of High Pressure centrifugal fans. Here again pressure drop is high but Air cleaning is almost complete. They can be used at a pitch of 30 mm. The water droplet elimination is also best.



6. **F – 14 (4 Pass):** The eliminators are only approx. 160 mm in width and may be used in H&V Plant of textile industries but losses are much higher and durability is much lesser than that of F-6. They can be used at a pitch of 30 mm.
7. **F – 16 (4 Pass):** Their use is restricted to only plants meant for comfort cooling or where return air entering the plant is quite clean. Pressure drop here again is high. They can be used at a pitch of 30 mm.
8. **F - 18:** These eliminators are easy to use and have lowest pressure drop across them. But as the width is less and no notches are provided cleaning of air by these Eliminators is marginal. They can be used at a pitch of 30 mm.
9. **F - 20:** These are for high velocity air washers. These can reduce overall capital cost of air washer but once the manifold notches get clogged they loose their elimination and cleaning efficiency drastically. Advised for use in clean environment only. They can be used at a pitch of 30 mm.

It would be worth mentioning that:

The thickness of PVC Eliminator should be around 2 mm, so that it does not deform in due course of time.

LIFE OF PVC ELIMINATORS IS ALMOST UNLIMITED DUE TO PVC BEING A NON-BIO UNDEGRADABLE MATERIAL AND MAY BE USED UNTIL THESE BREAK.

There are other local types also available from various parties at slightly lower cost but pressure drop through eliminators is quite high causing excessive electrical energy consumption as compared to our F-6 (4 Pass) type eliminators which are most suited to textile industries.

The performance comparison of various eliminators is provided herewith to make the matter more clear on going through the:

- Pressure Drop with respect to velocity
- Separation efficiency with respect to velocity.

Further we would be pleased to welcome your queries and suggestion if any, on the issue of eliminators.



4.12.1 PERFORMANCE COMPARISON OF VARIOUS ELIMINATORS

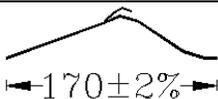
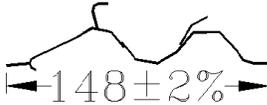
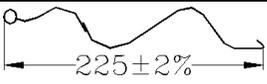
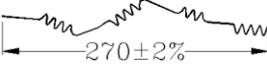
S. No.	Type of Pvc Eliminator	Max. Velocity Of Air Passing Through m/Sec.	Pressure Drop mm Of W.C. at standard velocity 3m/sec.	Mist Separation Efficiency %
1.	F – 4	4.25	2.2	99.8
2.	F – 6	3.50	4.0	99.5
3.	F – 8	2.75	4.0	98.7
4.	F – 10	4.00	4.0	99.5
5.	F – 12	4.25	5.5	99.8
6.	F – 14	5.00	5.6	99.5
7.	F – 16	3.50	4.0	99.0
8.	F – 18	4.00	2.0	99.5
9.	F – 20	5.5	4.0	99.5

Note: This data is collected after the eliminators were in use for 4-6 weeks in moderately clean environment.



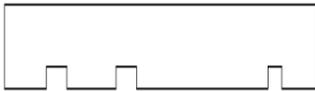
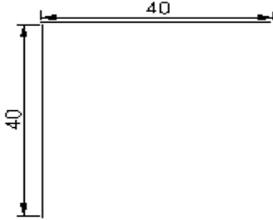
4.12.2 MATERIAL SPECIFICATIONS:

Eliminators are manufactured from Polyvinyl Chloride [Rigid] material. Weight and Dimensions are provided below for all type of eliminators:

Type	Wt/mtr.	Our choice	Profile	Best for
F-4	800 gm ± 10%	Medium Pressure Drop		Chilled water air washers
F-6	1100 gms ± 10%	Best Low Pressure Drop		Textile Industry
F-8	600 gms ± 10%	Low Pressure Drop		Cinemas Halls, Hotel etc.
F-10	800 gms ± 10%	Medium Pressure Drop		Textile Industry but low fluff operation
F-12	1350 gms ± 10%	High Pressure Drop		Tata Consultants [High velocity]
F-14	600 gms ± 10%	High Pressure Drop		Chilled water air wash
F-16	500 gms ± 10%	High Pressure Drop		Chilled water air wash
F-18	800 gms ± 10%	Low Pressure Drop		Textile Industry
F-20	900 gms ± 10%	Medium Pressure Drop		Very high velocity through eliminator



4.12.3 MATERIAL SPECIFICATION FOR ELIMINATOR ACCESSORIES:

S. No.	Item	Shape	Wt.
1	Stainless Steel Tie Rod with clip and Nut Nut – 5/16” Rod Dia – 5/16” Washer clip made from MS angle wt.275 gm/40x40x3 pair		150 gm/ Each ±5%
2	PVC Holding Block		250 gm/ Each ±5%
3	MS angle 60x40x5 Alu-Bitu coated OR Galvanised PVC for side and top sealing		
4	MS Z section for support of Holding Blocks Al. Bitu coated or Galvanised		kg/ mtr ±3%
5	MS End clips Manuf. From MS Flat 30x5 mm		475 gm/ mtr ±3%

4.13 POT STRAINERS

These are on line strainers, installed in suction or delivery of pump. Pot Strainers have perforated bucket, which collects the contaminations, and are required to be cleaned at regular intervals.

This system requires very high work efficiency.

The filtration screen should be of S.S wire mesh or brass sheet perforation.



4.14 RETURN AIR FILTRATION

Except for days when ambient conditions are very humid, the department air is sucked into return air trenches and taken back to Humidification Plant.

The department being contaminated with fine fluff, the return air also gets contaminated and if not cleaned tends to choke the Nozzles, Eliminators – hence the whole system.

There were only two types of filtration systems available.

- Static V Filters
- Rotary Filters

Both systems had its advantages and disadvantages. The Rotary Filter System, although clearing the Return Air, consumed lot of energy and static V filters were dependent on human efficiency.

We at **PACK PLAST** have developed a third system – **AUTO RETURN AIR CLEANSER**.

The filter mesh used in V Filters can be GI wire mesh or Nylon mesh or S.S. wire mesh. Regular manual cleaning of V filters is advisable to avoid load on axial flow fans.



4.15 RETURN AIR FLOOR GRILL

The basic requirement of return air floor grill is that it should allow the air to enter the return air duct with minimum possible resistance and also to be mechanically robust to bear the load of the trolleys passing over it.

We at **PACK PLAST** manufacture the Return Air Floor Grills considering the above requirement.

The Return Air Grill is manufactured as per customer's requirement/ specifications: -

1. With Pipe Structure
2. With Rod Structure
3. With Tee Structure
4. With Flat Structure

The Grills may be paint finished or galvanised plated as per choice of the customer.

MATERIAL SPECIFICATIONS:

The Return Air Grill has 2 Parts:

1. The Grill
2. The Grill Frame

The Grill:

The Grill can be manufactured from any of the above-mentioned four items but most common is Grills made out of MS Flat so that maximum opening for easy return air passage is available. Outer MS flat is 40x5 mm and inner MS Flat used is 30x5 mm with weight of 475 gms $\pm 3\%$ [Specification will vary with size]

The Grill Frame:

The Grill Frame is the frame to hold the grill. It is made from 50x50x5 angle for bigger sizes and 40x40x5 for smaller sizes.



4.16 SPRAY NOZZLES

An Air washer consists of primarily a spray chamber in which a number of water raisers and nozzles are installed. In spray chamber, air is brought into intimate contact with a dense mist of water. This dense spray or mist of water can only be obtained by using special nozzles.

We with our team of technical Experts at **PACK PLAST** have successfully developed various types of nozzles (with or without S.S. Orifice cap) in PLASTICS.

Spray nozzles are designed to produce a dense mist. To accomplish this at reasonable water pressure, the body of the nozzle is designed to give the water a swirling motion before it reaches the orifice cap. The cap, in turn, has been given a specific shape for added acceleration to the water before it emerges out of the orifice resulting in proper and thick mist.

The Air Washers may have one, two or some times even three banks of spray nozzles, depending on Relative Humidity requirement in work- hall.

The principal factors affecting the efficiency of an Air Washer are air velocity, the quantity of water sprayed per unit volume of air, the length of chamber and the fineness of the mist.

The fineness of the mist depends upon the design of nozzle and the operating pressure.

Nozzles used for Air Washer ordinarily have a capacity of approximately 0.082 LPS to 2.212 LPS per nozzle. The pressure required to force this quantity of water through the nozzles is approx. 2 Kg/cm².

In single bank air washers, about 0.32 LPS of water is required per 1700 CMH capacity of H&V Plant. In a two bank washer twice and in three bank thrice of this quantity i.e. 0.64 & 0.96 LPS respectively. This increased quantity of water results in a dancer & thicker mist (which makes it possible for total saturation of air.). The quantity of water bank can be varied by installing a larger or smaller number of nozzles.



PACK PLAST manufactures variety of spray nozzles as shown below:

(1) HYBRI-DOME Nozzles

These are Latest nozzles specially meant for Textile Industry. As Textile Industry Air Washers have lot of contamination even the non-clog type nozzles fail. Hybri – Dome Nozzles have very high output with very fine mist therefore the nozzle requirement is 1/15th of Conventional Type nozzles. This means maintenance is MINIMUM.

(2) Spoon Type Nozzles.

Please specify whether the connection required is female or male.

(3) Non Clog Type Nozzles

a. Non Clog spring on Clamp.

Please specify exact outer dia of pipe on which these nozzles are to be fixed.

b. Non Clog Nut & Bolt tightening Clamp type.

c. Non Clog screw type (Female).

Please specify exact outer dia of pipe on which these nozzles are to be fixed.

(4) Air Water Internal mix Nozzles.

These are most modern nozzles giving very fine spray. The atomization is to the extent of 0.05 mm, which causes high saturation efficiency of air washers. These being special nozzles operate on open circulation circuit using clean, soft water.



4.17 WATER FILTER

Even with high standards of Return Air clearing, it is essential to filter the water in tank so that Nozzle maintenance is minimum.

The water filters can be:

- Plain water screen filters installed in tank.
- Rotary water filters
- Pot Strainer.

The simple water screen filter has screen fitted in frame, which can be removed at regular intervals and cleaned to be refitted. The system should have spare slot for frame insertion so that cleaned frame can be inserted before taking out the choked screw. Please see diagram.

Rotary Water Filters have rotating screen or rotating brush, which cleans the system at predetermined cycle, fixed on timer. These though costly have higher level of efficiencies than manual filter.



Hope you have gained some insight on the running of Air Systems through our booklet.

For any type of Product/Project Enquiry or Consultancy, please feel free to **CONTACT US.**

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