DESIGN OF HVAC SYSTEM FOR BEVERAGE INDUSTRY

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Abstract. The objective of this project is to design HVAC system for beverage industry. Firstly, the requirements and Design Basic Report (DBR) of the HVAC system are defined. DBR gives a clear picture of filtration level, required conditions, Cost-effectiveness, Energy conservation, Fire safety, Indoor air quality (IAQ) and Ease of maintenance. Air Flow diagram makes you understand the Air Handling Unit (AHU) zoning for the HVAC system. Beverage industry zoning areas include pulp cutting, blending and homogenizer, filler, anteroom, CIP room and pasteurization. Design calculation provides the data for recirculation and 100% fresh air supply and return system. Processing line is having sequence process rooms and each room have its own individual cooling load calculations. Design calculation gives the value of Tonnage of refrigerant, CFM and Dehumidification capacity of the system. Ducting layout issue the best routing for the site installation to distribute the air from the supply and return system. It includes the details of Damper, Ducting, Duct Insulation and Instrumentation to use in the facility. Supply and return system placement are also covered in this layout drawing and the Bill of Quantity is prepared.

1 Introduction

Heating, ventilation, and air conditioning (HVAC) is the technology developed for environmental comfort both indoor and vehicular spaces. Environmental comfort in spaces aimed at providing thermal comfort and acceptable air quality. Based on the principles of thermodynamics, fluid mechanics and heat transfer, HVAC system design is a sub discipline of mechanical engineering.

HVAC is a part of residential structures such as hotels, single family homes, senior living facilities, apartment buildings and, medium to large industries, hospitals and office buildings. Transportation facilities such as cars, trains, airplanes, ships and submarines, and in marine environments, where safe and healthy building conditions are regulated with respect to humidity and temperature, using fresh air from outdoors.

Ventilating or ventilation (the V in HVAC) is the natural or mechanical/forced process of exchanging or replenishing air in any confined space. Ventilation provides high indoor air quality which involves temperature control, humidity control, oxygen replenishment, and removal of moisture, odors, smoke, heat, dust and airborne bacteria. Ventilation in addition to introducing outside air, maintains circulation in the interiors and prevents stagnation of interior air. Ventilation includes both the exchange
of air to the outside as well as circulation of air within the building. It is one of the most important factors for maintaining acceptable indoor air quality in buildings.

2 Scheme Design and DBR

The purpose of Design Basis Report (DBR is to specify the requirements and general scheme of HVAC system for proposed Tetra line project. The HVAC system design scheme is based on a) Standards and Guidelines, b) Basic Concept Design and c) System Description. The HVAC system design shall conform / comply with the requirements of SMACNA, ASHRAE, ISHRAE and NBC.

Basic concept design is done based on Metrological data of location, occupancy level, internal heat generation due to lighting load, equipment load, etc. Input data for air conditioning system and ventilating system were provided based designated temperature to be maintained, occupancy, volume and thermal load data. Lighting and equipment load, ACPH, volume and area data, temperature are used as input parameters for AHU, Air-conditioning and ventilating system [1].

System description provides the AHU configuration needed based on input design parameters. Filtration level, type of blower, chilled water cooling coil requirements, operating pressure, electrical requirement and electrical motor details define the selection of AHU for HVAC system.

2.1 Standards and Guidelines

The HVAC system design shall conform / comply with the requirements of the following Standards and Guidelines as mentioned below:

a. Sheet Metal & Air Conditioning contractors’ National Association (SMACNA)
b. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
c. Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE)
d. National Building code of India (NBC)

2.2 Basic Concept Design

Concept design of HVAC system is developed using the above mentioned guidelines stated for the purpose. Concept design part need data pertaining to location, climatic conditions, conditions to be maintained in particular area and number of people working in that area [2].

2.2.1 Basic Service conditions

The HVAC system designing will be done considering the environmental conditions such as temperature, humidity etc, as applicable around the facility, during all seasons. The design condition for Bidadi (Place near Bangalore) is as mentioned below (Reference Considered nearest City Bangalore from ISHRAE HVAC Handbook / Metrological Data).

| Season  | Dry bulb temperature [°F] | Wet bulb temperature [°F] | Relative Humidity [%] |
|---------|---------------------------|---------------------------|-----------------------|
| Summer  | 96.0 (35.6°C)             | 78.0 (25.6°C)             | 45                    |
| Monsoon | 82.0 (27.8°C)             | 78.0 (25.6°C)             | 82                    |
| Winter  | 58.0 (14.4°C)             | 54.0 (12.2°C)             | 78                    |

The selection of HVAC equipment shall be governed by safety, reliability and compatibility with respect to specified future expansion, design margins, suitability for environment, economic considerations and past service history. The SI & FPS system of units shall be used. English language shall be used for all drawings, texts and communications. For the purpose of electrical grounding calculations (soil electrical resistivity) and cable rating calculations (soil thermal resistivity); the soil resistivity data indicated in the Geotechnical investigation report for provided by Client shall be used.

2.2.2 Occupancy Level
Maximum no. of people working in a given area will be considered for HVAC designing. The amount of physical human effort needed to do the work is proportional to heat generated while doing the work. Moderate physical working shall be considered for calculating latent and sensible load from the personnel.

2.2.3 Fresh Air Selection
The amount of fresh air taken into the system is decided on process happening in the given area. More fresh air intake will reduce the efficiency of HVAC system. Hence, fresh air will be selected on the following basis
a. Minimum fresh air 10% of CFM (As per industrial standard practice.)
b. Ex-filtration through doors

2.2.4 Internal Load
In addition to above discussed parameters, process happening in the area will have a major effect in designing HVAC system. Usage of electrical equipment and process equipment will generate heat due to energy conversion and this is to be considered while deciding on conditions to be maintained in processing area.

| Type of Load                              | Values                                          |
|-------------------------------------------|------------------------------------------------|
| Lighting Load                             | 2 Watts/sq.ft.                                  |
| Heat Dissipated from the occupancy Sensible Latent | 265 / 365 Btu/hr                               |
| Heat Dissipated from electrical motor     | Inefficiency of the motor. For calculations 20% considered for all motors. |
| Heat Dissipated from AHU / motor          | Motor HP calculated based on the dehumidifier. CFM and same is considered for heat load calculations. |
| Heat gain return air duct                 | 20 CFM leakage per 100 sq.ft. of duct.          |
| Convection + radiation heat               | At actual                                      |
| Heat Dissipated from UPS System           | On Full load of UPS system, for calculations 8% considered |
| Heat Dissipated from Battery System       | On Full load of Battery system, for calculations 2% considered |

3 Process Description
Beverage industry in which HVAC system to be installed consists of a tetra-pack line processing. The line moves through the following rooms. Room description and processes involved in those rooms are to be provided as input for detailed design of HVAC system.

Tetrapack line processes start at pulp cutting room and moves to blending and homogenizer room. Filling room, PM store and compactor are the areas down the process line that are to be considered for HVAC system design. Partial installation of HVAC system in a building without isolation of rooms will make the system inefficient. Office rooms, both existing and new office are considered in HVAC system design and necessary conditions are maintained in office area accordingly. Battery room and UPS room which normally gets heated are included, while designing the system.
Table 3. Input Data for Air conditioning System

| S.No. | Description            | Area (sq. ft.) | Lighting Load (Watts) | Equip Load (kW) | Occupancy | Design Temperature (°C) | ACPH |
|-------|------------------------|----------------|-----------------------|-----------------|-----------|-------------------------|------|
| 1     | Pulp Cutting           | 627            | 1254                  | 2               | 2         | 24 ° ± 2°                | 4 to 6|
| 2     | Blending &             | 1899           | 3798                  | 28              | 2         | 24 ° ± 2°                | 4 to 6|
|       | Homogenizer Room       |                |                       |                 |           |                         |      |
| 3     | Filling                | 1305           | 2610                  | 12              | 2         | 22 ° ± 2°                | 4 to 6|
| 4     | PM Store               | 870            | 1740                  | 0               | 2         | 28 ° ± 2°                | 4 to 6|
| 5     | Compactor              | 1423           | 2134                  | 0               | 2         | 28 ° ± 2°                | 4 to 6|
| 6     | Existing Office        | 236            | 472                   | 1               | 4         | 24 ° ± 2°                | 4 to 6|
| 7     | Office                 | 86             | 172                   | 0.5             | 2         | 24 ° ± 2°                | 4 to 6|
| 8     | UPS Room               | 241            | 482                   | 32              | ---       | 22 ° ± 2°                | 4 to 6|
| 9     | Battery Room           | 146            | 392                   | 8               | ---       | 22 ° ± 2°                | 4 to 6|

Table 4. Input Data for Air Washer, Exhaust and Ventilation System

| S.No. | Description                | Length (m) | Width (m) | Area (m²) | Height (m) | Volume (m³) |
|-------|----------------------------|------------|-----------|-----------|------------|-------------|
| 1     | Air Washer System          |            |           |           |            |             |
| 1.1   | CIP Room                   | 11.25      | 9.7       | 109       | 4.8        | 524         |
| 1.2   | Pasteurizer Room           | 6.02       | 9.7       | 58        | 4.8        | 280         |
| 1.3   | Considering 6 nos. pot cooling points in at1000 CFM per point | | | | | |
| 2     | Exhaust Air System         |            |           |           |            |             |
| 2.1   | CIP Room                   | 11.25      | 9.7       | 109       | 4.8        | 524         |
| 2.2   | Pasteurizer Room           | 6.02       | 9.7       | 58        | 4.8        | 280         |
| 3     | Ventilation System         |            |           |           |            |             |
| 3.1   | CIP Tank Area Exhaust      | 5.4        | 2.5       | 13.5      | 4.8        | 64.8        |
| 3.2   | CIP Tank Area Fresh Air    | 5.4        | 2.5       | 13.5      | 4.8        | 64.8        |

The various data inputs required for HVAC system, Ventilation air washer system and exhaust air system from various rooms and areas are given in the tables 3 and 4. Based on the inputs, Air handling system configuration suitable for beverage industry is given in table 5.
Table 5. AHU System configuration

| AHU Configuration                  | Recommendations                                      |
|-----------------------------------|------------------------------------------------------|
| Unit Construction                 | Double Skin, Single Blower.                          |
| Filtration level                  | Supply through Pre filter (G-4), Fine Filter (F6 & F9) in Plenum. Fresh air filter G-4 |
| Type of Blower                    | Plug type fan with flow measuring device comprising of Calibrated nozzle and differential pressure switch. Supply air fan shall be provided with variable speed Drive and shall be compatible with VFD. |
| Chilled Water cooling coil         | Minimum 4-6 row deep                                 |
| AHU Bleed                         | Bleed air exhaust to atmosphere through G-4 Filter   |
| Dampers                           | At AHU return and supply air cut-outs, fresh air and bleed air cut-out. Motorized Fire Damper inSupply and Return, mounted on AHU. |
| Pressure                           | Controlled air flow to protect the product throughPressure differential. |
| Magnallic Gauge                   | To be installed across the Filter                    |
| Construction arrangement          | All door shall be hinged type and Limit Switch       |
| Electrical Requirement            | AHU shall have remote start stop arrangement andStart-stop |
| Electrical Motor                  | 415 V 3 Phase, IE 2 Type Motor suitable to operate through VFD |

4 System Description

HVAC system design is concerned with heat removal and maintaining comfort conditions, allied systems like ventilation air washer system and exhaust air systems are also to be designed properly for better and durable functioning of system.

4.1 HVAC System

The HVAC systems shall be designed to produce an environment, 24 hours a day, entire year that will have the appropriate air change rates, temperatures, and achievable humidity levels as providing comfort conditions in the following areas

4.1.1 Pulp cutting Room, Blending and Homogenizer Room

The pulp cutting Room, blending and homogenizer Room shall be fed with one recirculation AHU which is located in the loft area inside the pasteurizer room. The supply air from the AHU is passed through rectangular duct above the false ceiling area. It is suggested to have the jet nozzle diffuser for supply air in the pulp cutting and blending and homogenizer room.

The return air shall be collected through the return air grills which are fixed at the false ceiling and connected to the Return air duct. The return air duct running above the false ceiling to reach mixing box of AHU.
The supply air duct shall be provided with thermal insulation with 19mm thick nitrile rubber insulating material and return air ducts shall be provided with thermal insulation with 13mm thick nitrile rubber insulation. The fresh air is drawn from the outside to the mixing box through the fresh air duct at ceiling level. The fresh air duct shall be with louver fixed at the external wall, damper and filter. The cooling coil shall be connected with chilled water supply and return pipes with necessary valves and fittings. The chilled water temperature shall be around 7 °C and 12 °C.

The suggested air treatment process is as follows. Fresh air will be sent through Pre-filter (G4) and then supplied to Mixing Box. Return air is mixed with 10% fresh air in mixing chamber and passed through Pre-filter (G4), Intermediate filter (F6), Cooling Coil, Fan and after passing through fine filter (F9) in Plenum, it is supplied to rooms through Jet Nozzles mounted at false ceiling.

4.1.2 Filling area
The Filling area shall also be fed with samerecirculation AHU which is located in the loft area inside the pasteurizer room. The supply air from the AHU is passed through rectangular duct above the false ceiling area. It is suggested to have the jet nozzle diffuser for supply air in the filling area from the ceiling and part of supply air is supplied through the return air grille fixed in the panel and level of the return air grille from the floor level maintained is around 500mm.

The return air shall be collected through the return air grills which are fixed at the false ceiling and connected to the Return air duct. The return air duct running above the false ceiling to reach mixing box of AHU. The fresh air is drawn from the outside to the mixing box through the fresh air duct at ceiling level. The fresh air duct shall be with louver fixed at the external wall, damper and filter. The supply air duct shall be provided with same amount of thermal insulation as specified above. The ducts running above the false ceiling area shall be rectangular in shape and ducts running in non-false ceiling areas shall be with circular in shape. The cooling coil is connected with chilled water supply and return pipes.

The suggested air treatment process is as follows. Fresh air will be sent through Pre-filter (G4) and then supplied to Mixing Box. Return air is mixed with 10% fresh air in mixing chamber and passed through Pre-filter (G4), Intermediate filter (F6), Cooling Coil, Fan and after passing through fine filter (F9) in Plenum, it is supplied to rooms through Jet Nozzles mounted at false ceiling and few supply grills mounted at wall panels at floor level and is around 500mm.

4.2 Ventilation Air Washer System
Two stages Air washer system is adopted to feed the CIP, Pasterization and spot cooling to Tetra Line Areas. The inside condition will be few degrees less than the ambient.

Air washer unit shall be with double skin construction and comprising of Blower section, sensible heat exchanger, adiabatic Heat exchanger, filters and recirculation pumps. Filters shall be G4, F6 and F9 and pumps shall be submersible type. Common unit is considered to feed the CIP, Pasteurization and spot cooling requirement for Tetra line area.

The Air washer unit is placed outside near to the feeding areas. The air washer system unit shall be provided water connection and arrangement shall be made for adequate water quantity and required water quality. The duct from the air washer unit shall be running above the false ceiling and air supplied through the grills. The supply air duct shall be thermally insulated with 19mm thick nitrile rubber insulating material.

Fresh air is passed through pre-filter (G4) and Intermediate filter (F6). Using spray arrangement and fan it is again passed through fine filter (F9) in Plenum before supplying to rooms through grills mounted at false ceiling.

4.3 Exhaust Air System
Exhaust air system shall be provided for CIP and Pasteurization areas. The Common exhaust fan is placed outside and near to the feeding areas. The duct from the Exhaust air unit shall be running above the false ceiling and air drawn from exhaust grill which are fixed in the false ceiling. Used air is filtered using pre-filter (G4) before its exhaust to the atmosphere. Spot cooling supplied to the Tetra line Area shall escape through the turbo ventilator provided at the roof level.
5 Detail Engineering

Detail engineering or detailed design engineering is a development of all required construction documents and drawings up to AFC (Approved for Construction) Stage for the construction and detailed bill of materials (BOM) for the bulk material procurement based on the basic or front end engineering design (FEED) package. The detailed Design and engineering is limited to verifying design basis but producing all construction drawings after incorporating vendor information.

5.1 Air Flow Diagram

Air Flow Diagram consisting of details air handling unit parts, dimensions and zoning. Areas that covered with one air handling unit called AHU zoning. This will give you the parts information AHU size, blower, filter, heating coil, cooling coil, louvers, dampers, and the number of rooms covered.

Air Flow diagram makes you understand the AHU zoning for the HVAC system. Tetra line process areas pulp cutting, blending and homogenizer, filler, anteroom, CIP room, Pasteurization and tetra line area zonings are included. Design calculation provides you a data for recirculation and 100% fresh air supply and return system. Tetra packs line having sequence process rooms, each room having individual cooling load calculation. Calculation gives the value of Tonnage of refrigerant, CFM, Dehumidification and capacity of the systems.

5.1.1 Recirculation System

Recirculation system is providing the fresh air considering space and occupancy level according ISHRAE standard. People to breathe and space ventilation. Thermal comfort zones are recommended to recirculation system for better efficiency of operation.AFD for Recirculation system schematic drawing is prepared for understanding the flow.

5.1.2 Air Washer Unit

Air washer is a piece of equipment that is designed to improve air quality by scrubbing the air that moves through it and adjusting humidity levels keep the environment consistent. As per the process requirement of the tetra pack line we go with the air washer unit with 100% exhaust system.It is the healthier system since it works on 100% fresh air. Low installation cost and low running cost. As per the process requirement of the tetra pack line we go with the air washer unit with 100% exhaust system.AFD for Air Washer Unit schematic drawing is also prepared for understanding the flow.

5.2 Design Calculation for heat generation/gain

Design calculation gives you a full study of heat gain from all part of the room also from the equipment. Heat gain from the wall, roof, and processing equipment are used to calculate the overall heat load, based on which, the ton of refrigerant (TR) and dehumidified CFM are decided [3,4]. In beverage industries, pulp cutting room, filler room and ante room are recommended to recirculation system as per ASRHAE standard and sample calculation of one room is given below.

5.2.1 Pulp Cutting Room

The pulp contains the juice of the fruit. The pulp usually removed from fruit juice by filtering it out. The colour of the pulp can change depending on the species and the ripening stage. Usually it has the colour of the fruit’s peel. This is process room for juice flavour where all the fruit getting processed and sized for soft drink preparation. The next process is to blend and homogenise the drink. Design conditions for pulp cutting room is given in table 6.

5.2.2 Filler Room

Filling describe the process whereby a receptacle in tetra pack is filled with a viscous and pasteurized product. Filler machine need thermal comfort for better performance so we are recommending the recirculation system.

5.2.3 Ante Room

Ante room acts as a store and they do not get wet due to condensation while unloading for dispatch.
5.2.4 Design calculation for Pulp cutting room
Temperature, Humidity, Occupancy of people, etc. are given as input to calculate total air change required per hour. Table 7 provides the heat load calculation for pulp cutting room. Total heat generated from the room is calculated which includes heat emitted from walls, roofs, occupants, equipment, latent heat, sensible heat and heat from outside air [3,5].

| Design Conditions | DB  | WB  | RH% | GR/LB |
|-------------------|-----|-----|-----|-------|
| Outside           | 96  | 78  | 45  | 134   |
| Room              | 72  |     | 55  | 72    |
| Diff.             | 24  | Daily range - 22 | | 62    |
| Ventilation: People | 2  | X   | 15  |       |
| 1 air change/Hr   |     |     |     | 235   |
| Outside air       | 40  |     |     | CFM   |
| ADP               |     |     |     | 57    |
| Dehumidified rise |     |     |     | 13.5  |
| Dehumidified CFM  |     |     |     | 3962  |

Check figures

| CFM/TR            | 544 |
| Sq.ft/person      | 352 |
| Watts/sq.ft       | 2.0 |
| Sq.ft/TR          | 97  |
| Dehum. CFM/sq.ft  | 5.62|
| Total air change/Hr | 9.9 |
**Table 7. Heat load calculation for Pulp cutting room**

| JOB NAME          | TETRA PACK LINE | AREA     | 704.534 | Sq.ft |
|-------------------|-----------------|----------|---------|-------|
| SPACE USED FOR    | Pulp cutting    | VOLUME   | 14096.3 | Cu.ft |
| Length            | 5.745           | Breadth  | 11.393  |       |
| Height            |                 |          |         | 20.008|

| Item                            | Area/ Qty | Sungain | Temp. diff factor | BTU/HR |
|---------------------------------|-----------|---------|------------------|--------|
| **SOLAR GAIN - GLASS**          |           |         |                  |        |
| Glass                           | 0 Sq.ft   | X 0.56  |                  | 0      |
| Glass                           | 0 Sq.ft   | X 0.56  |                  | 0      |
| **SOLAR & TRANS. GAIN - WALLS & ROOF** | | | | |
| Wall                            | 0 Sq.ft   | X 0.366 |                  | 0      |
| Wall                            | Sq.ft     | X 0.366 |                  | 0      |
| Wall                            | Sq.ft     | X 0.366 |                  | 0      |
| Wall                            | Sq.ft     | X 0.366 |                  | 0      |
| Wall                            | Sq.ft     | X 0.366 |                  | 0      |
| Roof                            | Sq.ft     | X 0.12  |                  | 0      |
| **TRANS.GAIN - EXCEPT WALLS & ROOF** | | | | |
| All glass                       | 0 Sq.ft   | 24 X 1.13 |                  | 0      |
| Partition (wall)                | 674.31 Sq.ft | 19 X 0.375 | 4804      |
| Partition (panel)               | 1376.66 Sq.ft | 19 X 0.1 | 2616      |
| Partition (glass)               | 135.63 Sq.ft | 19 X 0.446 | 1149      |
| Ceiling                         | 704.53 Sq.ft | 19 X 0.1 | 1339      |
| Outside air                     | 400 CFM   | 24 X 1.08 | 1037      |
| **INTERNAL HEAT**               |           |         |                  |        |
| People                          | 2 People  | X 265   |                  | 530    |
| Appliances                      |           |         |                  | 0      |
| Lights                          | 1409.07 Watts | 1.08 X 3.413 | 5194    |
| Equipment                       | 12 kW     | 1 X 3413 | 40956      |
| System gain & safety factor -5% |           |         |                  | 2750   |
| Total room sensible heat        |           |         |                  | 57760  |
| **Room latent heat**            |           |         |                  |        |
| Outside air                     | 400 CFM   | 62 X 0.68 | 1686      |
| People                          | 2 People  | X 365   |                  | 730    |
| Steam                           |           |         |                  | 0      |
| System gain & safety factor -5% |           |         |                  | 121    |
| Total room latent heat          |           |         |                  | 2537   |
| **Room total heat**             |           |         |                  | 60297  |
| **Outside air heat**            |           |         |                  |        |
| Sensible                        | 400 CFM   | 24 X 1.08 | 9331      |
| Latent                          | 400 CFM   | 62 X 0.68 | 15178     |
| System gain & safety factor -3% |           |         |                  | 2544   |
| Return air heat gain            |           |         |                  | 0      |
| **GRAND TOTAL HEAT**            | TR =      |         |                  | 87350  |
5.3 Design Calculation for Ventilation System

Two stages Air washer system is adopted to feed the CIP, pasteurization and spot cooling to Tetra Line Areas. The inside condition will be few degrees less than the ambient. Air washer unit shall be with double skin construction and comprising of Blower section, sensible heat exchanger, adiabatic Heat exchanger, filters and recirculation pumps. Filters shall be G4, F6 and F9 and pumps shall be submersible type.

Common unit is considered to feed the CIP, Pasteurization and spot cooling requirement for Tetra line area. The Air washer unit is placed outside near to the feeding areas. The air washer system unit shall be provided water connection and arrangement shall be made for adequate water quantity and required water quality.

| Sl.No. | Description                  | Length (m) | Width (m) | Area (m²) | Height (m) | Volume (m³) | Volume (cu.ft) |
|--------|------------------------------|------------|-----------|-----------|------------|-------------|---------------|
| 1a     | CIP ROOM                     | 6.3        | 11.5      | 72        | 5.5        | 398         | 14060.98      |
| 1b     | CIP ROOM                     | 3.42       | 11.5      | 39        | 4          | 157         | 5551.35       |
| 2      | Pasteurizers Room            | 5.72       | 11.04     | 63        | 5.5        | 347         | 12255.82      |
| 3      | Considering 6 Nos spot cooling points in Tetra Line Area at 1000 cfm per point |            |           |           |            |             |               |

Table 8 provides volumetric area for ventilation in CIP, Pasteurization and Tetra line. Table 9 provides ventilation calculations to find total air supply and exhaust from the system [4,6,7].

| Sl. No. | Description                  | Volume (cu.ft) | ACPH | Supply Air CFM | Rounded Supply Air CFM | Exhaust Air CFM (90% of Supply Air) | Rounded Exhaust Air CFM |
|---------|------------------------------|----------------|------|----------------|------------------------|--------------------------------------|-------------------------|
| 1a      | CIP ROOM                     | 14060.98       | 40   | 9373.99        | 9400                   | 8460                                 | 8500                    |
| 1b      | CIP ROOM                     | 5551.35        | 40   | 3700.90        | 3700                   | 3330                                 | 3500                    |
| 2       | Pasteurizers Room            | 12255.82       | 40   | 8170.54        | 8400                   | 7560                                 | 7500                    |
| 3       | Considering 6 Nos spot cooling points in Tetra Line Area at 1000cfm per point | 6000          | 0    |                |                        |                                      |                          |

Table 9. Ventilation calculation for CIP, Pasteurizer and tetra line

5.4 Ducting layout

Ducts are used in heating, ventilation, and air conditioning (HVAC) to deliver and remove air. The needed airflows include, for example, supply air, return air, and exhaust air. Ducts commonly also deliver ventilation air as part of the supply air. As such, air ducts are one method of ensuring acceptable indoor air quality as well as thermal comfort.
Ducting layout issue the best routing for the site installation to distribute the air from the supply and return system. It consisting of the details of Damper, Ducting, Duct Insulation and Instrumentation to use. A duct system is also called ductwork. Planning (laying out), sizing, optimizing, detailing, and finding the pressure losses through a duct system is called duct design.

6 Conclusion
Design calculation provides the data for recirculation and 100% exhaust System. Tetra packs line having sequence process rooms and for each room, individual cooling load calculation. Calculation gives the value of Tonnage of refrigerant, CFM, Dehumidification and capacity of the systems. Ducting layout issue the best routing for the site installation to distribute the air from the supply and return system. Details like damper requirements, ducting, duct insulation and instrumentation to use in the facility will be available. Supply and return system placement are also covered in the layout drawing. Bill of quantity provides the detailed equipment requirements for HVAC system installation.

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