PNEUMATIC CONVEYING SYSTEM

Practical Design of Lean Phase Pneumatic Conveying System And development of Application in Microsoft Excel

Summer Internship Project-2023

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ABSTRACT

The project report contains detailed theoretical design aspect of lean phase pneumatic conveying system, development of Microsoft Excel based application to calculate desired flow rate and pressure drop for determining optimum specifications of equipments, and analysis of various parameters which affect the system values.

Acknowledgements

I have accomplished the summer internship project having title "***Pneumatic Conveying System - Practical Design of Lean Phase Pneumatic Conveying System And development of software in Microsoft Excel***" under the guidance and supervision of ***Mr. Piyush Srivastava, (Technical Consultant at Green Tech. Solutions)*** who has provided valuable suggestions and support throughout the duration of the project.

I have gone through various research papers and theoretical work done on this topic and have tried to accomplish numerical practical solution for practical industrial design of lean phase pneumatic conveying system by carefully understanding complex formulae of fluid flow and particle flow behavior, and developing Excel based software to work out various design parameters by putting desired input parameters and complex equation calculations.

Any references, data, figures, or ideas obtained from external sources have been duly acknowledged and cited within the project report.

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INTRODUCTION

A pneumatic conveying system is a method of transferring bulk materials, such as powders, granules, or pellets, through pipelines using air or gas as the conveying medium. It is commonly used in industries such as food processing, pharmaceuticals, chemicals, and manufacturing, where the efficient and reliable transfer of materials is essential. The basic components of a pneumatic conveying system include:

1. Material Source: This is the point where the bulk material is fed into the system. It could be a hopper, silo, or any other storage vessel.

2. Conveying Pipeline: This is a closed pipeline through which the material is transported. It is typically made of metal or plastic and can be horizontal, vertical, or inclined.

3. Air/Gas Source: A blower or compressor provides the necessary air or gas pressure and desired volumetric flow to transport the material through the pipeline.

4. Material Receiver: The material receiver is the destination point where the material is collected after it has been conveyed. It may be a Cyclone silo, bin, or any other storage container.

5. Control System: A control system regulates the flow of material and air/gas in the conveying system. It includes various instruments and devices such as pressure sensors, flow meters, and valves to ensure proper operation.

Advantages of pneumatic conveying systems include:

1. Versatility: Pneumatic conveying systems can handle a wide range of materials, including fine powders, granules, abrasive materials, and fragile particles.

2. Dust-Free Operation: The enclosed pipeline design minimizes dust emissions during material transfer, enhancing worker safety and maintaining a clean working environment.

3. Flexibility: Pneumatic conveying systems can be designed to handle various routing configurations, allowing for flexible material transfer across different areas of a facility.

4. Automation and Control: These systems can be easily automated and integrated into a larger control system, enabling precise control of material flow and monitoring of process parameters.

5. Reduced Manual Handling: Pneumatic conveying systems eliminate the need for manual handling of materials, reducing labour costs and the risk of injuries.

Disadvantages of pneumatic conveying system include:

1.Energy Consumption: Pneumatic conveying systems require a significant amount of energy to generate and maintain the airflow & Pressure needed to transport materials. The compressors, blowers, or vacuum pumps used in these systems consume electricity or other forms of energy, leading to higher operating costs.

2. Material Degradation or Damage: Some materials, especially those that are fragile, abrasive, or prone to degradation, can be susceptible to damage during pneumatic conveying. The high-velocity airflow or impact within the pipeline can cause particle attrition, breakage, or generation of fines. Careful consideration of material characteristics and proper system design is required to minimize potential damage.

3. Limited Material Compatibility: Pneumatic conveying systems may not be suitable for all types of materials. Certain materials may be too cohesive, sticky, or have poor flow properties, making it challenging to transport them effectively. Additionally, materials with a high moisture content or those prone to moisture absorption may require additional drying or dehumidification steps before pneumatic conveying.

4. Noise and Dust Generation: Pneumatic conveying systems can generate noise and dust during operation. The high-velocity airflows, material impact, and air-material separation can produce noise levels that require noise control measures. Additionally, the handling and movement of materials can generate dust, necessitating proper dust collection and filtration systems to maintain a clean and safe working environment.

TYPES OF PNUMATIC CONVEYING SYSTEM

Based on flow regime:

1. **Lean/dilute phase pneumatic conveying system.**
2. **Dense phase pneumatic conveying system.**

Lean/dilute phase pneumatic conveying system

Lean / Dilute phase pneumatic conveying systems is essentially a process that transfers material with low pressure and at high velocity. Lean Phase pneumatic conveying system is a suitable process for conveying of non-friable and non-abrasive materials suspended in air with low material to air ratio.

Also referred as suspension flow, most of the materials are conveyed irrespective of the particle size, shape or density.

Powders with low bulk density that are fine in nature with less air retention capability are conveyed in suspension flow in a dilute mode wherein material to air ratio is low.

Features of Lean/Dilute Phase Pneumatic Conveying:

The positive lean/dilute phase pneumatic conveying system has several key features that make it suitable for handling fine powders and granular materials. Here are some of its notable features:

1. Dilute Phase Conveying: The system operates in a dilute phase, which means that the material is transported in a relatively low concentration within the conveying air or gas. This feature allows for efficient and fast material transfer.

2. High Conveying Velocity: The air or gas velocity in a positive lean/dilute phase system is typically high. The high velocity ensures effective suspension and transport of the material particles through the pipeline.

3. Gentle Material Handling: The low material-to-air ratio in this system results in gentle handling of the materials. This feature is particularly important when dealing with fragile or delicate materials that are prone to breakage or degradation.

4. Reduced Material Degradation: The positive lean/dilute phase conveying system minimizes collisions and impacts between material particles, reducing the risk of material degradation or damage during transportation.

5. Suitable for Fine Powders and Granular Materials: This system is well-suited for handling fine powders and granular materials with particle sizes ranging from microns to a few millimeters.

8. Dust-Free Operation: The enclosed pipeline design of the system minimizes the release of dust or fine particles into the surrounding environment, ensuring a clean and dust-free operation. This feature is important for maintaining a safe and healthy working environment.

Dense phase pneumatic conveying system

Dense Phase Pneumatic Conveying System is essentially a conveying process that transfers the material with high pressure at low velocity and high product-air ratio. It is suitable for conveying of materials that are friable, fragile, abrasive, or agglomerated in nature.

Dense phase conveying system conveys bulk solids at long distances from single/multiple locations to single /multiple points preventing low material degradation. It transports abrasive materials with comparatively less wear and tear of the system and product as well. Compared to Mechanical conveying, long distance transportation is an added advantage in dense phase conveying.

Features of Dense Phase Pneumatic Conveying:

1. High Material-to-Air Ratio: Dense phase conveying systems typically have a high material-to-air ratio, meaning a larger quantity of material is conveyed with a lower volume of air. This results in more efficient transportation and reduced energy consumption.

2. Low Velocity: The airflow in a dense phase system is relatively low, typically below the saltation velocity of the material being conveyed. This ensures that the material remains in a dense, solid phase, reducing the risk of pipe wear and material degradation.

3. Gentle Material Handling: Dense phase conveying is known for its gentle handling of materials. The low-velocity air stream minimizes particle attrition and degradation, making it suitable for fragile or sensitive materials.

4. Minimal Segregation: Dense phase conveying minimizes material segregation during transportation. The material tends to flow uniformly, maintaining its original composition and quality.

5. Lower Energy Consumption: Dense phase conveying systems require lower air volumes and pressure compared to dilute phase systems. This results in reduced energy consumption and operating costs.

6. Limited Dust Emission: Due to the low-velocity air stream, dense phase conveying systems generate minimal dust compared to dilute phase systems. This feature improves workplace safety and reduces the need for additional dust collection equipment.

7. Low Noise Levels: Dense phase conveying systems typically produce lower noise levels compared to high-velocity dilute phase systems. This is beneficial in noise-sensitive environments or areas where noise regulations need to be followed.

Lean Phase system Based on pressure type:

1. **Positive pressure type**
2. **Negative pressure type**

Positive pressure pneumatic conveying system

In positive pressure pneumatic conveying, the material is pushed or forced through the pipeline using a positive pressure source, such as a blower or compressor. The pressure in the pipeline is higher than atmospheric pressure, which propels the material forward. Positive pressure systems are commonly used for conveying materials from a source point to a destination point, such as transferring materials from a storage silo to a processing unit.

Negative pressure pneumatic conveying system

In negative pressure pneumatic conveying, also known as vacuum conveying, the material is pulled or sucked through the pipeline using a vacuum or negative pressure source. The pressure in the pipeline is lower than atmospheric pressure, creating a pressure differential that draws the material into the system. Negative pressure systems are often used for material collection, extraction, or recovery, such as removing dust or debris from a production line or collecting materials from multiple sources.

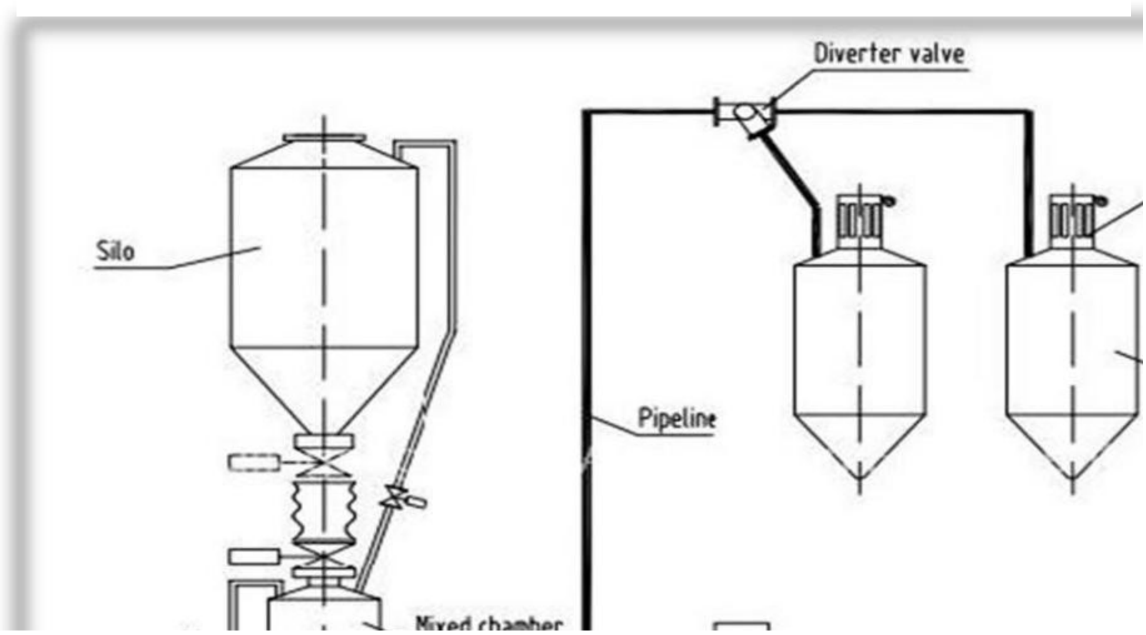
Both positive and negative pressure pneumatic conveying systems have their advantages and are suitable for different applications depending on factors such as material characteristics, distance, capacity, and process requirements. It is essential to consider the specific needs of your application to determine the most appropriate type of pneumatic conveying system.

SCHEMATIC DESIGN

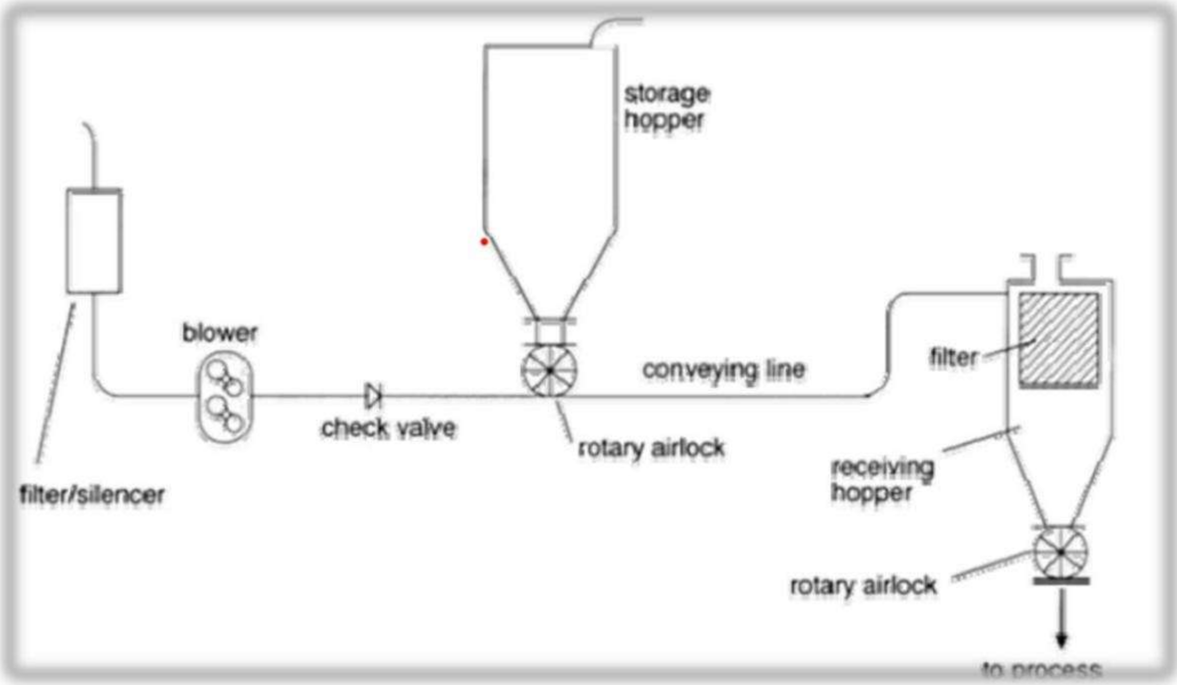
A pneumatic conveying system is used to transport bulk materials, such as powders or granules, through a pipeline using air or gas as the conveying medium. The system typically consists of several components, including an air compressor, conveying pipeline, material feed system, air/material separator, and control system.

1. Material Feed System:
   Hopper or storage silo: Holds the bulk material to be conveyed.
   Material feeder: Provides controlled feeding of the material into the conveying pipeline.
   Rotary valve: Regulates the material flow and prevents air leakage.
2. Air Generation:
   Air compressor/Blower: Generates air or gas at desired pressure and volumetric flow for conveying.
   Air receiver tank: Stores the compressed air to ensure a steady supply.
3. Conveying Pipeline:
   Main pipeline: Transports the material from the feeder to the destination point.
   Pipe bends and elbows: Allows for changes in direction.
   Pipe supports: Hold the pipeline in place and prevent sagging.
   Inspection ports: Provide access for maintenance and cleaning.
4. Air/Material Separator:
   Cyclone separator: Separates the material from the conveying air using centrifugal force.
   Filter receiver: Removes fine particles from the air stream before discharging it.
   Dust collection system: Collects and contains the separated material for further processing or disposal.
5. Control System:
   Pressure control valve: Regulates the air pressure in the pipeline.
   Flow control valve: Adjusts the material flow rate.
   Level sensors: Monitor material levels in the hopper or feeder.
   Pressure sensors: Measure the air pressure at different points in the system.
   Control panel: Integrates the control devices and allows for system monitoring and adjustments.

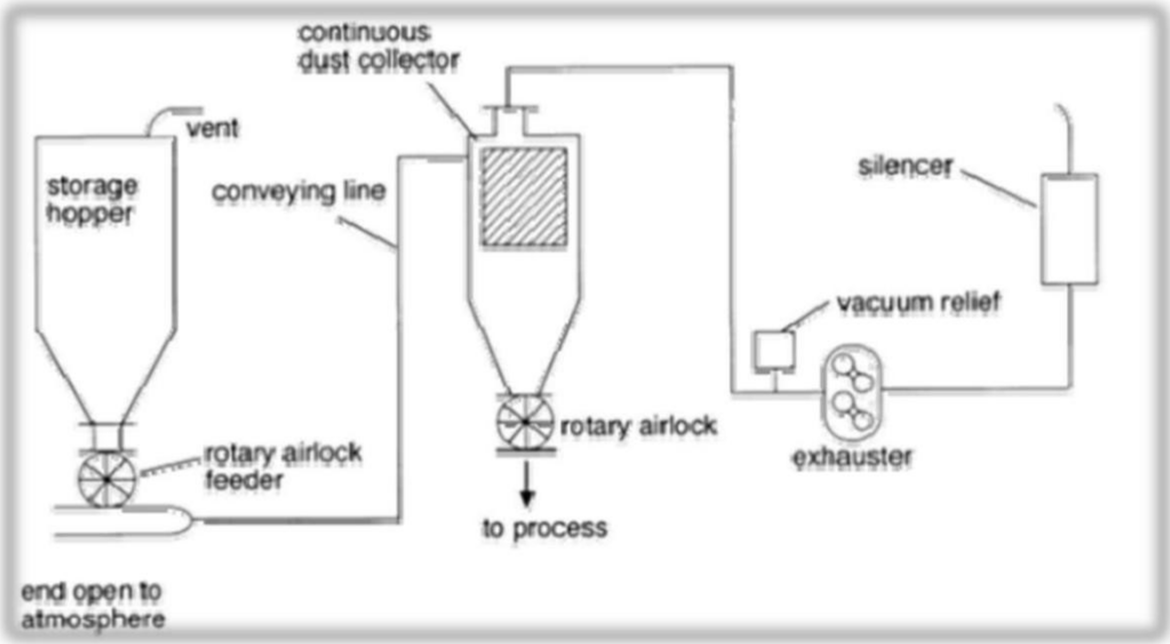
Positive pressure Dense Phase Pneumatic conveying system:



Positive pressure Lean Phase Pneumatic conveying system:



Negative pressure Lean Phase Pneumatic conveying system:



THEORETICAL TECHNICAL DESIGNING

1. **Solid Loadings:** The solid loading ratio, also known as the solids-to-air ratio or material-to-air ratio, is a parameter used to quantify the amount of solid material being conveyed relative to the volume of air in a pneumatic conveying system. It represents the ratio of the mass or weight of the solid material to the mass or weight of the conveying air.
   The solid loading ratio is typically expressed as a percentage or in terms of weight or mass. For example, a solid loading ratio of 20% means that the weight of the solid material being conveyed is 20% of the total weight of the conveying air. A low solid loading ratio may result in dilute phase conveying with higher airflow velocities, while a high solid loading ratio may lead to dense phase conveying with lower airflow velocities.

$$S = \frac{\dot{m}_s}{\dot{m}_g} = \frac{\dot{m}_s}{\rho_g v_g A} \quad ; \quad \begin{aligned} &\dot{m}_s = mass\ flow\ rate\ of\ solids \\ &\dot{m}_g = mass\ flow\ rate\ of\ gases \\ &\rho_g = density\ of\ gas \\ &v_g = velocity\ of\ gas \\ &A = area\ of\ cross\ section\ of\ pipe \end{aligned}$$

2. **Saltation Velocity**: Saltation velocity is the minimum airflow velocity required to initiate particle movement in pneumatic conveying. Particles remain settled below the saltation velocity, while they become suspended and start moving above it. Factors such as particle size, shape, density, and air properties influence the saltation velocity. Maintaining an airflow velocity above the saltation velocity ensures efficient particle transport and prevents issues like blockages. Determining the appropriate saltation velocity is crucial for optimizing pneumatic conveying systems.

$$U_{salt} = \left(\frac{4\dot{m}_s 10^{\alpha} g^{\frac{\beta}{2}} D^{\left(\frac{\beta}{2} - 2\right)}}{\pi \rho_g} \right)^{\left(\frac{1}{\beta + 1}\right)} \quad ; \quad \begin{aligned} &D = diameter\ of\ pipe \\ &\alpha = 1440 d_p + 1.96 \\ &\beta = 1100 d_p + 2.5 \end{aligned}$$

3. **Velocity of Gas/fluids and Solids:** The velocity of gas in a pneumatic conveying system depends on various factors such as the type and properties of the conveyed material, the design of the system, and the desired conveying characteristics. Velocity of gas is generally taken 1.5 times the saltation velocity.

$$v_g = 1.5\left(U_{salt} \right)$$

$$void\ fraction\left(\xi_{horizontal} \right) = 1 - \frac{\dot{m}_s}{A v_s \rho_s} \quad ; \quad \begin{aligned} &\rho_s = density\ of\ solid\ particle \\ &v_s = velocity\ of\ solid\ particle \end{aligned}$$

$$v_{g(desired)} = \frac{v_g}{\xi_{horizontal}}$$

The velocity of solids in a pneumatic conveying system can vary depending on several factors, including the type and size of the particles, the gas velocity, and the conveying mode (dilute-phase or dense-phase).
In dilute-phase pneumatic conveying, where the solids are conveyed in a low concentration within the gas stream, the velocity of the solid particles is typically lower than the gas velocity. The solids typically have a velocity ranging from a few meters per second (m/s) to tens of meters per second (m/s).

$$v_s = v_g\left(1 - 0.0638 \cdot d_p^{\,0.3} \cdot \rho_s^{0.5}\right)$$

ρ_s: *density of solid particle*

d_p: *diameter of particle*

4. **Reynolds number for Gas/fluids:**

$$Re_g = \frac{D\, v_{g(desired)}\, \rho_g}{\mu_f}$$

; D: *diameter of pipe*
ρ_g: *density of gas or fluid*
μ_f: *viscocity of fluid*

5. **Reynolds number for solids:**

$$Re_s = \frac{d_p\left(v_{g(desired)} - v_s\right)\rho_g}{\mu_f}$$

; d_p: *diameter of particle*

6. **Drag coefficient (Cd):**

$$C_D = \frac{24}{Re_s}\left(1 + 0.15 Re_s^{\,0.687}\right) + \frac{0.42}{\left(1 + \frac{42300}{Re_s}\right)}$$

7. **Friction Factor for particle (fs) and gas (fg):**

$$f_s = \frac{3\rho_g D C_D}{8\rho_s d_p}\left(\frac{v_{g(desired)} - v_s}{v_s}\right)^2$$

$$f_g = \frac{1}{\left[1.14 - 2\log\left(\frac{\varepsilon}{D} \cdot \frac{21.25}{Re_g^{\,0.9}}\right)\right]^2}$$

; ε: *internal wall roughness of pipe*

8. **Pressure Drop**: Pressure drop in a pneumatic conveying system refers to the decrease in air pressure as the air and material flow through the system. It occurs due to various

factors such as frictional losses, changes in pipe geometry, bends, fittings, and the presence of material particles.

The calculation of pressure drop in a pneumatic conveying system can be complex and involves considering multiple parameters. One commonly used equation for estimating pressure drop is the Darcy-Weisbach equation, which relates the pressure drop to factors such as the flow rate, pipe diameter, length, roughness, and density of the conveying material.

$$\Delta P_{total} = \Delta P_{horizontal} + \Delta P_{vertical} + \Delta P_{bends}$$

$$\Delta P_{horizontal} = \Delta P_{acc.f} + \Delta P_{acc.s} + \Delta P_{friction\ f} + \Delta P_{friction\ s}$$

$$\Delta P_{acc.f} = 0.5\,\rho_g\,\xi_h\,v_{g(desired)}{}^2$$

$$\Delta P_{acc.s} = 0.5\,\rho_s\left(1-\xi_h\right)v_s{}^2$$

$$\Delta P_{friction\ f} = 2f_g\,\rho_g\,v_{g(desired)}{}^2\,L_h\,\frac{\xi_h}{D} \qquad ;\ L_h\text{: length of horizontal pipe}$$

$$\Delta P_{friction\ s} = 2f_s\,\rho_s\,v_s{}^2\,L_h\,\frac{\left(1-\xi_h\right)}{D}$$

$$v_{relative(vertical)} = 1.74\sqrt{\frac{d_p\left(\rho_s-\rho_g\right)g}{\rho_g}}$$

$$J = \frac{4\dot{m}_s}{3.14\,D^2\,\rho_s}$$

$$\xi_v = \frac{\left(J+v_{relative}+v_g\right)-\sqrt{\left(J+v_{relative}+v_g\right)^2-4\,v_g\,v_{relative}}}{2\,v_{relative}}$$

$$v_{s(vertical)} = \frac{v_g}{\xi_v} - v_{relative}$$

Vertical Pressure Drop Calculation:

$$\Delta P_{head\ f} = \rho_g\,g\,L_v\,\xi_v\sin\theta$$

$$\Delta P_{head\ s} = \rho_s\,g\,L_v\left(1-\xi_v\right)\sin\theta$$

$$\Delta P_{friction\ f} = 2f_g\,\rho_g\,v_{g(desired)}{}^2\,L_v\,\frac{\xi_v}{D}$$

$$\Delta P_{friction\ s} = 2f_s\,\rho_s\,v_{s(vertical)}{}^2\,L_v\,\frac{\left(1-\xi_v\right)}{D}$$

Pressure Drop due to Bends:

$$\Delta P_{bends} = \frac{7.5\ \Delta P_{vertical}\ n_b}{L_v} \quad ; \quad \begin{array}{l} n_b = number\ of\ bends\ in\ pipe \\ L_v = length\ of\ vertical\ pipe \end{array}$$

9. **Volumetric air flow rate:** volumetric flow rate is the amount of air flowing through the pipe in 1 second. It can be calculated by the product of velocity of gas and the area of cross section of the pipe.

$$Q = (safety\ factor)\ A\ v_{g(desired)}$$

$$safety\ factor = 1.2$$

10. **Power:**

$$Power = \frac{Q_v\ \Delta P_{gross}}{761.9\ \eta}$$

$$\eta = 60\%$$

INPUTS REQUIRED

GAS

- **Type of gas – Air**
- **Density of gas at ambient temperature**
- **Viscosity of fluid at ambient temperature**

SOLIDS

- **Mass flow rate**
- **Density of solids**
- **Diameter of particle**

PIPES

- **Length of pipe**
- **Height of pipe**
- **Number of bends**
- **Diameter of pipe**
- **Roughness of pipe**

EXCEL BASED APPLICATION DEVELOPMENT

Objective: To develop comprehensive application in Microsoft Excel to determine proper blower specifications (Flow rate, Pressure and power) to conduct Pneumatic transfer of given material (feed rate, density and average particle size) at given rate for various standard pipe size viz. 50NB, 80NB, 100NB, 125NB, 150NB, 200NB & 250NB which are most commonly used in the industry.

Methodology:

1. Create Input section in Excel sheet as described before.
2. Perform various intermediate calculations in table form for above mentioned pipe sizes to calculate final pressure drop using various standard formula developed by various researchers: viz.

   a) Saltation Velocity
   b) Air terminal velocity
   c) Air desired velocity
   d) Particle velocity in horizontal and vertical flow
   e) Void fraction for horizontal and vertical flow
   f) Reynolds numbers for air and particle
   g) Drag force
   h) Friction coefficients for Air and Particle
   i) Horizontal pressure loss due to air and particle acceleration
   j) Horizontal pressure loss due to air and particle friction
   k) Vertical pressure loss due to air and particle acceleration
   l) Vertical pressure loss due to air and particle friction
   m) Summing up I, j, k, l to get total pressure loss
   n) Pressure loss in cyclone and Blower suction have been assumed at most common industrial levels

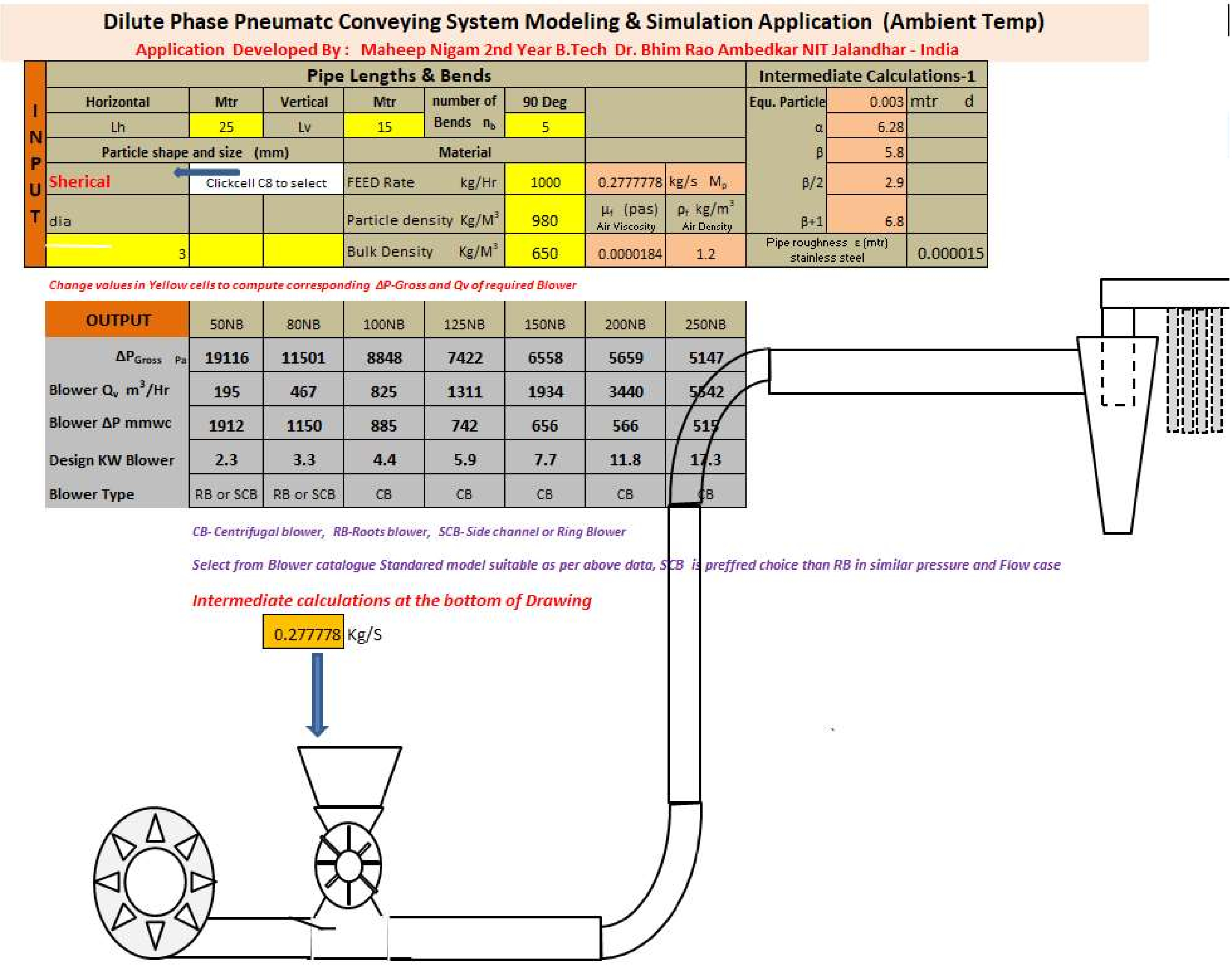
3. Create Output section in same file to give Desired air velocity, Air flow rate, Gross pressure loss, for desired blower specifications and calculate blower power.
4. So by changing values in input cell we get desired calculated output in desired cells without a heck almost instantly.

Trend Line Graphs

Calculated various options using developed excel application to know the pattern of total pressure drop and Air flow rate Viz.

Parameters	**Case-1**	**Case-2**	**Case-3**	**Case-4**	**Case 5**	**Case-6**
Material feed rate	Fix	Variable	Fix	Fix	Fix	Fix
Particle density	Fix	Fix	Variable	Fix	Fix	Fix
Particle diameter	Fix	Fix	Fix	Fix	Variable	Fix
Total Horizontal pipe length	Fix	Fix	Fix	Fix	Fix	Variable
Total vertical pipe length	Fix	Fix	Fix	Variable	Fix	Fix
No of Bends	Fix	Fix	Fix	Fix	Fix	Fix
Pipe size (50…250NB)	Variable	Fix	Fix	Fix	Fix	Fix

Screenshot of Developed Microsoft Excel application Interface



Dilute Phase Pneumatc Conveying System Modeling & Simulation Application (Ambient Temp)

Application Developed By : Maheep Nigam 2nd Year B.Tech Dr. Bhim Rao Ambedkar NIT Jalandhar - India

INPUT	Pipe Lengths & Bends								Intermediate Calculations-1		
	Horizontal	Mtr	Vertical	Mtr	number of Bends n_b	90 Deg			Equ. Particle	0.003	mtr d
	Lh	25	Lv	15		5			α	6.28	
	Particle shape and size (mm)			Material					β	5.8	
	Sherical	Clickcell C8 to select		FEED Rate kg/Hr		1000	0.2777778	kg/s M_p	β/2	2.9	
	dia			Particle density Kg/M³		980	μ_f (pas) Air Viscosity	ρ_f kg/m³ Air Density	β+1	6.8	
	3			Bulk Density Kg/M³		650	0.0000184	1.2	Pipe roughness ε (mtr) stainless steel		0.000015

Change values in Yellow cells to compute corresponding ΔP-Gross and Qv of required Blower

OUTPUT	50NB	80NB	100NB	125NB	150NB	200NB	250NB
ΔP_{Gross} Pa	19116	11501	8848	7422	6558	5659	5147
Blower Q_v m³/Hr	195	467	825	1311	1934	3440	5542
Blower ΔP mmwc	1912	1150	885	742	656	566	515
Design KW Blower	2.3	3.3	4.4	5.9	7.7	11.8	17.3
Blower Type	RB or SCB	RB or SCB	CB	CB	CB	CB	CB

CB- Centrifugal blower, RB-Roots blower, SCB- Side channel or Ring Blower

Select from Blower catalogue Standared model suitable as per above data, SCB is preffred choice than RB in similar pressure and Flow case

Intermediate calculations at the bottom of Drawing

0.277778 Kg/S

Note:

Cells in Yellow color are Input cells and are open for user. Calculated cells have been locked for safety of equation in cells in output cells, which are linked with Input data and intermediate calculations1&2 (shown in next page)

For best selection of pipe and blower size we have to be intuitive for optimal power, and costs, as well as smooth choke free operation.

In above screen shot case we observe that for 100NB Power is optimal and simple centrifugal blower can be used.

For selection of blower, Centrifugal blower can be first choice, next for even higher range of pressure Side channel blower should be used and lastly roots blower may be selected.

Intermediate Calculations-2								
Pipe	50NB	80NB	100NB	125NB	150NB	200NB	250NB	
Dia D	0.05479	0.0828	0.1082	0.13450	0.16148	0.21156	0.26462	mtr
X-sec A	0.00236	0.00538	0.00919	0.0142	0.02047	0.035135	0.05497	m^2
U_{salt}	12.6278	13.3372	13.8179	14.2216	14.5699	15.10025	15.5542	m/s
U_t	18.9417	20.0057	20.7269	21.3324	21.8549	22.65038	23.3313	m/s
U_p	12.3197	13.0117	13.4808	13.8746	14.2144	14.73183	15.1747	m/s
ξ_h	0.99024	0.99595	0.99771	0.99856	0.99903	0.999452	0.99966	
U_f	19.1285	20.087	20.7744	21.3632	21.8762	22.66279	23.3392	m/s
Re_f	68351.1	108470	146595	187392	230385	312687.4	402784	
Re_p	1332.15	1384.3	1427.01	1465.15	1499.04	1551.709	1597.41	
C_D	0.40956	0.40484	0.40118	0.39805	0.39537	0.391388	0.3881	
f_p	0.00105	0.00152	0.00194	0.00239	0.00284	0.003673	0.00455	
f_f	0.00488	0.00443	0.00416	0.00396	0.00381	0.003596	0.00343	
ΔP_h - Horizontal Pipe line								
$\Delta P_{fh\text{-}acc}$	217.396	241.114	258.353	273.437	286.861	307.9924	326.72	Pa
$\Delta P_{ph\text{-}acc}$	726.1	335.794	203.731	135.698	96.4473	58.23545	38.3418	Pa
$\Delta P_{fh\text{-}fric}$	1936.81	1288.59	993.78	806.031	676.751	523.5596	423.853	Pa
$\Delta P_{ph\text{-}fric}$	834.187	369.14	219.719	144.502	101.743	60.66659	39.5601	Pa
Ur	8.52512	8.52512	8.52512	8.52512	8.52512	8.525125	8.52512	
J	0.12028	0.05267	0.03084	0.01996	0.01385	0.008067	0.00516	
ξv	0.98869	0.99545	0.99748	0.99845	0.99896	0.999429	0.99965	
U_{pv}	10.6333	11.5721	12.254	12.8405	13.3524	14.13818	14.8143	
ΔP_v - Vertical Pipe line								
$\Delta P_{fv\text{-}head}$	174.583	175.776	176.136	176.306	176.397	176.4792	176.519	Pa
$\Delta P_{pv\text{-}head}$	1631.23	656.321	362.957	224.162	149.551	82.28626	50.1952	Pa
$\Delta P_{fv\text{-}fric}$	1160.27	772.766	596.131	483.562	406.025	314.1286	254.31	Pa
$\Delta P_{pv\text{-}fric}$	719.999	328.297	199.724	133.732	95.5733	58.22192	38.6205	Pa
$\Delta P_h+\Delta P_v$	7400.57	4167.8	3010.53	2377.43	1989.35	1581.57	1348.12	Pa
Loss in Bends	9215.21	4832.9	3337.37	2544.4	2068.87	1577.79	1299.11	Pa
Pipe size	50NB	80NB	100NB	125NB	150NB	200NB	250NB	
ΔP_{Total}	**16615.8**	**9000.7**	**6347.9**	**4921.83**	**4058.21**	**3159.36**	**2647.23**	
Loss BlowerInlet	1000	1000	1000	1000	1000	1000	1000	Pa
Loss Cyclone	1500	1500	1500	1500	1500	1500	1500	Pa
ΔP_{Grossl}	**19115.8**	**11500.7**	**8847.9**	**7421.83**	**6558.21**	**5659.36**	**5147.23**	Pa
Design Flow Qv	0.05409	0.12973	0.2291	0.36405	0.53735	0.955501	1.53951	m3/s
Design Flow Qv	194.732	467.014	824.776	1310.58	1934.47	3439.805	5542.24	m3/Hr
Blower Power KW	2.3	3.3	4.4	5.9	7.7	11.8	17.3	KW
Standard Motor	3	3.7	5	7.5	10	15	18	KW

Note :
All cells are linked with input data in formula and are auto calculated

TREND ANALYSIS - 1&2

Case 1:

Trend analysis of pressure drop and volumetric flow rate on variable pipe size of 50NB, 65NB, 80NB, 100NB, 125NB, 150NB, 200NB, 250NB with constant feed rate, particle density, particle diameter, horizontal and vertical lengths and bends.

Case 2:

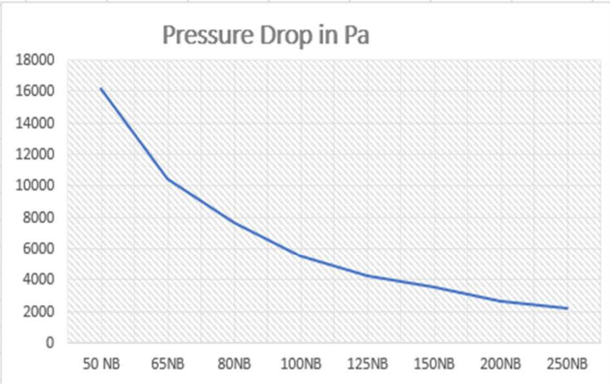
Trend analysis of pressure drop and volumetric flow rate on variable feed rate of 500kg/hr, 1000 kg/hr, 1500 kg/hr, 2000 kg/hr, 2500 kg/hr, 3000 kg/hr, 3500 kg/hr, 4000 kg/hr with constant pipe size, particle density, particle diameter, horizontal and vertical lengths and bends.

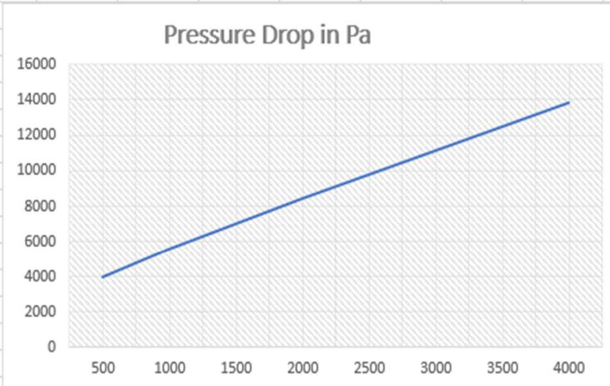
EFFECT OF PIPE SIZE

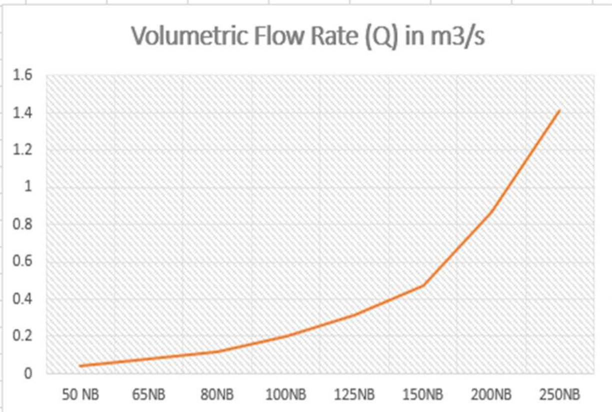
Case-1				Pipe size	ΔP-Total	Qv
Feed rate	1000	kg/hr	Fix	50 NB	16177.38	0.0424
Particle de	960	kg/M3	Fix	65NB	10415.88	0.0766
Particle di	3	mm	Fix	80NB	7669.8	0.12
HL	25	mtr	Fix	100NB	5563.754	0.2
Hv	15	mtr	Fix	125NB	4294.146	0.316
Bends	3		Fix	150NB	3510.04	0.4699
Pipe size		NB	Variable	200NB	2666.122	0.868
				250NB	2218.135	1.409

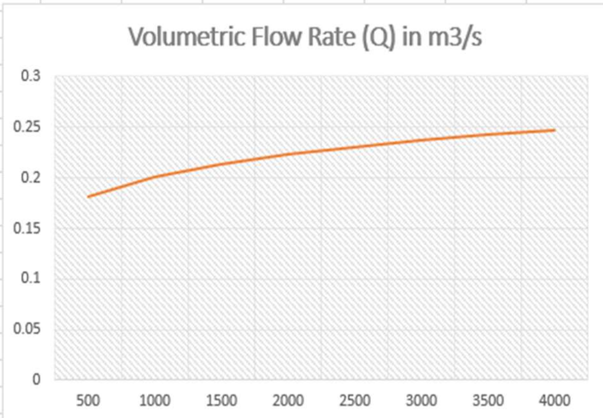
EFFECT OF FEED RATE

Case-2				Feed Rate	ΔP-Total	Qv
Feed rate		kg/hr	Variable	500	3970.661	0.1808
Particle de	960	kg/M3	Fix	1000	5563.754	0.2004
Particle di	3	mm	Fix	1500	7011.116	0.213
HL	25	mtr	Fix	2000	8401.029	0.2224
Hv	15	mtr	Fix	2500	9763.625	0.23
Bends	3		Fix	3000	11112.92	0.2366
Pipe size	100	NB	Fix	3500	12456.57	0.2422
				4000	13799.19	0.2473









TREND ANALYSIS - 3&4

Case 3:

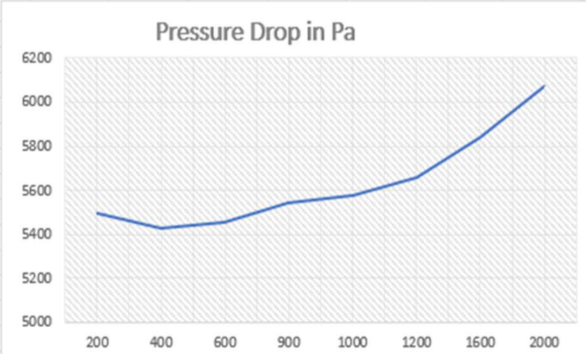
Trend analysis of pressure drop and volumetric flow rate on variable particle density of 200kg/m3, 400 kg/m3, 600 kg/m3, 900 kg/m3, 1000 kg/m3, 1200 kg/m3, 1600 kg/m3, 2000kg/m3 with constant feed rate, pipe size, particle diameter, horizontal and vertical lengths, and bends.

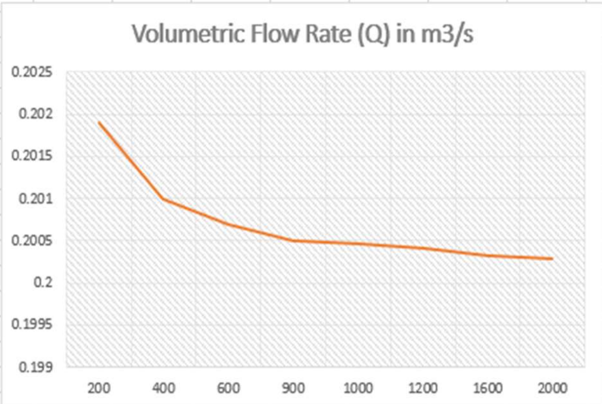
Case 4:

Trend analysis of pressure drop and volumetric flow rate on variable vertical length of 5m, 10m, 15m, 20m, 25m, 30m, 35m, 40m, 45m, 50m with constant pipe size, particle density, particle diameter, horizontal lengths, feed rate and bends.

EFFECT OF PARTICLE DENSITY

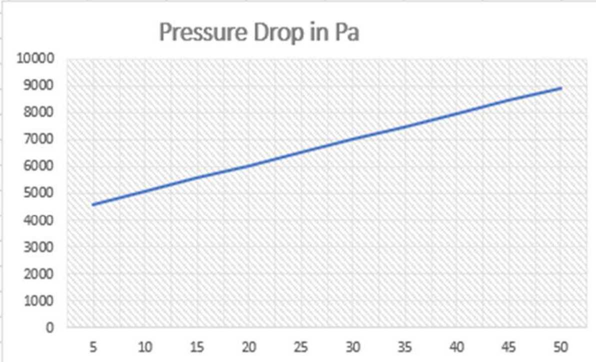
Case-3				Part. Dens	ΔP-Total	Qv
Feed rate	1000	kg/hr	Variable	200	5494.988	0.2019
Particle density		kg/M3	Variable	400	5427.386	0.201
Particle di	3	mm	Fix	600	5455.361	0.2007
HL	25	mtr	Fix	900	5542.651	0.2005
Hv	15	mtr	Fix	1000	5578.36	0.20047
Bends	3		Fix	1200	5657.349	0.200414
Pipe size	100	NB	Fix	1600	5843.494	0.20033
				2000	6069.905	0.200293

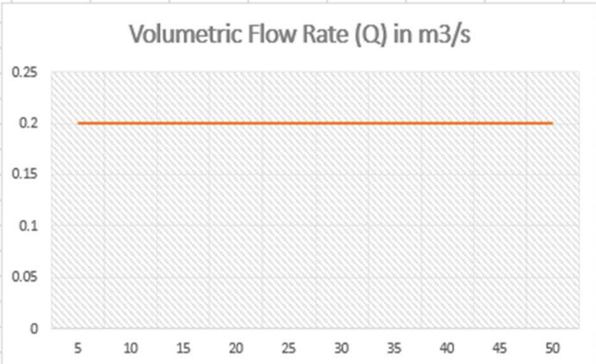




EFFECT OF VERTICAL LENGTH

Case-4				VL	ΔP-Total	Qv
Feed rate	1000	kg/hr	Fix	5	4600.013	0.2004
Particle de	960	kg/M3	Fix	10	5081.883	0.2004
Particle di	3	mm	Fix	15	5563.754	0.2004
HL	25	mtr	Fix	20	6045.624	0.2004
Hv		mtr	Variable	25	6527.494	0.2004
Bends	3		Fix	30	7009.365	0.2004
Pipe size	100	NB	Fix	35	7491.235	0.2004
				40	7973.105	0.2004
				45	8494.576	0.2004
				50	8936.846	0.2004





TREND ANALYSIS - 5&6

Case 5:

Trend analysis of pressure drop and volumetric flow rate on variable particle diameter of 0.1mm, 0.3mm, 0.6mm, 1mm, 2mm, 3mm, 5mm, 8mm, 10mm, 12mm, 15mm with constant feed rate, particle density, pipe size, horizontal and vertical lengths and bends.

Case 6:

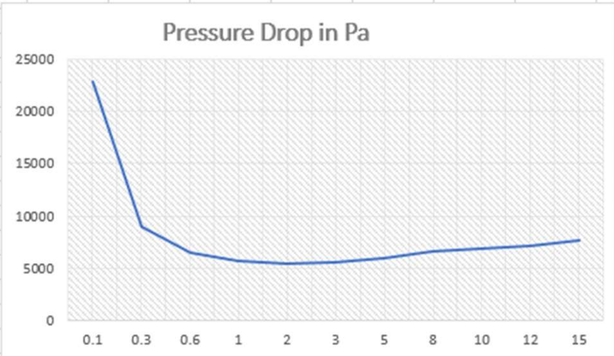
Trend analysis of pressure drop and volumetric flow rate on variable horizontal length of 10m, 20m, 30m, 40m, 50m, 60m, 70m, 80m, 90m, 100m, 200m with constant pipe size, particle density, particle diameter, vertical lengths, feed rate and bends.

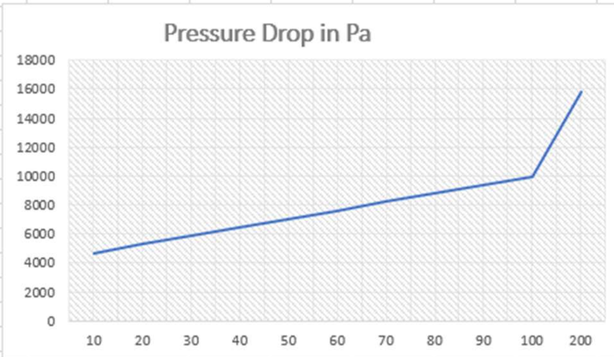
EFFECT OF PARTICLE SIZE

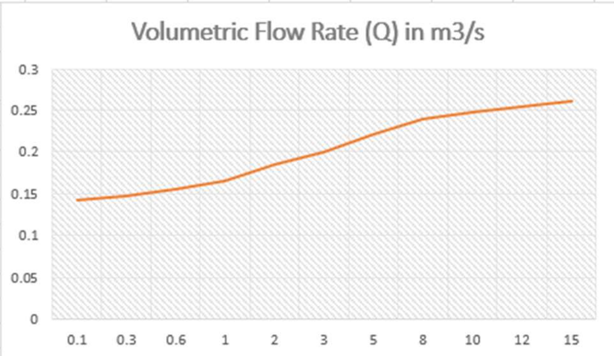
Case-5				Part. Dia	ΔP-Total	Qv
Feed rate	1000	kg/hr	Fix	0.1	22817.9	0.14149
Particle de	960	kg/M3	Fix	0.3	8942.56	0.1476
Particle dia		mm	Variable	0.6	6442.07	0.15611
HL	25	mtr	Fix	1	5673.45	0.16603
Hv	15	mtr	Fix	2	5419.47	0.1858
Bends	3		Fix	3	5563.75	0.2004
Pipe size	100	NB	Fix	5	5975.21	0.2207
				8	6531.98	0.2391
				10	6852.68	0.24726
				12	7149.87	0.25338
				15	7582.34	0.2602

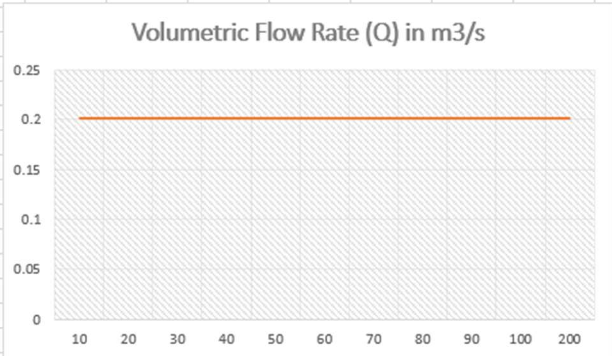
EFFECT OF HORIZONTAL LENGTH

Case-6				HL	ΔP-Total	Qv
Feed rate	1000	kg/hr	Fix	10	4684.86	0.2004
Particle de	960	kg/M3	Fix	20	5270.79	0.2004
Particle di	3	mm	Fix	30	5856.72	0.2004
HL		mtr	Variable	40	6442.65	0.2004
Hv	15	mtr	Fix	50	7028.57	0.2004
Bends	3		Fix	60	7614.5	0.2004
Pipe size	100	NB	Fix	70	8200.43	0.2004
				80	8786.36	0.2004
				90	9372.29	0.2004
				100	9958.22	0.2004
				200	15817.5	0.2004









ANNEXURE 1

Standard Motor and Pipe Sheets for Motor/Pipe Selection

Standard motors					FLC = kw*10(
KW	HP	Voltage	PF	efficiency	FLC @ 415V
0.10	1/8	415	0.84	0.92	0.18
0.12	1/6	415	0.84	0.92	0.22
0.18	1/4	415	0.84	0.92	0.32
0.25	1/3	415	0.84	0.92	0.45
0.37	0.5	415	0.84	0.92	0.67
0.56	0.75	415	0.84	0.92	1.01
0.75	1	415	0.84	0.92	1.35
1.10	1.5	415	0.84	0.92	1.98
1.50	2	415	0.84	0.92	2.70
2.20	3	415	0.84	0.92	3.96
3.00	4	415	0.84	0.92	5.40
3.70	5	415	0.84	0.92	6.66
5.00	6.7	415	0.84	0.92	9.00
5.50	7.5	415	0.86	0.92	9.67
7.50	10	415	0.86	0.92	13.19
10.00	13.5	415	0.86	0.92	17.58
11.00	15	415	0.86	0.92	19.34
15.00	20	415	0.89	0.92	25.49
18.00	25	415	0.89	0.92	30.58
22.00	30	415	0.89	0.92	37.38
30.00	40	415	0.89	0.92	50.97
37.00	50	415	0.89	0.92	62.87
45.00	60	415	0.89	0.92	76.46
55.00	75	415	0.89	0.92	93.45
75.00	100	415	0.89	0.92	127.43
90.00	125	415	0.89	0.92	152.92
110.00	150	415	0.89	0.92	186.90
130.00	175	415	0.89	0.92	220.88
150.00	200	415	0.89	0.92	254.86

Pipe Chart SS304 Schedule 10 in mm				
NB	OD	WT	ID	ID mtr
50	60.33	2.77	54.79	0.05479
80	88.9	3.05	82.8	0.0828
100	114.3	3.05	108.2	0.1082
125	141.3	3.4	134.5	0.1345
150	168.28	3.4	161.48	0.16148
200	219.08	3.76	211.56	0.21156
250	273	4.19	264.62	0.26462

ANNEXURE 2.1

Standard Centrifugal Blower Sheets for Blower Selection

DIRECT DRIVE - STANDARD "EMINENT MAKE"					
Model	Volume	Static		Fan	Motor
r-1-	m3ph	in. of wc	mm of wc	rpm	HP
0005	850	2	51	1440	0.5
0010	2549	2	51	1440	0.75
0015	3398	2	51	1440	1
0020	5098	2	51	1440	1.5
0025	6797	2	51	1440	2
0030	8496	2	51	1440	3
0035	13594	2	51	1440	5
0040	19541	2	51	1440	7.5
0045	850	3	76	1440	0.5
0050	1529	3	76	1440	0.75
0055	2039	3	76	1440	1
0060	3229	3	76	1440	1.5
0065	4248	3	76	1440	2
0070	6372	3	76	1440	3
0075	10195	3	76	1440	5
0080	13594	3	76	1440	7.5
0085	16992	3	76	1440	10
0090	22090	3	76	1440	12.5
0095	27188	3	76	1440	15
0500	680	4	102	2850	0.5
0100	1274	4	102	1440	0.75
0505	1274	4	102	2850	0.75
0105	1699	4	102	1440	1
0510	1699	4	102	2850	1
0110	2549	4	102	1440	1.5
0515	2549	4	102	2850	1.5
0115	3398	4	102	1440	2
0520	3398	4	102	2850	2
0120	5098	4	102	1440	3
0525	5098	4	102	2850	3
0125	8496	4	102	1440	5
0530	7647	4	102	2850	5
0130	12319	4	102	1440	7.5
0135	15293	4	102	1440	10
0140	18692	4	102	1440	12.5
0145	21240	4	102	1440	15
0150	25489	4	102	1440	20
0535	510	6	152	2850	0.5
0540	850	6	152	2850	0.75
0155	1105	6	152	1440	1
0545	1189	6	152	2850	1
0160	1699	6	152	1440	1.5
0550	1699	6	152	2850	1.5
0165	2379	6	152	1440	2
0555	2124	6	152	2850	2
0170	3398	6	152	1440	3
0560	3144	6	152	2850	3
0175	5947	6	152	1440	5
0565	5098	6	152	2850	5
0180	7647	6	152	1440	7.5
0570	7222	6	152	2850	7.5
0185	11045	6	152	1440	10
0190	13594	6	152	1440	12.5
0195	16143	6	152	1440	15
0200	21240	6	152	1440	20

DIRECT DRIVE - STANDARD "EMINENT MAKE"					
Model	Volume	Static		Fan	Motor
r-1-	m3ph	in. of wc	mm of wc	rpm	HP
0205	25489	6	152	1440	25
0575	510	8	203	2850	0.75
0580	680	8	203	2850	1
0585	1189	8	203	2850	1.5
0210	1699	8	203	1440	2
0590	1699	8	203	2850	2
0215	2549	8	203	1440	3
0595	2549	8	203	2850	3
0220	4248	8	203	1440	5
0600	4248	8	203	2850	5
0225	5947	8	203	1440	7.5
0605	6372	8	203	2850	7.5
0230	8071	8	203	1440	10
0610	8496	8	203	2850	10
0235	10195	8	203	1440	12.5
0615	10195	8	203	2850	12.5
0240	12744	8	203	1440	15
0620	11470	8	203	2850	15
0245	16143	8	203	1440	20
0250	19541	8	203	1440	25
0255	22090	8	203	1440	30
0625	595	10	254	2850	1
0630	1020	10	254	2850	1.5
0635	1359	10	254	2850	2
0260	2124	10	254	1440	3
0640	2209	10	254	2850	3
0265	3398	10	254	1440	5
0645	3398	10	254	2850	5
0270	5098	10	254	1440	7.5
0650	5098	10	254	2850	7.5
0275	6797	10	254	1440	10
0655	6797	10	254	2850	10
0280	8496	10	254	1440	12.5
0660	8496	10	254	2850	12.5
0285	10195	10	254	1440	15
0665	9771	10	254	2850	15
0290	14019	10	254	1440	20
0670	12319	10	254	2850	20
0295	16992	10	254	1440	25
0300	20391	10	254	1440	30
0675	425	12	305	2850	1
0680	765	12	305	2850	1.5
0685	1020	12	305	2850	2
0690	1699	12	305	2850	3
0305	2974	12	305	1440	5
0695	3059	12	305	2850	5
0310	4248	12	305	1440	7.5
0700	4248	12	305	2850	7.5
0315	5947	12	305	1440	10
0705	5523	12	305	2850	10
0320	7222	12	305	1440	12.5
0710	6797	12	305	2850	12.5
0325	8496	12	305	1440	15
0715	8071	12	305	2850	15
0330	11045	12	305	1440	20

ANNEXURE 2.2

Standard Centrifugal Blower Sheets for Blower Selection

DIRECT DRIVE - STANDARD "EMINENT MAKE"					
Model	Volume	Static		Fan	Motor
r-1-	m3ph	in. of wc	mm of wc	rpm	HP
0720	10195	12	305	2850	20
0335	13594	12	305	1440	25
0725	12319	12	305	2850	25
0340	16992	12	305	1440	30
0730	14868	12	305	2850	30
0345	3398	15	381	1440	7.5
0350	4673	15	381	1440	10
0355	5947	15	381	1440	12.5
0360	6797	15	381	1440	15
0365	9346	15	381	1440	20
0370	11895	15	381	1440	25
0375	14444	15	381	1440	30
0735	510	16	406	2850	1.5
0740	765	16	406	2850	2
0745	1189	16	406	2850	3
0750	2039	16	406	2850	5
0755	2974	16	406	2850	7.5
0760	4248	16	406	2850	10
0765	5098	16	406	2850	12.5
0770	6797	16	406	2850	15
0775	9006	16	406	2850	20
0780	10620	16	406	2850	25
0785	12319	16	406	2850	30
0790	595	20	508	2850	2
0795	935	20	508	2850	3
0800	1699	20	508	2850	5
0805	2549	20	508	2850	7.5
0810	3398	20	508	2850	10
0815	4248	20	508	2850	12.5
0820	5098	20	508	2850	15
0825	6797	20	508	2850	20
0830	8071	20	508	2850	25
0835	9346	20	508	2850	30
0840	510	24	610	2851	2
0845	850	24	610	2850	3
0850	1444	24	610	2850	5
0855	2124	24	610	2850	7.5
0860	2974	24	610	2850	10
0865	3653	24	610	2850	12.5
0870	4248	24	610	2850	15
0875	5523	24	610	2850	20
0880	6797	24	610	2850	25
0885	8071	24	610	2850	30
0890	680	28	711	2850	3
0895	1105	28	711	2850	5
0900	1869	28	711	2850	7.5
0905	2549	28	711	2850	10
0910	2974	28	711	2850	12.5
0915	3738	28	711	2850	15
0920	5098	28	711	2850	20
0925	6372	28	711	2850	25
0930	7647	28	711	2850	30
0935	1020	32	813	2850	5
0940	1614	32	813	2850	7.5
0945	2124	32	813	2850	10

DIRECT DRIVE - STANDARD "EMINENT MAKE"					
Model	Volume	Static		Fan	Motor
r-1-	m3ph	in. of wc	mm of wc	rpm	HP
0950	2719	32	813	2850	12.5
0955	3229	32	813	2850	15
0960	4248	32	813	2850	20
0965	5523	32	813	2850	25
0970	6627	32	813	2850	30
0975	935	36	914	2850	5
0980	1444	36	914	2850	7.5
0985	1954	36	914	2850	10
0990	2379	36	914	2850	12.5
0995	2889	36	914	2850	15
1000	3398	36	914	2850	20
1005	4843	36	914	2850	25
1010	5862	36	914	2850	30
1015	1274	40	1016	2850	7.5
1020	1699	40	1016	2850	10
1025	2124	40	1016	2850	12.5
1030	2549	40	1016	2850	15
1035	3398	40	1016	2850	20
1040	4248	40	1016	2850	25
1045	5183	40	1016	2850	30
1050	1529	44	1118	2850	10
1055	1954	44	1118	2850	12.5
1060	2124	44	1118	2850	15
1065	2889	44	1118	2850	20
1070	3908	44	1118	2850	25
1075	4758	44	1118	2850	30
1080	1444	48	1219	2850	10
1085	1784	48	1219	2850	12.5
1090	2124	48	1219	2850	15
1095	2889	48	1219	2850	20
1100	3568	48	1219	2850	25
1105	4248	48	1219	2850	30

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ANNEXURE 3.1

Standard Roots Blower Sheets for Blower Selection

ACME AIR EQUIPMENTS CO. PVT. LTD.

Roots blower (Air cooled Twin lobe blower)

nb = Blower Speed - RPM			V1 = Inlet Volume for Air (over pressure condition)								Suction Air Data :											
nm = Motor Speed RPM			N = Power at blower shaft.								Temp : 30°C RH : 65%									Air	Cooled	
		mmwc	1020		2039		3059		4079		5099		6118		7138		8158		9177		10197	
		mbar	100		200		300		400		500		600		700		800		900		1000	
	nb	nm	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N
	rpm	rpm	m3/ h	kW	m3/ h	kW	m31	kW	m3/	kW	m31	kW	m31	kW	m3/	kW	m31	kW	m3/	kW	m3/ h	kW
Model AEC 7	1500	1450	41	0.17	31	0.30	24	0.42	18	0.53	13	0.65	-	-	-	-	-	-	-	-	-	-
Model AEC 7	1700	1450	47	0.19	37	0.32	30	0.44	24	0.55	18	0.67	-	-	-	-	-	-	-	-	-	-
Model AEC 7	2000	1450	65	0.26	54	0.45	44	0.64	36	0.82	30	1.00	-	-	-	-	-	-	-	-	-	-
Model AEC 7	2200	2900	75	0.29	64	0.48	55	0.67	46	0.86	37	1.06	29	1.25	22	1.42	16	1.58	10	1.75	-	-
Model AEC 7	2400	2900	86	0.32	75	0.53	65	0.74	57	0.95	49	1.15	43	1.35	37	1.55	32	1.75	27	1.95	-	-
Model AEC 7	3000	2900	109	0.40	96	0.64	86	0.88	78	1.12	70	1.36	64	1.59	58	1.82	52	2.04	47	2.27	-	-
Model AEC 9	1450	1450	61	0.22	50	0.57	47	0.85	34	1.15	29	1.4	23	1.70	-	-	-	-	-	-	-	-
Model AEC 9	1933	1450	90	0.32	75	0.62	68	0.90	61	1.22	55	1.52	45	1.82	-	-	-	-	-	-	-	-
Model AEC 9	2280	2900	100	0.36	91	0.76	84	1.16	77	1.56	70	1.96	65	2.36	-	-	-	-	-	-	-	-
Model AEC 9	2580	2900	115	0.40	106	0.80	98	1.20	94	1.60	88	2.00	83	2.40	-	-	-	-	-	-	-	-
Model AEC 9	2900	2900	142	0.48	132	0.98	122	1.48	118	1.98	108	2.48	100	2.98	-	-	-	-	-	-	-	-
Model AEC 10	1610	1450	111	0,44	96	0,87	85	1,30	75	1,73	67	2,17	60	2,60	-	-	-	-	-	-	-	-
Model AEC 10	1810	1450	130	0,49	115	0,98	104	1,46	94	1,95	86	2,44	78	2,92	72	3,41	-	-	-	-	-	-
Model AEC 10	1933	1450	142	0,52	127	1,04	115	1,56	106	2,08	97	2,60	90	3,12	83	3,64	-	-	-	-	-	-
Model AEC 10	2127	2900	160	0,57	145	1,15	133	1,72	124	2,29	116	2,86	108	3,43	101	4,01	95	4,58	-	-	-	-
Model AEC 10	2239	2900	171	0,60	155	1,21	144	1,81	134	2,41	126	3,01	119	3,61	112	4,22	106	4,82	-	-	-	-
Model AEC 10	2391	2900	185	0,65	170	1,29	158	1,93	149	2,57	141	3,22	133	3,86	126	4,50	120	5,15	114	5,79	-	-
Model AEC 10	2549	2900	200	0,69	185	1,37	173	2,06	164	2,74	155	3,43	148	4,11	141	4,80	135	5,49	129	6,17	-	-
Model AEC 10	2732	2900	217	0,74	202	1,47	190	2,21	181	2,94	173	3,68	165	4,41	158	5,14	152	5,88	146	6,61	-	-
Model AEC 10	2900	2900	233	0,78	218	1,56	206	2,34	197	3,12	188	3,90	181	4,68	174	5,46	168	6,24	162	7,02	157	7,80
Model AEC 12	1368	1450	157	0,60	138	1,19	123	1,78	111	2,38	100	2,97	90	3,56	81	4,16	-	-	-	-	-	-
Model AEC 12	1450	1450	170	0,63	150	1,26	135	1,89	123	2,52	112	3,15	102	3,78	93	4,41	-	-	-	-	-	-
Model AEC 12	1610	1450	194	0,70	174	1,40	160	2,10	147	2,80	136	3,49	126	4,19	117	4,89	109	5,59	-	-	-	-
Model AEC 12	1810	1450	224	0,79	205	1,57	190	2,36	177	3,14	166	3,93	156	4,71	147	5,50	139	6,28	131	7,07	-	-
Model AEC 12	1933	1450	243	0,84	223	1,68	208	2,52	196	3,36	185	4,20	175	5,03	166	5,87	158	6,71	150	7,55	-	-
Model AEC 12	2127	2900	272	0,93	253	1,85	238	2,77	225	3,69	214	4,62	204	5,54	195	6,46	187	7,38	179	8,31	-	-
Model AEC 12	2239	2900	289	0,97	269	1,95	255	2,92	242	3,89	231	4,86	221	5,83	212	6,80	204	7,77	196	8,74	-	-
Model AEC 12	2391	2900	312	1,04	292	2,08	277	3,11	265	4,15	254	5,19	244	6,23	235	7,26	227	8,30	219	9,34	-	-
Model AEC 12	2549	2900	336	1,11	316	2,21	301	3,32	289	4,43	278	5,53	268	6,64	259	7,74	251	8,85	243	9,95	235	11,1
Model AEC 12	2732	2900	363	1,19	344	2,37	329	3,56	316	4,74	306	5,93	296	7,11	287	8,30	278	9,48	270	10,7	263	11,9
Model AEC 12	2900	2900	389	1,26	369	2,52	354	3,78	342	5,03	331	6,29	321	7,55	312	8,81	304	10,1	296	11,4	288	12,6
Model AEC 14	1450	1450	244	0,86	221	1,71	203	2,57	188	3,42	175	4,28	163	5,14	152	5,99	142	6,85	r	-	-	-
Model AEC 14	1610	1450	277	0,95	254	1,90	236	2,85	221	3,80	208	4,75	196	5,70	185	6,65	174	7,60	165	8,55	-	-
Model AEC 14	1810	1450	318	1,07	295	2,14	277	3,21	262	4,27	249	5,34	237	6,41	226	7,48	216	8,54	206	9,61	-	-
Model AEC 14	1933	1450	343	1,14	320	2,28	302	3,42	287	4,56	274	5,70	262	6,84	251	7,98	241	9,13	231	10,3	-	-
Model AEC 14	2127	2900	383	1,26	360	2,51	342	3,77	327	5,02	314	6,28	302	7,53	291	8,79	281	10,1	271	11,3	262	12,6
Model AEC 14	2239	2900	406	1,32	383	2,64	365	3,97	350	5,29	337	6,61	325	7,93	314	9,25	304	10,6	294	11,9	285	13,2
Model AEC 14	2391	2900	438	1,41	415	2,82	397	4,23	382	5,64	369	7,06	357	8,47	346	9,88	335	11,3	326	12,7	317	14,1
Model AEC 14	2549	2900	470	1,51	447	3,01	429	4,51	414	6,02	401	7,52	389	9,02	378	10,6	368	12,1	358	13,6	349	15,1
Model AEC 14	2732	2900	508	1,61	485	3,23	467	4,84	452	6,45	439	8,06	427	9,67	416	11,3	406	12,9	396	14,5	387	16,1
Model AEC 14	2900	2900	542	1,71	519	3,42	502	5,14	487	6,85	473	8,56	461	10,3	450	12,0	440	13,7	431	15,4	421	17,1

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ANNEXURE 3.2

Standard Roots Blower Sheets for Blower Selection

ACME AIR EQUIPMENTS CO. PVT. LTD.

Roots blower (Air cooled Twin lobe blower)

nb = Blower Speed - RPM			V1 = Inlet Volume for Air (over pressure condition)								Suction Air Data :											
nm = Motor Speed RPM			N = Power at blower shaft.								Temp : 30°C		RH : 65%							Air	Cooled	
		mmwc	1020		2039		3059		4079		5099		6118		7138		8158		9177		10197	
		mbar	100		200		300		400		500		600		700		800		900		1000	
	nb	nm	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N
	rpm	rpm	m3/ h	kW	m3/ h	kW	m31	kW	m3/	kW	m31	kW	m31	kW	m3/	kW	m31	kW	m3/	kW	m3/ h	kW
Model AEC 16	1196	1450	311	1,09	281	2,18	258	3,27	238	4,36	221	5,45	205	6,54	190	7,63	177	8,72		-	-	-
Model AEC 16	1275	1450	336	1,17	306	2,33	283	3,49	263	4,65	246	5,81	230	6,98	216	8,14	202	9,30		-	-	-
Model AEC 16	1368	1450	366	1,25	336	2,50	313	3,74	293	4,99	276	6,24	260	7,48	245	8,73	232	9,98		-	-	-
Model AEC 16	1450	1450	392	1,32	362	2,65	339	3,97	319	5,29	302	6,61	286	7,93	271	9,25	258	10,6	245	11,9	-	-
Model AEC 16	1610	1450	443	1,47	413	2,94	390	4,40	L370	5,87	353	7,34	337	8,81	322	10,3	308	11,8	296	13,2	-	-
Model AEC 16	1810	1450	506	1,65	476	3,30	453	4,95	434	6,60	416	8,25	400	9,90	386	11,6	372	13,2	359	14,9	347	16,5
Model AEC 16	1933	1450	546	1,76	516	3,53	492	5,29	473	7,05	455	8,81	439	10,6	425	12,4	411	14,1	398	15,9	386	17,6
Model AEC 16	2127	2900	607	1,94	577	3,88	554	5,82	534	7,76	517	9,70	501	11,7	487	13,6	473	15,5	460	17,5	448	19,4
Model AEC 16	2239	2900	643	2,04	613	4,08	590	6,12	570	8,17	553	10,2	537	12,3	522	14,3	509	16,4	496	18,4	484	20,4
Model AEC 16	2391	2900	691	2,18	661	4,36	638	6,54	618	8,72	601	10,9	585	13,1	570	15,3	557	17,5	544	19,6	532	21,8
Model AEC 16	2549	2900	741	2,33	711	4,65	688	6,97	669	9,30	651	11,6	635	14,0	621	16,3	607	18,6	594	20,9	582	23,3
Model AEC 16	2732	2900	800	2,49	770	4,98	746	7,47	727	9,96	709	12,5	694	15,0	679	17,5	665	19,9	652	22,4	640	24,9
Model AEC 19	1230	1450	514	1,71	475	3,42	445	5,12	418	6,83	395	8,54	374	10,3	354	12,0	336	13,7	318	15,4	-	-
Model AEC 19	1300	1450	548	1,81	509	3,61	479	5,42	452	7,22	429	9,02	408	10,9	388	12,7	370	14,5	352	16,3	-	-
Model AEC 19	1375	1450	584	1,91	546	3,82	515	5,73	489	7,64	466	9,54	444	11,5	425	13,4	406	15,3	389	17,2	-	-
Model AEC 19	1450	1450	621	2,02	582	4,03	552	6,04	525	8,05	502	10,1	481	12,1	461	14,1	443	16,1	425	18,1	-	-
Model AEC 19	1535	1450	662	2,13	623	4,26	593	6,39	567	8,52	543	10,7	522	12,8	502	14,9	484	17,1	466	19,2	450	21,3
Model AEC 19	1620	1450	703	2,25	665	4,50	634	6,75	608	9,00	585	11,3	563	13,5	544	15,8	525	18,0	508	20,3	491	22,5
Model AEC 19	1720	1450	752	2,39	713	4,78	683	7,16	657	9,55	633	12,0	612	14,4	592	16,7	574	19,1	556	21,5	540	23,9
Model AEC 19	1825	1450	803	2,54	764	5,07	734	7,60	708	10,2	684	12,7	663	15,2	643	17,8	625	20,3	607	22,8	591	25,4
Model AEC 19	1969	2900	873	2,74	834	5,47	804	8,20	778	11,0	754	13,7	733	16,4	713	19,2	695	21,9	677	24,6	661	27,4
Model AEC 19	2071	2900	923	2,88	884	5,75	853	8,63	827	11,5	804	14,4	783	17,3	763	20,1	744	23,0	727	25,9	710	28,8
Model AEC 19	2203	2900	987	3,06	948	6,12	918	9,17	891	12,3	868	15,3	847	18,4	827	21,4	809	24,5	791	27,5	774	30,6
Model AEC 22	1095	980	772	2,51	719	5,03	677	7,54	641	10,1	608	12,6	577	15,1	549	17,6	523	20,1		-	-	-
Model AEC 22	1165	1450	828	2,68	776	5,35	733	8,02	697	10,7	664	13,4	634	16,1	606	18,7	579	21,4	554	24,1	-	-
Model AEC 22	1230	1450	881	2,82	828	5,65	785	8,47	749	11,3	716	14,1	686	17,0	658	19,8	631	22,6	606	25,4	-	-
Model AEC 22	1300	1450	937	2,98	884	5,97	842	8,95	805	12,0	772	14,9	742	17,9	714	20,9	687	23,9	662	26,9	638	29,8
Model AEC 22	1375	1450	997	3,16	944	6,31	902	9,46	865	12,6	832	15,8	802	19,0	774	22,1	748	25,3	723	28,4	699	31,6
Model AEC 22	1450	1450	1057	3,33	1004	6,65	962	9,98	926	13,3	893	16,7	863	20,0	834	23,3	808	26,6	783	30,0	759	33,3
Model AEC 22	1535	1450	1125	3,52	1073	7,04	1030	10,6	994	14,1	961	17,6	931	21,2	903	24,7	876	28,2	851	31,7	827	35,2
Model AEC 22	1625	1450	1198	3,73	1145	7,46	1103	11,2	1066	14,9	1033	18,7	1003	22,4	975	26,1	948	29,8	923	33,6	899	37,3
Model AEC 22	1720	1450	1274	3,95	1221	7,89	1179	11,9	1142	15,8	1110	19,8	1078	23,8	1051	27,6	1025	31,6	1000	35,5	976	39,5
Model AEC 22	1825	1450	1358	4,19	1306	8,37	1263	12,6	1227	16,8	1194	21,0	1164	25,1	1136	29,3	1109	33,5	1084	37,7	1060	41,9
Model AEC 22	1935	2900	1447	4,44	1394	8,88	1352	13,3	1315	17,8	1282	22,2	1252	26,7	1224	31,1	1197	35,5	1172	40,0	1148	44,4
Model AEC 22	2035	2900	1527	4,67	1474	9,34	1432	14,0	1395	18,7	1362	23,4	1332	28,0	1304	32,7	1278	37,4	1253	42,0	1229	46,7
Model AEC 26	1030	965	1167	3,76	1098	7,53	1043	11,3	995	15,1	953	18,8	914	22,6	878	26,4	844	30,1	812	33,9	782	37,6
Model AEC 26	1095	1450	1250	4,00	1181	8,00	1126	12,0	1078	16,0	1036	20,0	997	24,0	961	28,0	927	32,0	895	36,0	865	40,0
Model AEC 26	1165	1450	1340	4,26	1270	8,51	1215	12,8	11168	17,0	1125	21,3	1086	25,6	1050	29,8	1017	34,1	985	38,3	954	42,6
Model AEC 26	1230	1450	1423	4,49	1353	8,99	1298	13,5	1250	18,0	1208	22,5	1169	27,0	1133	31,5	1100	36,0	1068	40,5	1037	44,9
Model AEC 26	1300	1450	1512	4,75	1442	9,50	1387	14,3	1340	19,0	1297	23,8	1259	28,5	1223	33,3	1189	38,0	1157	42,8	1126	47,5
Model AEC 26	1375	1450	1608	5,02	1538	10,1	1483	15,1	P1435	20,1	1393	25,1	1354	30,2	1318	35,2	1285	40,2	1253	45,2	1222	50,2
Model AEC 26	1450	1450	1703	5,30	1634	10,6	1579	15,9	1531	21,2	1489	26,5	1450	31,8	1414	37,1	1380	42,4	1348	47,7	1318	53,0
Model AEC 26	1535	1450	1812	5,61	1742	11,2	1687	16,8	1640	22,5	1597	28,1	1559	33,7	1522	39,3	1489	44,9	1457	50,5	1426	56,1
Model AEC 26	1620	2900	1920	5,92	1851	11,9	1796	17,8	11748	23,7	1706	29,6	1667	35,5	1631	41,4	1597	47,4	1565	53,3	1535	59,2
Model AEC 26	1720	2900	2048	6,28	1978	12,6	1923	18,9	1876	25,2	1833	31,4	1795	37,7	1759	44,0	1725	50,3	1693	56,6	1662	62,8
Model AEC 26	1825	2900	2182	6,67	2112	13,4	2057	20,0	2010	26,7	1967	33,4	1929	40,0	1893	46,7	1859	53,3	1827	60,0	1796	66,7
Model AEC 30	716	965	1289	4,28	1199	8,56	1129	12,9	1069	17,1	1015	21,4	967	26,7	922	30,0	879	34,3	-	-	-	-
Model AEC 30	760	965	1381	4,55	1291	9,09	1220	13,7	1160	18,2	1107	22,7	1058	27,3	1013	31,8	971	36,4	-	-	-	-
Model AEC 30	807	965	1479	4,83	1389	9,65	1318	14,5	1258	19,3	1205	24,1	1156	29,0	1111	33,8	1069	38,6	-	-	-	-
Model AEC 30	856	965	1581	5,12	1491	10,3	1420	15,4	1360	20,5	1307	25,6	1258	30,7	1213	35,8	1171	41,0	1131	46,1	-	-
Model AEC 30	909	965	1691	5,44	1601	10,9	1530	16,3	1470	21,8	1417	27,2	1368	32,6	1323	38,1	1281	43,5	1241	48,9	-	-
Model AEC 30	965	965	1807	5,77	1717	11,6	1647	17,3	1587	23,1	1533	28,9	1485	34,6	1440	40,4	1398	46,2	1358	51,9	1320	57,7
Model AEC 30	1024	965	1930	6,12	1840	12,3	1770	18,4	1710	24,5	1656	30,6	1607	36,8	1562	42,9	1520	49,0	1481	55,1	1443	61,2
Model AEC 30	1088	1450	2063	6,51	1973	13,0	1903	19,5	1843	26,0	1789	32,5	1741	39,1	1696	45,6	1654	52,1	1614	58,6	1576	65,1
Model AEC 30	1155	1450	2203	6,91	2113	13,8	2042	20,7	1982	27,6	1929	34,6	1880	41,5	1835	48,4	1793	55,3	1753	62,2	1716	69,1
Model AEC 30	1212	1450	2321	7,25	2231	14,5	2161	21,8	2101	29,0	2047	36,3	1999	43,5	1954	50,7	1912	58,0	1872	65,2	1834	72,5
Model AEC 30	1287	1450	2478	7,70	2387	15,4	2317	23,1	2257	30,8	2203	38,5	2155	46,2	2110	53,9	2068	61,6	2028	69,3	1990	77,0

ANNEXURE 3.3

Standard Roots Blower Sheets for Blower Selection

ACME AIR EQUIPMENTS CO. PVT. LTD.

Roots blower (Air cooled Twin lobe blower)

nb = Blower Speed - RPM | V1 = Inlet Volume for Air (over pressure condition) | Suction Air Data :

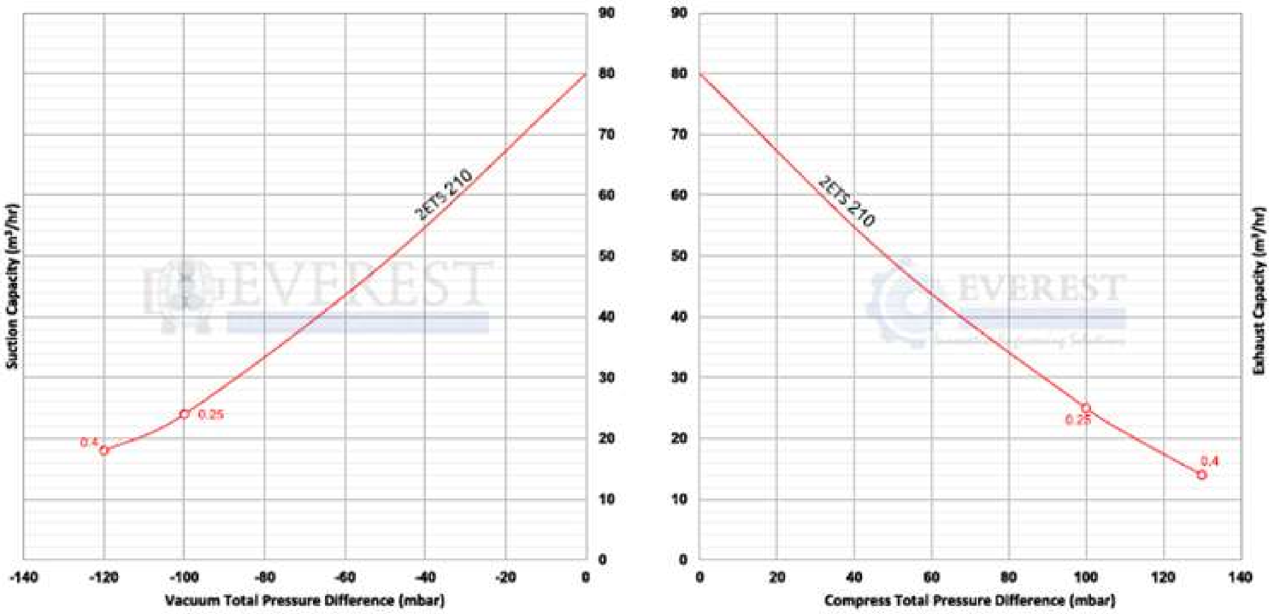
nm = Motor Speed RPM | N = Power at blower shaft. | Temp : 30°C RH : 65% | Air Cooled

		mmwc	1020		2039		3059		4079		5099		6118		7138		8158		9177		10197	
		mbar	100		200		300		400		500		600		700		800		900		1000	
	nb	nm	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N	V1	N
	rpm	rpm	m3/ h	kW	m3/ h	kW	m31	kW	m3/	kW	m31	kW	m31	kW	m3/	kW	m31	kW	m3/	kW	m3/ h	kW
Model AEC 36	606	725	1913	6,28	1783	12,6	1681	18,9	1594	25,2	1516	31,4	1445	37,7	1379	44,0	1317	50,3	1259	56,6	-	-
Model AEC 36	643	725	2046	6,67	1917	13,4	1815	20,0	1728	26,7	1650	33,4	1579	40,0	1513	46,7	1451	53,4	1393	60,0	-	-
Model AEC 36	716	965	2311	7,43	2181	14,9	2079	22,3	1992	29,7	1914	37,1	1843	44,6	1777	52,0	1716	59,4	1657	66,8	1602	74,3
Model AEC 36	760	965	2470	7,88	2340	15,8	2239	23,7	2151	31,5	2073	39,4	2002	47,3	1937	55,2	1875	63,1	1817	70,9	1761	78,8
Model AEC 36	807	965	2640	8,37	2511	16,8	2409	25,1	2321	33,5	2244	41,9	2173	50,2	2107	58,6	2045	67,0	1987	75,3	1931	83,7
Model AEC 36	856	965	2818	8,88	2688	17,8	2586	26,7	2499	35,5	2421	44,4	2350	53,3	2284	62,1	2222	71,0	2164	79,9	2109	88,8
Model AEC 36	909	965	3010	9,43	2880	18,9	2778	28,3	2691	37,7	2613	47,1	2542	56,6	2476	66,0	2414	75,4	2356	84,8	2301	94,3
Model AEC 36	965	965	3212	10,0	3083	20,0	2981	30,0	2894	40,0	2816	50,0	2745	60,0	2679	70,1	2617	80,1	2559	90,1	2503	101
Model AEC 36	1024	965	3426	10,6	3296	21,3	3194	31,9	3107	42,5	3029	53,1	2958	63,7	2892	74,3	2831	84,9	2773	95,6	2717	107
Model AEC 36	1088	1450	3658	11,3	3528	22,6	3426	33,9	3339	45,1	3261	56,4	3190	67,7	3124	79,0	3063	90,3	3004	102	2949	114
Model AEC 42	606	725	3078	9,87	2905	19,8	2767	29,6	2650	39,5	2545	49,4	2449	59,3	2360	69,1	2276	79,0	2197	88,9	-	-
Model AEC 42	643	725	3289	10,5	3115	21,0	2978	31,2	2860	41,9	2755	52,4	2659	62,9	2570	73,3	2487	83,8	2408	94,3	2332	106
Model AEC 42	716	965	3704	11,7	3531	23,4	3394	35,0	3276	46,7	3171	58,3	3075	70,0	2986	81,7	2902	93,3	2823	106	2748	117
Model AEC 42	760	965	3955	12,4	3781	24,8	3644	37,2	3526	49,5	3421	61,9	3325	74,3	3236	86,7	3153	99,1	3074	112	2998	125
Model AEC 42	807	965	4222	13,2	4049	26,3	3912	39,5	3794	52,6	3689	65,8	3593	78,9	3504	92,0	3420	106	3341	119	3266	132
Model AEC 42	856	965	4501	14,0	4328	27,9	4191	41,9	4073	55,8	3968	69,7	3872	83,7	3783	97,6	3699	112	3620	126	3545	140
Model AEC 42	909	965	4803	14,8	4630	29,6	4492	44,4	4375	59,3	4270	74,1	4174	88,9	4084	104	4001	119	3922	134	3847	149
Model AEC 42	965	965	5122	15,7	4948	31,5	4811	47,3	4694	62,9	4588	78,6	4492	94,3	4403	111	4320	127	4241	142	4166	158
Model AEC 42	1024	965	5458	16,7	5284	33,4	5147	50,1	5029	66,7	4924	83,4	4828	101	4739	118	4656	134	4577	151	4501	168
Model AEC 42	1088	1450	5822	17,8	5649	35,5	5511	53,2	5393	70,9	5289	88,6	5193	107	5104	125	5020	143	4941	160	4866	178
Model AEC 50	512	580	4413	14,1	4169	28,2	3975	42,3	3807	56,3	3657	70,4	3519	84,5	3391	98,5	3271	113	3157	127	-	-
Model AEC 50	544	580	4720	15,0	4476	29,9	4282	44,9	4115	59,8	3964	74,8	3827	89,7	3699	105	3578	120	3464	135	3356	150
Model AEC 50	578	725	5047	19,9	4803	31,8	4609	47,7	4441	63,6	4291	79,5	4153	95,4	4025	112	3905	128	3791	144	3682	160
Model AEC 50	606	725	5316	16,7	5072	33,3	4878	50,0	4710	66,7	4560	83,3	4422	100	4294	117	4174	134	4060	151	3951	167
Model AEC 50	643	725	5672	17,7	5428	35,4	5233	53,1	5066	70,7	4916	88,4	4778	107	4650	125	4529	142	4415	160	4307	178
Model AEC 50	716	965	6373	19,7	6129	39,4	5935	59,1	5767	78,8	5617	98,4	5479	119	5351	139	5231	158	5117	178	5008	198
Model AEC 50	760	965	6796	20,9	6552	41,8	6357	62,7	6190	83,6	6040	105	5902	126	5774	147	5653	168	5539	189	5431	210
Model AEC 50	807	965	7247	22,2	7003	44,4	6809	66,6	6641	88,8	6491	112	6353	134	6225	156	6105	178	5991	200	5882	223
Model AEC 50	856	965	7718	23,6	7474	47,1	7280	70,6	7112	94,1	6962	118	6824	142	6696	166	6576	189	6462	213	6353	236
Model AEC 70	580	725	7200	27.5	6840	49.8	6540	72.1	6300	94.4	6120	116	- -	- -	- -	- -	- -					
Model AEC 70	650	725	8160	32	7800	56.9	7560	81.9	7320	107	7080	132	- -	- -	- -	- -	- -					
Model AEC 70	738	965	9420	38.5	9060	66.9	8820	95.3	8580	124	8340	152	- -	- -	- -	- -	- -					
Model AEC 70	820	965	10560	44.9	10200	76.2	9900	108	9660	139	9480	170	- -	- -	- -	- -	- -					
Model AEC 70	905	965	11720	53.3	11360	87.8	11105	123	10865	158	10639	192	- -	- -	- -	- -	- -					
Model AEC 70	930	965	12060	55.8	11700	91.2	11460	127	11220	163	10980	198	- -	- -	- -	- -	- -					
Model AEC 70	965	965	12556	59.3	12196	95.8	11956	133	11716	170	11476	207	- -	- -	- -	- -	- -					
Model AEC 70	985	965	12840	61.4	12480	98.4	12240	137	12000	174	11760	212	- -	- -	- -	- -	- -					
Model AEC 70	1040	1450	13620	67.5	13260	107	12960	146	12720	187	12540	226	- -	- -	- -	- -	- -					
Model AEC 70	1180	1450	15600	84.4	15180	129	14940	174	14700	219	14460	264	- -	- -	- -	- -	- -					
AEP - 40	1450	1450									137	4.1.	126	4.8.	124	6.	122	6.	120	7.0	118	8.
AEP - 40	2850	2900									392	7.9.	367	9.4.	362	11.	358	12.	354	14.	350	15.
AEP - 60	1450	1450									624	12.5.	580	15.0.	570	17.0	560	19.	555	22.	550	24.
AEP - 60	2000	1450									932	17.0.	870	20.0.	860	23.0	850	26.	840	29.0	835	32
AEP -110	1450	1450									812	16.8.	795	19.9.	783	23.	770	26.	-	-	-	-
AEP -110	2000	1450									1200	22.2.	1183	26.9.	1170	31.	1158	36.	-	-	-	-
AEP - 150	980	970									1360	25.2.	1270	30.0.	1250	34.	1230	40.	1220	44.0	1210	49.
AEP - 150	1450	1450									2160	36.8.	2010	45.0.	1980	52.	1960	58.	1940	65.	1920	72.
AEP - 230	980	970									1620	30.6.	1608	37.6.	1583	43.	1560	50.	-	-	-	-
AEP - 230	1450	1450									2562	47.7.	2538	56.4.	2503	65.	2478	73.	-	-	-	-
AEP - 300	725	725									2640	47.7.	2500	58.0.	2450	67.0	2400	76.0	2360	85.0	2320	93.
AEP - 300	980	970									3780	66.4.	3570	80.0.	3520	92.	3480	104	3440	116.	3410	127
AEP - 400	725	725									3150	61.2.	3080	72.7.	3070	84	3010	95.1.	-	-	-	-
AEP - 400	980	980									4500	84.0.	4460	98.8.	4400	115	4350	130	-	-	-	-

ANNEXURE 4.1

Standard Side Channel Blower Sheets for Blower Selection

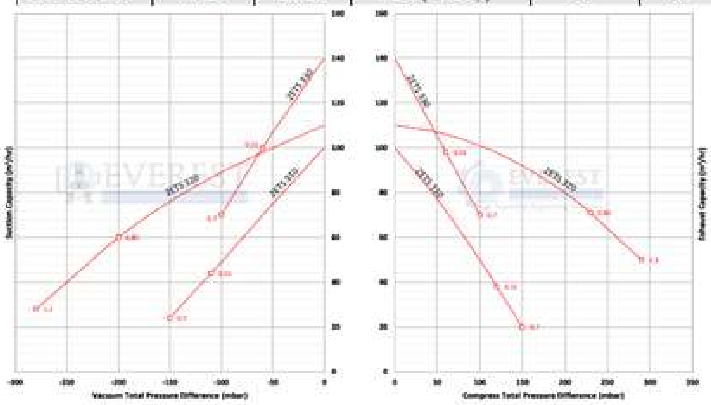
MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m^3/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-210-A11	SINGLE	SINGLE	G1¼ (15 Deep)	50	0.37	80	-110	110	53	11	ESF-10	RV-01
2ETS-310-A01	SINGLE	SINGLE	G1¼ (15 Deep)	50	0.55	100	-120	120	55	13	ESF-10	RV-01
2ETS-310-A11	SINGLE	SINGLE	G1¼ (15 Deep)	50	0.7	100	-150	150	55	14	ESF-10	RV-01
2ETS-410-A01	SINGLE	SINGLE	G1½ (15 Deep)	50	0.7	145	-120	120	60	15	ESF-12	RV-01
2ETS-410-A11	SINGLE	SINGLE	G1½ (15 Deep)	50	0.8	145	-150	160	63	15	ESF-12	RV-01
2ETS-410-A21	SINGLE	SINGLE	G1½ (15 Deep)	50	1.1	145	-150	190	63	16	ESF-12	RV-01
2ETS-420-A31	SINGLE	DOUBLE	G1½ (15 Deep)	50	1.5	150	-280	290	66	26	ESF-12	RV-01
2ETS-510-A11	SINGLE	SINGLE	55 mmNB	50	1.1	210	-160	160	64	21	ESF-12	RV-01
2ETS-510-A21	SINGLE	SINGLE	55 mmNB	50	1.5	210	-190	200	64	24	ESF-12	RV-01
2ETS-610-A11	SINGLE	SINGLE	56 mmNB	50	2.2	270	-230	250	64	30	ESF-12	RV-01
2ETS-710-A11	SINGLE	SINGLE	55 mmNB	50	2.2	318	-190	190	72	30	ESF-16	RV-01



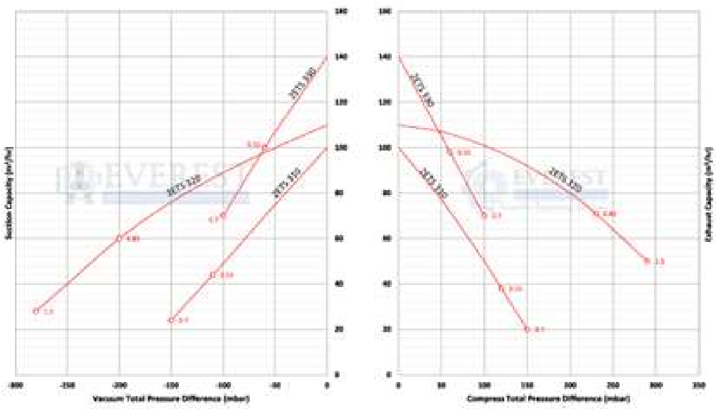
ANNEXURE 4.2

Standard Side Channel Blower Sheets for Blower Selection

MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m³/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-310-H06	THREE	SINGLE	G1¼ (15 Deep)	50	0.55	100	-110	120	55	11	ESF-10	RV-01
2ETS-310-H16	THREE	SINGLE	G1¼ (15 Deep)	50	0.75	100	-150	150	55	12	ESF-10	RV-01
2ETS-320-H26	THREE	DOUBLE	G1¼ (15 Deep)	50	0.85	110	-200	230	58	17	ESF-10	RV-01
2ETS-320-H36	THREE	DOUBLE	G1¼ (15 Deep)	50	1.3	110	-280	290	58	18	ESF-10	RV-01
2ETS-330-H06	THREE	SINGLE	G1¼ (15 Deep)	50	0.55	140	-60	60	56	12	ESF-10	RV-01
2ETS-330-H16	THREE	SINGLE	G1¼ (15 Deep)	50	0.7	140	-100	100	56	13	ESF-10	RV-01



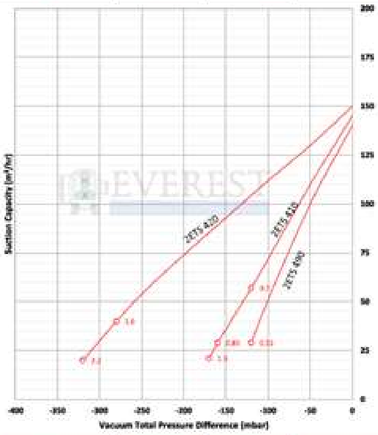
MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m³/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-310-H06	THREE	SINGLE	G1¼ (15 Deep)	50	0.55	100	-110	120	55	11	ESF-10	RV-01
2ETS-310-H16	THREE	SINGLE	G1¼ (15 Deep)	50	0.75	100	-150	150	55	12	ESF-10	RV-01
2ETS-320-H26	THREE	DOUBLE	G1¼ (15 Deep)	50	0.85	110	-200	230	58	17	ESF-10	RV-01
2ETS-320-H36	THREE	DOUBLE	G1¼ (15 Deep)	50	1.3	110	-280	290	58	18	ESF-10	RV-01
2ETS-330-H06	THREE	SINGLE	G1¼ (15 Deep)	50	0.55	140	-60	60	56	12	ESF-10	RV-01
2ETS-330-H16	THREE	SINGLE	G1¼ (15 Deep)	50	0.7	140	-100	100	56	13	ESF-10	RV-01

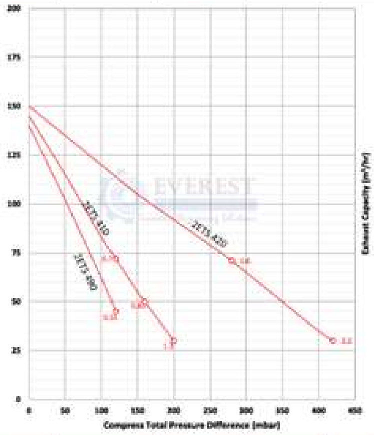


ANNEXURE 4.3

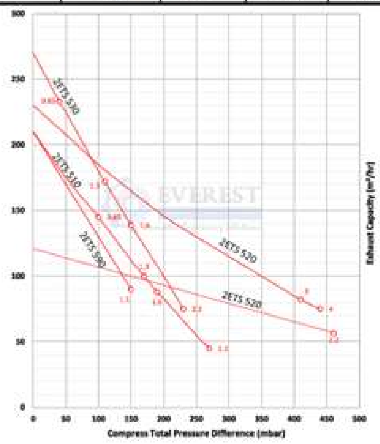
Standard Side Channel Blower Sheets for Blower Selection

MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m³/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-410-H06	THREE	SINGLE	G1½ (15 Deep)	50	0.7	145	-120	120	63	13	ESF-12	RV-01
2ETS-410-H16	THREE	SINGLE	G1½ (15 Deep)	50	0.85	145	-160	160	63	16	ESF-12	RV-01
2ETS-410-H26	THREE	SINGLE	G1½ (15 Deep)	50	1.3	145	-170	200	63	17	ESF-12	RV-01
2ETS-420-H36	THREE	DOUBLE	G1½ (15 Deep)	50	1.6	150	-280	280	66	25	ESF-12	RV-01
2ETS-420-H46	THREE	DOUBLE	G1½ (15 Deep)	50	2.2	150	-330	440	66	27	ESF-12	RV-02
2ETS-490-H16	THREE	SINGLE	G1½ (15 Deep)	50	0.55	140	-120	120	63	14	ESF-12	RV-01





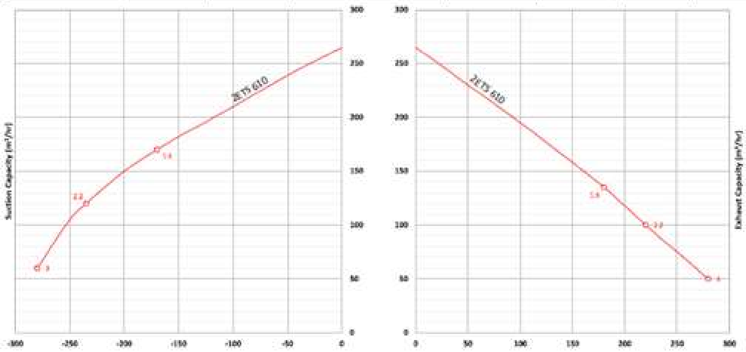
MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m³/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-510-H06	THREE	SINGLE	55 mmNB	50	0.85	210	-110	100	64	20	ESF-16	RV-01
2ETS-510-H16	THREE	SINGLE	55 mmNB	50	1.3	210	-170	170	64	22	ESF-16	RV-01
2ETS-510-H26	THREE	SINGLE	55 mmNB	50	1.6	210	-200	190	64	23	ESF-16	RV-01
2ETS-510-H36	THREE	SINGLE	55 mmNB	50	2.2	210	-220	270	64	25	ESF-16	RV-01
2ETS-520-H36	THREE	DOUBLE	G1¼ (15 Deep)	50	2.2	120	-470	460	64	40	ESF-16	RV-02
2ETS-520-H46	THREE	DOUBLE	58 mmNB	50	3	230	-340	410	72	40	ESF-16	RV-02
2ETS-520-H57	THREE	DOUBLE	55 mmNB	50	4	230	-390	490	72	44	ESF-16	RV-02
2ETS-530-H06	THREE	SINGLE	55 mmNB	50	0.85	270	-40	40	65	21	ESF-16	RV-01
2ETS-530-H16	THREE	SINGLE	55 mmNB	50	1.3	270	-120	110	65	23	ESF-16	RV-01
2ETS-530-H26	THREE	SINGLE	55 mmNB	50	1.6	270	-160	150	65	24	ESF-16	RV-01
2ETS-530-H36	THREE	SINGLE	55 mmNB	50	2.2	270	-220	230	65	26	ESF-16	RV-01
2ETS-590-H26	THREE	SINGLE	55 mmNB	50	1.1	210	-130	150	64	23	ESF-16	RV-01



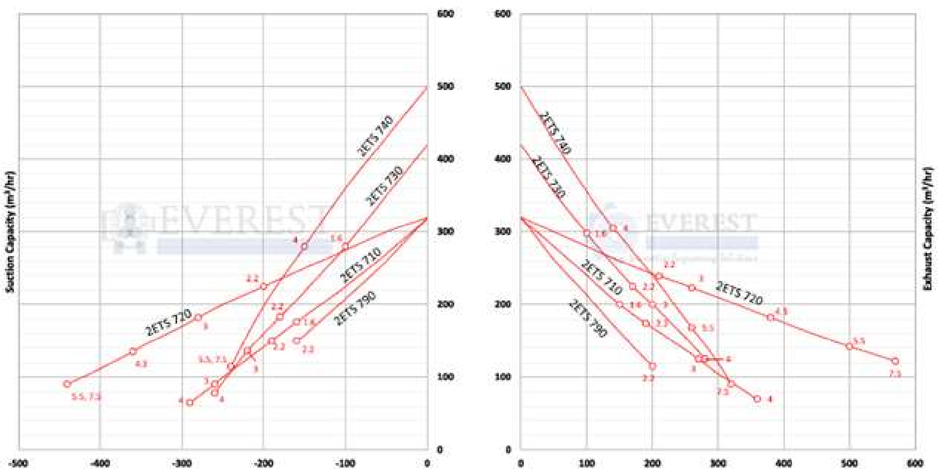
ANNEXURE 4.4

Standard Side Channel Blower Sheets for Blower Selection

MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m³/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-610-H06	THREE	SINGLE	56 mmNB	50	1.6	265	-170	180	68	25	ESF-16	RV-01
2ETS-610-H16	THREE	SINGLE	56 mmNB	50	2.2	265	-235	220	69	28	ESF-16	RV-01
2ETS-610-H26	THREE	SINGLE	56 mmNB	50	3	265	-280	280	69	34	ESF-16	RV-01



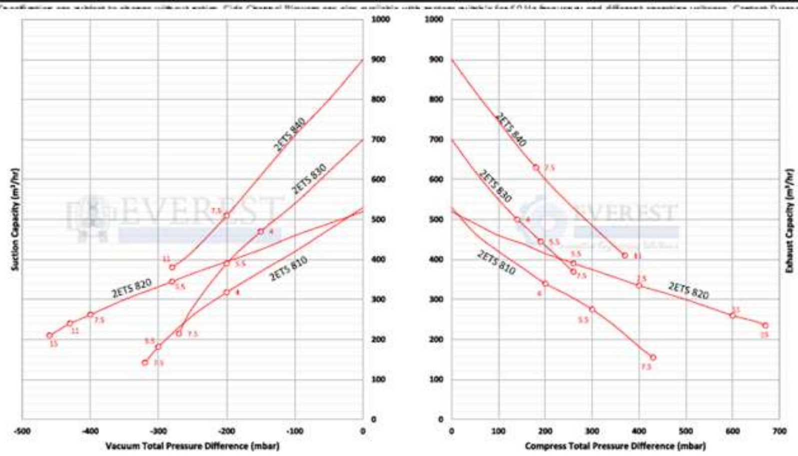
MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m³/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-710-H06	THREE	SINGLE	55 mmNB	50	1.6	318	-160	150	69	27	ESF-16	RV-01
2ETS-710-H16	THREE	SINGLE	55 mmNB	50	2.2	318	-210	200	69	30	ESF-16	RV-01
2ETS-710-H26	THREE	SINGLE	55 mmNB	50	3	318	-270	290	69	36	ESF-16	RV-01
2ETS-710-H37	THREE	SINGLE	55 mmNB	50	4	318	-290	330	69	40	ESF-16	RV-02
2ETS-720-H16	THREE	DOUBLE	55 mmNB	50	2.2	320	-220	210	73	43	ESF-16	RV-01
2ETS-720-H26	THREE	DOUBLE	55 mmNB	50	3	320	-280	260	73	48	ESF-16	RV-01
2ETS-720-H37	THREE	DOUBLE	55 mmNB	50	4.3	320	-360	380	73	54	ESF-16	RV-02
2ETS-720-H47	THREE	DOUBLE	55 mmNB	50	5.5	320	-440	500	73	66	ESF-16	RV-02
2ETS-720-H57	THREE	DOUBLE	55 mmNB	50	7.5	320	-440	570	73	73	ESF-16	RV-02
2ETS-730-H06	THREE	SINGLE	55 mmNB	50	1.6	420	-100	100	70	29	ESF-20	RV-01
2ETS-730-H16	THREE	SINGLE	55 mmNB	50	2.2	420	-170	170	70	32	ESF-20	RV-01
2ETS-730-H26	THREE	SINGLE	55 mmNB	50	3	420	-220	220	70	37	ESF-20	RV-01
2ETS-730-H37	THREE	SINGLE	55 mmNB	50	4	420	-260	310	70	43	ESF-20	RV-01
2ETS-740-H37	THREE	DOUBLE	55 mmNB	50	4	500	-150	140	74	54	ESF-20	RV-01
2ETS-740-H47	THREE	DOUBLE	58 mmNB	50	5.5	500	-240	260	74	69	ESF-20	RV-01
2ETS-740-H57	THREE	DOUBLE	58 mmNB	50	7.5	500	-240	320	74	75	ESF-20	RV-02
2ETS-790-H26	THREE	SINGLE	55 mmNB	50	2.2	320	-160	200	69	36	ESF-16	RV-01



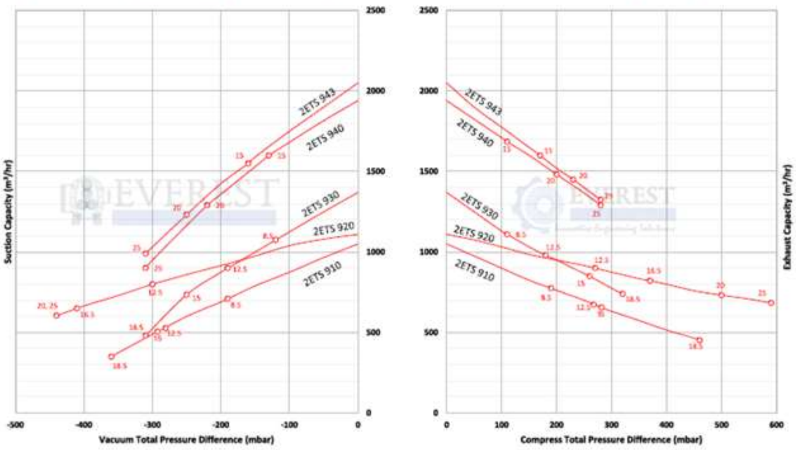
ANNEXURE 4.5

Standard Side Channel Blower Sheets for Blower Selection

MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m^3/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-810-H07	THREE	SINGLE	63.5 mmNB	50	4	530	-200	200	70	54	ESF-20	RV-01
2ETS-810-H17	THREE	SINGLE	63.5 mmNB	50	5.5	530	-300	300	70	63	ESF-20	RV-01
2ETS-810-H27	THREE	SINGLE	63.5 mmNB	50	7.5	530	-320	430	70	66	ESF-20	RV-02
2ETS-820-H17	THREE	DOUBLE	63.5 mmNB	50	5.5	520	-240	240	74	83	ESF-20	RV-01
2ETS-820-H27	THREE	DOUBLE	63.5 mmNB	50	7.5	520	-400	400	74	86	ESF-20	RV-02
2ETS-820-H37	THREE	DOUBLE	63.5 mmNB	50	11	520	-430	600	74	104	ESF-20	RV-02
2ETS-820-H47	THREE	DOUBLE	63.5 mmNB	50	15	520	-460	670	74	120	ESF-20	RV-02
2ETS-830-H07	THREE	SINGLE	63.5 mmNB	50	4	700	-150	140	70	57	ESF-20	RV-01
2ETS-830-H17	THREE	SINGLE	63.5 mmNB	50	5.5	700	-200	180	70	66	ESF-20	RV-01
2ETS-830-H27	THREE	SINGLE	63.5 mmNB	50	7.6	700	-270	260	70	61	ESF-20	RV-01
2ETS-840-H27	THREE	DOUBLE	63.5 mmNB	50	7.5	900	-200	180	74	91	ESF-32	RV-01
2ETS-840-H37	THREE	DOUBLE	63.5 mmNB	50	11	900	-280	370	74	110	ESF-32	RV-02



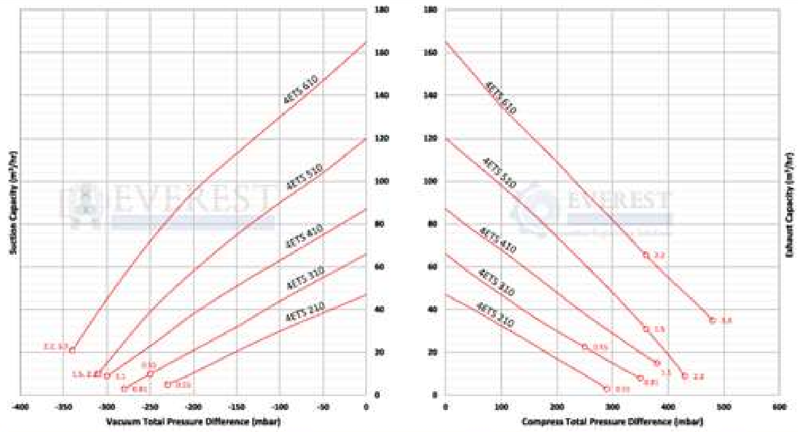
MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m^3/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
2ETS-910-H07	THREE	SINGLE	100 mmNB	50	8.5	1050	-210	210	74	93	ESF-32	RV-01
2ETS-910-H17	THREE	SINGLE	100 mmNB	50	12.5	1050	-280	270	74	116	ESF-32	RV-01
2ETS-910-H27	THREE	SINGLE	100 mmNB	50	15	1050	-290	280	74	120	ESF-32	RV-01
2ETS-910-H37	THREE	SINGLE	100 mmNB	50	18.5	1050	-340	460	74	126	ESF-32	RV-02
2ETS-920-H17	THREE	DOUBLE	100 mmNB	50	12.5	1110	-300	370	74	187	ESF-32	RV-02
2ETS-920-H27	THREE	DOUBLE	100 mmNB	50	16.5	1110	-410	370	74	197	ESF-32	RV-02
2ETS-920-H37	THREE	DOUBLE	100 mmNB	50	20	1110	-440	500	74	204	ESF-32	RV-02
2ETS-920-H47	THREE	DOUBLE	100 mmNB	50	25	1110	-440	590	74	211	ESF-32	RV-02
2ETS-930-H07	THREE	SINGLE	100 mmNB	50	8.5	1370	-120	110	75	98	ESF-32	RV-01
2ETS-930-H17	THREE	SINGLE	100 mmNB	50	12.5	1370	-210	190	75	121	ESF-32	RV-01
2ETS-930-H27	THREE	SINGLE	100 mmNB	50	15	1370	-250	260	75	128	ESF-32	RV-01
2ETS-930-H37	THREE	SINGLE	100 mmNB	50	18.5	1370	-310	320	75	131	ESF-32	RV-02
2ETS-940-H27	THREE	DOUBLE	100 mmNB	50	15	1940	-130	110	75	187	ESF-32	RV-01
2ETS-940-H37	THREE	DOUBLE	100 mmNB	50	20	1940	-220	200	75	212	ESF-32	RV-01
2ETS-940-H47	THREE	DOUBLE	100 mmNB	50	25	1940	-310	270	75	219	ESF-32	RV-01
2ETS-943-H27*	THREE	DOUBLE	130 mmNB	50	15	2050	-160	170	75	220	ESF-32	RV-01
2ETS-943-H37*	THREE	DOUBLE	130 mmNB	50	20	2050	-250	230	75	230	ESF-32	RV-01
2ETS-943-H47*	THREE	DOUBLE	130 mmNB	50	25	2330	-310	270	75	235	ESF-32	RV-01



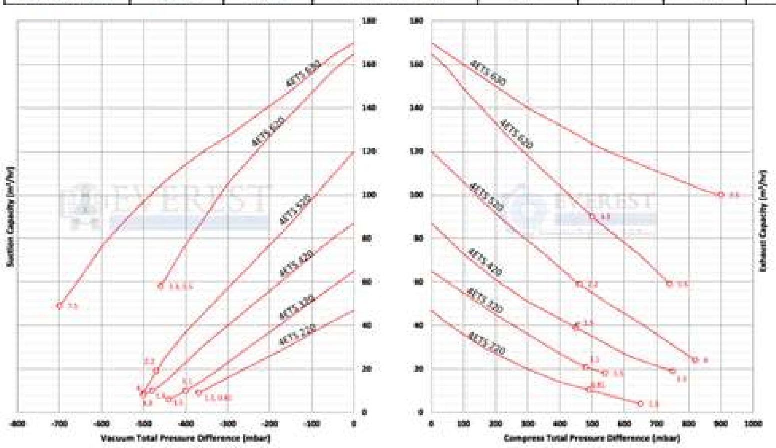
ANNEXURE 4.5

Standard Side Channel Blower Sheets for Blower Selection

MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m^3/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
4ETS-210-H16	THREE	SINGLE	G1¼ (15 Deep)	50	0.55	47	-230	290	57	16	ESF-10	RV-01
4ETS-310-H16	THREE	SINGLE	G1¼ (18 Deep)	50	0.55	66	-250	250	57	16	ESF-10	RV-01
4ETS-310-H26	THREE	SINGLE	G1¼ (18 Deep)	50	0.81	66	-280	350	57	17	ESF-10	RV-02
4ETS-410-H16	THREE	SINGLE	G1¼ (18 Deep)	50	1.1	87	-300	380	58	23	ESF-10	RV-02
4ETS-510-H16	THREE	SINGLE	G1¼ (18 Deep)	50	1.5	120	-310	360	64	26	ESF-10	RV-02
4ETS-510-H26	THREE	SINGLE	G1¼ (18 Deep)	50	2.2	120	-310	470	64	29	ESF-10	RV-02
4ETS-610-H16	THREE	SINGLE	G1¼ (18 Deep)	50	2.2	165	-340	360	65	32	ESF-10	RV-02
4ETS-610-H36	THREE	SINGLE	G1¼ (18 Deep)	50	3.3	165	-340	480	65	35	ESF-10	RV-02



MODEL	SINGLE/ THREE PHASE	SINGLE/ DOUBLE/ STAGE	BLOWER OPENING DETAILS	FREQUENCY (Hz)	MOTOR INPUT POWER (kW)	VOLUME FLOW RATE (m^3/hr)	VACUUM (mbar)	PRESSURE (mbar)	NOISE LEVEL @ 1mt dB(A)	WEIGHT (kG)	FILTER	RELIEF VALVE
4ETS-220-H26	THREE	DOUBLE	G1¼ (18 Deep)	50	0.81	47	-370	490	58	24	ESF-10	RV-02
4ETS-220-H56	THREE	DOUBLE	G1¼ (15 Deep)	50	1.5	47	-370	650	58	28	ESF-10	RV-02
4ETS-320-H46	THREE	DOUBLE	G1¼ (18 Deep)	50	1.1	65	-400	480	59	29	ESF-10	RV-02
4ETS-320-H56	THREE	DOUBLE	G1¼ (18 Deep)	50	1.5	65	-440	540	59	30	ESF-10	RV-02
4ETS-420-H26	THREE	DOUBLE	G1¼ (18 Deep)	50	1.5	87	-480	450	61	33	ESF-12	RV-02
4ETS-420-H56	THREE	DOUBLE	G1¼ (18 Deep)	50	3.3	87	-500	750	61	39	ESF-12	RV-02
4ETS-520-H26	THREE	DOUBLE	G1¼ (18 Deep)	50	2.2	120	-470	460	64	40	ESF-16	RV-02
4ETS-520-H77	THREE	DOUBLE	G1¼ (18 Deep)	50	4	120	-500	820	65	51	ESF-16	RV-02
4ETS-620-H36	THREE	DOUBLE	G1¼ (18 Deep)	50	3.3	165	-460	500	67	48	ESF-16	RV-02
4ETS-620-H57	THREE	DOUBLE	G1¼ (18 Deep)	50	5.7	165	-460	740	68	65	ESF-16	RV-02
4ETS-630-H67	THREE	SINGLE	G1¼ (18 Deep)	50	7.5	170	-730	1040	72	86	ESF-16	RV-02



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While making the report, I went through the following Papers and websites for understanding of the topic and theoretical analysis of Pneumatic Conveying System:

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2. Drag Coefficients of Variously Shaped Solid Particles, Drops, and Bubbles **G. I. Kelbaliyev** *Institute of Chemical Problems, Academy of Sciences of Azerbaijan,* February 24, 2010
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3. **Pneuvay engineering, www.pneuvay.com**
4. **www.powderprocess.net**
5. **For photos and figures, www.Googleimages.com**
6. **Centrifugal Blower data sheet From Eminent company available for free download**
7. **Roots blower data sheet from ACME Air Equipments available for free download**
8. **Side channel Blower data sheet from Everest company available for free download**

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TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr. Maheep Nigam (2nd Year B.Tech student at Dr. B.R. Ambedkar NIT Jalandhar) has undergone summer internship with us and has worked on "**Practical Design of Lean Phase Pneumatic Conveying System And development of Application in Microsoft Excel**"

He has worked hard to understand and compile all critical theoretical aspects involving Lean Phase Pneumatic Conveying by going through several research papers, and developed excel base application to evaluate desired fluid flow regime and pressure drops in order to easily determine Blower and pipe specifications for practical design in industrial scenario.

We are pleased with his work and overall compilation and mostly computer application. We wish him all success for his future.

Piyush Srivastava
Technical Consultant