MODIFIED STARCH FLASH DRYER PROJECT					
FAN CALCULATION					
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FLASH DRYER

FAN CALCULATION

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REV.	**ISSUE**	**PURPOSE OF ISSUE**	**PREPARED**	**CHECKED**	**APPROVED**

TABLE OF CONTENT

1. Centrifugal Fan Calculation

1.1. Fan Air Volume

The required air volume or flow of the centrifugal fan are calculated in sections 1.3 and 1.4:

$Qs = Ma.\Delta H$
Where:
Ma: Mass of air, kg/h
ΔH: Change in enthalpy of air: Ho – Hi
Hi: Enthalpy of air (Outlet air temp. 55 ˚C, 43 % Moisture)
Ho: Enthalpy of air (after heater 170 ˚C, 1% Moisture)
Hence:
$Ma = ra.Va$
ra: Density of air, kg/m^3
Va: *Volume of air,* m^3*/h*

$7{,}739{,}363{,}411 = Ma.(319768–171430)$
$Ma = 52{,}174\ Kg/h$
$53{,}121 = 0.78 \times Va$
$Va = 66{,}890\ m^3/h$

Required Air Volume is: 67000 $\mathbf{m^3/h}$

1.2. Pressure Drop

The total pressure loss of the pneumatic system can be expressed as:

$$\Delta Pt = \Delta Pacc + \Delta Pg + \Delta Ps + \Delta Hg + \Delta Hs + \Delta Pmisc$$

ΔPt: *Total pressure loss in the system*
$\Delta Pacc$: *Pressure loss due to acceleration of the solids from their "at rest" condition at the pickup point.*
ΔPg: *Friction pressure loss of the gas*
ΔPs: *Friction pressure loss of the solids*
ΔHg: *Elevation pressure loss of the gas*
ΔHs: *Elevation pressure loss of the solid*
$\Delta Pmisc$: *Pressure losses from miscellaneous equipment (cyclone, bag filter)*

1.2.1. *Pressure loss due to acceleration of the solids*:

$$\Delta Pacc = 6894.8 \frac{W.Vp}{144.g}\ (Pa)$$

Where:
W: *Solids mass velocity,* $(\frac{lbs}{s.ft^2})$
Vp: *Particle velocity, (ft/s)*
g: *Acceleration due to gravity, (32.2)*

Hence:
$Vp = 0.8Vg$
Vg: Maximum Air velocity, (ft/s) = 65.6

$$W = \frac{Ms}{A}$$

Ms: Starch feed rate, (lbs/s)
A: Duct Area, (ft^2)
$W = 0.454 \frac{lbs}{s.ft^2}$
$Vp = 52\ \frac{ft}{s}$
$$\Delta Pacc = 6894.8 \frac{0.454 \times 52}{144 \times 32.2} = 35.4\ (Pa)$$

1.2.2. Friction Pressure loss of the gas:

The frictional pressure drop of the gas is calculated based on the following diagram:

$$\Delta Pg = Fl.L\ (Pa)$$

Where:

Fl: Friction loss, from chart, *(Pa/m)*
L: Pipes equivalent length, *(m) (From 1.2.3)*

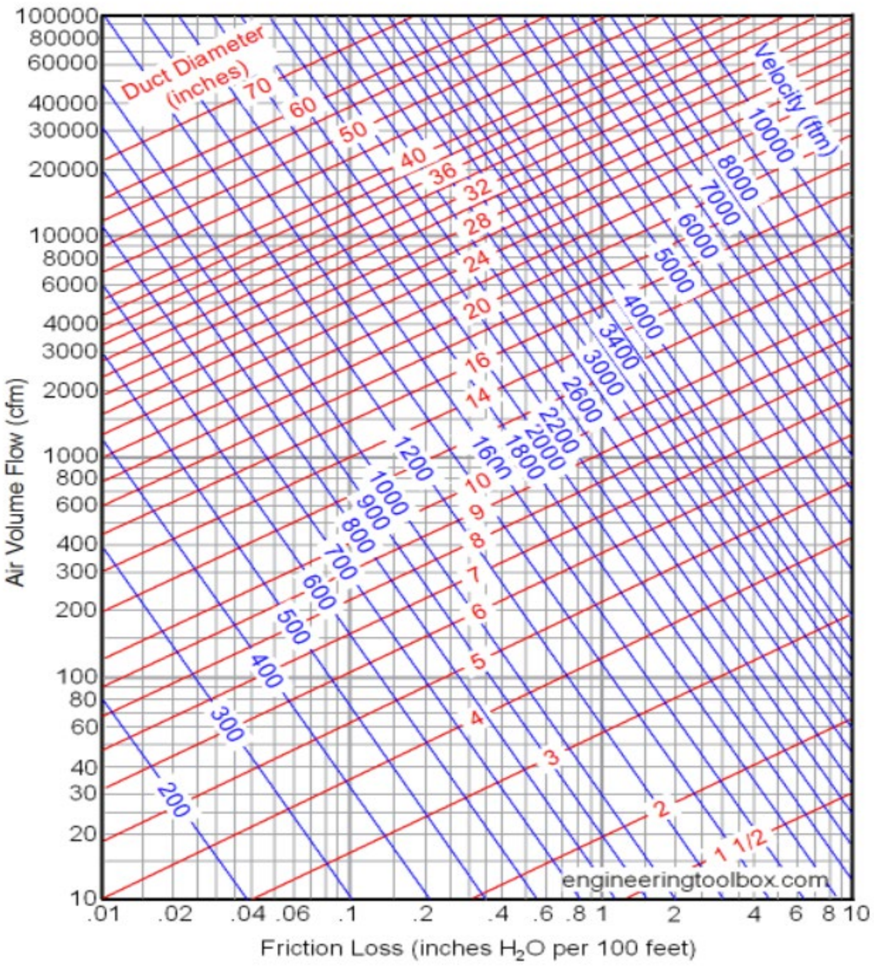

Figure -1

$$Q = 90000\frac{m^3}{h} = 52\,950\ CFM$$

$$Duct\ Size\ = 1300\ mm = 51\ in$$

$$Fl = Friction\ Loss\ = 0{,}2\ \frac{Inch\ H2O}{100\ ft} = 1{,}64\ Pa/m$$

$L\ = 282\ m$ *(From 1.2.3)*

$$\Delta Pg = Fl.L = 1.64 \times 282 = 463\ (Pa)$$

1.2.3. Pipes equivalent length:

For straight runs use the actual length of the pipe. For bends and other devices, use the table-1 below as a guide:

Table-1

Component	Equivalent Length
Bends, 90° bend, long radius (10 to 1 radius to diameter ratio)	40 x diameter or 20 ft (whichever is larger)
Diverter Valves 45° divert angle 30° divert angle	 20 x diameter 10 x diameter
Flexible Hoses Stainless steel, with lined interior Rubber or vinyl hose	 3 x pipe length 5 x pipe length
For bends that are less than 90°, use the following equivalent lengths: L = 40 x (Degree of bend / 90)	

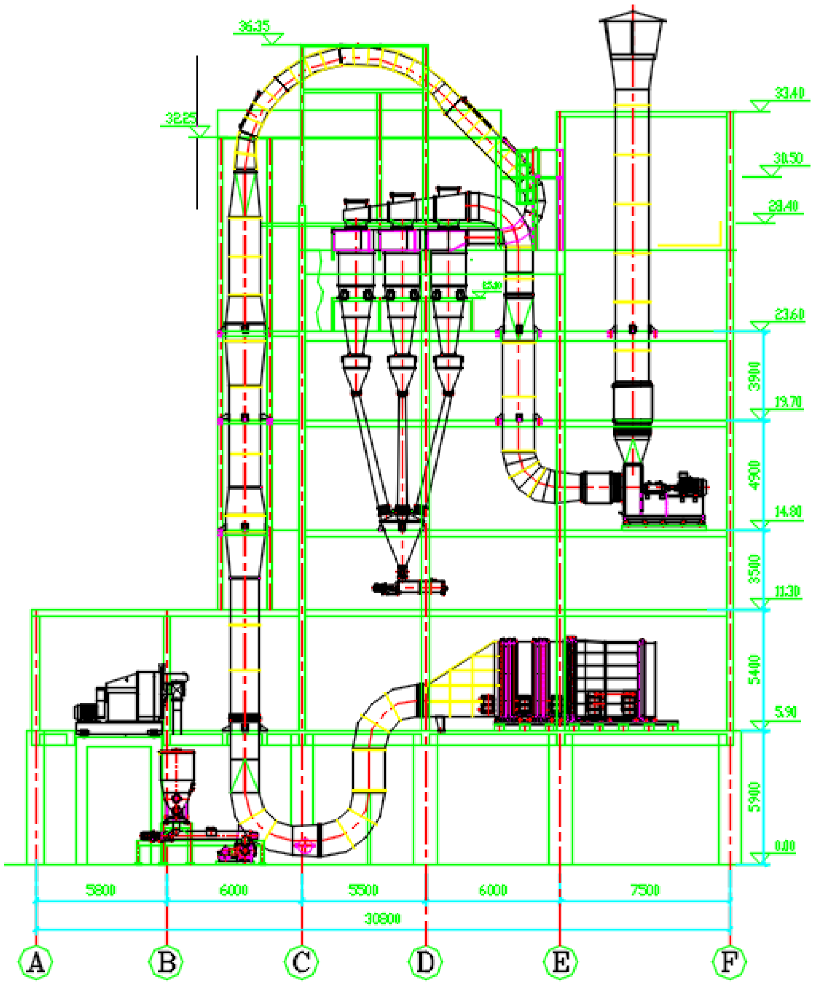

Figure -2

Table -2 (Duct Equivalent Calculation)

Componenet	Quantity	Max. Diameter (ft)	Equivalent Lenth (ft)	Equivalent Lenth (m)
Bend 90	6	4.59	184	61
Flexible Hoses	2	4.59	91.8	30
Straight Length				50
Total				**141**

$Safety\ Factor\ = 2$

$Total\ Duct\ Length\ = 2\ \times 141$

$Total\ Duct\ Length\ = 282\ m$

1.2.4. Friction pressure loss of the solids:

$\Delta Ps = \Delta Pg.K.R\quad (Pa)$

Where:

ΔPg: Friction pressure loss of the gas *(Pa)(From 1.2.2)*

K*:* Friction multiplier for the solids conveyed*=10*

R*:* Solids to gas mass flow ratio*, (lb/lb)*

Hence:$R = \frac{W}{Vp.\rho}$

W: Solids mass velocity, $\frac{lbs}{s.ft^2}$

Vp*:* Particle velocity*, ft/s*

ρ*:* Air density *(lb/ft^3)*

W*:* Starch Feed Rate / Duct Area, $\frac{lbs}{s.ft^2}$

$$W = \frac{10600 \times \frac{2.2}{3600}}{3.14 \times \frac{4.27^2}{4}} = 0.454$$

$Vp = (0.8 \times 20 \times 3.28) = 52$

$\rho = 0.048$

$$R = \frac{W}{Vp.\rho} = \frac{0.454}{52 \times 0.048} = 0.179$$

$\Delta Ps = 463 \times 10 \times 0.179 = 828.77\ \ (Pa)$

1.2.5. **Elevation pressure loss of the gas:**

$$\Delta Hg = 6894.8\frac{\Delta Z.\rho.g}{144.gc} \ (Pa)$$

Where:

ΔHg: Elevation pressure loss of the gas, *(Pa)*

ΔZ: Elevation change in pipeline, *(ft)*

ρ: Air density, *(lb/ft^3)*

$g: Acceleration\ \ due\ to\ gravity = 32.2$

$gc: Constant = 32.174$

$\Delta Z = 30\ m = 98\ ft$

$\rho = 0.048$

$$\Delta Hg = 6894.8\frac{\Delta Z.\rho.g}{144.gc} = 6894.8 \times \frac{98 \times 0.048 \times 32.2}{144 \times 32.174} = 226(Pa)$$

1.2.6. **Elevation pressure loss of the solids:**

$$\Delta Hs = 6894.8\frac{\Delta Z.W.g}{144.Vp.gc} \ (Pa)$$

Where:

ΔHs: Elevation pressure loss of the solids, *(Pa)*

ΔZ: Elevation change in pipeline, *(ft)*

W: Solids mass velocity, *($\frac{lbs}{s.ft^2}$)*

Vp: Particle velocity, *(ft/s)*

$g: Acceleration\ \ due\ to\ gravity = 32.2$

$gc: Constant = 32.174$

$$\Delta Hs = 6894.8\frac{\Delta Z.W.g}{144.Vp.gc} = 6894.8 \times \frac{98 \times 0.454 \times 32.2}{144 \times 52 \times 32.174} = 41\ \ (Pa)$$

The total pressure loss of the pneumatic system can be expressed as:

$$\Delta Pt = \Delta Pacc + \Delta Pg + \Delta Ps + \Delta Hg + \Delta Hs + \Delta Pmisc$$

$$\Delta Pmisc = \Delta P\ cyclone = 1433\ Pa$$

$$\Delta Pt = 35.4 + 463 + 828.7 + 226 + 41 + 1432$$
$$= 3026\ Pa$$

$$Safety\ Factor = 2$$

$$\boldsymbol{\Delta Pt = 3027 \times 2 = 6052\ \ Pa}$$

1.3. Fan Motor Power

$$P = S.F \frac{Va.\Delta Pt}{e.3.6 \times 10^6}\ (Kw)$$

$Va: Fan\ Air\ Volume\ (m^3/h)$
$\Delta Pt: Total\ Pressure\ Drop\ (Pa)$
$S.F: Satety\ Factor$
$e: Fan\ Mechanical\ and\ Electrical\ Efficiancy$

$Va = 67{,}000\ m^3/h$
$\Delta Pt = 6054\ Pa$
$e = 0.68$
$S.F = 1.15$

$$P = 1.15 \frac{67{,}000 \times 6052}{0.68 \times 3.6 \times 10^6} = 190\ (Kw)$$

$$Fan\ Motor\ Power\ \ = 190 (Kw)$$

1.4. Summary

The summary of calculation is according to below table:

Table -3 (Summary of Calculation)

Pressure Safety Factor	**2.00**	
Flow Safety Factor	**1.15**	
Fan Efficiency	**0.68**	
Total Pressure Drop	**3,026**	**Pa**
Fan Power	**190**	**Kw**
Fan Air Volume	**67,000**	**m3/h**
Fan-Total Pressure	**6,052**	**Pa**