Planning and Design of Extraction Systems

Considerations

The following points must be considered and a clear definition must be developed before design of the system can be undertaken.

❑ Determine the function of the system – source extraction, cleaning or pneumatic transportation. In many cases it can be wise to equip the system for different functions apart from the main function of the system, ie: cleaning.

❑ Choose the outlet configuration. Determine for each outlet the type of extraction equipment required as well as the type of closure (automatic or manual). To determine this, a detailed study of the types of activities in each work place must be undertaken.

Determine the number of outlets in simultaneous use. The system will be designed for a maximum number of users at any point in time. In larger systems, the number of simultaneous uses in different parts of the system should be determined.

❑ Decide the routing of the tubing runs and location of the central unit. Consider the degree of difficulty for installation; ceiling height, wall and roof perforations, moving equipment into place, etc.

❑ Consider the type of material to be extracted, the degree of abrasion, risk for explosion and risk for clogging, etc.

❑ Determine the volume of material to be collected per unit time. Select the type of pre-separator and type of material handling for collected material. Material discharge etc, must be determined according to the customers wishes.

❑ Select the type of control system to be used, for example; programmable start – stop or intermittent running.

❑ Determine electrical and compressed air supply requirements for the system. Indicate location of the requirement and assign responsibility for the supply and installation.

Tube Sizing

The tube dimensions are selected on the basis of maintaining the correct transportation velocity in all parts of the tubing system. It is necessary not only to consider the velocity in the main runs but also in all the branches of the tubing system. The tube diameter should be selected so that a velocity of > 20 m/s is maintained for particle transportation - for fume, a lower velocity of > 12 m/s is used.

As an exception in normal systems, we recommend that the smallest tube diameter be 76 mm, even if the minimum transportation velocity recommended is not maintained.

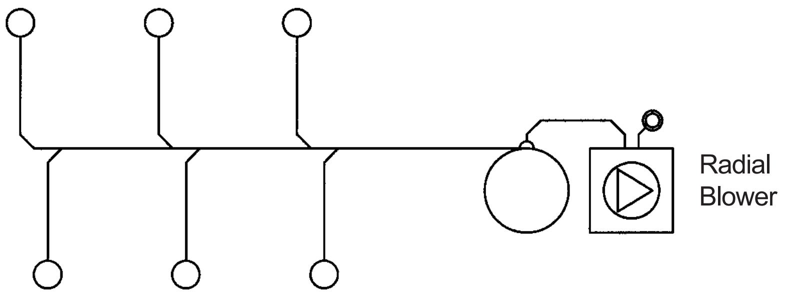
System Design

Always try to maintain a star configuration for the tubing system where the main runs are of more or less equal length leading to the central unit in the middle.

A balancing of the system must be done to ensure that air-flows are sufficient for proper extraction at all points in the system and that transportation velocities are maintained.

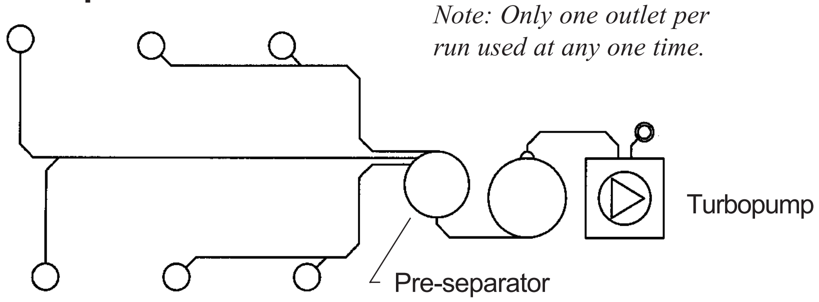
In a system for fume extraction, a large main duct can distribute the system's capacity. Any combination of outlets can be used. Conversely, in a system for the pneumatic transportation of heavy material, the transportation velocity must be maintained. In these systems, one open outlet per tubing run is the norm (usually 76 mm).

Typical tubing configuration for light dust and fume



Typical tubing configuration for heavy cleaning and material transportation

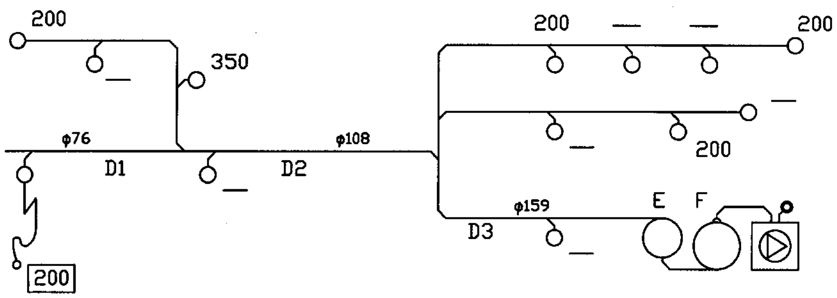
Note: Only one outlet per run used at any one time.



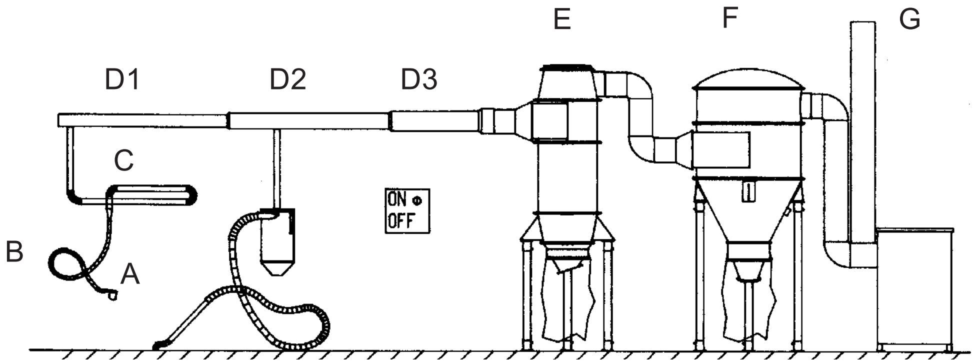
Design

The system's capacity is determined by the worst case – usually the maximum number of users with the highest air-flow collectively. If you are unable to determine which scenario gives the highest pressure loss, several calculations may need to be performed.

Select design air-flows for respective operations from chapter 6 and 7.



Design flows in m³/h given for outlets in use simultaneously. Pressure loss is calculated from the outlet at the lower left.

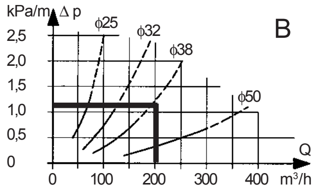


	System Part	Q	Calculation	Δp
A	Suction Casing Hand-held Tool	200 m³/h	Table page 61 Δp=3.5 kPa	3.5 kPa
B	Hose ø38x3m	200 m³/h	Δp= 1.2 kPa/m x 3 m = 3.6 kPa	3.6 kPa
C	Swingarm 4,5 m	200 m³/h	Δp= 0,7 kPa	0.7 kPa
D1	Tubing ø76x10 m + bends (bend is counted as 2 m)	200 m³/h	Δp= 0.02 kPa/m x (10 + 4)m	0.28 kPa
D2	Tubing ø108x15m	750 m³/h	Δp= 0.06 kPa/m x 15m	0.9 kPa
D3	Tubing ø159x25 m + 4 bends	1350 m³/h	Δp= 0.02 kPa/m x (25 + 8)m	0.7 kPa
E	Pre Separator F 20000	1350 m³/h	inlet ø160: Δp= 1.1 kPa	1.1 kPa
F	Filter Unit S 32000	1350 m³/h	inlet ø160: Δp= 1.8 kPa	1.8 kPa
			Total pressure loss	12.6 kPa
	With safety factor 10%		Δp= 12.6 kPa x 1.1 = 13.9	13.9 kPa

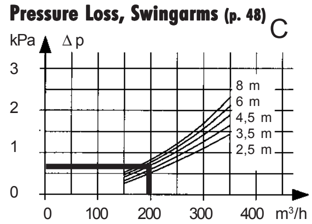
Design capacity: 1350 m³/h @ 13,9 kPa
Vacuum Producer Selection: TPR 50, 30 kW

* Further information regarding system design calculations is available from our handbook.

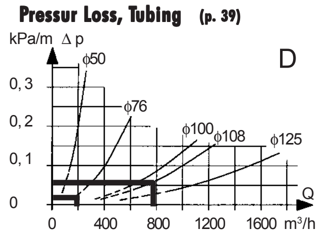
Pressure Loss, Suction Hoses (p. 53)



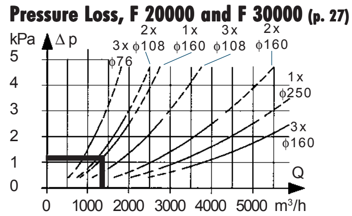
Pressure Loss, Swingarms (p. 48)



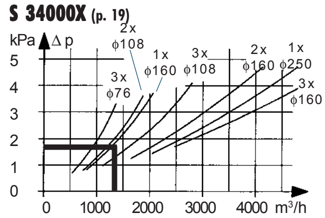
Pressur Loss, Tubing (p. 39)



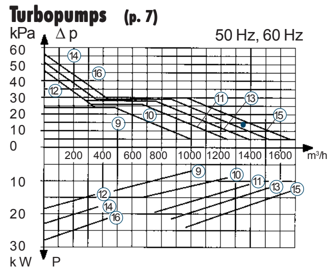
Pressure Loss, F 20000 and F 30000 (p. 27)



Pressure Loss, S 32000, S 34000, S 34000X (p. 19)



Turbopumps (p. 7)



Pneumatic Material Transport

To transport larger volumes of coarse dust or other material requires a series of special considerations to minimize the possibility of clogs in the tubing system or problems discharging collected material. Analyze both the type and volume of material according to the following considerations:

1. Material Volume

- ❑ Average volume liter/hour _____
- ❑ Max. volume liter/hour _____

2. Material Characteristics

- ❑ description of material ____________________
- ❑ material created by ____________________
- ❑ particle size distribution ____________________
- ❑ bulk density _____
- ❑ max. moisture content _____
- ❑ hygroscopic material?
- ❑ chemically aggressive material?
- ❑ explosible material ____________________

3. Abrasion and Clogging

- ❑ Abrasive material _____
- ❑ Bridging _____ º

Test with a paper cone for the included angle that facilitates free flowing of the material.

4. Operating Conditions

- ❑ System in operation __ hours/day
- ❑ Filter cleaning
  - a) after shut down _____
  - b) during operation _____
- ❑ material to be introduced into system with ____________________ (suction lance, floor funnel, etc.)
- ❑ transport distance ____ m
- ❑ number of bends __ pcs

Configuration of Extraction Systems for Material Transportation

- ❑ The system should be designed for transportation velocities from 20 – 25 m/s. Higher velocities result in increased wear. Ensure minimum transportation velocity is maintained in the tubing system (only one outlet in use per run)
- ❑ Select tools and accessories which allow sufficient transport air into the system
- ❑ Minimize the number of 90° bends. Never install two 90° bends closer together that 25 times the tube diameter.
- ❑ Select horizontal or vertical tubing runs. Avoid sloping runs where material ”corning” may occur. In sloping runs material will have a tendency to precipitate and run down against the direction of flow in the bottom of the tube.
- ❑ Select, hose, tubing and separator with consideration to abrasion.
- ❑ Select material discharge with consideration to the consistency and volume of material to be discharged.
- ❑ Plan emptying intervals and routines (plastic bag or container)

Pressure Loss Calculation in a Material Transport System

Pressure loss calculations for this type of system are influenced by a number of different factors and exact calculations can be very complex. In general, the following calculation can be used. With material loadings greater than 1 : 1 (= 1,2 kg material per m^3 air), a practical test should always be done.

Calculate the pressure loss for clean air from the extraction point to the pre-separator according to the calculation on the previous page. Calculate the added pressure loss that the transported material will result in according to the following:

$\Delta p_{material} = \Delta p_0 x\ m_1/(Q\ x\ 1,2)$ (kPa)

where Q is air-flow in m^3/h

m_1 is material flow in kg/h

Calculate then the pressure loss for the remainder of the system (pre-separator to vacuum producer). Add this value together with the pressure loss value from the previous calculation. Add the safety factor to the sum of these.

Example:

Suction Lance	2 kPa
Hose	8 kPa
Tubing	<u>3 kPa</u>
Sum	13 kPa
Air-flow	350 m^3/h
Material flow	100 kg/h

Added pressure loss from material

$\Delta p = 13\ x\ 100/(350\ x\ 1.2) = 3$ kPa

Pre-separator	2 kPa
Filter unit	<u>2 kPa</u>
Sum	4 kPa

Sum tot 13+3+4=20 kPa

Safety factor 10% =>

<u>Required negative pressure = 22 kPa</u>