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THE DIMENSIONING OF THE COMPRESSED AIR NETWORKS

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Abstract: *In the last period there is a new trend in light industry, specifically the use of pneumatic systems for realization of process operations. The actuation systems that use compressed air has the advantage of a reduced size, high power density, ease of operation and maintenance. In this paper we present a modality of a network of compressed air transport so as pneumatic energy losses on the route to be minimal.*

Key words: *dimensioning, compressed air, flow, pressure, network*

1. INTRODUCTION

The dimensioning of a distribution network of air is made based on the criteria of cost but without affecting the proper functioning from the technical point of view regarding the installation.

The existing necessity of a distribution network of compressed air within a production unit consists in the role it has in the integrated system. Pneumatic network is designed to transport the compressed air generated in the compressor system to the consumer provided on the route network.

An air distribution network includes all the components that compose it. These elements are: pipes, hoses, fittings, valves, filter, lubricator, dryers and other items for the transport of compressed air from source to consumer.

Design and sizing of a distribution network will be made according to the technical specification required in the specifications of the customer. In addition to the requirements of the customer, a network must comply with a series of general specifications, such as:

- Pressure loss of the entire length of the network to be minimal;
- There are not permitted pressure loss on the entire route of the network, loss resulting from leak;
- The installation will be equipped with additional elements that will ensure the elimination of condensation, or will include a drying system on the route of the network;
- All the items which are making the pneumatic network will be designed to resist to corrosion;
- Route of the network will be designed so as to avoid degrading it, to allow its verification and repairing;
- It will take into account a possible method of expansion the designed network.

Besides above mentioned requirements is require that the network components and network overall to present structural strength correlated with existing tasks and respecting legislation.

The dimensioning of the main pipes is determined by limiting airflow in the pipe normally set at a maximum of 6 m/s, while the secondary pipes, for shorter lengths of meters, speed can reach up to 20 m/s when in the pipe we find a pressure of 6 bar.

Pressure drop between the power generator pneumatic/hydraulic (pump) and its consumer (motor linear/rotary) must not exceed 0.3 bar.

2. DIMENSIONING MODEL OF A PNEUMATICS NETWORK

Next it will present a model that allows correct sizing of pipe diameters based on a nomogram, shown in the figure below.

It starts from the requirement: Determine the inner diameter of a pipe which carries an air flow rate of 15,000 l / min with a maximum pressure drop of 0.3 bar over a distance of 100 meters. The average pressure provided by compressor that services the network, in this case is 8 bar.

To determine the internal diameter of pipe that services actuated pneumatic equipment networks depart from the calculation of the ratio of maximum allowable pressure drop and pipe length

For the case discussed the pressure drop over the length of 100 meters of compressed air network will be:

$$\frac{0{,}3\ bar}{100\ m} = \frac{30\ KPa}{100\ m} = 0{,}3\ kPa/m \qquad (1)$$

In the second step of determining the internal diameter of the pipe is using a monogram shown in the figure below.

In monogram below merges with a dotted line which represents the average value of pressure (in the present case it has pressure of 8 bar) to the point that defines the pressure drop/m. It will so obtain a point "x" of intersection with the reference line.

To get the inside diameter of the pipe will be shown the flow volume in m3/s thus obtaining a flow of 0.25 m3/s in the specific case.

The last step for determining the internal diameter of the supply pipe is to unite the point "x" from the reference line with the point which represents flow in m3 / s. If it is extended the line which is connecting the two points on the reference line and from the line representing value of the transported flow to the intersection with the line which represent the internal diameter of the pipe will be obtained an intersectiion point.

The value read on the internal diameter line represents nominal diameter size of the pipe corresponding to the input data set.

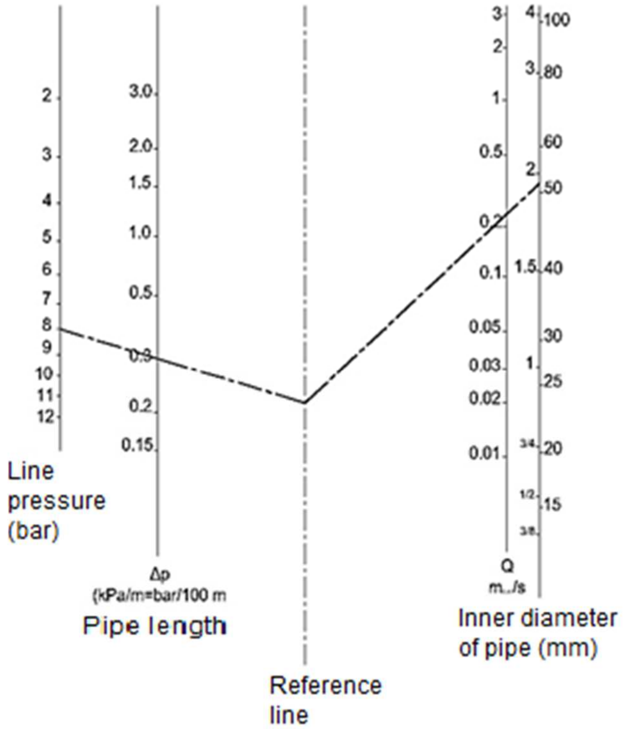

Fig. 1. The dimensioning of a compressed air pipe monogram

In conclusion, in order to carry a flow rate of 15,000 l / minute at a pressure drop of maximum 0.3 bar and a pressure of 8 bar in the system will have to have a theoretical pipe inner diameter of 52 mm. From the the standards for pipes that carries compressed air is choose a pipe with a nominal diameter of 50mm, having an outer diameter of 60.3 mm (2 inches) and an inside diameter of 53 mm.

For the case previously examined if on the pipeline route are provided four curves at 90^0, 8 standard T-fittings, 3 elbows at 135^0 and one faucet with the valve, so, what internal diameter will have to have the pipe?

To be able to answer the question above will equate all the changes in direction of the compressed air flow with a further length of the existing pipe.

In the next stage will be used the table below from where will be extracted specific values correlated with nominal diameter and will be determined the length of the additional pipe needed that the distribution network to comply

Table 1
Additional length of the pipe

Connecting time	The nominal diameter of the pipe (mm)									
	15	20	25	30	40	50	65	80	100	125
Elbow 135^0	0.3	0.4	0.5	0.7	0.8	1.1	1.4	1.8	2.4	3.2
90° Curve (long)	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.2	1.5
90° Elbow	1.0	1.2	1.6	1.8	2.2	2.6	3.0	3.9	5.4	7.1
180° Curve	0.5	0.6	0.8	1.1	1.2	1.7	2.0	2.6	3.7	4.1
Faucet with sphere	0.8	1.1	1.4	2.0	2.4	3.4	4.0	5.2	7.3	9.4
Faucet with valve	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.9	1.2
T standard	0.1	0.2	0.2	0.4	0.4	0.5	0.7	0.9	1.2	1.5
T with lateral connection	0.5	0.7	0.9	1.4	1.6	2.1	2.7	3.7	4.1	6.4

with the technical specification requirements.

In the analyzed case finds that for the pipes with nominal diameter of 50mm, with every elbow at 90^0, will generate an additional length of 0.6m. Multiplying the number of bends with extra length / elbow is obtaining a total length generated by the presence of 4 elbows on route 2. 4 meters.

From the table is deducing that for every T connection , the length of the pipe will grow by 0.5 m and for each side 45^0 by 1.1 meters. For the 8 connections will be supplementary length will be 4 m, and for the three bends 3.3 m.

Faucet with the valve mounted on the supply line will generate an supplementary length of 0.4 meters. Synthesizing all information from the table corelated to the supply network structure with compressed air will obtain the following data:

- Curves at 90^0 4 x 0.6m = 2.4m
- 8 T connection 8 x 0.5m = 4.0m
- 3 elbow 135^0 3 x 1.1m = 3.3m
- 1 faucet with valve
  1 x 0.4m = 0.4m

Total = 10.1m

The effective length of the theoretical pipe taken in calculation, will increase due to the resistance of tha 16 elements from its structure with 10.1m. The new length based on which will be calculated the pressure drop/meter will be 100m+10.1m=110.1m. The new pressure drop/meter resulted will be:

$$\frac{0{,}3\ bar}{110.1\ m} = \frac{30\ KPa}{110.1\ m} = 0{,}272\ kPa/m \quad (2)$$

Next to determine the nominal diameter of a pipeline that meet the specification required in terms of configuration and technical parameters imposed are repeated the steps explained above.

After that will determine the points of intersection with the reference line and the internal diameter line will deduce as the internal diameter of the pipe that meet the specification and structure imposed must be 50 mm (2 inches).

From the nomogram shown below can be deduced as a pipe with nominal diameter of 50 mm (2 inches) , and meet the additional pressure drop by the 16 additional elements mounted .

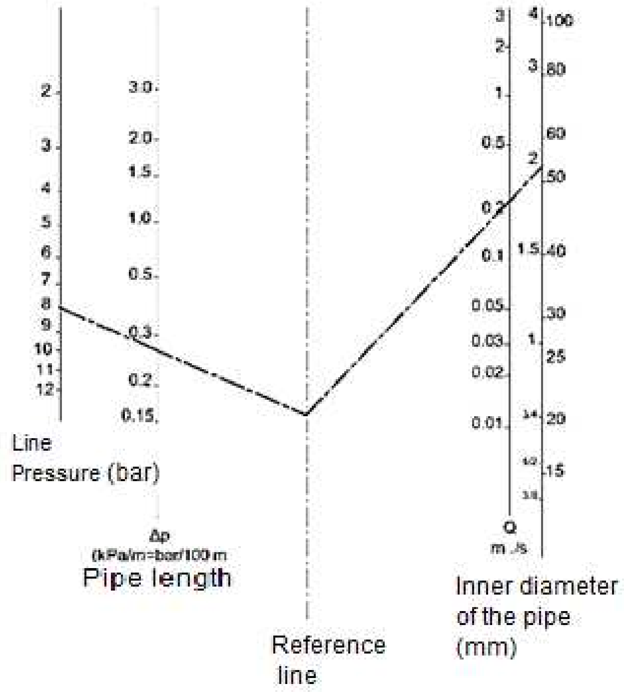

Fig.2 The monogram for dimensioning of a compressed air pipe equipped with additional elements

3. CONCLUSION

This paper is presenting a simple and quick method through which can be dimensioned the diameter of a pneumatic network which will comply with a series of technical specifications. For the dimensioning there are followed also a series of steps and it is making a monogram based on the results obtained in the first step.

Following the steps for the dimensioning of the pneumatic network which can transport a flow equal with 15000 l/min at a pressure drop of bar and an average pressure in the system of 8 bar, was obtained a theoretical internal diameter for the pneumatic pipe of 52mm.

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DIMENSIONAREA RETELELOR DE AER COMPRIMAT

Rezumat: *In ultima perioada apre o nou tendinta in domeniul industriei usoare, mai exact utilizarea sistemelor pneumatice pentru realizarea anumitor operatii de proces. Sistemele de actionare care utilizeaza aerul coprimat prezinta avantajul unui gabarit redus, densitate de forta ridicata, usurinta in exploatare si mentenanta. In prezenta lucrare se va prezenta o modalitate de dimensionare a unei retele de transport a aerului comprimat astfel incat pierderile de energine pneumatica de pe traseu sa fie minimale.*

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