



Universitat de Girona

Departament d'Enginyeria  
Industrial

This report is developed after carrying out the corresponding trials established in the scientific collaboration agreement of mechanic-fluid behavior of rectangular airflow ducts.

## **TECHNICAL REPORT**

### **REQUESTER**

Mr. Francesc Bolló. Technical Director  
POLIURETANOS S.A.  
C/ Matamala s/n  
17244 Cassà de la Selva (Girona)

### **TRIAL OBJECTIVE**

Determine the head loss in two duct sectors, and to check out its concordance with the theoretic model proposed by the manufacturer.

### **SAMPLE CHARACTERISTICS**

Airflow ducts manufactured with a PIR-ALU 45 panel made up with polyisocianurate nucleus layered with embossed aluminum plates. The panel thickness is of 20mm.

The trial has been carried out with two different ducts at different airflow speed.

Ducts inner section:

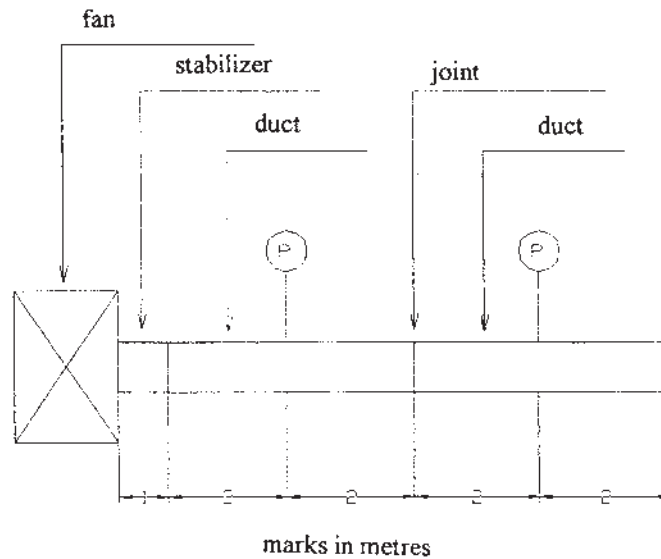
- Duct: 560x560 mm<sup>2</sup>
- Duct: 200x150 mm<sup>2</sup>

### **TRIAL METHOD**

In order to determine the head loss air has been flowing through two different PIR-ALU 45 ducts of 200x150 and 560x560 sections respectively. These ducts were of eight meters of length made up by two sectors of four meters each united by a central joint.

The forced airflow is done by a centrifugal fan placed at one end of the installation that way it is possible to regulate airflow rate by a frequency variator. In the 560x560 duct, at the beginning of it a tube beam of 500 mm of length is used in order to stabilize the flow.

In two equidistant points at two (2) meters from the central point Prandtl tubes have been used to measure dynamic and static pressures.



## RESULTS

### Calculating head losses

The Darcy formula was used to calculate lineal head losses:

$$P_e = \lambda \cdot \frac{L}{D_e} \frac{v^2}{2g} \delta$$

$P_e$ , head loss

$\lambda$ , head losses coefficient

$D_e$ , duct diameter

$L$ , duct length

$v$ , speed in m/s

$\delta$ , density 1.2 Kg/m<sup>3</sup>

The Darcy formula is applied on circular sections, for non circular sections it is necessary to determine its equivalent circular section. A equivalent section is considered to be that one that has the same head loss for each duct length unit.

Calculating the equivalent diameter was done according to the norm UNE-100.101-89:

$$D_e = 1.3 \frac{(bh)^{0.625}}{(b+h)^{0.25}}$$

$b$  and  $h$  are the rectangular duct dimensions.





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The  $\lambda$  coefficient of head losses is a function of the Reynolds number and the duct's relative roughness, and it is obtained by using the Colebrook-White formula:

$$\frac{1}{\sqrt{\lambda}} = -2 \log \left( \frac{\varepsilon}{3,7 D_e} + \frac{2,51}{Re \sqrt{\lambda}} \right)$$

$\varepsilon/D_e$ , relative roughness

Re, Reynolds number

$\lambda$ , head losses coefficient

The obtained results are:

Trial of duct PIR-ALU 45 of 200 x 150 section

Equivalent diameter 188 mm

Q, flow rate in m<sup>3</sup>/h.

P, head loss in Pa for lineal meter.

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**PIR-ALU 45 DUCT: Section 200 x 150**

low rate (m <sup>3</sup> /h)	Measured (Pa) head loss per meter	Calculated (Pa) head loss per meter	Deviation %
199	0.4	0.38	-5.1
499	2.18	2.16	-1.3
898	6.71	6.71	0
1296	11.69	13.77	17
1498	18.03	18.3	1



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## Trial of PIR-ALU 45 DUCT of section 560/560

Equivalent diameter 613 mm.

Q, flow rate in m<sup>3</sup>/h.

P, head loss in Pa for lineal meter.

### PIR-ALU 45 DUCT: Section 560 x 560

Flow rate (m <sup>3</sup> /h )	Measured (Pa) head loss per meter	Calculated (Pa) head loss per meter	Deviation
1062	-	-	-
2123	0.09	0.08	-1.2
5309	0.49	0.49	1.2
8495	1.2	1.22	1.2
11682	2.25	2.25	1

The calculated head loss has been obtained by using a 0.45 mm relative roughness.

Trial date: Girona. July 24, 1998.

O.K.  
Area Manager

Joanulí Velayos Solé  
Fluid Mechanics Lecturer



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Fluids Laboratory Manager

Josep R. González Castro  
Fluid Mechanics Associated Teacher

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