

Regulation of air flow Injustering av luftdon Einstelldaten für ventile

» 02/2025



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Definitions of symbols

Symbol	Description	Unit
q_v	air volume flow	l/s, m ³ /s, m ³ /h
Δp_m	pressure difference	Pa
k	k-factor ($q_v = k \times \sqrt{\Delta p_m}$)	
D, d	diameter	mm
a, s	slot, position, opening	mm
L	safety distance to source of disturbance	m
n	factor of safety distance	-
m_2	inaccuracy of measurement method (error of method)	%
ρ_t	air density at the moment of measurement	kg/m ³

Methods of measurement

1. Measurement of pressure drop (Δp_m) in calibrated valves by means of measuring probe (KSO, KTS, STQA...).
The regulation is carried out by adjusting the valve opening (a) or number of holes.
2. Measurement of pressure drop (Δp_m) at a supply/exhaust valve equipped with an installed, calibrated probe SVQC...).
The regulation is achieved by means of regulating strings by changing the damper position, at exhaust valves EHC by adjusting the slot.
3. Measurement of pressure drop (Δp_m) at measuring devices installed permanently in the duct (IRIS).

Use of measurement and regulation guide

The guide contains the k-factors for standard products of FläktGroup Oy (if necessary, the product information is also available as diagrams).

For each product, information about deviating safety distances, correction factors as well as measurement and regulation actions are given in the guide.

Product-specific data of diffusion patterns, sound attenuation etc. is available in product catalogue of FläktGroup Oy.

Factor k has been defined on the basis of the air volume flow unit l/s

$$q_v = k \times \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / k)^2$$

If other units of air volume flow are used, the following correction has to be made:

$$\text{m}^3/\text{s}: \qquad q_v = 0,001 \times k \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / (0,001 \times k))^2$$

$$\text{m}^3/\text{h}: \qquad q_v = 3,6 \times k \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / (3,6 \times k))^2$$

Example:

KSO-125, position a=+5, has to be adjusted for air volume flow $q_v = 30 \text{ l/s}$

- read correction k on page 47
- insert $k = 3,3$ in the formula to get the pressure difference

$$\Delta p_m = (30 / 3,3)^2 = 82 \text{ Pa}$$

- adjust the valve to achieve the required pressure difference

Effect of the air density on measuring results

The k values given in the Manual are valid under normal conditions (20 °C and 101,3 kPa).

Should the measuring conditions deviate from these values, the actual air volume flow (q_{vt}) can be deduced from the air volume flow (q_v) calculated by means of the k factor as follows:

$$q_{vt} = q_v \times \sqrt{(1,2 / \rho_t)}$$

Evaluation of measurement errors

$$m = \pm \sqrt{c_1^2 m_1^2 + c_2^2 m_2^2 + c_3^2 m_3^2 + \dots + c_n^2 m_n^2}$$

m	relative inaccuracy of the result of measurement %
m_1	inaccuracy of the measuring instrument (device error) %
m_2	inaccuracy of the measuring method (error of method) %
m_3	reading inaccuracy of the instrument (error of observation) %
m_n	other possible inaccuracies %
$c_{1..n}$	factors for taking into account the influence of different inaccuracies on the final result. The formula takes into account the influence of random errors as well as of minor systematic errors of unknown direction. Error percentages small in comparison with other factors may be disregarded, their influence on the value of m being negligible.

Example of evaluation of the total amount of error:

m_1	$= \pm 4 \%$ (information from the instrument manufacturer)
c_1	$= 1/2$ (measurement of pressure drop, $q_v = k \times \sqrt{\Delta p_m}$ *)
m_2	depends on measurement method and means of installation
c_2	$= 1$
m_3	$= 4 \%$ (depends on the instrument and pressure range)
c_3	$= 1/2$ (measurement of pressure drop) *)
	*) E.g. an error of 10 % in pressure difference has an effect of about 5 % on the air volume flow.

$$m = \pm \sqrt{(1/2)^2 \times 4^2 + 1 \times m_2^2 + (1/2)^2 \times 4^2} = \pm \sqrt{8 + m_2^2}$$

By inserting various values on the error of method m_2 , the following table is achieved:

$m_2 =$	5	7	10	12	15	20	%
$m =$	5,8	7,6	10,4	12,3	15,3	20,2	%

Beteckningar

Beteckning	Beskrivning	Enhet
q_v	luftflöde	l/s, m ³ /s, m ³ /h
Δp_m	mättdifferenstryck	Pa
k	k-faktor ($q_v = k \times \sqrt{\Delta p_m}$)	
D, d	diameter	mm
a, s	spalt, läge, öppning	mm
L	skyddsavstånd till störningskälla	m
n	skyddsavståndskoefficient	-
m_2	mätmetodens fel	%
ρ_t	lufttätthet vid mättdpunkten	kg/m ³

Mätmetoder

1. Mätning av mättdifferenstryck (Δp_m) i de kalibrerade ventilerna med mätsond (KSO, KTS, STQA...)
Injusteringen sker genom att ändra på ventilens öppning (a) eller antalet hål.
2. Mätning av mättdifferenstryck (Δp_m) i ett till-/frånluftsdon (SVQC...) utrustat med en fast, kalibrerad givare.
Injustering sker genom att ändra på spjällbladets läge med hjälp av injusteringsnöre i donet, i frånluftsdonet genom att injustera spalten EHC.
3. Mätning av mättdifferenstryck (Δp_m) i fasta reglerutrustningar monterade i kanalen (IRIS).

Användning av mät- och injusteringshandbok

Handboken innehåller samtliga k-faktorer för standardprodukter av Fläkt-Group Oy (vid behov finns dessa produktinformationer också i diagramform.)

I handboken finns information om avvikande skyddsavstånd, korrekationer och mät- och injusteringsåtgärder separat för resp produkt.

k-faktor är definierad med luftflödets enhet l/s

$$q_v = k \times \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / k)^2$$

Vid användning av andra enheter för luftflöde genomförs korrektionen enligt följande:

$$m^3/s: \qquad q_v = 0,001 \times k \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / (0,001 \times k))^2$$

$$m^3/h: \qquad q_v = 3,6 \times k \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / (3,6 \times k))^2$$

Exempel:

KSO-125, läge s=+5, bör injusteras så att luftflödet $q_v = 30$ l/s

- k-faktor kontrolleras på sidan 47
- $k = 3,3$ sätts i formeln av mätdifferenstryck, varvid värdet för differensstrycket blir

$$\Delta p_m = (30 / 3,3)^2 = 82 \text{ Pa}$$

- ventil injusteras, tills det önskade mätdifferenstrycket uppnås

Påverkan av lufttäthet i mätningsresultat

k-värden i manualen gäller vid normala förhållanden (20 °C och 101,3 kPa). Avviker mätförhållandena från dessa värden, erhålls det verkliga luftflödet (q_{vt}) av det med hjälp av k-faktorn beräknade luftflödet (q_v) på följande sätt:

$$q_{vt} = q_v \times \sqrt{1,2 / \rho_t}$$

Mätnoggrannhet

$$m = \pm \sqrt{c_1^2 m_1^2 + c_2^2 m_2^2 + c_3^2 m_3^2 + \dots + c_n^2 m_n^2}$$

m relativ mätnoggrannhet av mätresultat %

m_1 mätinstrumentets fel %

m_2 mätmetodens fel %

m_3 avläsningsfel %

m_n ev. övriga metodfel %

$c_{1...n}$ Korrektionsfaktor som används för att korrigera separata mät- och metodfel som påverkar slutresultatet. Formeln tar hänsyn till slumpfel och små systematiska fel med okänd funktionsriktning. Små felprocent i jämförelse med andra kan lämnas obeaktade, för deras påverkan på värdet m är obetydlig.

Exempel på felkalkyl:

$m_1 = \pm 4 \%$ (uppgift från instrumenttillverkare)
 $c_1 = 1/2$ (mätning av differensstryck, $q_v = k \times \sqrt{\Delta p_m}$ *)
 m_2 beror av mätmetod och montagesätt
 $c_2 = 1$
 $m_3 = 4 \%$ (beror på instrumentet och tryckområdet som används)
 $c_3 = 1/2$ (mätning av differensstryck *)
 *) t ex ett fel av 10 % i mättdifferensstryck påverkar luftflödet med ca 5 %.

$$m = \pm \sqrt{(1/2)^2 \times 4^2 + 1 \times m_2^2 + (1/2)^2 \times 4^2} = \pm \sqrt{8 + m_2^2}$$

Tabellen nedan fås fram genom att ange olika värden för metodfelet m_2 :

$m_2 =$	5	7	10	12	15	20	%
$m =$	5,8	7,6	10,4	12,3	15,3	20,2	%

Bezeichnungen

Bezeichnung	Grösse	Masseinheit
q_v	Volumenstrom	l/s, m ³ /s, m ³ /h
Δp_m	Messdifferenzdruck	Pa
k	Faktor ($q_v = k \times \sqrt{\Delta p_m}$)	
D, d	Durchmesser	mm
a, s	Spaltbreite, Lage, Öffnung	mm
L	Schutzabstand zur Störungsquelle	m
n	Schutzabstandsfaktor	-
m_2	Ungenauigkeit des Messverfahrens (Verfahrensfehler)	%
ρ_t	Luftdichte zum Messzeitpunkt	kg/m ³

Messverfahren

1. Messen des Messdifferenzdrucks (Δp_m) in den kalibrierten Ventilen (KSO, KTS, STQA...) mit Hilfe einer Messsonde.
Einstellung durch Ändern der Ventilöffnung (a) oder der Anzahl Löcher.
2. Messen des Messdifferenzdrucks (Δp_m) in einem mit festem, kalibrierten Geber ausgerüsteten Zuluft-/Abluftventil (SVQC...).
Einstellung durch Ändern der Lage der Blende mit Hilfe von Schnüren im Ventil, im Abluftventil durch Verstellen der Spaltbreite EHC.
3. Messen des Messdifferenzdrucks (Δp_m) in festem, im Kanalnetz installierten Messvorrichtungen (IRIS).

Anwendung der Mess- und Einstellanweisung

Die Mess- und Einstellanweisung enthält sämtliche k-Faktoren der Standardprodukte von FläktGroup Oy (bei Bedarf sind die Informationen der Produkte auch als Diagramme erhältlich.)

In der Mess- und Einstellanweisung sind die Informationen der abweichenden Schutzabstände, Korrekturfaktoren und Mess- sowie Regelungsmassnahmen gesondert für jedes Produkt dargestellt.

Die produktspezifischen Wurfweiten- und Geräuschdaten usw. sind den technischen Datenblättern zu entnehmen.

Der k-Faktor ist mit Hilfe der Masseinheit l/s des Luftvolumenstroms bestimmt

$$q_v = k \times \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / k)^2$$

Beim Verwenden von anderen Einheiten des Luftvolumenstroms wird die Korrektur auf folgende Weise durchgeführt:

$$\text{m}^3/\text{s}: \qquad q_v = 0,001 \times k \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / (0,001 \times k))^2$$

$$\text{m}^3/\text{h}: \qquad q_v = 3,6 \times k \sqrt{\Delta p_m} \qquad \Delta p_m = (q_v / (3,6 \times k))^2$$

Beispiel:

KSO-125, die Position des Ventilkegels $a=+5$, muss so eingestellt werden, dass der Luftvolumenstrom $q_v = 30$ l/s beträgt

- Der k-Faktor wird auf der Seite 47 abgelesen

- $k = 3,3$ wird in die Formel des Messdifferenzdrucks eingesetzt, daraus lässt sich der Messdifferenzdruck wie folgt errechnen

$$\Delta p_m = (30 / 3,3)^2 = 82 \text{ Pa}$$

- Der Ventilkegel wird eingestellt, bis der gewünschte Messdifferenzdruck erreicht ist

Einfluss der Luftdichte auf die Messergebnisse

Die im Handbuch aufgeführten k -Werte gelten unter Standardbedingungen (20 °C und 101,3 kPa). Sind die Messbedingungen abweichend von diesen Standardwerten, wird der tatsächliche Luftdurchfluss (q_{vt}) auf Basis des mit Hilfe des k -Faktors errechneten Luftdurchflusses (q_v) auf folgende Weise ermittelt:

$$q_{vt} = q_v \times \sqrt{1,2 / \rho_t}$$

Auswertung der Messfehler

$$m = \pm \sqrt{c_1^2 m_1^2 + c_2^2 m_2^2 + c_3^2 m_3^2 + \dots + c_n^2 m_n^2}$$

m	relative Ungenauigkeit des Messergebnisses %
m_1	Ungenauigkeit des Messgeräts (Vorrichtungsfehler) %
m_2	Ungenauigkeit des Messverfahrens (Verfahrensfehler) %
m_3	Ablesungsungenauigkeit des Messgeräts (Beobachtungsfehler) %
m_n	eventuelle weitere Ungenauigkeiten %
$c_{1...n}$	Faktoren, mit Hilfe von denen der Einfluss der separaten Ungenauigkeiten auf das Ergebnis berücksichtigt wird. Die Formel berücksichtigt den Einfluss der Zufallsfehler und der kleinen, systematischen Fehler, deren Einflussrichtung unbekannt ist. Die kleinen Fehlerprozente im Vergleich zu anderen können unbeachtet gelassen werden, da der Einfluss auf den Wert m unbedeutend ist.

Beispiel über Auswertung eines Gesamtfehlers:

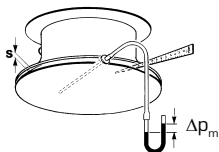
- m_1 = ± 4 % (Auskunft vom Messgerät-Hersteller) _____
 c_1 = $1/2$ (Messung des Differenzdrucks, $q_v = k \times \sqrt{\Delta p_m}$ *)
 m_2 hängt vom Messverfahren und von der Installationsweise ab
 c_2 = 1
 m_3 = 4 % (hängt vom Messgerät und Druckbereich ab)
 c_3 = $1/2$ (Messung des Differenzdrucks) *)
 *) z. B. ein Fehler von 10 % im Messdifferenzdruck beeinflusst den Luftvolumenstrom mit ca. 5 %.

$$m = \pm \sqrt{(1/2)^2 \times 4^2 + 1 \times m_2^2 + (1/2)^2 \times 4^2} = \pm \sqrt{8 + m_2^2}$$

Durch Angeben von unterschiedlichen Werten für den Verfahrensfehler m_2 bekommt man die folgende Tabelle:

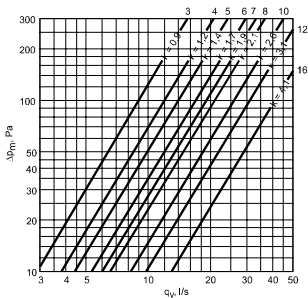
$m_2 =$	5	7	10	12	15	20	%
$m =$	5,8	7,6	10,4	12,3	15,3	20,2	%

CTVB

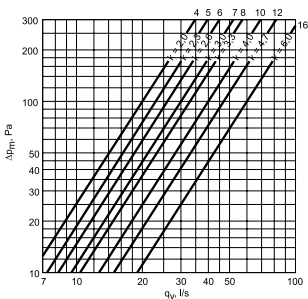


s	3	4	5	6	7	8	10	12	16	20
100	0.9	1.2	1.4	1.7	1.9	2.1	2.6	3.1	4.1	-
125	-	2.0	2.3	2.6	3.0	3.3	4.0	4.7	6.0	-
160	-	-	2.6	3.1	3.5	3.9	4.6	5.4	6.9	8.3

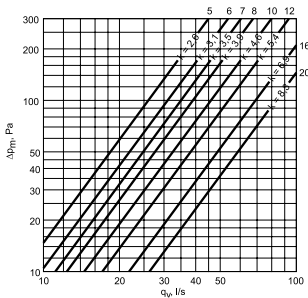
CTVB-100-C

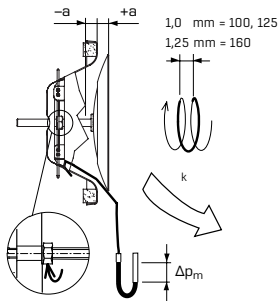


CTVB-125-C



CTVB-160-C

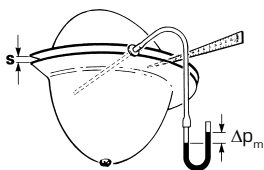




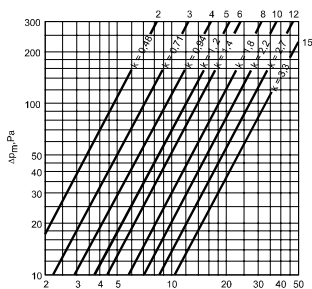
$\varnothing D$	a, mm	2	4	6	9	12
100	k	0,8	1,5	2,2	3,2	3,8

$\varnothing D$	a, mm	3	5	7	9	12	15
125	k	1,4	2,3	3,2	4,1	5,3	6,5

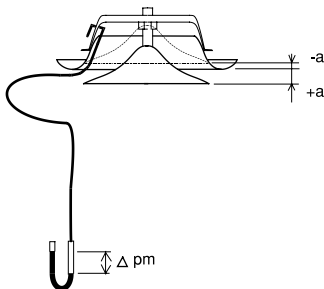
$\varnothing D$	a, mm	4	6	9	12	15	20
160	k	2,6	3,6	5,1	6,6	7,9	9,2



s	2	3	4	5	6	8	10	12	15
100 / 125	0.48	0.71	0.94	1.2	1.4	1.8	2.2	2.7	3.3



KE



Ø80	a (mm)	-3	-2	0	3	6	9
	k	0.3	0.5	0.9	1.6	2.3	2.8

Ø100	a (mm)	-3	-2	0	2	4	6	8	10
	k	0.5	0.7	1.2	1.8	2.5	3.2	4.1	4.9
	k 9.1.06 →	0.6	0.9	1.4	1.9	2.5	3.0	3.6	4.1

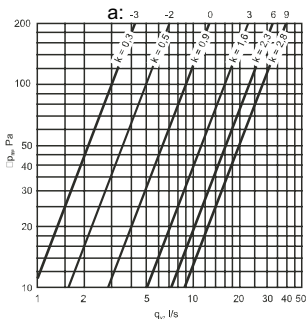
Ø125	a (mm)	-7	-3	0	3	6	9	12	15
	k	1.6	2.4	3.0	4.1	5.3	6.8	8.7	10.0
	k 9.1.06 →	1.0	2.2	3.2	4.2	5.2	6.2	7.2	8.2

Ø150	a (mm)	-5	-3	0	3	6	10	15
	k	2.3	3.0	4.2	5.7	7.4	9.9	12.0
	k 9.1.06 →	2.2	3.0	4.2	5.4	6.6	8.4	10.3

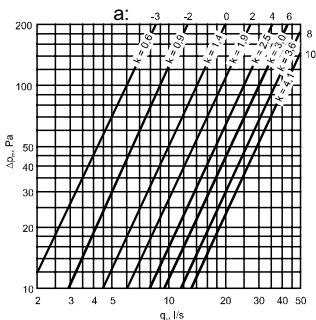
Ø160	a (mm)	-10	-5	0	5	10	15
	k	1.4	2.7	4.4	6.9	9.9	14.0
	k 9.1.06 →	1.0	2.7	4.4	6.2	7.8	9.5

Ø200	a (mm)	-3	0	3	6	9	12	15	20
	k	1.5	3.0	4.7	6.6	8.8	11.1	13.5	17.3
	k 13.2.06 →	1.4	3.4	5.4	7.4	9.4	11.2	13.2	16.6

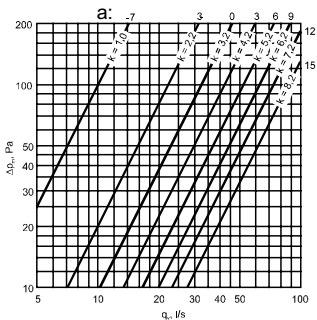
KE-80-C



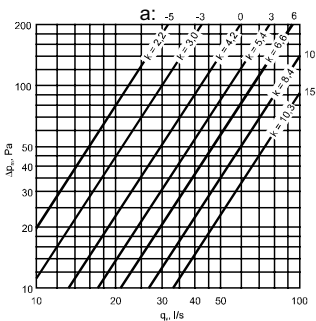
KE-100-C



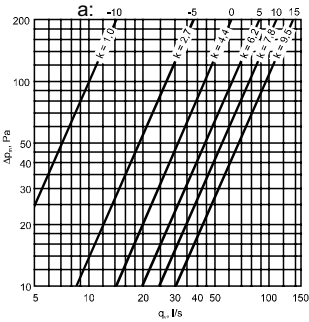
KE-125-C



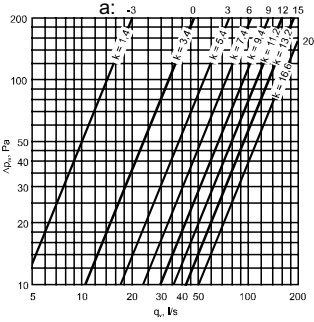
KE-150-C

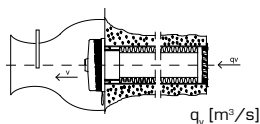


KE-160-C



KE-200-C

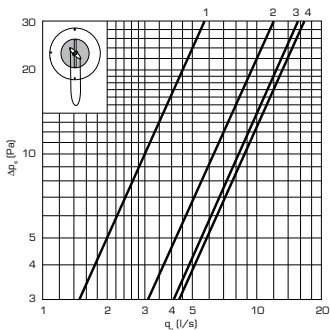




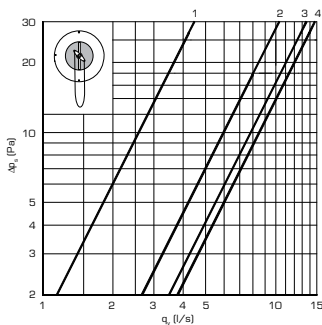
$$v = q_v / 0,015$$

$$q_v = v * 0,015$$

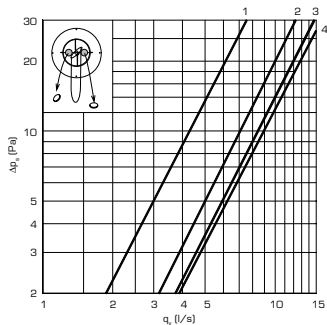
KIV-100



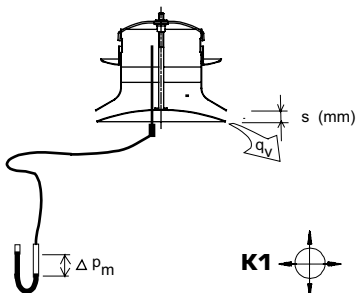
KIV-125



KIV-125



KTI



KTI-100-C

s (mm)	k1	k2	k3
2	1.0	1.1	0.8
3	1.6	1.5	1.1
4	2.0	1.8	1.4
6	3.0	2.5	1.7
8	3.8	3.2	2.2
10	4.8	3.9	2.6
12	5.6	4.2	3.0
16	-	-	3.6

KTI-125-C

s (mm)	k1	k2	k3
2	0.7	1.0	0.8
3	1.1	1.6	1.1
4	2.0	1.9	1.5
6	3.4	2.8	2.1
8	4.8	3.8	2.7
10	6.0	4.7	3.3
12	7.1	5.5	3.8
16	9.0	7.0	5.0

KTI-160-C

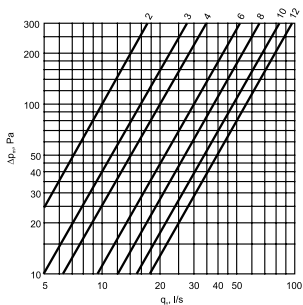
s (mm)	k1	k2	k3
2	1.6	-	-
3	2.4	2.3	1.6
4	3.2	2.7	2.1
6	4.7	3.8	2.9
8	6.3	5.0	3.6
10	7.7	6.1	4.4
12	9.1	7.1	4.9
16	11.8	9.2	6.5
20	14.3	11.2	7.8

KTI-200-C

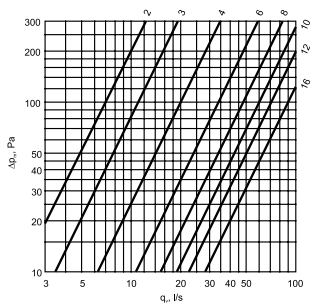
s (mm)	k1	k2	k3
3	2.9	2.5	1.8
4	3.8	3.0	2.7
6	5.7	4.4	3.6
8	7.4	5.7	4.5
10	9.3	7.1	5.4
12	11.0	8.3	6.4
16	14.6	11.0	8.0
20	17.9	13.5	9.8
25	21.9	16.2	11.7



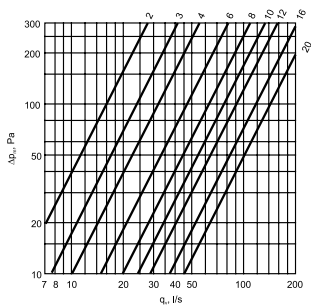
KTI-100-C



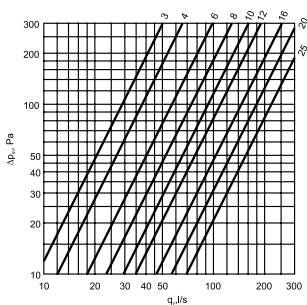
KTI-125-C



KTI-160-C

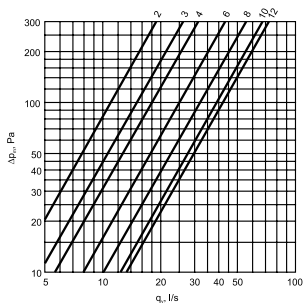


KTI-200-C

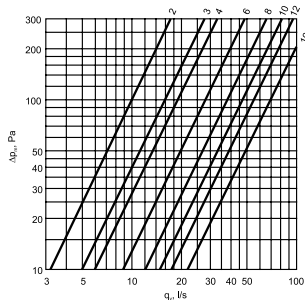




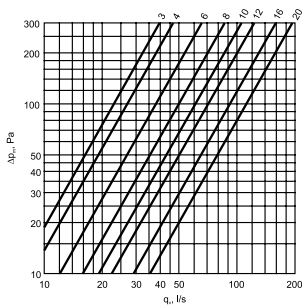
KTI-100-C



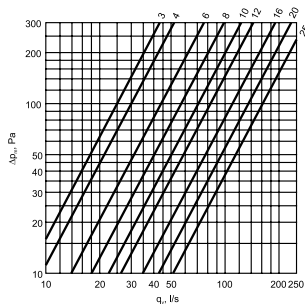
KTI-125-C



KTI-160-C

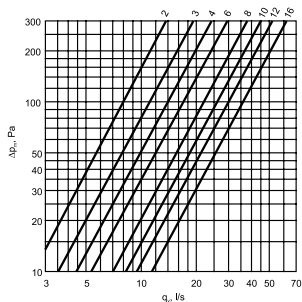


KTI-200-C

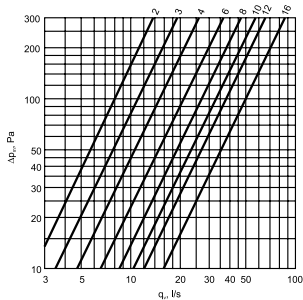




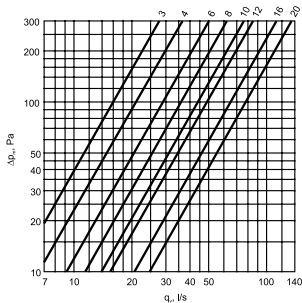
KTi-100-C



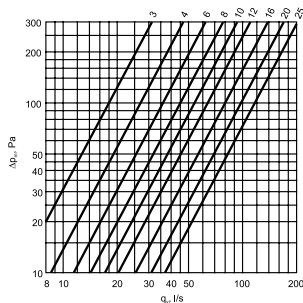
KTi-125-C



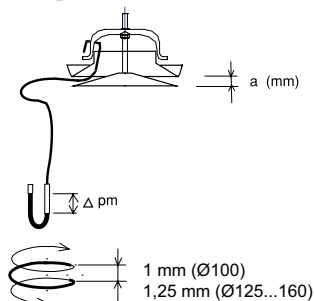
KTi-160-C



KTi-200-C



KTS

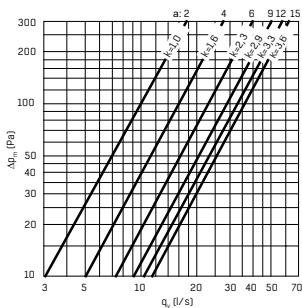
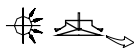


KTS-100-C			
a (mm)			
		06.2006 →	
2	0.9	1.0	1.1
4	1.5	1.6	2.0
6	1.9	2.3	2.7
9	2.3	2.9	4.0
12	2.8	3.3	5.1
15	3.3	3.6	-

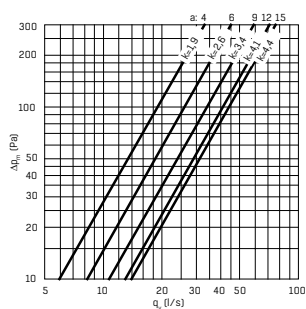
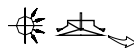
KTS-125-C			
a (mm)			
		06.2006 →	
4	2.0	1.9	2.2
6	2.6	2.6	3.1
9	3.3	3.4	4.2
12	3.8	4.1	5.5
15	4.4	4.4	7.0

KTS-160-C			
a (mm)			
		06.2006 →	
4	2.7	2.3	3.0
6	3.4	3.3	4.2
10	4.8	4.5	6.4
15	5.8	6.4	8.9
20	7.0	7.2	11.2

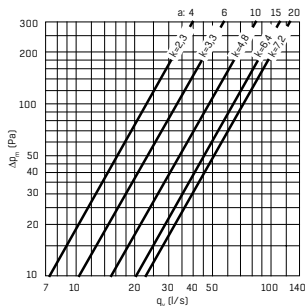
KTS-100-C



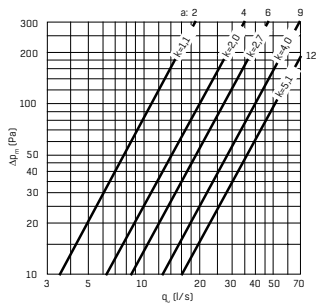
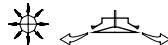
KTS-125-C



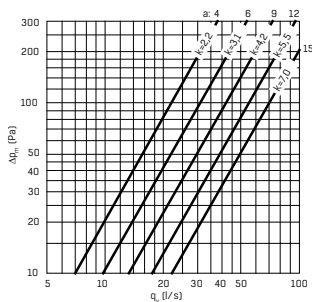
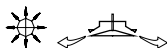
KTS-160-C



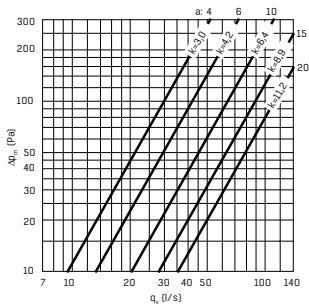
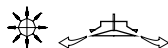
KTS-100-C

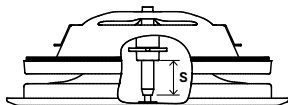
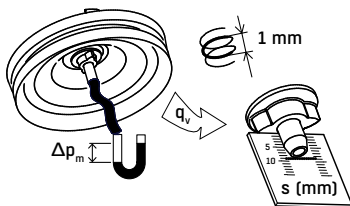


KTS-125-C



KTS-160-C





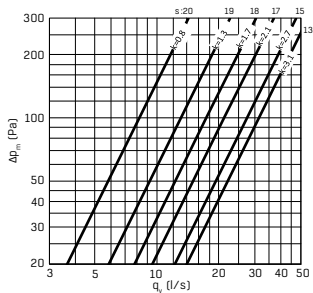
LUMI-100			
s (mm)	k 360°	k 270°	k 180°
20	0.82	0.71	0.52
19	1.31	1.04	0.70
18	1.74	1.35	0.87
17	2.13	1.63	1.04
16	2.46	1.89	1.20
15	2.73	2.13	1.35
14	2.96	2.34	1.50
13	3.13	2.52	1.64
12	-	2.68	1.78
11	-	2.82	1.91
10	-	2.93	2.04

LUMI-125			
s (mm)	k 360°	k 270°	k 180°
27	1.08	0.95	0.66
26	1.71	1.44	0.98
25	2.31	1.90	1.29
24	2.87	2.33	1.59
23	3.38	2.74	1.88
22	3.86	3.13	2.16
21	4.29	3.49	2.42
20	4.69	3.82	2.68
19	5.05	4.14	2.92
18	5.36	4.42	3.16
17	5.64	4.68	3.38
16	5.87	4.92	3.59
15	6.07	5.13	3.79
14	6.22	5.32	3.98

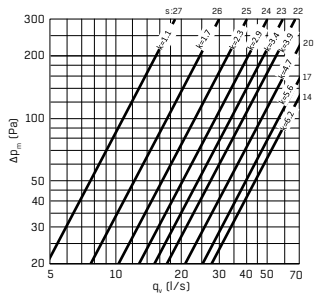
LUMI-160			
s (mm)	k 360°	k 270°	k 180°
33	3.1	2.3	1.5
32	3.8	2.8	1.9
31	4.5	3.3	2.2
30	5.1	3.8	2.5
29	5.7	4.2	2.7
28	6.2	4.6	3.0
27	6.7	5.0	3.3
26	7.1	5.4	3.5
25	7.5	5.7	3.8
24	7.9	6.0	4.0
23	8.2	6.3	4.3
22	8.4	6.6	4.5
21	8.6	6.8	4.7
20	8.8	7.1	4.9
19	8.9	7.3	5.1
18	9.0	7.4	5.3
17	9.0	7.6	5.5

LUMI-200			
s (mm)	k 360°	k 270°	k 180°
44	3.6	3.0	2.5
43	4.7	3.8	3.0
42	5.7	4.5	3.4
41	6.7	5.2	3.9
40	7.6	5.9	4.4
39	8.5	6.6	4.8
38	9.4	7.2	5.3
37	10.2	7.8	5.7
36	11.0	8.4	6.2
35	11.7	9.0	6.6
34	12.4	9.6	7.0
33	13.1	10.1	7.4
32	13.7	10.6	7.8
31	14.3	11.1	8.2
30	14.8	11.6	8.6
29	15.3	12.1	8.9
28	15.7	12.5	9.3

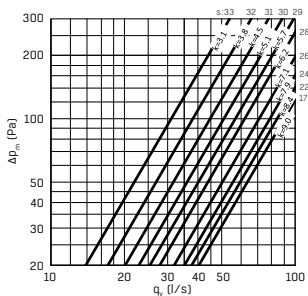
LUMI-100 - 360°



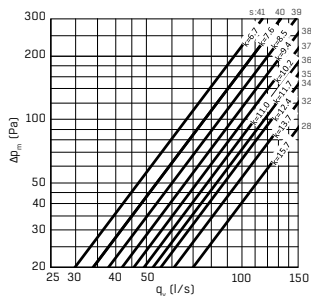
LUMI-125 - 360°



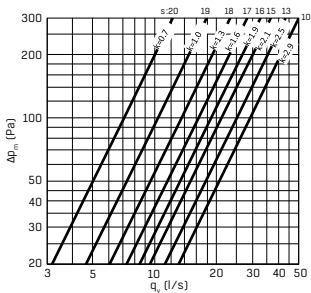
LUMI-160 - 360°



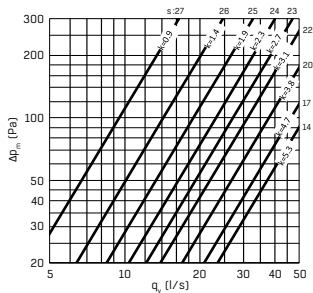
LUMI-200 - 360°



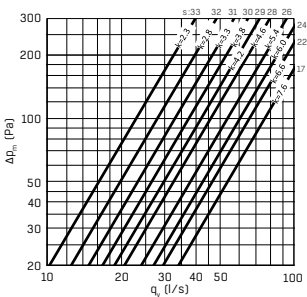
LUMI-100 - 270°



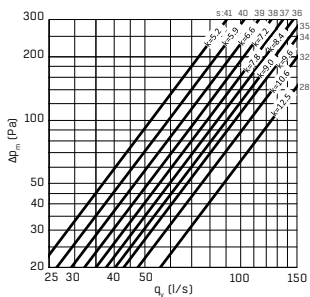
LUMI-125 - 270°



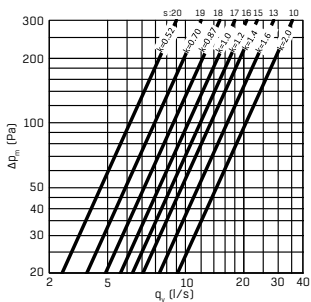
LUMI-160 - 270°



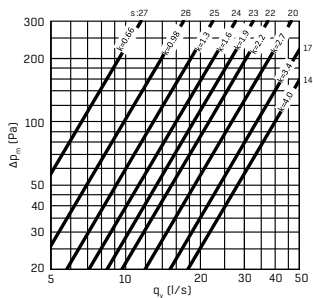
LUMI-200 - 270°



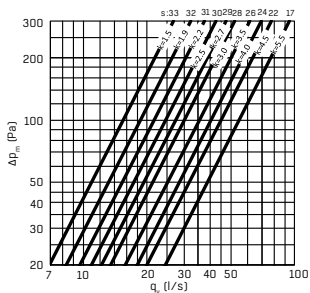
LUMI-100 - 180°



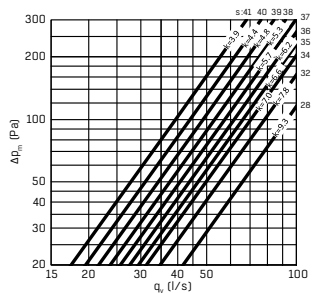
LUMI-125 - 180°

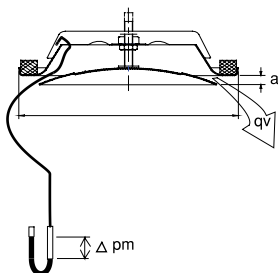


LUMI-160 - 180°



LUMI-200 - 180°





Ø80	a (mm)	2	4	6	9	12
	k	0.8	1.3	1.9	2.8	3.0

Ø100	a (mm)	2	4	6	9	12
	k	0.8	1.4	2.1	3.2	4.0
	k 9.1.06 →	0.8	1.4	2.1	3.0	4.0

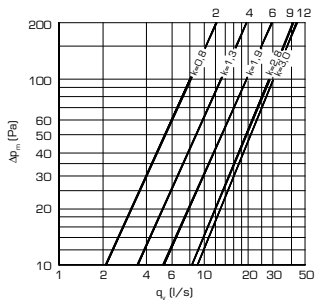
Ø125	a (mm)	3	5	7	9	12	15
	k	1.5	2.3	3.1	4.0	5.3	6.8
	k 9.1.06 →	1.4	2.3	3.2	4.1	5.4	6.7

Ø150	a (mm)	4	6	9	12	15	20
	k	2.2	3.3	4.8	6.4	8.2	10.6
	k 9.1.06 →	2.2	3.3	4.8	6.4	8.0	10.6

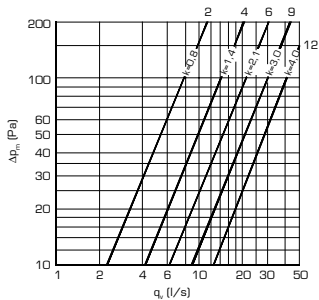
Ø160	a (mm)	4	6	9	12	15	20
	k	2.9	3.4	5.0	6.7	8.6	11.7
	k 9.1.06 →	2.2	3.3	4.7	6.2	7.6	10.0

Ø200	a (mm)	5	6	9	12	15	20
	k	3.8	4.4	6.3	8.2	10.2	13.6
	k 13.2.06 →	4.0	4.7	6.6	8.6	10.5	13.6

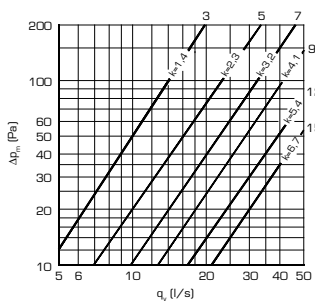
NE-80-C



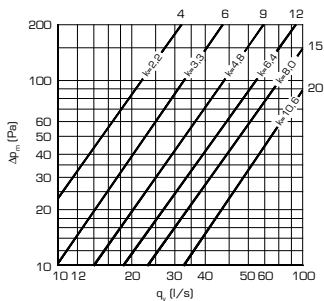
NE-100-C



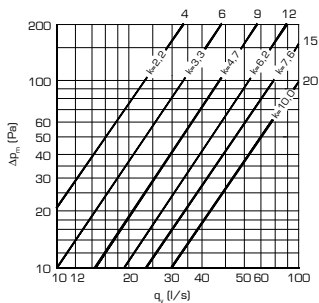
NE-125-C



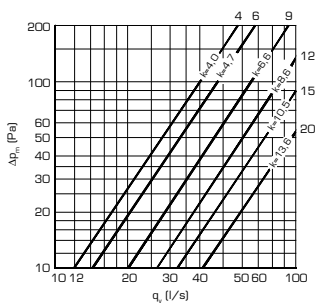
NE-150-C



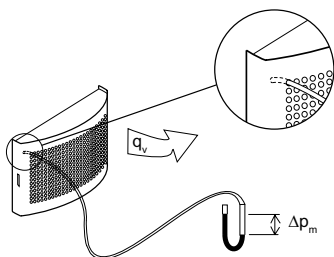
NE-160-C



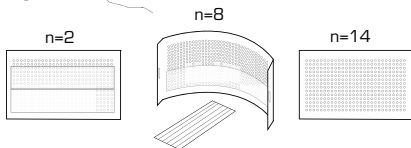
NE-200-C



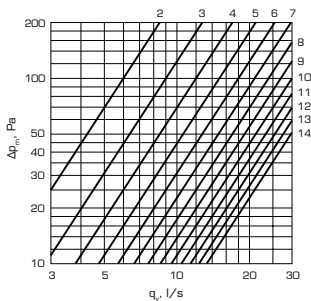
STQA



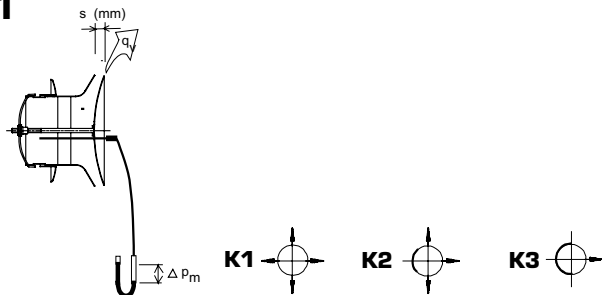
k	
n	100 / 125
2	0,6
3	0,9
4	1,2
5	1,5
6	1,8
7	2,1
8	2,4
9	2,7
10	3,0
11	3,3
12	3,6
13	3,9
14	4,2



STQA-100-C / STQA-125-C



STI



STI-100-C

s (mm)	k1	k2	k3
0	0.6	-	0.6
2	1.6	-	1.6
3	2.1	-	1.8
4	2.7	2.5	2.1
6	3.6	3.3	2.4
8	4.6	4.1	2.9
10	5.6	4.8	3.2
12	6.1	5.3	3.6
16	7.0	6.3	4.3

STI-125-C

s (mm)	k1	k2	k3
0	0.8	-	0.8
2	2.0	-	1.5
3	2.5	-	1.9
4	3.2	2.6	2.2
6	4.4	3.5	2.8
8	5.8	4.4	3.3
10	6.9	5.2	3.9
12	7.8	6.1	4.5
16	10.3	7.8	5.6

STI-160-C

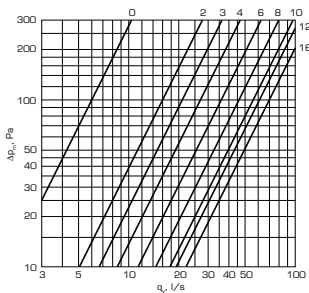
s (mm)	k1	k2	k3
0	1.0	-	1.0
2	2.1	-	2.1
3	2.7	-	2.6
4	3.6	3.3	3.1
6	5.0	4.2	4.1
8	6.5	5.5	4.9
10	8.1	6.6	5.6
12	9.6	7.7	6.5
16	12.7	9.9	7.7

STI-200-C

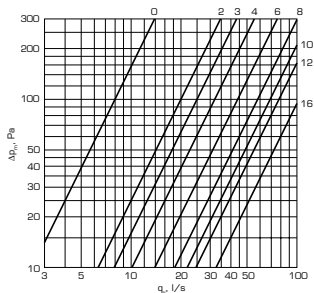
s (mm)	k1	k2	k3
0	1.8	-	1.8
2	3.0	-	3.0
3	3.4	-	3.2
4	4.7	3.9	3.8
6	6.7	5.3	4.9
8	8.5	6.9	6.3
10	10.0	8.4	7.5
12	12.2	9.7	8.5
16	16.1	12.3	10.3
20	19.4	14.9	12.1
25	23.3	17.8	14.6



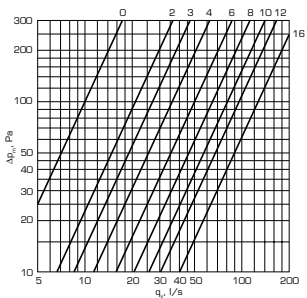
STI-100-C



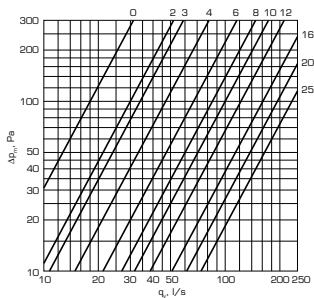
STI-125-C



STI-160-C

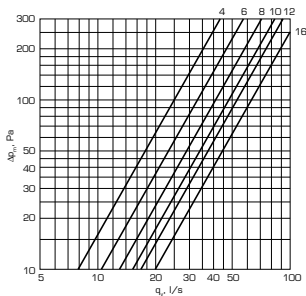


STI-200-C

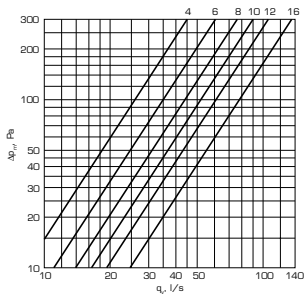




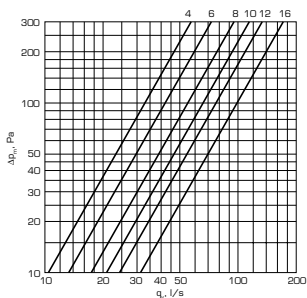
STI-100-C



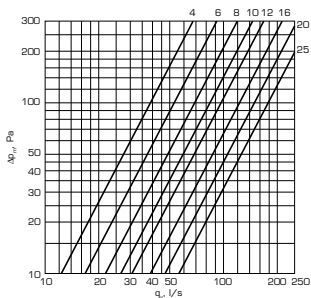
STI-125-C



STI-160-C

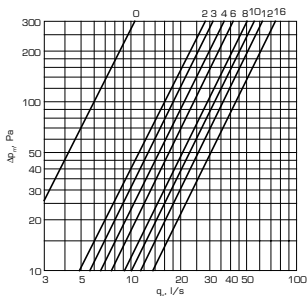


STI-200-C

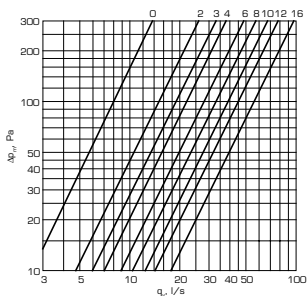




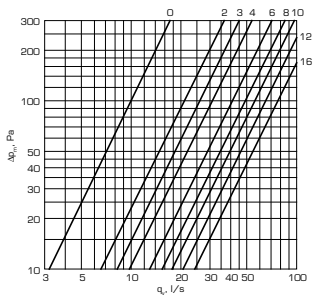
STI-100-C



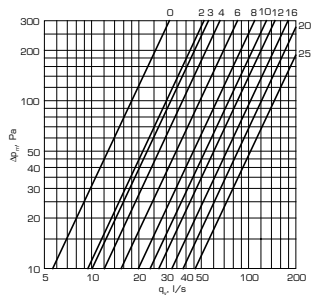
STI-125-C



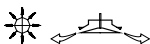
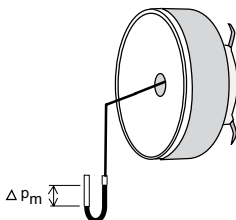
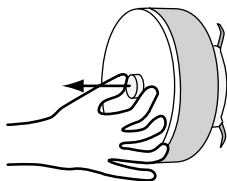
STI-160-C



STI-200-C



VST

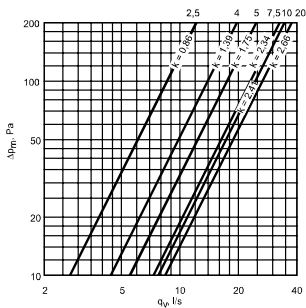
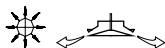


a	2.5	4	5	7.5	10	20
ø80	0.86	1.39	1.75	2.34	2.41	2.66
ø100	1.08	1.67	2.16	3.10	4.05	5.17
ø125	1.15	1.96	2.92	3.73	4.79	7.59
ø160	1.86	2.75	3.43	4.81	6.62	10.32

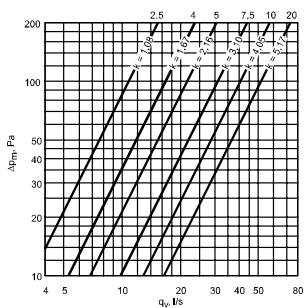
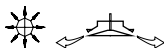


a	2.5	4	5	7.5	10	20
ø80	0.83	1.00	1.31	1.73	2.05	-
ø100	0.90	1.13	1.55	2.25	3.00	3.50
ø125	1.62	1.93	2.34	3.85	4.15	4.91
ø160	1.89	2.26	3.19	4.27	5.29	6.11

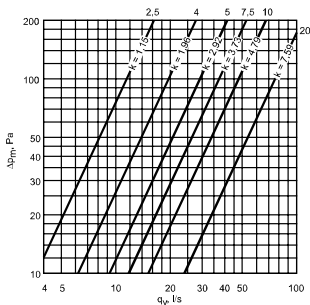
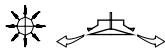
VST-80



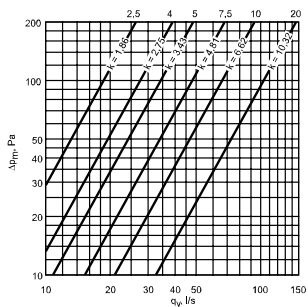
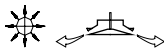
VST-100



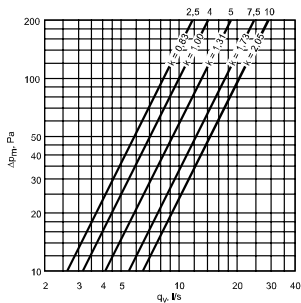
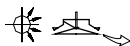
VST-125



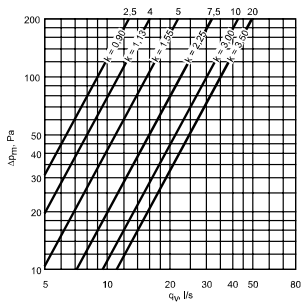
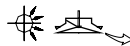
VST-160



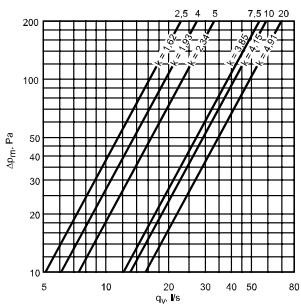
VST-80



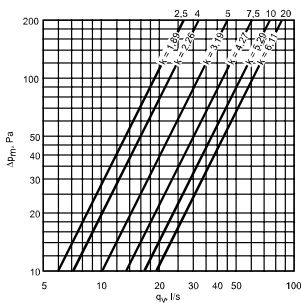
VST-100



VST-125



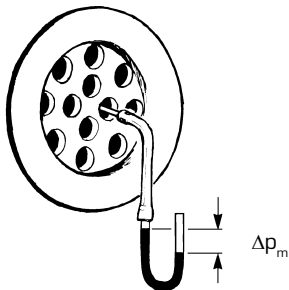
VST-160



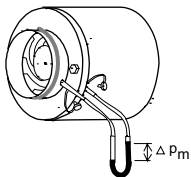
BYBA

a	1	2	3	4	5	6
k	0.24	0.42	0.59	0.80	0.98	1.2

a	7	8	9	10	11	12
k	1.5	1.6	1.8	2.1	2.3	2.5

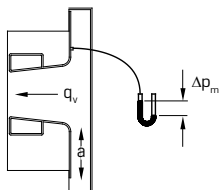


EHI



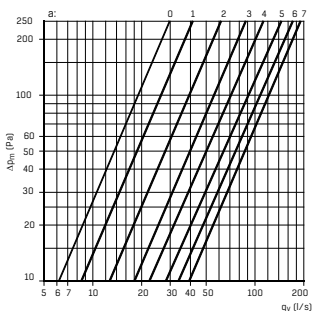
a (mm)	1	2	3	4	5	6	7	8
315	118.0	70.0	58.7	45.1	37.0	30.0	21.8	15.8
400	131.0	102.0	88.3	67.3	52.7	38.5	28.4	15.5

EHC

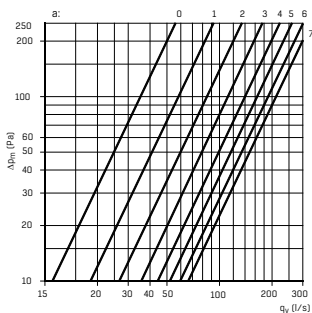


a	k		
	300x150	500x150	800x150
0	1.9	3.5	6.0
1	2.6	5.8	10.8
2	4.0	8.5	14.6
3	5.7	11.2	19.0
4	7.1	14.0	23.9
5	8.9	16.4	28.3
6	10.8	19.0	32.9
7	12.4	21.0	35.4

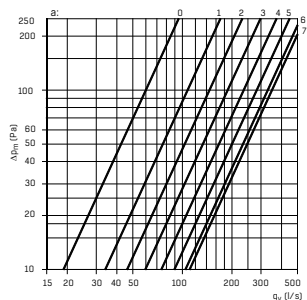
EHC-300x150



EHC-500x150

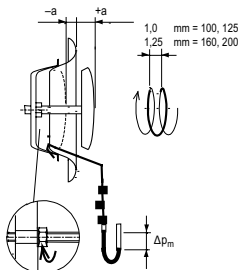


EHC-800x150

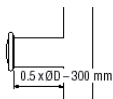


GPDF, GPDB

GPDF = 100-160
GPDB = 100-200



Ø100	a (mm)	-12	-9	-5	0	5	8	12
	k	0.4	0.7	1.1	1.8	2.4	2.7	3.2



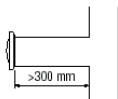
Ø100	a (mm)	-12	-9	-5	0	5	8	12
	k	0.4	0.7	1.2	1.8	2.4	2.7	3.2

Ø125	a (mm)	-17	-13	-9	-6	-3	0	5	10	15
	k	0.8	1.3	1.9	2.4	2.8	3.2	3.9	4.7	5.6

Ø160	a (mm)	-18	-14	-10	-5	0	6	12	18
	k	1.8	2.7	3.3	4.4	4.9	6.3	7.5	-
	k *	1.5	2.3	3.1	4.2	5.1	6.3	7.6	-
	k **	1.1	1.9	2.7	3.6	4.5	5.6	6.8	7.8

*) 1.9.2003 →

**) 1.5.2006 →



Ø100	a (mm)	-12	-9	-5	0	5	8	12
	k	0.4	0.8	1.3	1.9	2.5	2.8	3.2

Ø125	a (mm)	-17	-13	-9	-6	-3	0	5	10	15
	k	0.7	1.3	1.9	2.4	2.8	3.3	4.0	4.8	5.7

Ø160	a (mm)	-18	-14	-10	-5	0	6	12	18
	k	1.8	2.7	3.4	4.6	5.4	6.6	7.8	-
	k *	1.5	2.3	3.1	4.2	5.1	6.3	7.6	-
	k **	1.1	1.9	2.7	3.6	4.5	5.6	6.8	7.8

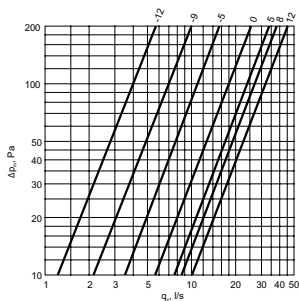
*) 1.9.2003 →

**) 1.5.2006 →

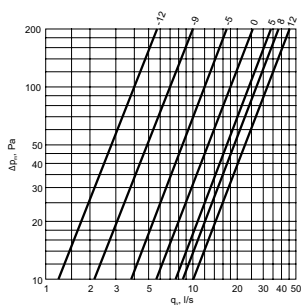
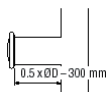
Ø200	a (mm)	-23	-18	-15	-10	-5	0	10	20
	k	2.1	2.9	3.7	5.0	6.1	7.4	9.9	12.7
	k **	2.2	3.3	4.0	5.2	6.4	7.6	10.0	12.5

**) 1.5.2006 →

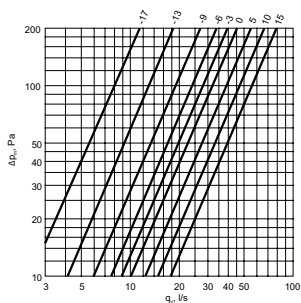
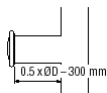
GPD(F,B)-100-C



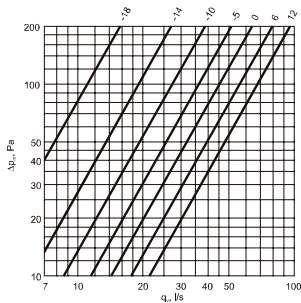
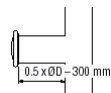
GPD(F,B)-100-C



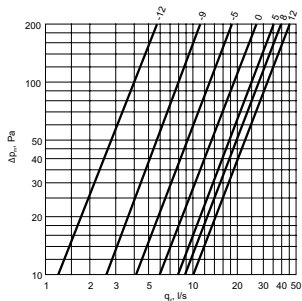
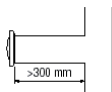
GPD(F,B)-125-C



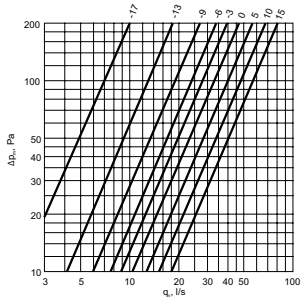
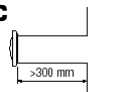
GPD(F,B)-160-C



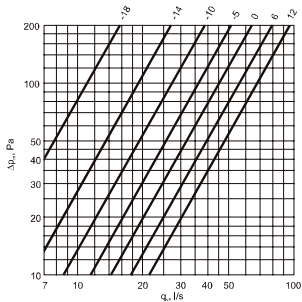
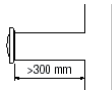
GPD(F,B)-100-C



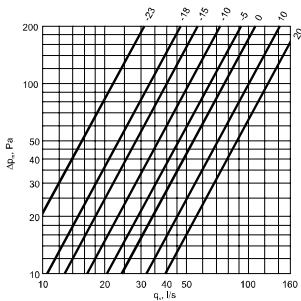
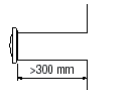
GPD(F,B)-125-C



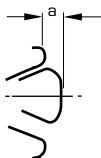
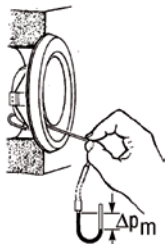
GPD(F,B)-160-C



GPDB-200-C



KGEB

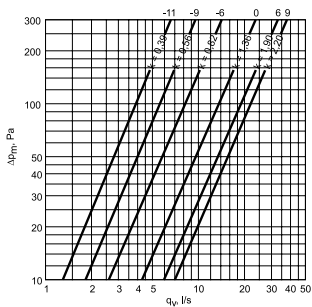


Ø100	a (mm)	-11	-9	-6	0	6	9
	k	0.39	0.56	0.82	1.36	1.9	2.2

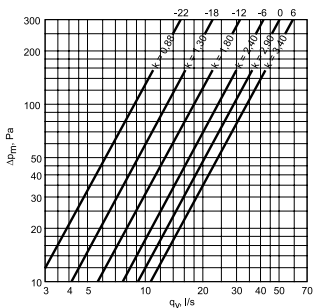
Ø125	a (mm)	-22	-18	-12	-6	0	6
	k	0.88	1.3	1.8	2.4	2.9	3.4

Ø160	a (mm)	-24	-18	-12	-6	0	6
	k	1.8	2.5	3.1	4.1	4.4	5.0
	k 1.1.03 →	1.8	2.5	3.1	3.9	4.6	5.4

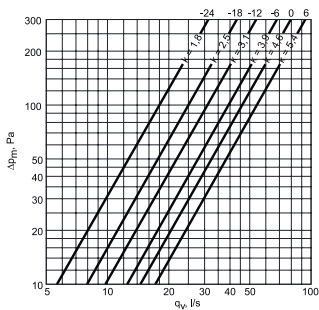
KGEB-100-C

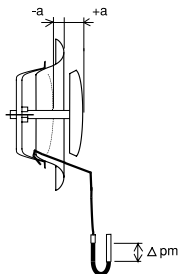


KGEB-125-C



KGEB-160-C





Ø80	a (mm)	-12	-10	-6	-3	0	3	6	9
	k	0.3	0.5	0.8	1.1	1.3	1.6	1.9	2.1

Ø100	a (mm)	-10	-8	-5	0	5	10
	k	0.5	0.7	1.0	1.7	2.3	2.9
	k 9.1.06 →	0.5	0.7	1.1	1.7	2.3	2.9

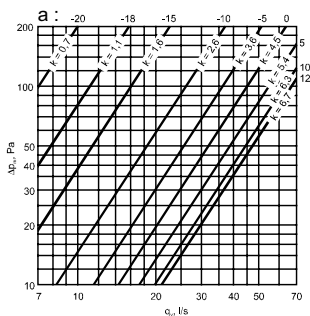
Ø125	a (mm)	-17	-15	-12	-9	-6	-3	0	3	6	9
	k	0.7	1.1	1.5	2.0	2.5	2.9	3.4	3.9	4.3	4.8

Ø150	a (mm)	-15	-13	-10	-5	0	5	10
	k	2.1	2.4	2.9	3.9	4.8	5.6	6.7
	k 9.1.06 →	1.8	2.1	2.7	3.6	4.5	5.4	6.3

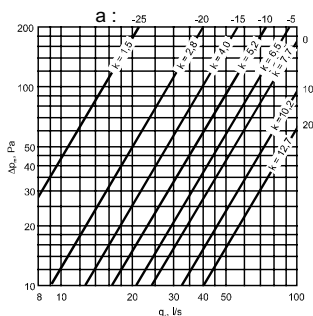
Ø160	a (mm)	-20	-18	-15	-10	-5	0	5	10	12
	k	1.4	1.7	2.3	3.3	4.3	5.3	6.3	-	-
	k 9.1.06 →	0.7	1.1	1.6	2.6	3.6	4.5	5.4	6.3	6.7

Ø200	a (mm)	-25	-20	-15	-10	-5	0	10	20
	k	1.4	2.5	3.7	4.9	6.1	7.3	9.8	12.5
	k 13.2.06 →	1.5	2.8	4.0	5.2	6.5	7.7	10.2	12.7

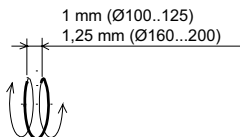
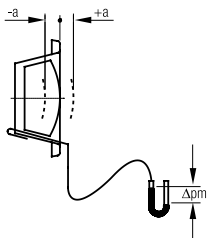
KK-160-C



KK-200-C



KSO, KSOF, KSOV



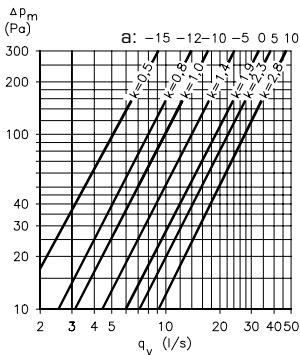
Ø100	
a	k
-15	0.5
-14	0.6
-13	0.7
-12	0.8
-11	0.9
-10	1.0
-9	1.1
-8	1.16
-7	1.24
-6	1.3
-5	1.4
-4	1.5
-3	1.6
-2	1.7
-1	1.8
0	1.9
1	2.0
2	2.06
3	2.14
4	2.2
5	2.3
6	2.4
7	2.5
8	2.6
9	2.7
10	2.8

Ø125	
a	k
-10	1.5
-9	1.6
-8	1.7
-7	1.9
-6	2.0
-5	2.1
-4	2.2
-3	2.3
-2	2.5
-1	2.6
0	2.7
1	2.8
2	2.9
3	3.1
4	3.2
5	3.3
6	3.4
7	3.6
8	3.7
9	3.9
10	4.0

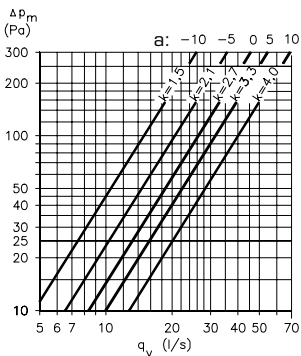
Ø160	
a	k
-10	2.0
-9	2.2
-8	2.3
-7	2.5
-6	2.6
-5	2.8
-4	3.0
-3	3.1
-2	3.3
-1	3.4
0	3.6
1	3.8
2	3.9
3	4.1
4	4.2
5	4.4
6	4.6
7	4.8
8	4.9
9	5.1
10	5.3
11	5.5
12	5.7
13	5.8
14	6.0
15	6.2

Ø200	
a	k
-3	1.4
-2	1.6
-1	1.9
0	2.1
1	2.4
2	2.6
3	2.9
4	3.1
5	3.4
6	3.6
7	3.9
8	4.1
9	4.4
10	4.6
11	4.8
12	5.1
13	5.3
14	5.6
15	5.8
16	6.1
17	6.3
18	6.6
19	6.8
20	7.1
21	7.3
22	7.6
23	7.8
24	8.1
25	8.3

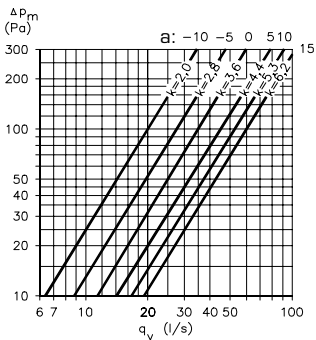
KSO/KSOF/KSOV-100-C



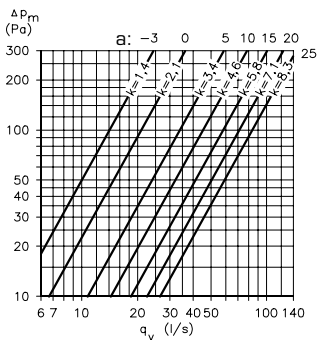
KSO/KSOF/KSOV-125-C



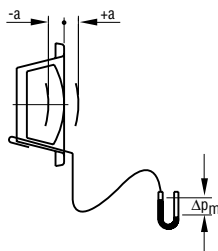
KSO/KSOF/KSOV-160-C



KSO/KSOF/KSOV-200-C



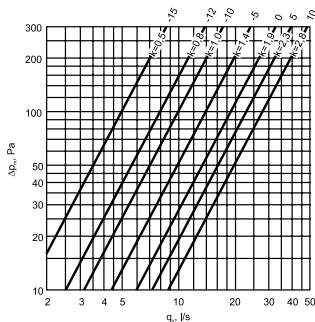
KSOM



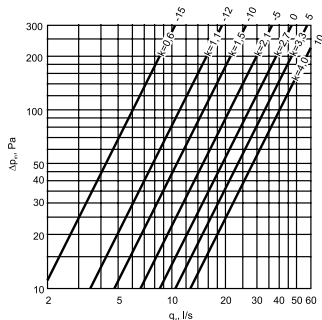
Ø100	
a	k
-15	0.5
-14	0.6
-13	0.7
-12	0.8
-11	0.9
-10	1.0
-9	1.1
-8	1.16
-7	1.24
-6	1.3
-5	1.4
-4	1.5
-3	1.6
-2	1.7
-1	1.8
0	1.9
1	2.0
2	2.06
3	2.14
4	2.2
5	2.3
6	2.4
7	2.5
8	2.6
9	2.7
10	2.8

Ø125	
a	k
-15	0.6
-12	1.1
-10	1.5
-9	1.6
-8	1.7
-7	1.9
-6	2.0
-5	2.1
-4	2.2
-3	2.3
-2	2.5
-1	2.6
0	2.7
1	2.8
2	2.9
3	3.1
4	3.2
5	3.3
6	3.4
7	3.6
8	3.7
9	3.9
10	4.0

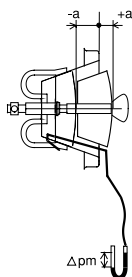
KSOM-100-C



KSOM-125-C



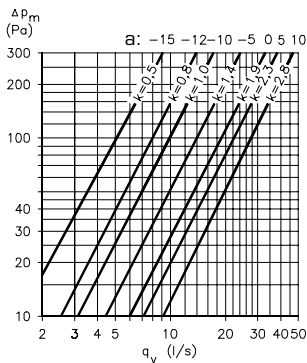
KSOS



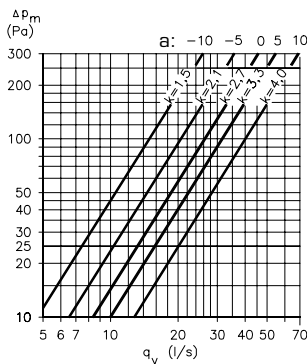
Ø100	
a	k
-15	0.5
-14	0.6
-13	0.7
-12	0.8
-11	0.9
-10	1.0
-9	1.1
-8	1.16
-7	1.24
-6	1.3
-5	1.4
-4	1.5
-3	1.6
-2	1.7
-1	1.8
0	1.9
1	2.0
2	2.06
3	2.14
4	2.2
5	2.3
6	2.4
7	2.5
8	2.6
9	2.7
10	2.8

Ø125	
a	k
-10	1.5
-9	1.6
-8	1.7
-7	1.9
-6	2.0
-5	2.1
-4	2.2
-3	2.3
-2	2.5
-1	2.6
0	2.7
1	2.8
2	2.9
3	3.1
4	3.2
5	3.3
6	3.4
7	3.6
8	3.7
9	3.9
10	4.0

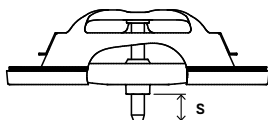
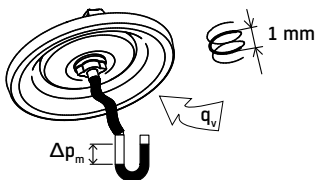
KSOS-100-C



KSOS-125-C



LUMO



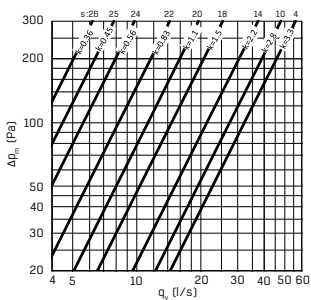
LUMO-100	
s (mm)	k
26	0.36
25	0.45
24	0.56
23	0.69
22	0.83
21	0.98
20	1.14
19	1.30
18	1.47
17	1.65
16	1.82
15	1.99
14	2.16
13	2.33
12	2.49
11	2.64
10	2.77
9	2.90
8	3.01
7	3.10
6	3.17
5	3.23
4	3.26

LUMO-125	
s (mm)	k
32	0.75
31	0.91
30	1.06
29	1.23
28	1.39
27	1.56
26	1.74
25	1.91
24	2.09
23	2.28
22	2.46
21	2.65
20	2.85
19	3.04
18	3.24
17	3.45
16	3.65
15	3.87
14	4.08
13	4.30
12	4.52
11	4.74
10	4.97
9	5.20
8	5.43
7	5.67

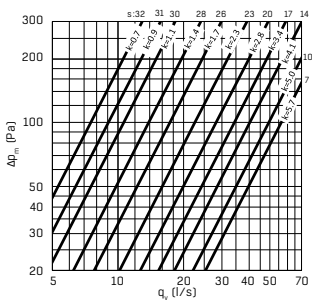
LUMO-160	
s (mm)	k
34	1.67
33	1.84
32	2.02
31	2.19
30	2.38
29	2.57
28	2.76
27	2.96
26	3.16
25	3.37
24	3.58
23	3.79
22	4.01
21	4.24
20	4.47
19	4.70
18	4.94
17	5.18
16	5.43
15	5.68
14	5.94
13	6.20
12	6.47
11	6.74
10	7.02
9	7.30
8	7.58
7	7.87

LUMO-200	
s (mm)	k
41	1.85
40	2.09
39	2.33
38	2.58
37	2.83
36	3.09
35	3.35
34	3.61
33	3.88
32	4.15
31	4.43
30	4.71
29	4.99
28	5.28
27	5.57
26	5.86
25	6.16
24	6.46
23	6.77
22	7.08
21	7.39
20	7.71
19	8.03
18	8.35
17	8.68
16	9.02
15	9.35
14	9.69
13	10.04
12	10.38
11	10.73
10	11.09
9	11.45
8	11.81
7	12.18

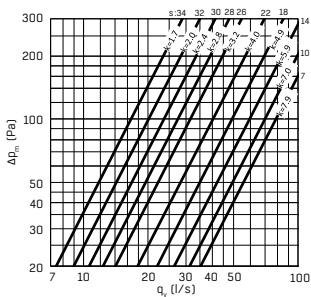
LUMO-100



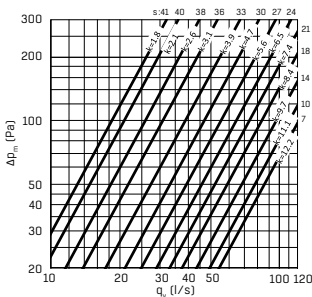
LUMO-125

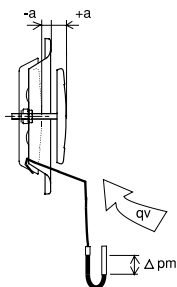


LUMO-160



LUMO-200





Ø80	a (mm)	-12	-9	-6	-3	0	3	6
	k	0.4	0.6	0.9	1.1	1.4	1.7	1.9

Ø100	a (mm)	-14	-12	-9	-5	0	5
	k	0.4	0.5	0.9	1.4	2.1	2.7
	k 9.1.06 →	0.5	0.7	1.1	1.5	2.1	2.7

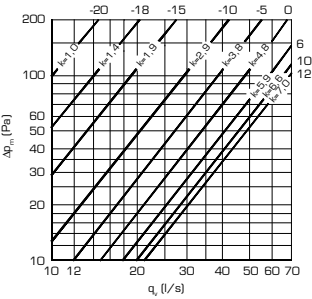
Ø125	a (mm)	-17	-15	-12	-9	-6	-3	0	5
	k	1.1	1.4	1.8	2.3	2.7	3.1	3.6	4.3
	k 9.1.06 →	1.1	1.4	1.8	2.3	2.7	3.2	3.7	4.4

Ø150	a (mm)	-15	-12	-9	-3	3	9
	k	2.1	2.6	3.2	4.2	5.3	6.4
	k 9.1.06 →	1.9	2.4	3.0	4.1	5.2	6.4

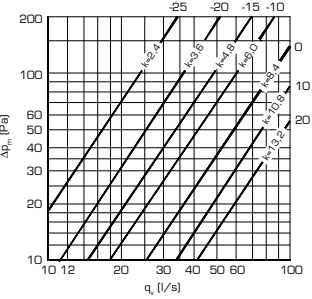
Ø160	a (mm)	-20	-18	-15	-10	-5	0	6	10	12
	k	1.7	2.0	2.7	3.6	4.5	5.5	6.7	-	-
	k 9.1.06 →	1.0	1.4	1.9	2.9	3.8	4.8	5.9	6.6	7.0

Ø200	a (mm)	-25	-20	-15	-10	0	10	20
	k	1.8	2.9	4.1	5.3	7.8	10.1	12.7
	k 13.2.06 →	2.4	3.6	4.8	6.0	8.4	10.8	13.2

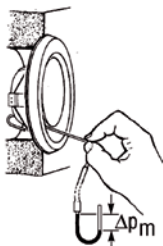
NK-160-C



NK-200-C



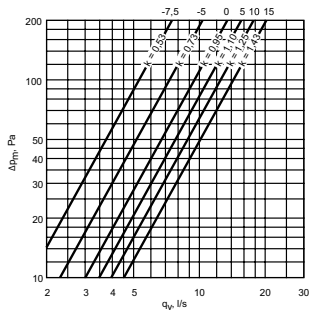
FVEF



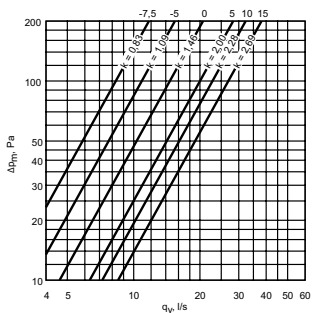
a	-7.5	-5	0	5	10	15
ø80	0.53	0.73	0.95	1.10	1.25	1.43
ø100	0.83	1.09	1.46	2.00	2.28	2.69
ø125	0.85	1.11	1.63	2.15	2.41	3.45

a	-2.5	0	5	10	15	20
ø160	2.02	2.63	3.93	4.53	6.08	7.56
ø200	-	3.47	4.61	5.97	6.60	7.66

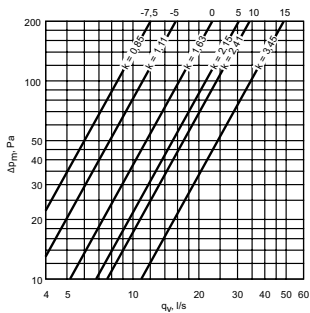
FVEF-80



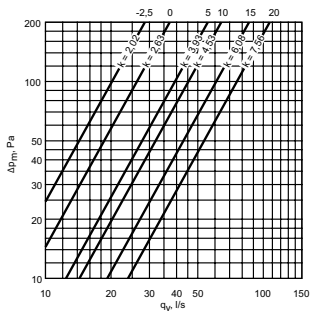
FVEF-100



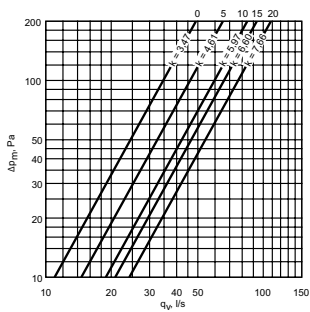
FVEF-125



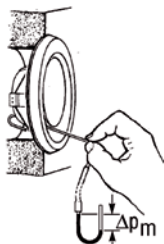
FVEF-160



FVEF-200



VEL

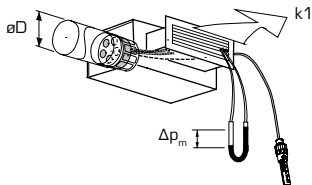


VEL	a, mm	-5	-0	+5	+10	+15	forced
0	k	0.58	1.46	2.29	3.09	3.47	–
1	k	0.66	0.95	1.30	1.79	2.59	3.59

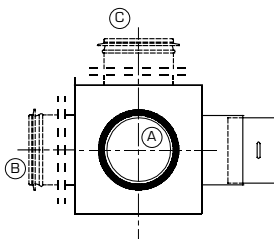
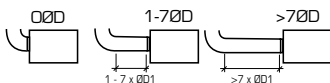
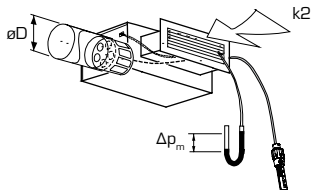
VEL	a, mm	-5	-3	0	forced
2	k	0.65	0.98	1.52	2.90

TG/TGE, AVS, SV, USR

TG



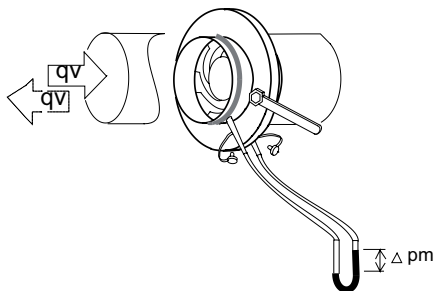
TGE



10.2011 →

B x H	ØD	k1 TG			k2 (AVS) TGE			k2 (SV2, USR) TGE			k2 (SV1) TGE		
		ØD	1-7D	>7D	A	B	C	A	B	C	A	B	C
200x100	125	10,1	10,6	10,1	9	11	10	11	13	11	10	8	10
300x100	160	17,1	19,9	17,3	15	17	16	19	21	19	16	15	16
400x100	160	17,1	19,9	17,3	22	22	22	25	31	26	22	21	22
500x100	200	27,0	30,8	27,9	34	28	25	34	37	36	28	25	27
600x100	250	40,9	42,7	39,9	36	32	36	38	35	39	33	30	33
800x100	250	40,9	42,7	39,9	53	47	46	60	50	51	-	-	-
1000x100	250	40,9	42,7	39,9	63	59	60	62	62	63	71	64	69
300x150	200	27,0	30,8	27,9	25	27	20	25	34	24	25	22	24
400x150	250	40,9	42,7	39,9	32	34	36	45	46	39	32	30	32
500x150	250	40,9	42,7	39,9	43	47	42	50	52	48	37	38	40
600x150	250	40,9	42,7	39,9	53	53	53	65	92	62	50	44	49
800x150	315	65,9	67,2	64,1	74	77	73	86	90	82	63	59	65
1000x150	315	65,9	67,2	64,1	109	91	96	118	106	103	-	-	-
400x200	250	40,9	42,7	39,9	45	52	43	47	63	45	44	42	45
500x200	315	65,9	67,2	64,1	60	63	63	74	74	61	59	54	58
600x200	315	65,9	67,2	64,1	75	77	71	80	89	70	74	63	69
800x200	315	65,9	67,2	64,1	82	107	104	105	131	107	99	85	94
1000x200	315	65,9	67,2	64,1	176	124	139	177	154	151	147	109	126

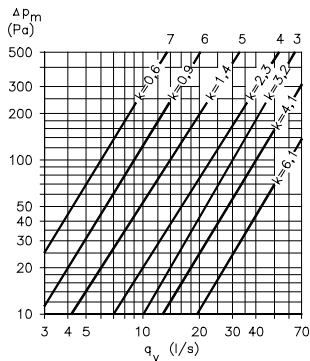
IRIS



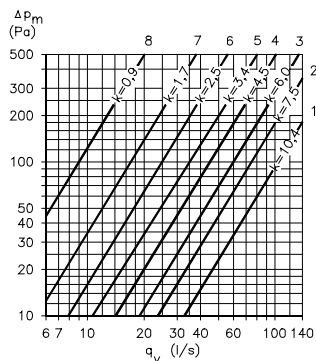
$\varnothing$	a							
	1	2	3	4	5	6	7	8
80	6.1	4.1	3.2	2.3	1.4	0.9	0.6	-
100	10.4	7.5	6.0	4.5	3.4	2.5	1.7	0.9
125	13.8	8.8	6.5	4.7	3.5	2.7	1.5	-
150	24.1	16.5	13.4	11.0	8.9	6.9	5.2	3.7
160	22.1	14.8	12.5	10.7	8.5	6.8	4.9	3.5
200	44.2	30.9	23.2	18.2	14.0	11.0	8.4	5.0
250	64.4	45.6	38.7	30.7	24.1	18.4	12.8	8.9
315	118.0	70.0	58.7	45.1	37.0	30.0	21.8	15.8
400	131.0	102.0	88.3	67.3	52.7	38.5	28.4	15.5
500	230.0	177.0	146.0	112.0	88.5	66.6	48.0	30.0
630	451.0	297.0	238.0	169.0	127.0	91.6	62.8	35.1
800	489.0	402.0	344.0	267.0	217.0	170.0	122.0	73.7

$\varnothing$	a						
	1.5	2.5	3.5	4.5	5.5	6.5	7.5
100	7.9	6.6	5.2	3.8	2.9	2.1	1.2
125	10.4	7.3	5.5	4.0	3.1	2.2	-
150	20.0	14.9	12.0	10.0	7.9	6.0	4.4
160	17.2	13.4	11.5	9.5	7.5	5.6	4.0
200	36.6	26.9	20.6	15.9	12.3	9.6	6.5
250	53.5	41.8	34.5	27.3	21.4	15.8	10.9
315	88.3	64.5	53.0	42.4	33.3	25.9	19.0

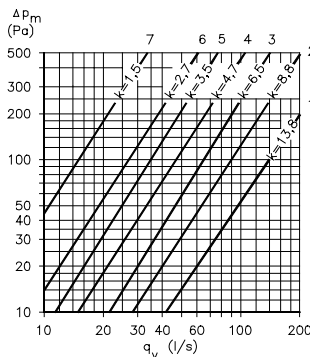
IRIS-080



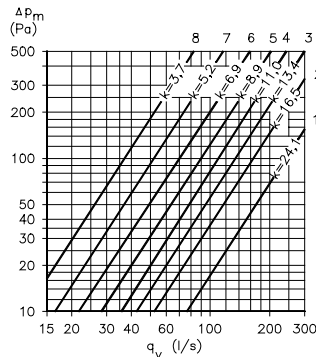
IRIS-100



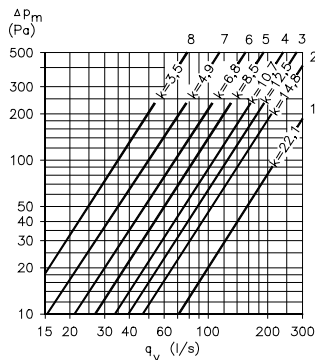
IRIS-125



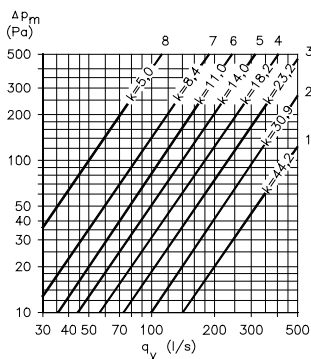
IRIS-150



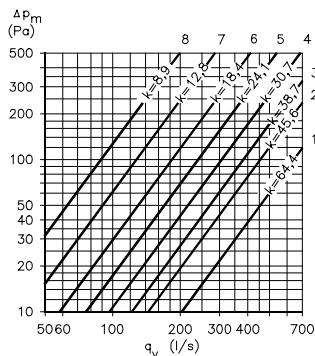
IRIS-160



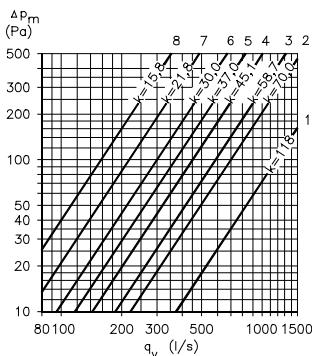
IRIS-200



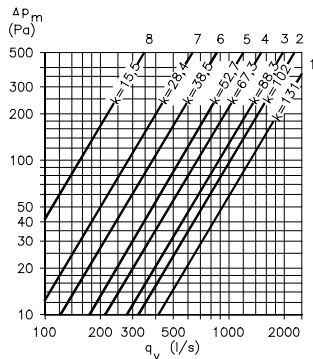
IRIS-250



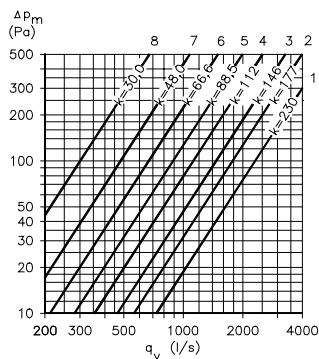
IRIS-315



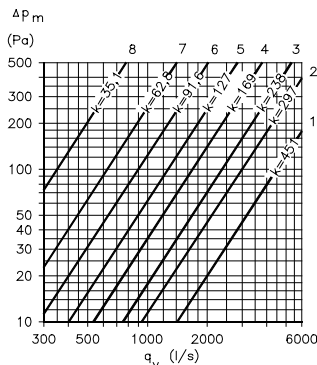
IRIS-400



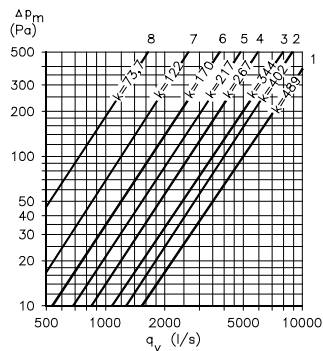
IRIS-500



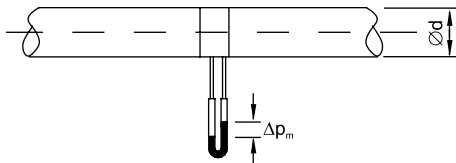
IRIS-630



IRIS-800



MR



MR	k
100	4.0
125	7.4
160	13.6
200	23.4
250	40
315	66
400	114
500	180
630	294
800	481
1000	764
1250	1330

