höntzsch
flow measuring technology

Vane Wheel Flow Sensors FA 07/2010

Probes · Probe Extensions · Probe Guide Pieces · Measuring Tubes

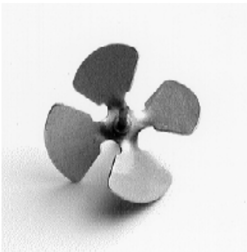
Flow · Flow rate
Also combined with
temperature · Pressure

Specifications
Designs
Information for the user

The principle of measurement
is based on the fact that a vane wheel rotates at a speed proportional to the flow velocity v of a fluid into which it is immersed. The rotational speed is almost independent of density, pressure and temperature of the medium.

The sensing of the vane wheel rotation is carried out by an inductive proximity switch. By fitting a further inductive proximity switch, sensing of the direction of the vane wheel rotation and the indication of the ±direction of flow is made possible.

This form of measurement of rotational speed is carried out without the slightest braking effect on the vane wheel. Soilage does not effect the impulse recognition. The light weight of the vane wheel makes it most suitable for adapting its rotational speed in millisecond range to intervening velocity changes. All vane wheel flow sensors are calibrated on the same frequency, so that sensors of the same type are interchangeable.

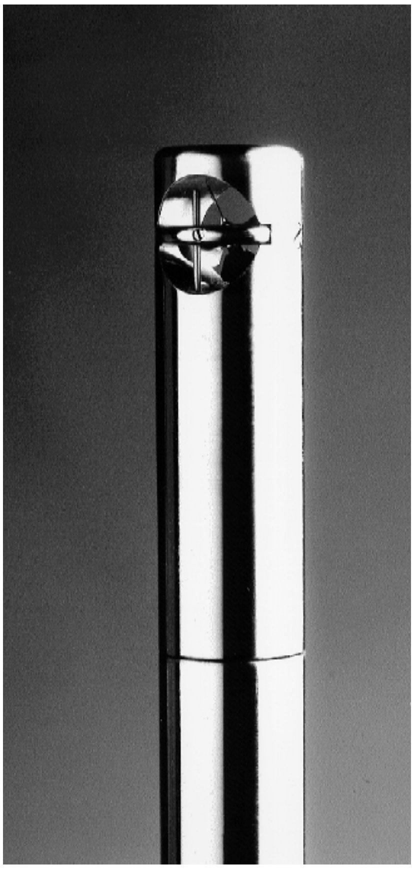


The length of cable between sensor and electronic evaluation unit can measure up to several hundred meters.

Types of sensor with vane wheel
- v-sensors for measuring the flow velocity v
- vt-sensors for measuring the flow velocity v and also the temperature t
- v-sensors for sensing the ±direction of flow: FAR
- v-sensors FA/FAR also in protective system Ex ia IIC T6 Ex
- vt-sensors FT for HFA-Ex also in protective system Ex ia IIC T4

Designs
- cylinder probes with Ø from 14/15 mm
- cylinder probes with Ø from 16 mm also sensing ±direction of flow
- cylinder probes with Ø from 25 mm also as vt-sensors
- probes of fixed length and extendable probes

Probe ZS 18 GE

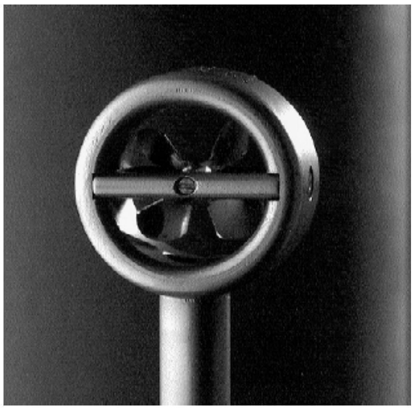


Probe FT

Measuring tubes FA·Di...
for direct, independent of position, stationary installation in pipelines with inside diameters Di from 9.7...150 mm. Measuring tubes FA Di... are designed for the smallest possible blockage. Tube connection by flange, cutting ring fitting, pipe fitting, connecting nipple, etc.

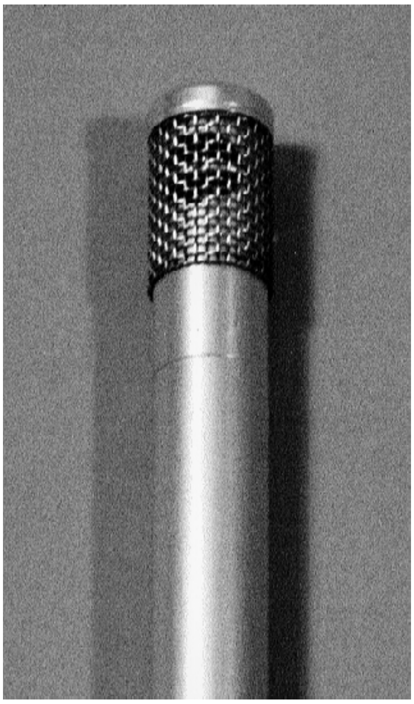
Customer-specific designs, special designs

T-probes and T-probes with cone for higher indifference to indirect oncoming flow

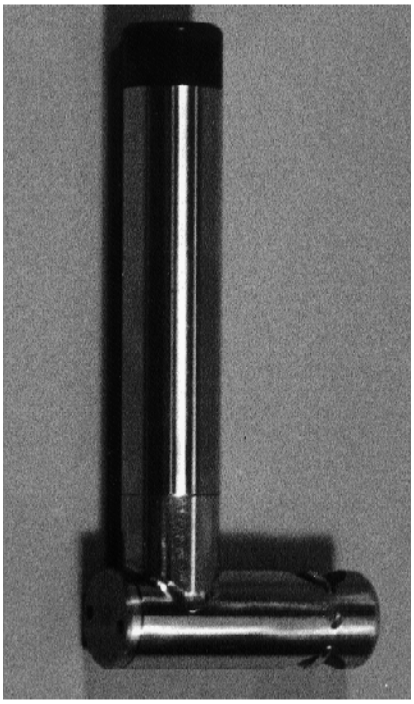


T-probe withvery small size, 16 mm long, shaft diameter 8 mm, sensing ±direction of flow

and others, for example
cylinder probe with integral flange as well as lapped flange cylinder probes ZS25 or ZS30 with integrated transducer



Cylinder probe with protective mesh for measuring water velocity up to max. 1.5 m/s



Cylinder probe with 90° elbow

Cylinder probe of an exact length with connector box

ZS25/27 GFE-mn40 /370-2/p6/Ex
FT30 G E-md20 T /100 /p6

Sensor
Probe diameter in mm
Diameter in mm from sensor
Medium
G = air/gases
F = water/liquids
Probe material
A = aluminium
E = stainless steel
T = titanium
Type of vane wheel
Vane wheel material
Working temperature range
Length of cable in m up to cable amplifier
Working pressure above atmospheric
Protective system

Types of sensor
ZS cylinder probe, v-sensor FA
ZSR cylinder probe sensing ±direction of flow, v-sensor FAR
FT cylinder probe with integrated temperature sensor Pt100, Flowtherm sensor, vt-sensor:
v-sensor FA
t-sensor Pt100, DIN IEC 751, tolerance class B, 4-wire configurated

Probe diameter Ø
Ø14/15, Ø16, Ø18, Ø25 or Ø30 mm

Probe tube diameter
from sensor in mm

The description of a conical expansion on the handle or on the probe tube directly screwed on to the sensorcan be found in the sensor identification (e. g. ZS25/27...), handle identification HG (e. g. ZS25G... + HG25/27...) or probe tube identification SR (e. g. ZS16G... + SR16/18E...).

The conical expansion protects the sensor during feed through the through hole of a probe guide piece; besides this increased demands on impermeability and maximum working pressures can be met.

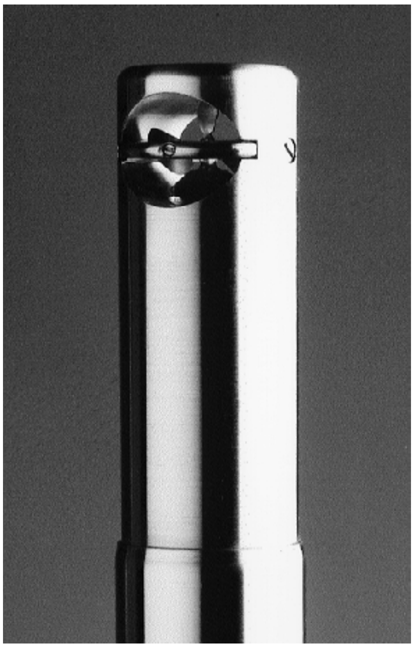
Should details of the conical expansion be missing then probe extension and sensor have the same diameter.

Medium
G air/gases
GF water/liquids and air/gases

Vane wheel flow sensors FA are primarily intended for measurements in single-phase flow streams. Slight medium impurities, especially the usual dust content in the air, are of no impairment to the fatigue strength for infinite time. When measuring gases with a solids content a reduction in the fatigue strength of the vane wheel axle tips must be reckoned with depending on type and quantity of the solid particles.

Likewise moisture in gases is of no disadvantage, as long as condensation does not set in. In the case of slight condensation a self-cleaning effect can be reckoned with, as long as the velocities are greater than 10% of the nominal value. Drops of condensation must not come in to contact with the vane wheel.

Höntzsch vane wheel flow sensors are calibrated in air. GF sensors calibrated in air can also be used for measuring in liquids, as research has shown that in the case of measurements in water the sensor characteristic which is deposited as a straight line simply causes parallel shift. GF commutable evaluation units take into account the respective corresponding characteristic.



Probe ZS25/27

When measuring in liquids with a viscosity greater than 10 cSt or less than 1 cSt measured value divergencies must be reckoned with. Nevertheless, positive experience has been made, for example, when measuring with fuel. In all cases the mediums must not contain fibres.

Sensor materials
A aluminium
E stainless steel, antirust and acidproof
T titanium

The material reference given to a sensor is the principal material used.

Vane wheel material
As a rule a vane wheel is made of the same material as that referred to in the sensor identification. Should another material be used for the vane wheel then this material will be referred to separately in the sensor identification. The vane wheels in Höntzsch vane wheel flow sensors are pivot suspended. The materials used for vane wheel axes and jewel bearings guarantee highest quality with regard to fatigue strength for infinite time, temperature stability and corrosion resistance.
Axes: sintered hard metal
Stones: synthetic sapphire

Type of vane wheel / Measuring range
The vane wheels differ in size
micro = mc,
mini = mn,
midi = md and the designated measuring range up to 20, 40, 80 or 120 m/s when measuring in air/gases (G) or up to 7.5 or 10 m/s when measuring in water/liquids (F).

Smallest measurable value, density influence
The smallest measurable value for measurements in air/gases specified in our documents results from a measuring medium density $\rho \cong 1{,}2\ kg/m^3$. The smallest measurable value v_0 is also increased / decreased negligibly even with a considerably different medium density $\rho \cong 1{,}2\ kg/m^3$ and follows in good approximation the relation

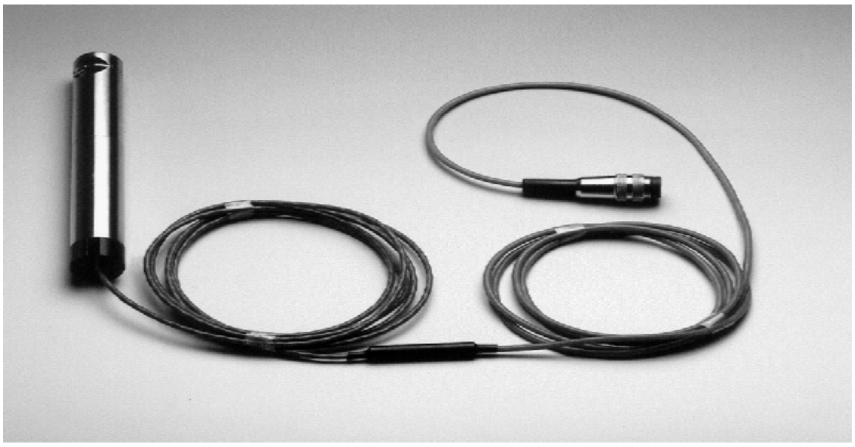
$$v_{0,real} \cong v_{0,spezif} \sqrt{\frac{1{,}2\ kg/m^3}{\rho_{real}}}$$

The characteristic is displaced by the difference
$v_{0,\,spezif} - v_{0,\,real} = \Delta v$.

Readout of measured values is too great by the amount Δv when measuring in gases of a density of $\rho_{real} > 1{,}2\ kg/m^3$, and too small by the amount Δv when measuring in gases of a density of $\rho_{real} < 1{,}2\ kg/m^3$. Δv is to be added to or subtracted from the respective output value.

High endurance with vane wheel flow sensors can also be attained by choosing the sensor with higher nominal value, but using it only in the range of up to 25 % of the nominal value. In such cases we recommend optimum calibration of the measuring probe up to 25 % of terminal value or the linearizing of characteristics. Case example: sensor with vane wheel mn80A, clean air at +20 °C, flow velocities 5...15 m/s; in these conditions 5 years continuous operation can be altogether expected. Of course the increased smallest measurable value resulting from this must be acceptable.

The measuring operation only up to 25 % of the nominal value should also be favoured in continuous use when the temperatures of the medium continually exceed +300°C. Probes with a midi vane wheel should only be put into continuous use when the velocity lies in a range of up to 20% of nominal value.



Working temperature range

100	-20 °C ... +100 °C C also
	-30 °C ... +100 °C C
140	-20 °C ... +125 °C C also
	-30 °C ... +140 °C S
240	-20 °C ... +240 °C C
	-25 °C ... +240 °C S
260	-40 °C ... +260 °C C
	-40 °C ... +300 °C S also
260	0 °C ... +260 °C C
	0 °C ... +300 °C S
350	-40 °C ... +350 °C C
	-40 °C ... +400 °C S
370	-40 °C ... +370 °C C
	-40 °C ... +400 °C S
450	-40 °C ... +450 °C C
500	-40 °C ... +500 °C C
	-40 °C ... +550 °C S

C = continuous operation
S = short-time operation

The respective sensor working temperature range is especially influenced by the internal connection system, the materials, the proximity switch, the cable as well as the seals.

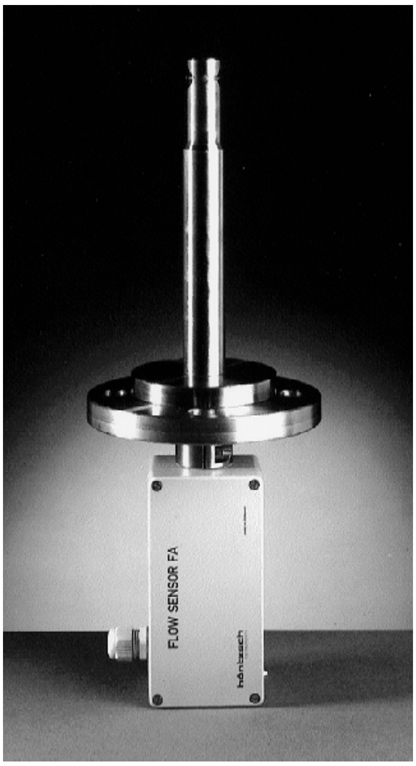
Temperature testing facilities for Höntzsch proximity switches

Measurements at temperatures for which short-time operation is specified should only last for a few minutes. If this advice is adhered to, then the measuring probe cannot be damaged.

In the case of vt-sensors the working temperature range corresponds to the temperature measurement range.

Continuous working temperature range at temperatures higher than +125 °C or rather lower than -30 °C is moreover achieved by the active electronic components of the proximity switch = cable amplifier being positioned at a distance from areas with high/low temperatures. The cable amplifier can be found in a bush on the sensor connection cable or in the connection housing. Permissible temperatures at the cable amplifier: -30... +125 °C. In order to keep to these regulations, in particular cases ambient temperature, the heat flow above the sensor connection cable or probe tube up to connection housing as well as eventual thermal radiation must be paid attention to.

A cable length of 0.5 m is sufficient between the place at which a sensor connection cable comes out of a zone of for example +350 °C up to the bush with cable amplifier, when the cable amplifier is in surroundings with temperatures of no more than +40 °C. Neither liquid nor aggressive gas must be allowed to penetrate the cable amplifier.



ZS25/30-200 with lapped flange

Cable amplifier in a bush

Cable length up to cable amplifier
Standard length 2 m. For example, the sensor identification 260-2 means that the sensor is resistant up to +260 °C and the length of cable between sensor and bush with cable amplifier is 2 m.

Type of cable up to cable amplifier
This connection cable is TEFLON-coated for +260 °C sensors. The connection cable for the 350 °C ... 450 °C sensors is temperature resistant up to 450 °C. This cable withstands atmospheric influences; it is resistant to almost all chemical substances and is corrosion-proof. The connection cable for the 500 °C sensors is temperature resistant up to 600 °C. This cable is not moisture-proof.

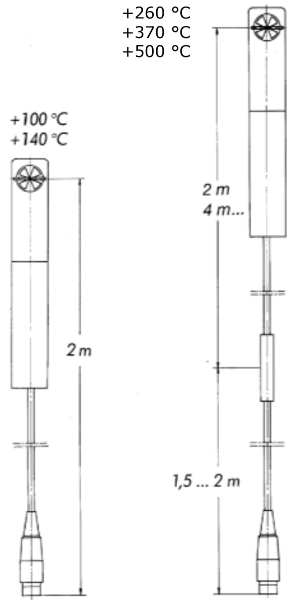
Warning: frequent movement and bending of cable for 350 °C should be avoided. Observe large bending radius whenever possible.

Cable after cable amplifier
Standard length 1.5...2 m. SILICONE-coated and temperature resistant up to +125 °C. Sensors for +100 °C and +140 °C also have as standard a 2 m long SILICONE-coated connection cable for max. +125 °C.

When ordering please name the accompanying evaluation unit so that the appropriate connector plug /connection identification can be supplied.

Maximum working pressure

p0 sensor is not tight, not pressure resistant
p... sensor is structurally designed for pressures above atmospheric of up to ...bar (1 bar = 100 kPa). When necessary a leak test should be carried out.



Seal materials
are, depending on sensor, VITON®, PFTE / TEFLON®, pure graphite. KALREZ® or SILICONE on request.
Working temperature range of the seal materials:

VITON®	-20°C ... +240 °C	**C**
	-25°C ... +240 °C	**S**
KALREZ®	0°C ... +300 °C	**C**
PTFE/ TEFLON®	-40°C ... +260 °C	**C**
	-40°C ... +300 °C	**S**
Pure graphite	-200 °C ... +600 °C	**C**

C : continuous operation,
S : short-time operation
® : DuPont trademark

Protective system

Explosion protection Ex
v-sensors FA and FAR are also available in protective system Ex ia IIC T6, electric circuit intrinsically safe.

Protection against medium
Neither liquids nor corrosive gases must be allowed to penetrate the sensor from the cable connection side. In this respect please enquire about protected sensors, e. g. for use under water, before ordering.

Probe extensions
are used for deeper insertion of probes in mediums, when the standard probe length is not sufficient for the required insertion depth. Extendable cylinder probes have, for this purpose, a connection thread onto which extension tubes can be fitted which are also suited for feed-through of sensor connection cable, if necessary bush with cable amplifier and connector plug.

In addition they are protected against mediums - water or corrosive gases - which should not be allowed to penetrate the sensor from the cable connection side. Probe tubes are suitable for use with probe guide pieces, even in corrosive mediums or at high temperatures and offer a mechanically steady probe support.

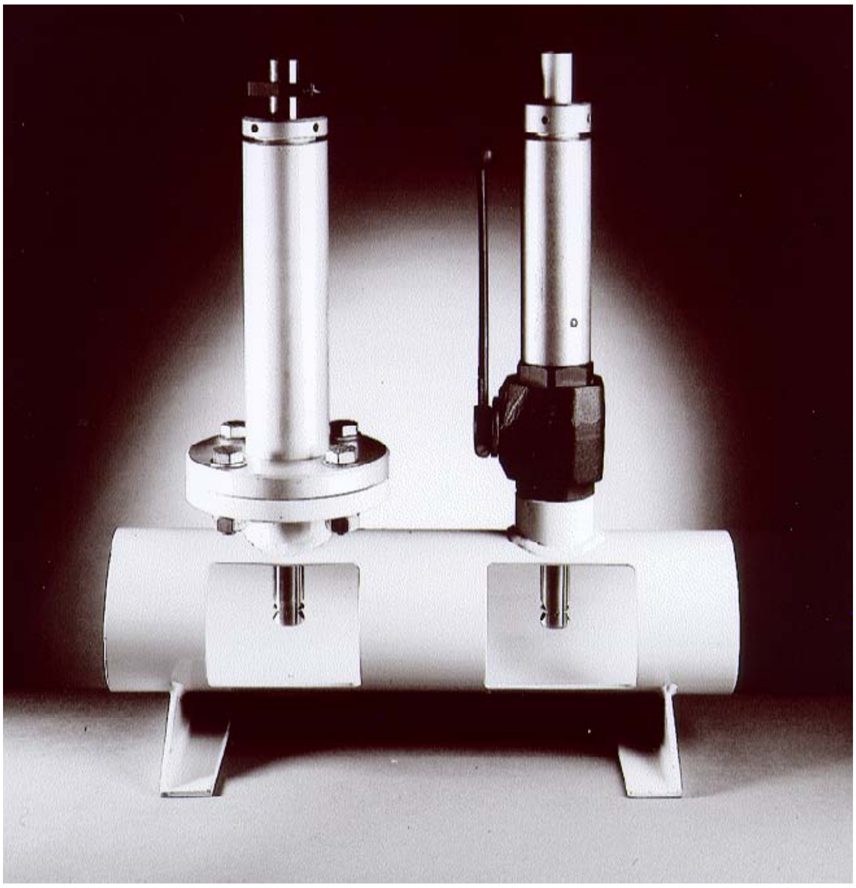
Probe tubes made of titanium can be manufactured only together with a complete order with the same diameter. The diameter of these tubes may differ slightly from the respective nominal diameter. Probe guide pieces must be manufactured to match these probe tubes. The mechanical burden of the tubes on the connection threads (burden due to weight of probe and extension tube as well as force of the flowing medium) limits the number of extension tubes which can be screwed together.

Besides this, the sensor must not be allowed to undergo any vibration. For the most cases we recommend that not more than 4 extension tubes of 350 mm or 400 mm in length or rather 2 extension tubes of 1000 mm in length should be screwed together without additional support.

Probe guide pieces SF
are used for inserting and retracting probes in and out of pipelines and ducts. The fixing device of the probe tube is to be chosen taking the temperature and pressure operating conditions into consideration.

Seal materials
on the screw fittings of extension tubes. The tube walls of the extension tubes are as thin as possible. As a result, the sealing functions of the normally used VITON O-rings at high temperatures can only be guaranteed up to a certain limit. Extension tubes with pure graphite seals fulfill high requirements of tightness and corrosion resistance.
Besides this they are also temperature resistant between -200 °C ... +600 °C.

PTFE / TEFLON and KALREZ O-rings on request. PTFE O-rings can only be recommended if the corrosion resistance of VITON should not be adequate and the temperatures are not too high. KALREZ O-rings are temperature resistant for certain mediums, according to DuPont, in a range from 0 °C ... +300 °C.



Probe guide piece with clamp

Measurement uncertainty
Vane wheel probes ZS, TS, ZSR and TSR are specified with a measurement uncertainty of <1.5 % of measured value + 0.5 % of terminal value.

Validity of this measurement uncertainty specification is limited for FT sensors and sensors with a measuring range terminal value value greater than 60 m/s.

For these sensors, a linearising of characteristics with pairs of values is essential in order to achieve the lowest possible measurement uncertainty. An application with the standard characteristic (available in each evaluation unit with FA-input) is possible, but results in an uncertainty of <5% of measured value + 2 % of terminal value.

Coefficient / Profile factor
In larger free jet as well as in larger ducts and measuring tubes the local velocity v_p will be displayed with PF = 1.000. PF is also used to calculate the local velocity vp to the average velocity vm in a measurement cross-section:

$$v_m = v_p \cdot PF$$

When measuring with cylinder probes in circular measurement cross-sections with interior diameter Di

- centric positioning of the sensor
- irrotational flow
- developed flow profile (measurement cross-section so chosen, that 20 Di straight, unhindered input section amount to 10 Di straight, unhindered output section)

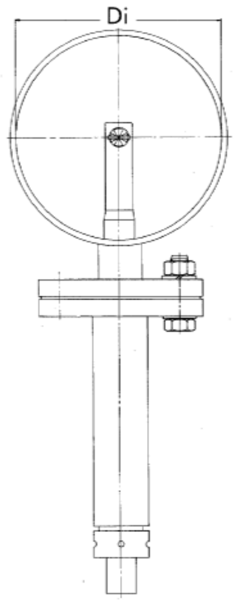
following coefficients are to be taken as a basis:

Di	PF (ZS16)	PF (ZS18)
40	0.914	0.898
50	0.933	0.916
60	0.950	0.932
70	0.964	0.948
80	0.976	0.962
90	0.987	0.975
100	0.994	0.986
120	1.004	1.004
170	1.008	1.021
180	1.008	1.021
220	1.008	1.021
...	1.008	1.021

Di	PF (ZS25, ZS30)
50	0.735
60	0.760
70	0.784
80	0.807
90	0.829
100	0.849
120	0.882
170	0.935
180	0.945
220	0.955
...	0.955

If these conditions for application of the coefficients are not prevailing then a pre-examination of flow should be carried out in the greater measurement cross section with PF = 1.000. As a result of this examination an optimal measurement point is to be determined and the corresponding coefficient is to be set.

For further information please consult VDI/VDE 2640, “Measurement of velocity area methods in flow cross-sections”.



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Subject to alteration