AFLOWT

ULTRASONIC FLOW METER

AFLOWT UF

(with cut-in converters)
VERSION UF-5xx d

INSTALLATION MANUAL

ISO 9001:2015

CONTENTS

The present manual covers procedures for on-site mounting and dismounting of AFLOWT UF ultrasonic flowmeters of UF-510 d, -520 d, -522 d, -530 d, -540 d, -542 d, -544 d models. In the course of work, also refer to manuals "ULTRASONIC FLOW METER AFLOWT UF (with cut-in converters). Version UF-5xx d. Operation manual" part 1 and 2.

LIST OF ABBREVIATIONS

CS	- Secondary measuring converter
DN	- Nominal diameter
MC	- Measuring cut
CP	- Primary converter
PEA	- Electro-acoustic converter

NOTE. Words in the text marked in bold, for example, **Settings** correspond to the items displayed on the flowmeter's screen.

CAUTION! It is highly recommended to study the Operation Manual before starting to use the flowmeter.

1. SAFETY INSTRUCTIONS

1.1. The flowmeter should be mounted (dismounted) by the qualified technical staff:

- Certified for performing work of this type on the site where the flowmeter is installed and authorized by the manufacturer
- Authorized to work with electrical installations up to 1000 V
- Upon reading all the instructions for the flowmeter and the auxiliary equipment used for mounting and dismounting.

1.2. When working with the flowmeter, the dangerous factors are as follows:

- AC voltage (RMS value up to 264 V, frequency 50 Hz)
- Pipeline pressure (up to 2.5 MPa)
- Fluid temperature (up to 160 °C)
- Other installation site-specific factors.

1.3. Prior to performance of works, make sure with the use of appropriate equipment that no dangerous AC/DC voltage which may cause injury or death is applied to pipeline section to be worked on.

1.4. In the course of mounting, start-up, commissioning and dismounting works, it is strictly forbidden:

- To make connections to the flowmeter, switch over modes and replace electronic components when the flowmeter is powered up
- To use defective electronic devices and electric tools or use them without proper grounding.

1.5. Prior to connection of the flowmeter to the electric mains the CS module is to be connected to the protective earthing trunk line (neutral earthing).

CAUTION! Prior to connecting the protective earthing trunk line make sure that the voltage is off.

2. MOUNTING PREPARATION

2.1. For on-site mounting of the flowmeter the following conditions should be met:

- A free pipeline section should be available for mounting of the flow sensor (CP)
- Availability of straight pipe runs of appropriate length upstream and downstream the flow sensor
- A free pipeline section for mounting of the secondary measuring converter (CS).

2.2. The flowmeter should be transported packed in the manufacturer's box.

After the flowmeter has been moved to the mounting location from a cold environment into a warm one (with ambient temperature above zero), it shall be left to stand in the manufacturer's box for at least 3 hours to make sure that no condensation remains inside.

When unpacking the flowmeter, check that the delivery package contains all items specified in the Passport.

3. MOUNTING REQUIREMENTS

3.1. Requirements for Mounting the Primary converter

3.1.1. General Requirements.

3.1.1.1. The following requirements should be observed on-site of CP mounting:

- Liquid pressure in the pipeline and operation conditions must not be of values that may facilitate gas (air) release and/or accumulation
- When the flowmeter is operated, the pipeline should be fully filled with liquid
- Flow turbulence and pulsations are minimal.

The CP can be mounted into the pipeline horizontally, vertically, or obliquely (Fig.1). The CP should not be placed at the upper point of the pipeline or in the open-ended pipeline. The recommended location (if applicable) is at the lower or uprising pipeline section.

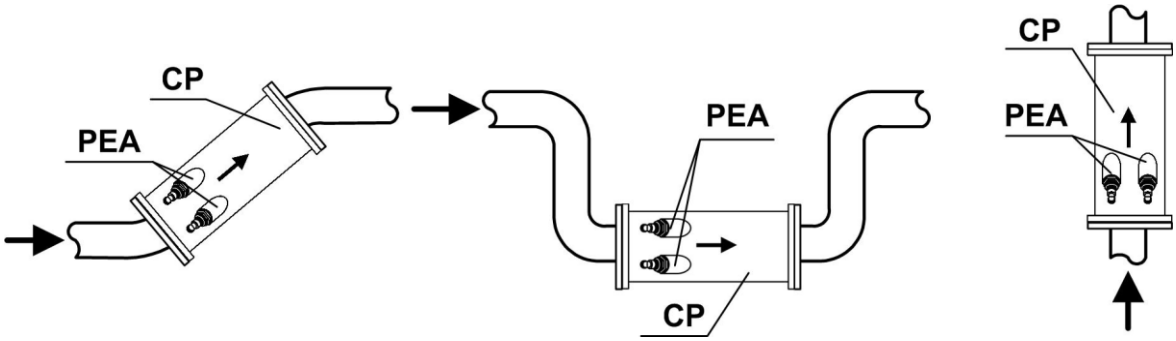


Fig.1. Recommended locations of the CP.

3.1.1.2. The difference in the internal diameters of the pipeline and a measuring cut (MS) of the CP at a link up point should not exceed 0.05 DN for straight measuring cuts and 0.1 DN for CPs of U-elbow type.

3.1.1.3. It is not recommended to install CP so that the PEA was in the upper or lower circular points of the pipeline cross-section.

3.1.2. Placing the PEA pair for single-beam sounding

CP with mounting PEAs on the diameter should be placed so that the PEA longitudinal axis (the axis that runs through the PEA pair along the pipeline axis) would make an angle with the vertical of $\beta = 45° \pm 10°$ (Fig.2). The PEAs can be mounted horizontally.

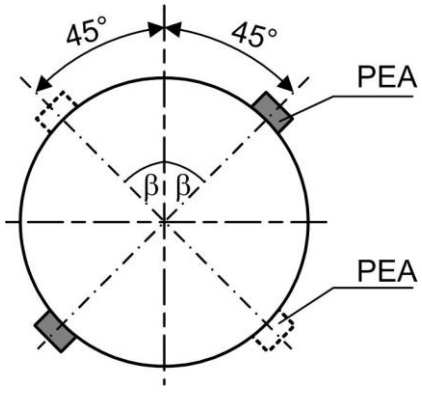
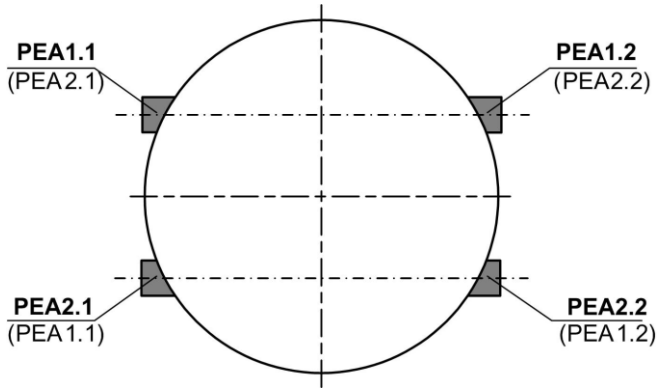


Fig.2. Recommended locations of the PEA pair when mounting "on the diameter" (single-beam sounding).

3.1.3. Placing the PEA pair for two-beam sounding

In case of two-beam scanning, the wetted PEAs should be mounted on the CP along two chords. The CP should be mounted so that the chords are directed horizontally (Fig.3).

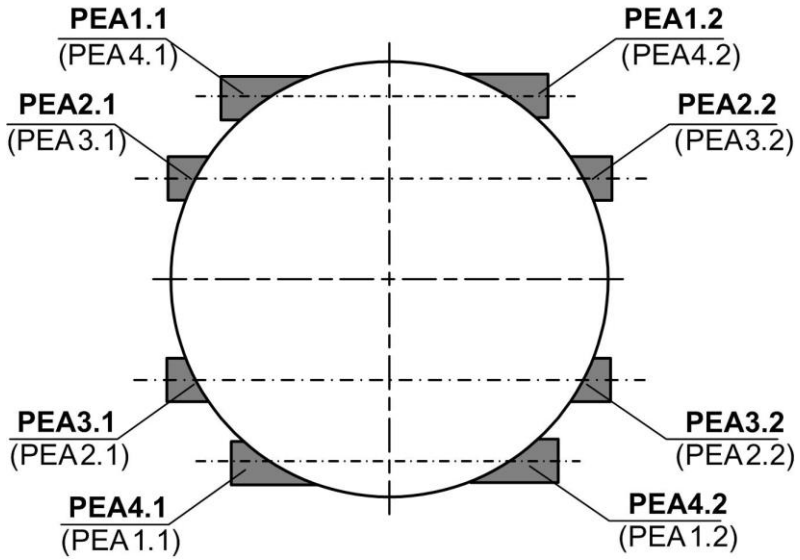


PEA1.1-PEA1.2 pair – 1st beam
PEA2.1-PEA2.2 pair – 2nd beam

Fig.3. Placing the PEA pairs "on chords" (single-beam sounding).

3.1.4. Placing the PEA for four-beam scanning

In case of four-beam scanning, the PEA pairs are mounted on the CP along four chords placed horizontally (Fig.4). The order of beams can be reverse.



PEA1.1-PEA1.2 pair – 1st beam
PEA2.1-PEA2.2 pair – 2nd beam
PEA3.1-PEA3.3 pair – 3rd beam
PEA4.1-PEA4.2 pair– 4th beam

Fig.4. Placing the PEA pairs "on chords" (four-beam sounding).

3.2. Length requirements for straight pipe runs

3.2.1. For proper flowmeter's operation, before the first and the last PEA with respect to the flow direction, there should be straight pipe runs of corresponding length with the DN equal to the DN of the CP. The "type" installation minimum values of relative length of the straight pipe runs for various PEA installation configurations and types of hydraulic resistance are shown in Table A.1 of Appendix A

The length of the straight pipe run L (mm) is calculated as follows:

$$L = N \times DN,$$

where N is the relative length defined in the number of DNs and specified in Table. A.1.

DN is the CP nominal diameter at the mounting location of PEAs, mm.

CAUTION! While measuring the reverse flow, all the PEAs are in upstream position, and the length of the straight pipe runs shall be defined in view of this condition.

3.2.2. In case of mounting the straightening vane into the pipeline before the measuring section (Appendix D), reduction of straight pipe run length is possible at the inlet of the CP up to two times.

3.2.3. For the flowmeter with PEAs mounted along the axis of the straight CP of U-elbow type, the requirements for the length of the straight pipe runs before and after the CP are not specified. The required technical and metrological characteristics of the flowmeter are provided by the CP design of U-elbow type.

3.3. Requirements for placing the Secondary measuring converter

The following conditions should be observed at the site of CS location:

- Operation conditions in accordance with the requirements of the Operation Manual
- Option for connecting the CS to the protective earthing trunk line (neutral earthing)
- Free access to the CS.

4. MOUNTING THE FLOWMETER

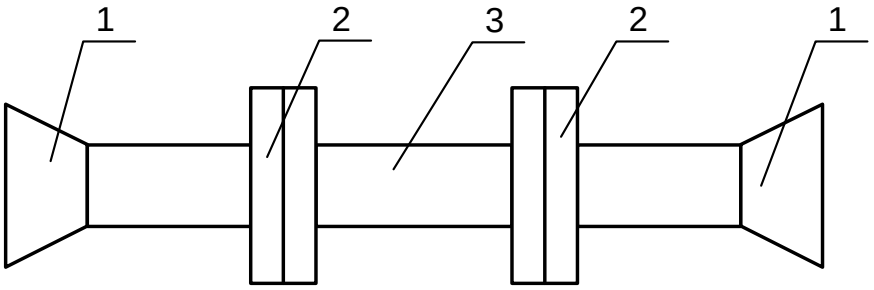
4.1. Mounting the Primary Converter

4.1.1. In order to install the CP into the pipeline the following fittings are to be delivered: companion flanges, pipe adaptors, taper adaptors (if the DN of the primary converter is less than the DN of the pipeline intended for mounting the CP).

4.1.2. Before working on the pipeline at the CP mounting location, fix the pipe sections that may tip out of their axes after cutting the pipeline.

4.1.3. To mount the flanged CP and companion flanges with the welded adaptors in the pipeline, the piping shall be assembled into a single construction. If necessary, the tapered adaptors are welded to the pipe adaptors (Fig.5).

If the hub diameter of the tapered adapter is wider than the mating pipeline diameter, the adapter hub is cut to match the diameter of the pipeline.



1 – taper adaptor; 2 – companion flange with the pipe adaptor; 3 – CP

Fig.5. Assembly-welded structure for mounting the flanged CP into the pipeline.

4.1.4. A pipe run of the required length is cut at the selected liquid-free pipeline section, and a structure with a flanged CP is welded instead. The arrow on the CP shall point to the flow direction or forward flow direction in case of bidirectional measurements.

CAUTION! It is **STRICTLY FORBIDDEN** to throw the CP and hit it while mounting. This can cause damage to the PEAs installed on it.

4.1.5. Components of the assembly-welded structure are welded together and then welded to the pipeline where the flow meter will be installed in compliance with local rules and regulations in force. Alignment of the whole unit and flatness/parallel alignment of the flanges for the CP to be mounted between them must be provided.

4.2. Mounting the Secondary Measuring Converter

Fixing the CS and Secondary power source in vertical plane is performed in accordance with the installation dimensions specified in the Operation Manual.

4.3. Wiring the Flowmeter

4.3.1. When connecting PEAs to the CS, it is necessary to provide that the elements of the measuring channel (PEAs and communications cables) be in correspondence with the characteristics of the channel.

PEA serial numbers with the measurement channel indicated are specified in the flowmeter's Passport.

The communications cable marking for the PEA pair is maintained in similar labels with one or two white transverse bars.

The label color denotes reference to the measurement channel:

- Black – channel 1
- Grey – channel 2
- Blue – channel 3
- Dark blue – channel 4;

One white transverse bar denotes that the communications cable refers to PEA1, two white transverse bars denote that the communications cable refers to PEA2 from the pair of cables labeled in the same color.

The PEA cable connectors and mounting locations can be labelled "PEA1" and "PEA2", which will refer them to the corresponding PEA in the pair.

4.3.2. The flowmeter's power cable, CS-PEA connection cables, and CS-external devices connection cables (if applicable) are laid in accordance with flowmeter's operating conditions.

4.3.3. Communications and network cables are fixed on the wall wherever possible. The network cable is laid separately at a distance of 30 cm as a minimum from other cables. To avoid mechanical damages, it is recommended to place all cables in metal tubes or sleeves.

IT IS FORBIDDEN to lay CS-PEA cables and external signal cables within proximity to power circuits. With presence of high-level electromagnetic interference (for instance, from a thyristor controller), **IT IS FORBIDDEN** to lay the cables without putting them into properly grounded (neutrally earthed) metal tubes or sleeves.

The metal tubes or sleeves shall only be grounded on one side – on the CS side.

4.3.4. It is recommended not to coil the excessive cables.

4.3.5. Prior to connection, cut isolation from cable ends by 5 mm. The cables are directed via cable glands and attached to the connectors according to the Wiring diagram given in Appendix B of Part I of the Operation Manual.

4.3.6 To prevent polyethylene insulation of the CS-PEA communications cable from burning, the cable shall not be in contact with the heated pipeline. The pipeline shall be thermally insulated at the points of contact, or you may use another type of cable.

4.3.7. The RS-output of the flowmeter is connected to an external device. You can use the standard 15 m Null-Modem cable as an RS-232 communications cable.

4.3.8. The need for protective grounding is determined by power supply and environment conditions under which the flow meter is operated.

The protective grounding and earthing device should correspond to the rules on design of power electric installations. Do not use the lightning protection system for grounding since in could result in device's failure.

As a grounding wire, you must use a copper ground wire between the flowmeter and grounding device. If mechanically protected, its cross-section must be minimum 2.5 mm^2. Minimum 4 mm^2 cross-section is required for installations without protection.

The grounding conductor is connected to the earthing terminal of the CS.

5. START-UP PROCEDURE

5.1. Before start-up you should check that flowmeter's operation parameters specified in the Passport correspond to data entered in the flowmeter memory.

5.2. Parameters of PEA are entered according to the Operation Manual, Sections 2.1 Part II.

5.3. Processing of measurement results is adjusted according to the Operation Manual, Section 2.4, Part II.

5.4. External devices (analog recorder, modem, etc.) are connected to the flowmeter, communication system and flowmeter outputs are adjusted according to the instructions given in Part II of the Operation Manual.

5.5. Current date and time are checked and set if necessary (see Section 2.5, Part II of the Operation Manual).

5.6. The device should be switched into the OPERATION mode (a jumper should be removed from terminal J4). Terminal J4 should be sealed. If necessary, two fixing screws are sealed from the front panel side.

If the parameters are set correctly, the flowmeter displays flowrate measurement results.

5.7. Requirements for mounting location and operating conditions specified in this operational documentation are based on the most typical factors affecting flowmeter performance.

The external factors that cannot be foreseen, evaluated or tested by the manufacturer during designing may exist or appear on site.

In this case such factors should be eliminated or flowmeter should be placed in other location.

6. DISMOUNTING

6.1. To dismount the flowmeter, do the following:

- Switch off the flowmeter
- Before dismounting the CP, cut off liquid flow in the pipeline section where they are located, ensure there is no pressure in the pipeline and drain the liquid
- Disconnect cables leading to the CS (PEAs)
- Dismount the CP and CS.

6.2. Before dispatching the flowmeter with the CP for calibration or repair, clean the measuring cuts and emitting surfaces of PEAs from sediment and liquid residues after dismounting.

APPENDIX A. Relative length of straight pipe runs

Table A.1 shows minimum values of relative length of pipeline straight runs for type installation, different scheme of sounding depending on local hydraulic resistance types.

Table A.1

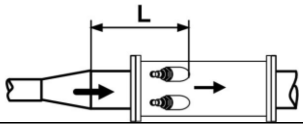
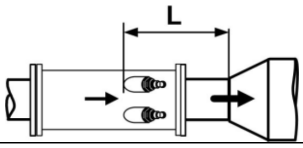
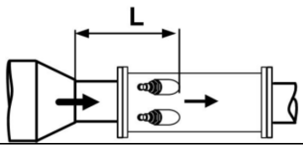
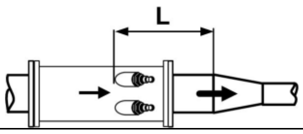
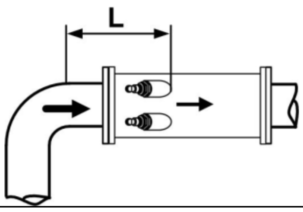
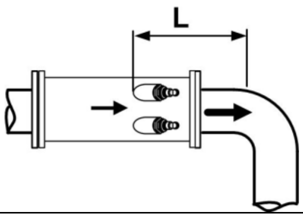
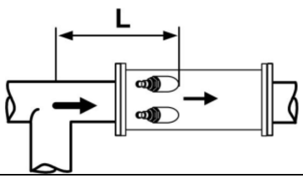
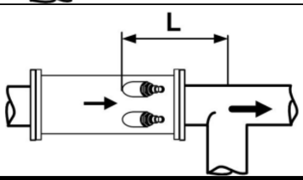
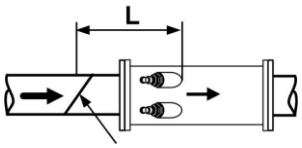
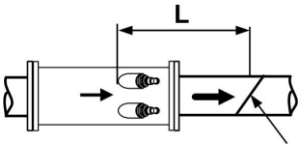
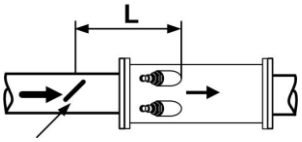
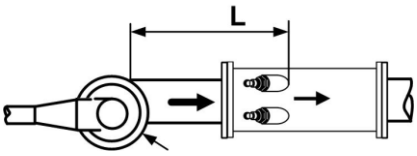
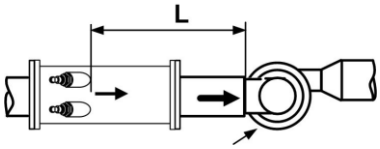
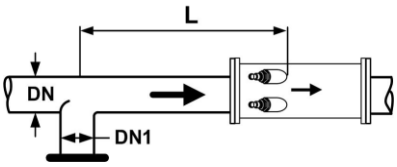
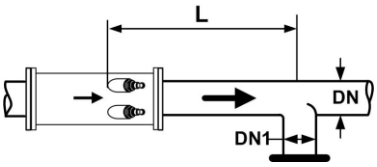
Type of local hydraulic resistance	Relative length of a straight run, N, minimum		
	single-beam "diametral" sounding	two-beam "chord" sounding	four-beam "chord" sounding
1	2	3	4
	10	10	10
	3	1	1
	10	10	10
	3	1	1
	10	10	10
	3	1	1
	10	10	10
	10	10	10

Table A.1 (cont'd)

1	2	3	4
 Control valve	30	15	15
 Control valve	3	2	2
 Not fully-open ball valve	10	10	10
 Pump	30	30	30
 Pump	3	3	3
 DN1 / DN > 0.1	10	10	10
 DN1 / DN > 0.1	3	1	1

In case of various types of hydraulic resistance in the pipeline, the length of a pipeline straight run related to the resistance nearest to the PEAs should be no less than the value specified in the table, and the distance from the PEAs to the other hydraulic resistances should be no less than the value specified in the table for hydraulic resistance of this type.

APPENDIX B. Report on mounting and start-up procedure

(recommended)

REPORT
on mounting and start-up procedure

for AFLOWT UF flowmeter, serial No. _____(sheet __ of ____)
UF-5__ d design version, channel No. _____

Beam 1 – PEA1.1 No. _____ / PEA1.2 No. _____ ;
Beam 2 – PEA2.1 No. _____ / PEA2.2 No. _____ ;
Beam 3 – PEA3.1 No. _____ / PEA3.2 No. _____ ;
Beam 4 – PEA4.1 No. _____ / PEA4.2 No. _____ ;

1. Site

_____
organization name, postal address, tel/fax

_____

2. Site characteristics: DN of measuring cut _____ mm;
PEA installation diagram _____ ; negative flow _____
Type of sounding _____, beam

Table B.1

	Type of hydraulic resistance	Length of a straight run, m
To PEA1.1, 2.1, 3.1, 4.1		
After PEA1.2, 2.2, 3.2, 4.2		

3. Parameters of the medium.

3.1. Kind of liquid _____

3.2. Temperature of liquid: maximum _____ °C
minimum _____ °C
average 0.5 (t_{max} + t_{min}) = _____ °C

3.3. Kinematic viscosity ratio of liquid, ν = _____ m^2/s

4. Length of CS-PEA communications cables

Table B.2

Parameter	Parameter value in the channel with PEAs			
	PEA1.1-PEA1.2	PEA2.1-PEA2.2	PEA3.1-PEA3.2	PEA4.1-PEA4.2
Length of CS-PEA communications cables, m				

5. Measurement channel parameters

5.1. Zero offset, dT_0 = _____ ms

5.2. Additional delay, P_{add} = _____ ms

Note:

_____

_____

Representative of start-up organization

_____ / _____ /

Signature name and initials

" ___ " _____ 20__

Customer representative

_____ / _____ /

Signature name and initials

" ___ " _____ 20__

Calibrator

_____ / _____ /

Signature name and initials

LS " ___ " _____ 20__

APPENDIX C. Kinematic viscosity ratio of water

Table C.1

t, °C	$\nu \cdot 10^{-6}$	t, °C	$\nu \cdot 10^{-6}$	t, °C	$\nu \cdot 10^{-6}$	t, °C	$\nu \cdot 10^{-6}$	t, °C	$\nu \cdot 10^{-6}$
0.00	1.7905	35.00	0.7247	70.00	0.4137	105.0	0.2807	140.0	0.2125
1.00	1.7307	36.00	0.7107	71.00	0.4083	106.0	0.2781	141.0	0.2111
2.00	1.6738	37.00	0.6972	72.00	0.4030	107.0	0.2756	142.0	0.2097
3.00	1.6198	38.00	0.6841	73.00	0.3979	108.0	0.2731	143.0	0.2083
4.00	1.5684	39.00	0.6714	74.00	0.3929	109.0	0.2707	144.0	0.2070
5.00	1.5196	40.00	0.6591	75.00	0.3880	110.0	0.2683	145.0	0.2056
6.00	1.4731	41.00	0.6472	76.00	0.3832	111.0	0.2659	146.0	0.2043
7.00	1.4289	42.00	0.6356	77.00	0.3785	112.0	0.2636	147.0	0.2030
8.00	1.3867	43.00	0.6244	78.00	0.3740	113.0	0.2613	148.0	0.2017
9.00	1.3464	44.00	0.6135	79.00	0.3695	114.0	0.2591	149.0	0.2005
10.00	1.3080	45.00	0.6030	80.00	0.3651	115.0	0.2569	150.0	0.1992
11.00	1.2713	46.00	0.5927	81.00	0.3608	116.0	0.2547	151.0	0.1980
12.00	1.2363	47.00	0.5827	82.00	0.3566	117.0	0.2526	152.0	0.1968
13.00	1.2028	48.00	0.5730	83.00	0.3525	118.0	0.2505	153.0	0.1956
14.00	1.1708	49.00	0.5636	84.00	0.3485	119.0	0.2485	154.0	0.1945
15.00	1.1401	50.00	0.5544	85.00	0.3446	120.0	0.2465	155.0	0.1933
16.00	1.1107	51.00	0.5455	86.00	0.3407	121.0	0.2445	156.0	0.1922
17.00	1.0825	52.00	0.5368	87.00	0.3370	122.0	0.2425	157.0	0.1911
18.00	1.0555	53.00	0.5284	88.00	0.3333	123.0	0.2406	158.0	0.1900
19.00	1.0295	54.00	0.5201	89.00	0.3297	124.0	0.2387	159.0	0.1889
20.00	1.004	55.00	0.5121	90.00	0.3261	125.0	0.2369	160.0	0.1878
21.00	0.9807	56.00	0.5043	91.00	0.3227	126.0	0.2351	161.0	0.1868
22.00	0.9577	57.00	0.4967	92.00	0.3193	127.0	0.2333	162.0	0.1858
23.00	0.9356	58.00	0.4893	93.00	0.3159	128.0	0.2315	163.0	0.1847
24.00	0.9143	59.00	0.4821	94.00	0.3127	129.0	0.2298	164.0	0.1837
25.00	0.8938	60.00	0.4751	95.00	0.3095	130.0	0.2281	165.0	0.1828
26.00	0.8741	61.00	0.4683	96.00	0.3064	131.0	0.2264	166.0	0.1818
27.00	0.8551	62.00	0.4616	97.00	0.3033	132.0	0.2248	167.0	0.1808
28.00	0.8367	63.00	0.4551	98.00	0.3003	133.0	0.2232	168.0	0.1799
29.00	0.8190	64.00	0.4487	99.00	0.2973	134.0	0.2216		
30.00	0.8019	65.00	0.4425	100.0	0.2944	135.0	0.2200		
31.00	0.7854	66.00	0.4365	101.0	0.2916	136.0	0.2185		
32.00	0.7694	67.00	0.4305	102.0	0.2888	137.0	0.2169		
33.00	0.7540	68.00	0.4248	103.0	0.2861	138.0	0.2155		
34.00	0.7391	69.00	0.4191	104.0	0.2834	139.0	0.2140		

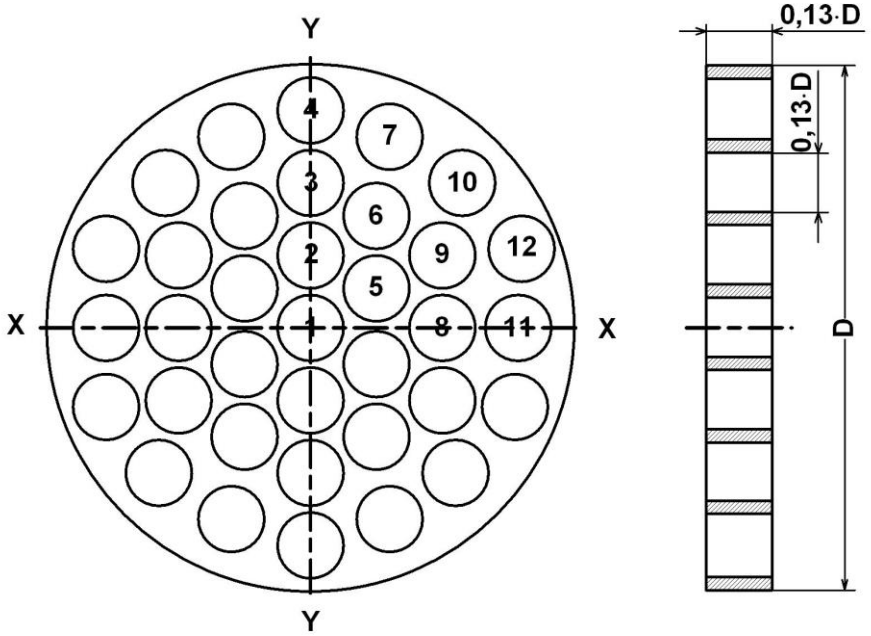
t – water temperature, °C

ν – kinematic viscosity ratio of water, m^2/s

$$1\ cSt = 1 \cdot 10^{-6}\ m^2/s$$

APPENDIX D. Straightening vane design

1. Fig.D.1 shows the design of type A straightening vane that is manufactured according to the following rules:
   a) straightening vane plate thickness is equal to the diameter of the holes; depending on material, the plate can be made of one or several sheets
   b) all the diameters of the holes in the plate are equal
   c) holes are spread more thickly in the center of the plate, and more rarely – at the periphery
   d) holes have chamfers from the flow inlet site.



D – internal diameter of the pipeline where the straightening vane is inserted.

Fig.D.1. Design of type A flow straightening vane.

2. To lower weight and material quantity a type B straightening vane (Fig. D.2) can be used, it is manufactured according to the following rules:
   a) tubes are inserted in the plate holes
   b) tube length is equal to tube diameter
   c) all the diameters of the holes in the plate are equal
   d) holes are spread more thickly in the center of the plate, and more rarely – at the periphery
   e) holes have chamfers from the flow inlet site.

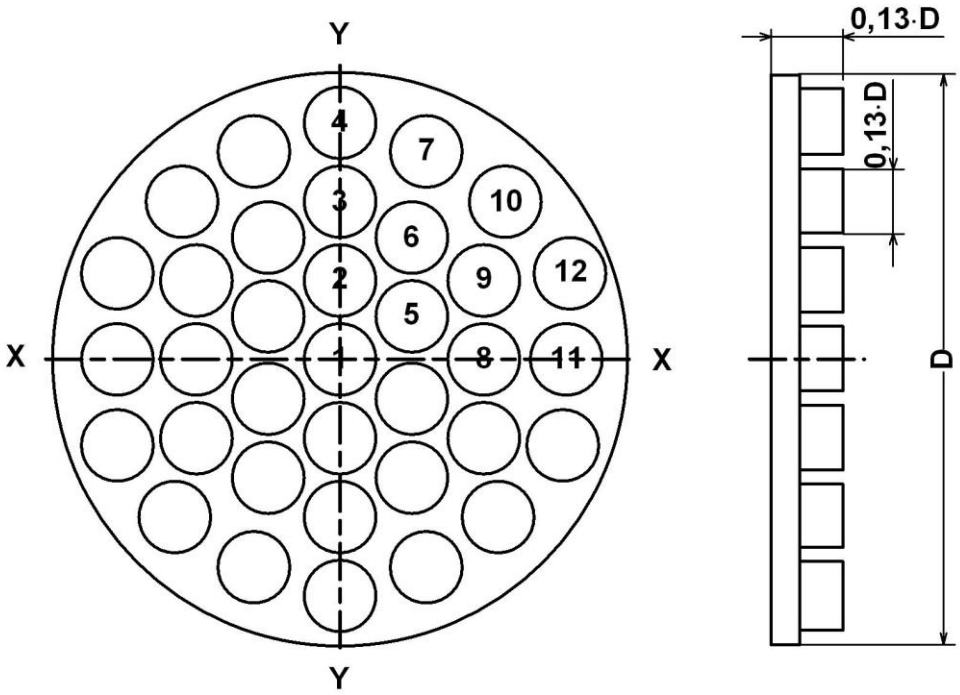


Fig.D.2. Design of type B flow straightening vane.

3. Hole marking in straightening vanes is shown in Table D.1.

Table D.1. Coordinates of the holes in straightening vanes of A and B type (D – pipeline internal diameter)

Item No.	X axis	Y axis
1	0	0
2	0	0.142·D
3	0	0.283·D
4	0	0.423·D
5	0.129·D	0.078·D
6	0.134·D	0.225·D
7	0.156·D	0.381·D
8	0.252·D	0
9	0.255·D	0.146·D
10	0.288·D	0.288·D
11	0.396·D	0
12	0.400·D	0.151·D

4. The straightening vane is installed in the pipeline at a distance of 1÷2 pipeline's DN from the last source of hydraulic resistance with respect to the flow direction. When installing the straightening vane, the length of a straight run before the PEA is determined as the distance from the source of hydraulic resistance to the PEA.