MIVI

Technical Manual

Process tuning rod probe for viscosity, density and temperature measurements

Original version

REF.: 379/3

SOFRASER
Pioneering viscometry since 1972

IMPORTANT

1° READ CAREFULLY THIS MANUAL

2° THE OFFSET ADJUSTMENT IN THE AIR MUST BE THE FIRST TASK COMPLETED.

- Clean and dry the vibrating rod of the viscometer in order to make it **neat and dry**;
- Install the sensor on the process and fix it with its screws; these must be tightened at the nominal torque (see § 2.3).
- Be sure the process is empty. The **rod must be vibrating in the air**;
- Power on the device and **wait at least 15 minutes**;
- Follow the instructions given in the electronic device manual delivered with the equipment.

Practical advices and important warnings are also listed in § 2.3.

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1. General presentation

1.1 A two-part equipment

The measuring chain is composed of two inseparable elements: the sensor and the electronic device that controls it (also called transducer). The sensor cannot be used with another electronic device because they are matched together as one vibrating system, and vice versa.

The provided viscosity information is relative. In the same fluid and under the same environmental conditions, the information is the same. For two fluids with a different rheological behaviour, the response can be different. Since it is perfectly repeatable, it just needs a different correlation.

The active part of the sensor is composed of a vibrating rod held in oscillation at resonance frequency (also called tuning-type) by driving magnets. When the rod is immersed into a viscous material, the amplitude of the vibration is dampened. The vibration amplitude and its frequency vary according to the viscosity and the density of the product where the rod is immersed. The sensor receiving coil detects the response and the signal is converted to a viscosity value through the electronic device. The factory calibration is performed with calibrated standard oils.

The transducer acquires the coils' amplitudes and generates various signals. These signals represent the properties being measured. It is also in charge of powering the whole system.

A choice of electronic from simple transducer to touchscreen PLC/HMI provides process information (viscosity, density or temperature) through different kinds of output.

1.2 Checking the equipment after receipt

- First and foremost, check the conformity with the ordered equipment. Mainly check if all the parts needed to mount the equipment are delivered. The parts that are intended to be mounted on the process shall be given to the concerned department, for the installation preparation.
- Place the sensor on a soft foam plate, connect it to the processor (see §3.3) and switch it on. The rod shall start vibrating and the viscosity indication shall be zero or close. When touching the rod, the value shall increase.

In case of a subnormal operation occurs, check as follows:

- power supply, connections, cables;
- vibrating rod's shape and condition (no bending, no damages,…).

1.3 Checking the equipment when placed in the process line

Before starting the process, check that the viscosity information is stable (vibrating rod in the air). If not, check first the strength of the sensor fitting, then rotate the sensor of 90° (4 possible positions). Choose the position where the information is the most stable. Locate this position in order to restore it when the sensor is removed and reinstalled.

Adjust the mounting offset, at room temperature. The rod is vibrating in the air.

When possible, note the viscosity information when a cleaning or rinsing solution is flowing.

If the original calibration is convenient, one of the 2 above mentioned values can be taken as reference for some periodic controls of the equipment. This operation must be done each time in the same conditions (rod in the air, or in the cleaning solution). Such a control can be assimilated to a self-checking. If the original calibration has been modified, the reference values will of course be those obtained with the new calibration.

1.4 Periodic checking

Conformity to regulations relative to Quality Insurance implicates a periodic control of the measuring equipment used in the manufacturing operations, taking in consideration (or correcting) their drift in time.

It is proved that this equipment drift is negligible. However, it is good to check their aspect and their response once a year, at the same time as the other process equipment.

A quick control is possible from time to time, if the sensor active part is in air, or immersed in a cleaning or rinsing solution. As long as these values stay similar, we can say that the sensor operation is right among its whole range (if no intermediate re-programming occurred).

1.4.1 Offset adjustment in air

The clean and dry rod is vibrating in the air since at least half an hour when the offset adjustment is carried out.

The amplitude, corrected with an offset, is shifted so that the viscosity value is 0.00 cP.

The frequency, corrected with an offset, is shifted so that the density value is 0.

1.4.2 Modification of the previous calibration

The paired transducer has been programmed in order to perfectly answer to the customer's needs. These features are noted in the factory specification pages at the end of this document.

At first, be sure that the modification is necessary, and not consecutive of a non-coherent comparative information (different measuring conditions, bad standards, inaccurate or wrong laboratory measurements …). The initial calibration parameters are protected and can only be modified at SOFRASER. For any modification, check in the electronic manual if this operation is allowed or contact your distributor.

1.5 Directives and Standards

1.5.1 European Pressure Equipment Directive and EMC directive

Up to 60 bars, MIVI sensors are in accordance with the article 4.3 of the PED 2014/68/UE. In case of higher pressure, sensors are agreed one by one.

The mounting flange is an accessory to be welded on the process line. It means it cannot be individually certified but has to be certified with the whole process line.

MIVI sensors have been designed and manufactured according to the electrical safety rules.

1.5.2 ATEX and FM flameproof enclosure certification

MIVI sensors are in agreement with 2014/34/EU directive (ATEX) and with FMRC-3615 class (FM) for equipments installed in explosive gas atmospheres or in presence of combustible dust:


II 2G and/or II 2D and/or II 2GD

Ex db IIC T* Gb and/or Ex tb IIIC IP6X T* Db

(*)≤ Tamb≤(*) see tables APPENDIX A

MIVI FM

Class I, Div. 1, Groups A, B, C & D T4A

ambient temp. range: from -20°C to 100°C

Be sure the sensor's certification is in accordance with the security level required on your process location: area classification, equipment group, protection method, gas type, temperature codes…

Area classification and equipment installation rules are detailed into EN 60079-0 / A11 standards and EN 60079-1 standard for gas or EN 60079-31 standard for dust.

To always keep the maximum security level, do not open it. We moreover recommend installing the sensor in a horizontal position or with the cable gland oriented to the ground.

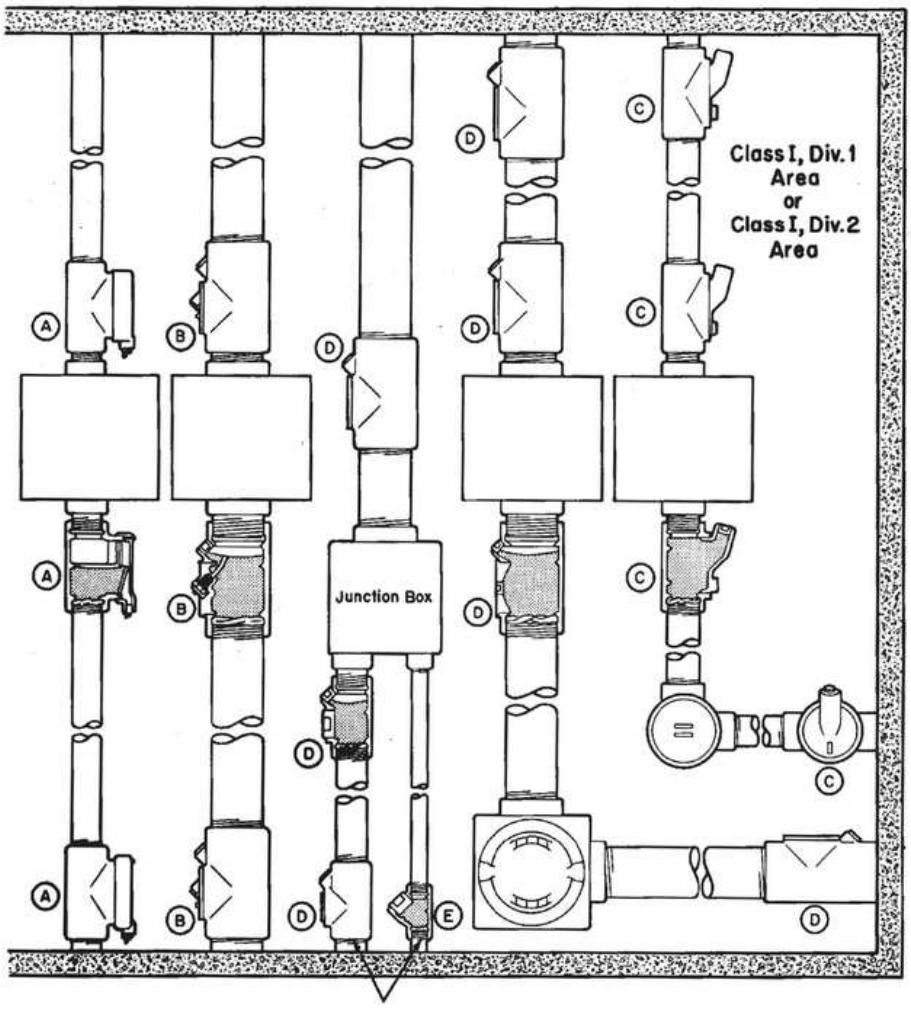
Check as often as possible that the information indicated on the sensor's identification plate is still visible.

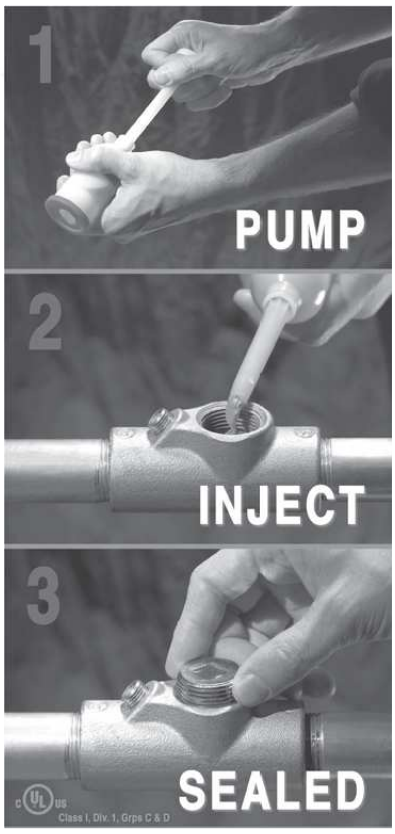
1.5.3 Special design and recommendations for flameproof FM sensors

For FM sensors, it is necessary to add a protection in accordance to the area's risks level. As long as the cable is in a hazardous area, it should be protected as recommended in the 2011 NEC code digest, appendix IV.

Our sensors are certified until the end of the flexible conduit, where we connected a NPT joint. For connecting the sensor in agreement with the class, the installer should follow the instructions given in the 2011 NEC code digest, appendix IV.

This means a conduit seal has to be connected to our NPT joint, according to the examples you have hereunder.





Note: In order to protect the inner part of the sensor (body + flexible conduit) during transportation, we use a black silicone tape to cover the NPT joint's end. This has nothing to do with a FM approved protection and shall be removed while being installed on site.

Hereunder are some features of the conduit seals to be installed.

EYS and EZS sealing fittings:

- Restrict the passage of gases, vapors, or flames from one portion of the electrical installation to another at atmospheric pressure and normal ambient temperatures.
- Limit explosions to the sealed-off enclosure.
- Prevent pre-compression or “pressure piling” in conduit systems.

While not an NEC requirement, many engineers consider it good practice to sectionalize long conduit runs by inserting seals not more than 50 to 100 feet apart, depending on the conduit size, to minimize the effects of “pressure piling.”

Sealing fittings are required:

- at each entrance to an enclosure housing an arcing or sparking device when used in Class I, Division 1 and 2 hazardous locations. To be located as close as practicable and, in no case, more than 18" from such enclosures. The enclosure's installation instructions may specify a distance less than 18".
- at each entrance of 2" size or larger to an enclosure or fitting housing terminals, splices, or taps when used in Class I, Division 1 hazardous locations. To be located as close as practicable and, in no case, more than 18" from such enclosures.
- in conduit systems when leaving the Class I, Division 1 or Division 2 hazardous locations.

where cables terminate at enclosures that are required to be explosion proof.

where cables leave Class I, Division 1 locations and where they leave a Class I, Division 2 location if they are attached to process equipment that may cause a pressure of over 6 in. of water to be exerted on a cable end.

1.5.4 ATEX and IEC Ex intrinsic safety certification

MIVI sensors are in agreement with ATEX directive 2014/34/EU and the associated standards EN 60079-0 (2012) / A11 (2013), EN 60079-11 (2012), but also with the IEC 60079-0 (2011) and the IEC 60079-11:Ed6 (2011).


II 1G Ex ia IIC T6 to T1 Ga

(*)≤ Tamb≤(*) see tables APPENDIX B

Be sure the sensor’s certification is in accordance with the security level required on your process location: area classification, equipment group, protection method, gas type, temperature codes…

To always keep the maximum security level, do not open it. We moreover recommend installing the sensor in a horizontal position or with the cable gland oriented to the ground.

Check as often as possible that the information indicated on the sensor’s identification plate is still visible.

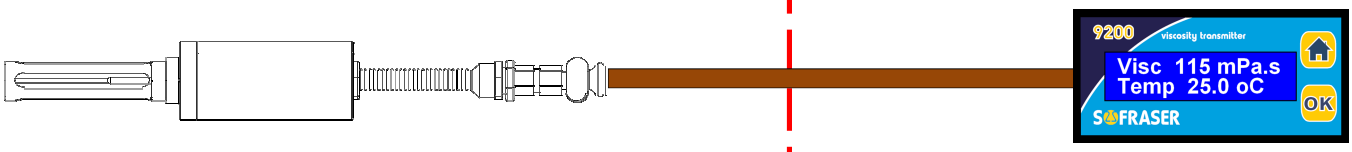
1.5.5 Installation in hazardous area

Here are the possible ways to install the MIVI sensors in a hazardous area.

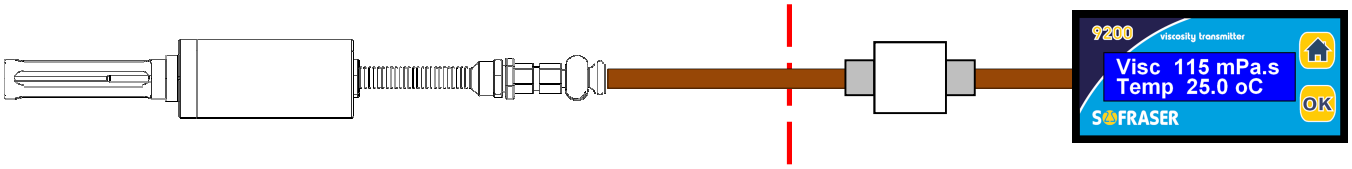
HAZARDOUS AREA | **SAFE AREA**

Ex d : zone 1 or zone 2

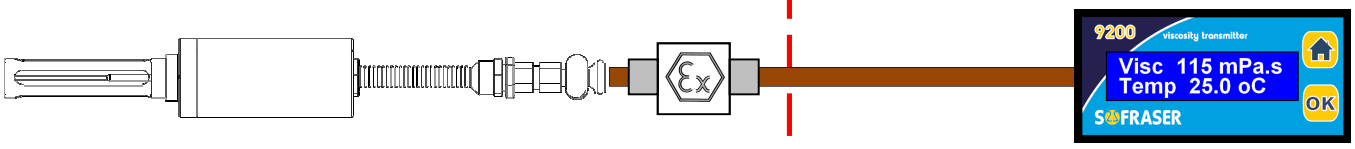
- ***Standard installation for a MIVI-ADF linked to a transducer***



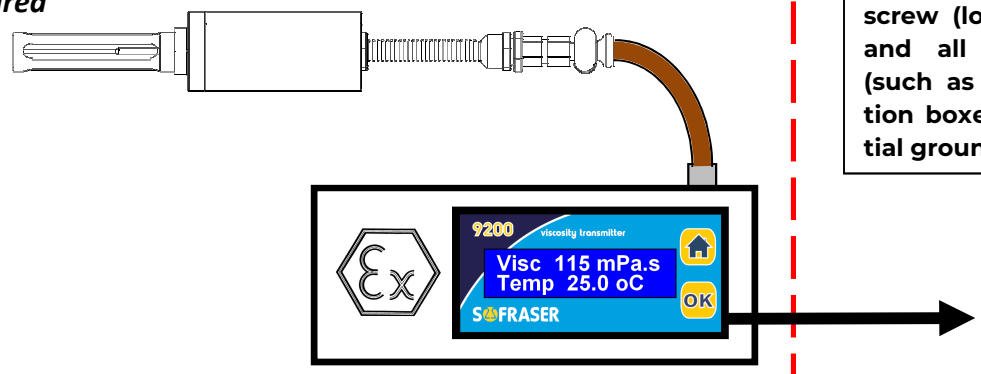
- ***The MIVI-ADF sensor is linked to the transducer with the help of a standard connection box***



- ***The MIVI-ADF sensor is linked to the transducer with the help of an Ex-proof connection box***



- ***The transducer device is installed in the hazardous area with the help of an Ex-proof box and linked to PLC/HMI or SCADA in safe area***



Always connect the sensor's Earth screw (located on top of the body) and all the metallic equipments (such as Ex-proof boxes or connection boxes) to the Earth (equipotential ground of the hazardous site).

Ex i : zone 0, zone 1 or zone 2

- ***Standard installation for a MIVI-SI linked to a transducer through intrinsic safe barriers (one for each coil plus an-other for the PT100) (See Appendix B)***

2. The MIVI sensor

2.1 Various models

The MIVI sensor can be assembled in many different ways to match with the process needed para-meters. Here are the main designs:

- general standard sensor;
- sanitary sensor;
- Ex-proof sensors (ATEX, FM, JIS, KOSHA);
- high pressure sensors (up to 1 000 bar);
- special models, according to the requirements (material and design);
- when required, a temperature probe can be incorporated to the MIVI sensor.

Special sensors can be manufactured on demand. Contact the distributor.

2.2 Sensor installation

It operates in any position, even upside down. Its active part has to be permanently immersed into the fluid (low part of the network or reactor). If the fluid temperature varies widely and fast, choose the upside down or horizontal position, in order to allow proper air convection among the sensor body.

The product-contact part or even the sensor body can be used up to 200 or 300 °C (392 or 572 °F) depending on the sensor category but the temperature at the output of cable must not exceed the temperature written on the marking plate (100 °C (212 °F) by default).

It is screwed to its mounting flange with the help of 4 screws M6X100 (or 8 screws M8 for high pressures). The mounting flange has to be welded close to the device generating the viscosity variations (heater, mixer, reactor, etc…). Retention, high flow velocities, strong vibrations and high magnetic fields have to be avoided.

According to the application, the mounting flange material can be:

- stainless steel Z3CND 17/11-02 (316L);
- carbon steel XC38;
- other materials, according to the requirement.

2.2.1 Elbow mounting

The flange is welded on a right angle tee as indicated in figure 1.

The minimal pipe diameter is of 32 mm.

The flange and the pipe axes have to be superjacent.

The flow direction is as indicated on figure 1 (unless for fibrous fluids where the flow is inverted and the rod protector removed. (see §2.2.5).

A free area of at least 150 mm length is necessary.

Advice: Choose a sensor position in order to assure a permanent fluid renewal and to avoid the existence of “dead zones”.

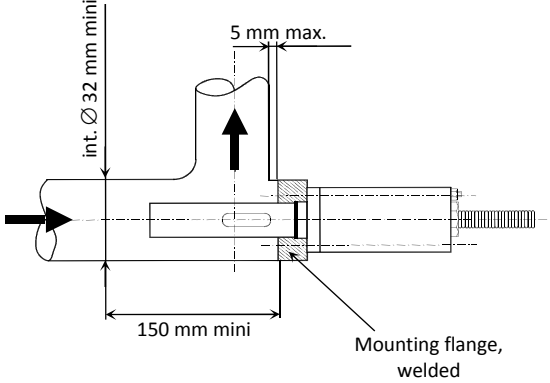


figure 1

2.2.2 Plane side mounting

The flange is welded on a metal plate as indicated on figure 2.

The free area around the vibrating rod has to be at least ∅ 40, 150 mm length.

In order to avoid parasitic vibrations, the plate where the flange is welded must be **thicker than 5 mm**.

Advice: Preferably choose a horizontal position for the rod placement with all the liquid flows turned to the top in order to avoid the apparition of bubbles.

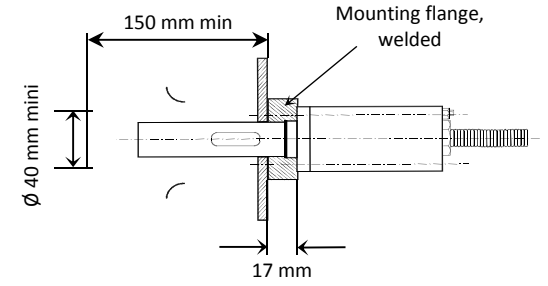


figure 2

2.2.3 Mounting on flow cell, for small flow rates or pilot plant

The small size of the sensing element allows many different mounting features according to the user's requirements. See example on figure 3 for the mounting pot.

on flow cell

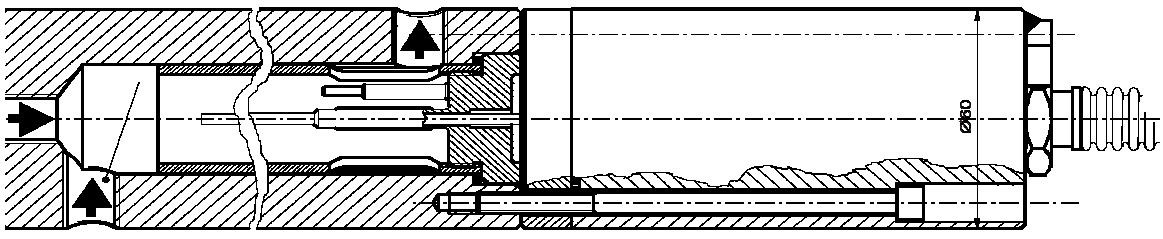


figure 3

2.2.4 Replacement cap

Each mounting flange is provided with an obturation kit (cap, O-ring,4 fixing screws CHC M6 (or 8 fixing screws M8 for high pressure sensor)) that allows the process to work when the sensor has to be removed.

2.3 Practical advices

Torque at the mounting screws: 9 N.m ± 1 at the M6×100 screws (4), or 21 N.m ± 1 at the M8 screws (8 for the high pressure design), or 42 N.m ± 1 at the M10 screws (8 for the very high pressure design).

Tightness is assured by one O-ring (three for the sanitary model). The grounds for the sensor and the electronic devices must be at the same voltage level.

Note: Each sensor is equipped with a flow damper tube in order to stabilize the flow around the vibrating rod. It is advices to keep on the sensor removed unless when the sensor is used in particular conditions: on flow cell mounting, sanitary use, very viscous fluids. The fluid renewal is done through the slits of the damper. At the time of the assembly on the mounting flange and during transport, it also protect the rod from mishandling.

WARNING!
In the case it is necessary to work without the 'flow damper', the mounting / removing of the sensor must be made with precaution, in order to avoid knocking or bending the vibrating rod.
Knocking will have an effect on the calibration when bending may damage seriously the probe.
A ring, with the same dimensions of the protector's base, must be placed on the head of the sensor in order to maintain the O-ring.
As soon as the sensor is removed, screw immediately its protection tube.

IMPORTANT:
- *IP 67 tightness is only secured when firmly screwing the cable gland.*
- *The minimal bending radius at the flexible pipe (electric outlet) is of 100 mm. A shorter radius can generate leakage, then failure.*

2.4 Checking

In case of subnormal operation, check the following points:

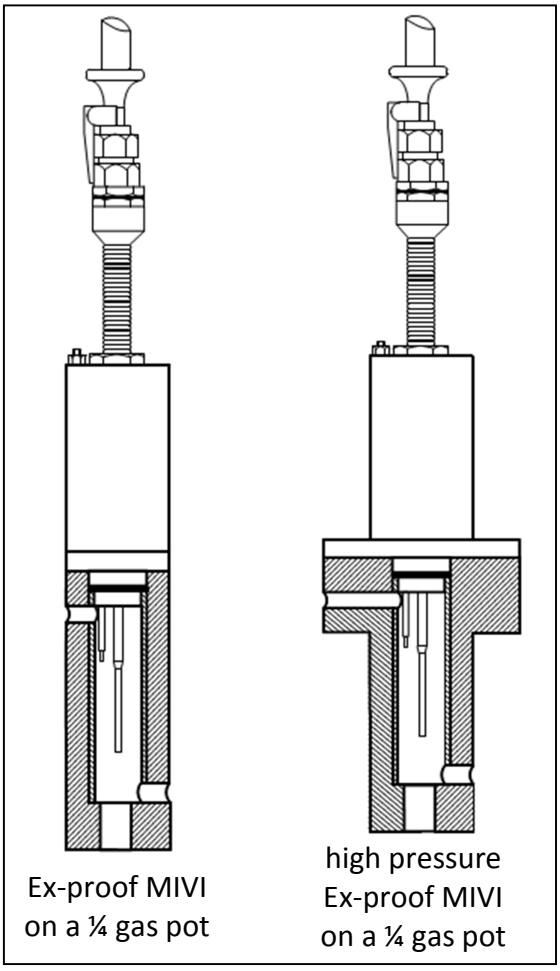
- Electrical connections (connectors, cables, power supply…)
- Remove the sensor from the process and clean it
- Check that the vibrating rod is not bent

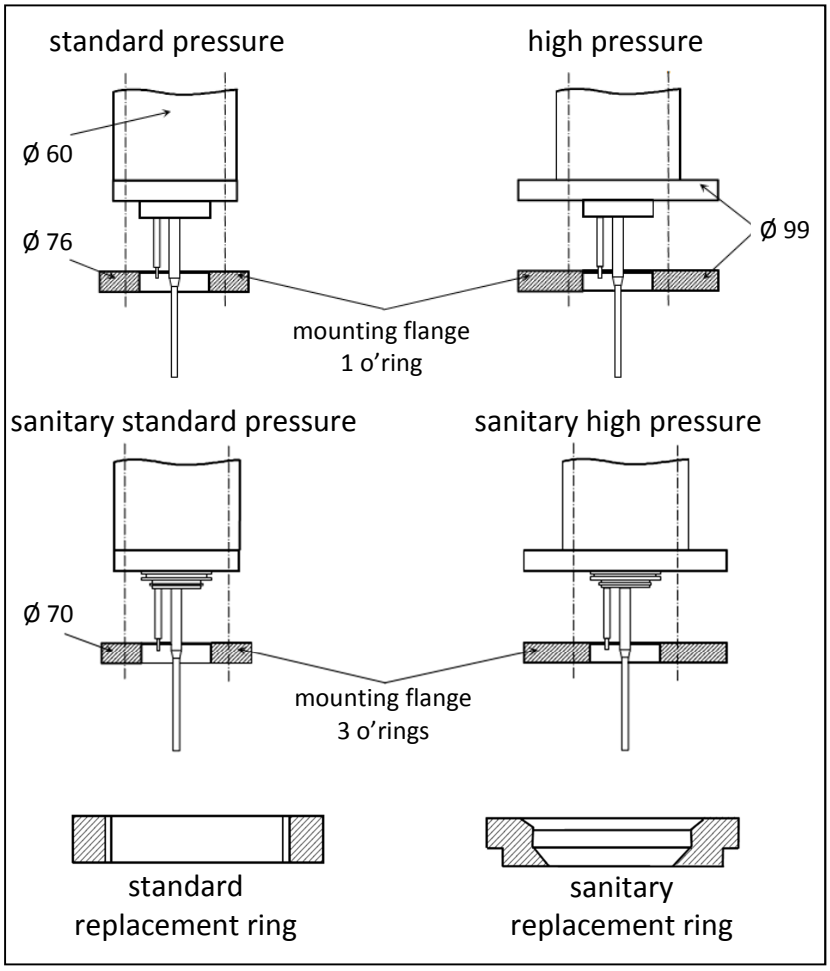
When powered on, check with the finger there is a vibration at the end of the rod. At this moment, the viscosity information (displayed on the electronic device) has to increase.

2.5 Cable wires allocation

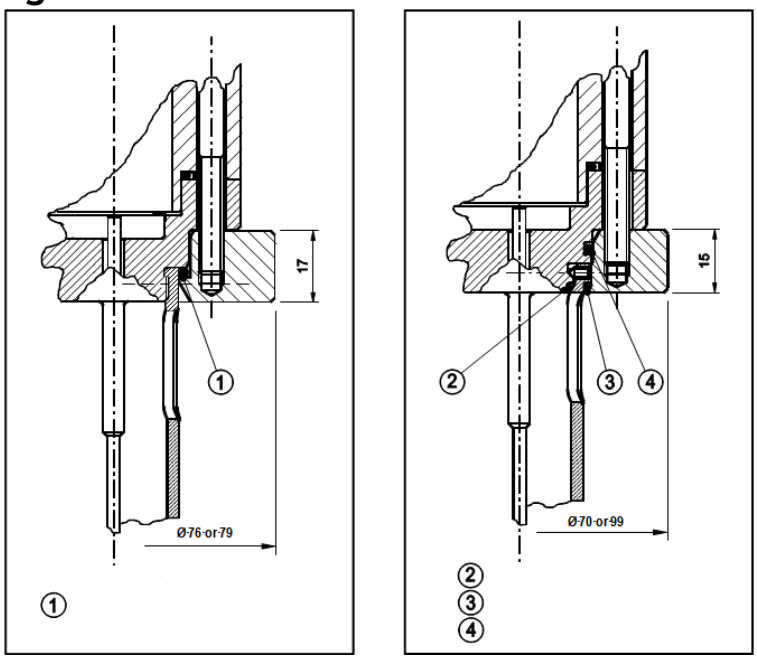
wire	colour	item
A B	blue brown	receiving coil
C D	transparent black	driving coil
E F G	red yellow green	Pt100
N/A	metal	Earth

2.6 Various models and mountings





2.7 Watertightness



standard design sanitary design

Appendix A: SPECIFIC CONDITIONS OF USE FOR MIVI-ADF

Ambient temperature for gas atmosphere:

	Ambient temperature depending of the different parts of this apparatus		
Temperature class	*Main body and sensor part (without pipe)*	*Entry of enclosure (without pipe)*	*Entry of enclosure (with pipe)*
T1	-20°C ≤ Tamb ≤ +300°C	N/A	-20°C ≤ Tamb ≤ +190°C
T2	-20°C ≤ Tamb ≤ +285°C	N/A	
T3	-20°C ≤ Tamb ≤ +190°C	-20°C ≤ Tamb ≤ +190°C	
T4	-20°C ≤ Tamb ≤ +125°C	-20°C ≤ Tamb ≤ +125°C	-20°C ≤ Tamb ≤ +125°C
T5	-20°C ≤ Tamb ≤ +90°C	-20°C ≤ Tamb ≤ +90°C	-20°C ≤ Tamb ≤ +90°C
T6	-20°C ≤ Tamb ≤ +75°C	-20°C ≤ Tamb ≤ +75°C	-20°C ≤ Tamb ≤ +75°C

Ambient temperature for gas and dust atmosphere:

Temperature class		*Ambient temperature depending of the different parts of this apparatus*		
Gas	*Dust*	*Main body and sensor part (without pipe)*	*Entry of enclosure (without pipe)*	*Entry of enclosure (with pipe)*
T1/T2/T3	T180	-17°C ≤ Tamb ≤ +180°C	-17°C ≤ Tamb ≤ +180°C	-17°C ≤ Tamb ≤ +180°C
T4	T125	-17°C ≤ Tamb ≤ +125°C	-17°C ≤ Tamb ≤ +125°C	-17°C ≤ Tamb ≤ +125°C
T5	T90	-17°C ≤ Tamb ≤ +90°C	-17°C ≤ Tamb ≤ +90°C	-17°C ≤ Tamb ≤ +90°C
T6	T75	-17°C ≤ Tamb ≤ +75°C	-17°C ≤ Tamb ≤ +75°C	-17°C ≤ Tamb ≤ +75°C

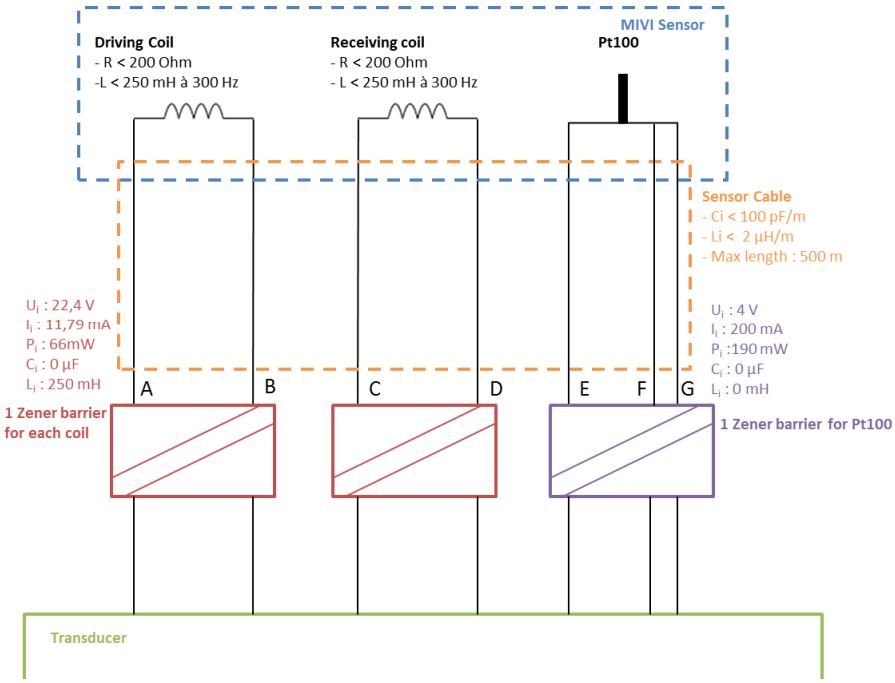
Other specific conditions:

The cable and the cable entry used shall have an operating temperature equal at the maximum ambient temperature at the entry of enclosure.

The entry of this apparatus is equipped with cable gland certified with a protection mode compatible for the intended use.

Appendix B: SPECIFIC CONDITIONS OF USE FOR MIVI-SI

Intrinsically Safe installation



Other specific conditions:

The equipment can be only connected to intrinsically safe certified associate equipment. These combinations must be compatible as regards with the intrinsic safety rules (see electrical parameters).

Approval's ambient temperature limits:

- Sensor body: -40°C to +200°C (200°C version) or -40°C to +300°C (300°C version)

- Cable: -40°C to +100°C

Cable length must be defined in such a way that total capacitance of sensor and cable does not exceed the maximum permitted capacitance of certified power supply.

To avoid the effects of process temperature and other thermal effects, care shall be taken to ensure that the temperature at sensor body and cable parts does not exceed assigned ambient temperature range.

The temperature classification depends on the ambient temperature as follows:

Temperature class	Ambiant temperature	
	With Pt100 sensor	Without Pt100 sensor
T6	-40°C ≤ Tamb ≤ +35°C	-40°C ≤ Tamb ≤ +65°C
T5	-40°C ≤ Tamb ≤ +50°C	-40°C ≤ Tamb ≤ +80°C
T4	-40°C ≤ Tamb ≤ +85°C	-40°C ≤ Tamb ≤ +115°C
T3	-40°C ≤ Tamb ≤ +150°C	-40°C ≤ Tamb ≤ +180°C
T2	-40°C ≤ Tamb ≤ +245°C	-40°C ≤ Tamb ≤ +275°C
T1	-40°C ≤ Tamb ≤ +300°C	-40°C ≤ Tamb ≤ +300°C