Technological characteristics of assembly procedure for fiber-optic sensors of fluid media parameters

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Abstract. Manufacturing and assembly technique for a fiber-optic sensor of fluid flow parameters is discussed in the work, this technique providing the required level of measurement accuracy and operational reliability. Operational sequence for the sensor assembly and optical fibers arrangement is described.

As part of fluid data-measuring systems, particularly within hydraulic engineering structures, life-support systems, petroleum pipeline systems, etc. the measuring instruments for fluid parameters are subject to strict requirements in terms of intrinsic-fire-explosion safety, as well as absence of hazardous electromagnetic effect on living organisms, assembly convenience, measurement accuracy and survival in corrosive environment. Fiber-optic sensors of fluid flow parameters fully comply with the necessary requirements for the abovementioned systems.

The works [1-13] comprise data on fiber-optic sensors of fluid flow parameters (FOSLFP) for the measurement of fluid parameters (velocity, volume). Key feature of a fiber-optic sensor is that the bellows with fixedly attached reflecting plate (top) and cylinder (bottom) acts as a detecting element (figure 1).

Figure 1. Design map of FOSLFP detecting element.
Technological characteristics of manufacturing process have been outlined, including:
1. Assembly of FOSLFP detecting element (DE) (refer to figure 1) includes several stages.

*At the first stage* mirror-bright reflecting plate 2 (refer to figure 3) is attached to bellows cap 1 (refer to figure 2) by means of laser spot welding in such a way so that bellows cap and mirror-bright plate planes form 90° angle. Weld quality and squareness of the planes are verified with micrometer microscope.

*At the second stage* of DE assembly it is necessary to place and secure cylinder 3 (refer to figure 4) on the bellows cap 1 in such a way so that section plane of these parts is parallel with the plane of reflecting plate 2. Cylinder is secured on the bellows cap 1 as follows: cylinder upper part has four males, and bellows cap has four females. Fill the females with cyanoacryl adhesive, fasten cylinder, notice that adhesive protruding out of the bellows cap is permitted for not more than 0.5 mm.

*At the third stage* bellows 4 (refer to figure 5) and bellow cap 1 are connected by means of adhesive or laser pulse welding.
Bellows is secured to the sensor bottom as follows:

Sensor bottom 5 (refer to figure 6) has a male for bellows fastening, which has to be covered with adhesive first, then bellows is placed on top of it subject to the following:

2.1 plane of the lower male is to be exactly parallel with the matchmarks on the sensor bottom (for example, parallel with OX or OY axis);

2.2 plane that has been formed at the junction of bellows cap and cylinder is to be parallel with the fluid flow (for this purpose the cap is engraved with direction of flow).

The sensor bottom 5 is to be secured to the body 6 (refer to figure 7) with screws, observing the conditions as per para. 2.2.

3. Assembly (arrangement) of optical fibers in FOSLFP body is performed as follows:

Optical fiber is put in a metal bushing and sealed with adhesive or sealer compound. Protruding of fiber end out of the bushing is not permitted. Bushings (not shown for clarity) within the sensor body 7 are arranged at 6.2 mm distance of reflecting planes of DE mirror-bright plate. Distance between the bushing end and reflecting planes is monitored with micrometer microscope. Bushings are to be secured with screws. Screws are to be locked by adhesive sealant «Viksint».

Place fibers into the groove within the body, notice that fibers bending radius is not to exceed 10 degrees.

Secure the optical-fiber cable within the sensor body by a bushing. Design map of the sensor with optical fibers is presented in figure 9.
Input optical fiber (IOF) and output optical fiber (OOF) are to be connected to radiation source and detector as follows:

Cavity with optical fibers is to be filled with «VGO» compound. Place cap (refer to figure 8) on the body. Secure cap on the body by means of argon-arc welding. Sensor general arrangement and design map of FOSLFP are presented in 3D-model (figure 10).

The sensor semitransparent model (figure 10) presents internal components of the sensor. Assembly of 3D-model has been performed according to the described sequence of elements assembly.

Thus, with due attention to the given technological characteristics of assembly procedures for fiber-optic sensor of fluid flow parameters, assembly of the sensor conforming to all accuracy and quality requirements is performed [5].

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