WebLog Journal of Applied Physics

Research Article
Published: 09 Jul, 2026

Calibration of Radioisotope Level Gauge Detector

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WebLog Open Access Publications
Article ID : wjap.2026.g0906
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Abstract

The article describes a process of glass fiber production, technological properties of glass fiber, and areas of its industrial application. The operating principle of the M7213 detector scintillation probe (Mesacon Messelektronik, GmbH Dresden) level detector is described. It contains a block of a radioactive source ionizing radiation of Cs-137, a block for recording gamma radiation (detector) and a block for processing information indicating the level of glass mass in the preliminary channel on the displays. To complete the level gauge detector M7213 the Cs-137 ionizing radiation source with activity of 3.33·1010 Bq (0.9 Ci) was used, which was checked for tightness by use 3 methods (immersion method, vacuum-liquid (bubble) method and smear radiometric method). A metal calibration stands with walls made of fireclay bricks and simulation liquids with a density of ρ=1799 g/dm^3 was manufactured. The radioisotope level gauge was calibrated in laboratory conditions by using a calibration stand. A calibrated radioisotope level gauge in a liquid glass production line was installed and continuous measurement of the liquid glass level in online mode was provided. Detector scintillation probe was calibrated to the permissible level of the gamma radiation flux at a level of 192.5 mm (max/min = ±1 mm) from the bottom of the pre-channel, where the intensity of γ- quants is 1660 pulses/sec.

Keywords: Preliminary Channel; Liquid Glass; Radionuclide Cs-137; Detection Block; Calibration Stand; Bromoform; Ethyl Alcohol; Calibration

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Received Date: *19 May 2026*
Accepted Date: *07 Jul 2026*
Published Date: *09 Jul 2026*

Citation:
Ashrapov U, Sadikov I, Malikov S, Aminjanov M, Ibraimov R. Calibration of Radioisotope Level Gauge Detector. WebLog J Appl Phys. wjap.2026. g0906. https://doi.org/10.5281/ zenodo.21443897

Introduction

Glass Fiber (GF) is one of the main reinforcing elements, accounting for almost 90% of the reinforcing materials used in global polymer composite consumption [1] and more than 85% of pultruded products currently produced worldwide are Class E glass fiber composites [2, 3]. Glass fiber roving is a versatile composite reinforcing material available in a variety of linear densities measured in tex, a unit representing grams per 1.000 meters. Common specifications include 4800 tex, 2400 tex, and 1200 tex, each suited to different manufacturing processes and performance requirements. Straight roving is widely used in the following end-use processes: filament winding to create hollow tubular structures (pipes, storage tanks, and pressure vessels); knitting and weaving for composite profiles; consumer product applications (sports and recreational equipment, telecommunications, and infrastructure); and the semi-finished product (fabric) can be used in a variety of applications (wind energy, marine, transportation, sports and recreation, and infrastructure).

Finished 2400 tex fiberglass product applications include: 1) It`s is often used in aircraft components, providing exceptional strength and rigidity with minimal weight, which is important for improving aircraft efficiency and reducing fuel consumption; 2) 2400 tex fiberglass is used in the production of lightweight body parts, chassis components, and interior trim elements, which helps reduce overall vehicle weight, improve fuel efficiency, and improve handling; 3) 2400 tex fiberglass roving is widely used in the wind energy industry for the production of wind turbine blades because its high strength and durability enable the blades to withstand extreme wind conditions and provide a long service life; 4) Glass Fiber Reinforced Plastics (GFRP) are widely used in the construction of small vessels (fishing boats and yachts) [4], because its resistance to corrosion and moisture makes it an ideal material for ensuring strength and long-term use; 5) GFRP are widely used as well as as a reinforcing material in concrete and other composite structures, providing increased strength and durability. They can also be used to produce lightweight roofing materials and thermal insulation panels; 6) 2400 tex glass fiber roving is an excellent material for electrical and electronic devices due to its excellent electrical conductivity and insulating properties and is used in the production of cables, wire harnesses and other electrical components.

In recent years, radioisotope devices in metallurgy, mineral extraction, chemical industry, gas production, fiber optic production and other industries were been successfully used. The high sensitivity of the equipment allows for the measurement of controlled parameters without taking samples – using non-destructive testing methods. The radioisotope density meter is designed for non-contact measurement of the density of pulps and liquid media in pipelines [5]. The radioisotope level gauges are designed for non-contact measurement of level and signaling of technological products (petroleum coke and foam in coke chambers, liquid sulfur and chemically harmful acids in bulk ectakades, gas condensate and powdered polypropylene intermediate product in closed containers [6]. The radioisotope devices provide rapid continuous measurement of density or level of technological products and conversion of the obtained density or level value to the output current signal, as well as alarm control when the main parameter goes beyond the specified range and registers the results obtained. The main advantage of the radioisotope method for measuring density or level is non-contact, which allows it to be used in determining the density or level of aggressive and viscous media, as well as liquids under high pressure or temperature, where the use of other types of instruments is almost impossible.

Calibration of radioisotope instruments is critical to ensuring accurate and reliable measurements from gamma, beta, and alpha radiation detection equipment. According to IAEA requirements, the main purposes of calibration of a radioisotope instrument are: 1) To ensure that the instrument is operating correctly; 2) To determine, under a controlled set of standard conditions, the instrument readings as a function of the measure value (the quantity intended to be measured); 3) Calibrate the instrument in such a way as to optimize the overall measurement accuracy of the instrument.

The company "Falk Porshe Fiberglass" JV LLC (Tashkent, Republic of Uzbekistan) is a plant that produces white E-glass, roving text: 1200 2400 4800 9600 for the production of drones, automobiles, railway and aviation equipment, highways and bridges, composite pipes, and hundreds of other important objects.

In the in special furnaces, a mixture of kaolin, limestone, sodium sulphate and colemanite is dissolved at a temperature of 1550˚C. This hot glass mass then is passed through a preliminary channel, where level of liquid glass is measured by radioisotope level gauge M7213 scintillation probe (Tesakon Messele-lectronics, GmbH Dresden) in on-line regime. Preliminary calibration of radioisotope level gauge in laboratory conditions and it`s adjustment on the production line is an important and urgent task to ensure uniform flow of high-temperature (T=1088˚C) liquid glass through the preliminary channel and to obtain high-quality products.

The aim of the study is to develop a method for calibrating the M7213 radioisotope level gauge in laboratory conditions by constructing a stand and calibration fluid, performing precise calibration of the measuring instrument to the required level, installing the radioisotope level meter in a preliminary channel and ensuring continuous operation of the measuring instrument in online mode.

Results and Discussion

Technological properties of fiberglass

The term E-glass is used to describe alumino-borosilicate glass with an alkali content of less than 2%. E-glass is produced into extremely fine, long filaments (fibers) (Table 1).

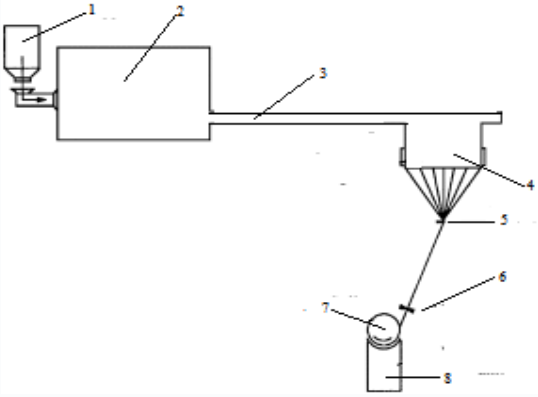

Figure 1: Schematic diagram of the traditional fiberglass manufacturing process.
1-hopper; 2-furnace; 3-pre-channal; 4-platinum bushing; 5- fillament collecting and size applicator; 6-strund transverse motion; 7-collet; 8-winding head unit.

The thickness of the glass fiber thread is approximately 10μm and they have high tensile strength (3100-3800 MPa) and excellent electrical insulating properties [6]; High dielectric strength with the ability to withstand significant voltages of 10-14 MV/m; low dielectric losses (tangent δ, tgδ) 0.0002, which ensures operation at high frequencies, minimizing energy losses; Moisture resistance while maintaining insulating properties when exposed to moisture; Heat resistance allows it to withstand operating temperatures up to 600-650˚C without significant loss of strength or structure, making it a key material for the production of industrial fiberglass fabrics, thermal insulation, fire-resistant materials, and composites In this form, glass exhibits the following properties: it doesn't shatter or break, and it bends without breaking. These fibers are then woven into threads, which are then used, for example, to produce fiberglass fabrics and various braids.

Stages of fiberglass production

A schematic representation of the traditional glass fiber manufacturing procedure is shown in Figure 1.

The raw material is heated in a hopper (1) and in special furnaces (2), a mixture of kaolin, limestone, sodium sulphate and colemanite is dissolved at a temperature of 1550˚C. The molten glass passes through a pre-channel (3) and is then fed into electrically heated platinum or platinum-rhodium bushings (4) with multiple holes. Typically, a screw-type sleeve has 200 holes in its base. A constant level of molten glass is maintained in the reservoir. The molten glass flows by gravity through these holes, forming a web of continuous threads. which are collected together and passed around a rapidly rotating collet, after which they are pulled out at a speed of 1-2 km/min. This hot glass mass then is passed through a preliminary channel, where level of liquid glass is measured by radioisotope level gauge M7213 scintillation probe (Tesakon Messelelectronics, GmbH Dresden) in on-line regime. Preliminary calibration of radioisotope level gauge in laboratory conditions and it`s adjustment on the production line

Table 1: Typical properties of some glass fibers.

Type of fiberglass	Densité, g/cm^3	Tensile strength (GPa)	Young's modulus (GPa)
E-glass	2.54	1.7-3.5	69-72
S-glass	2.48	2,0-4,5	85
C-glass	2.48	1.7-2.8	70

Table 2: Percentages of individual additives in different types of fiberglass.

Glass type	SiO_2	Al_2O_3	B_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2	Zr_2O_3	Fe_2O_3	F_2
Glass E, with boron	52-56	12-16	5-10	16-25	0.3-0.5	0.1- 2.0	0.1-2	0.2-1.5	0.1-0.4	0.1-0.4	0.1-0.7
Glass E, boron free	52-56	12-16	-	16-25	0.3-0.5	0.1- 2.0	0.1-2	0.2-1.5	0.1-0.4	0.1-0.4	0.1-0.7

Table 3: Technical characteristics of the radioisotope level gauge M7213 scintillation probe.

Technical data	Characteristics of the indication
Detector : Scintillator	Diameter - 38 mm, Length – 38 mm
Photomultiplier	9134 V
Lower threshold for γ-quanta	≥ 45 keV in stabilization mode Cs-137
Detector sensitivity, pulses/sec	$1.3 \cdot 10^3 \pm 160$
Gamma radiation background	approximately 120 pulses/sec at the entrance to the detector without peak stabilization, i.e., at a constant high voltage
Electric current used	30 mA
Maximum cable length	1000 m
Probe body material	High quality stainless steel, X6CrNiTi1810
Explosion safety	EExd ia IIC T6
Operating temperature range	(-20…+50)^{0}C with cooling to 100^{0}C
Cooling agent	filtered water
Coolant Temperature	≤ 25^{0}C
Dimensions of the Cs-137 source	height 12 mm, diameter – 8mm
Activity Cs-137 source	$3.33 \cdot 10^{10}$ Bq (0.9 Ci)
Minimum dose for *γ*-peak stabilization	1 mGr/h

is an important and urgent task to ensure uniform flow of high-temperature (T=1088˚C) liquid glass through the preliminary channel and to obtain high-quality products.

The production of fiberglass involves the following 5 stages:

Stage 1: Preparing batches. Precisely measured quantities of silica and additives are mixed. The Table 2 shows the percentage contents of individual additives in different types of glass [7]. The chemical compounds Na_2O and K_2O listed in Table 2 are used to lower the melting point of the glass mass.

Stage 2: Melting. A pre-charged batch of glass is fed into a high-temperature furnace fuelled nb ccf by natural gas for melting at ~ 1400˚C. The furnace is typically divided into three sections. The first section is where the batch is melted. The molten mixture enters the second section, the refiner, where the temperature is reduced to ~ 1370˚C. The final, third section is the hearth furnace, where the molten glass passes through a pre-channel, which is equipped with a radioisotope level gauge to maintain a precise level of the flowing glass. If the glass melt level is below a certain specified value, the glass may break when extruding into fiber. If the level of the molten glass is higher than a certain specified value, then when the molten glass is extruded into fiber, the fiber diameter may increase. The flowing glass is then fed into platinum and rhodium bushings, which are used to extrude the molten glass into fibers. This completes the melting stage.

Stage 3: Fiberizatio. Glass fiber formation, or fibrization, involves a combination of extrusion and quenching. During extrusion, molten glass exits the furnace through a core made of a wear-resistant platinum-rhodium alloy with very fine holes. A single core can have between 200 and 8,000 such holes. The core plates are electronically heated, and their temperature is precisely controlled to maintain a constant glass viscosity. Water jets cool the filaments exiting the core to approximately 1200˚C. The molten streams are then captured by a high-speed winder. The molten streams are then captured by a high-speed winder, which rotates much faster than the flow of molten glass, and as they exit the bushings, tension is created, drawing them into thin threads with a diameter of 4 to 34 microns.

Stage 4: Coating. At this stage, mechanical winders pull the fibers at a speed of 61 m/s through an applicator, which coats the fibers with a suitable chemical coating, called a preservative, to facilitate further processing and improve the quality of the final product. This process is called coating. The chemical composition of the resin is crucial to the performance of fiberglass. For example, the chemical composition of the resin used in the production of wind turbine blades can increase the blade's service life by an order of magnitude.

Preservatives typically contain between 0.5 and 2.0% by weight and may include lubricants, binders, and/or coupling agents.

Stage 5: Drying and Packaging. Finally, the drawn and processed yarns are collected into a bundle. A bundle consists of a strand containing between 51 and 1,624 yarns. The strand is wound onto a drum into a forming package, which resembles a spool of yarn. The forming packages, still damp from water cooling and processing, are then dried in an oven. They are then ready for palletizing and shipping or further processing into chopped fiber, roving, or yarn. Rovings are made from one or more yarns, which can be twisted to improve the yarn's integrity in subsequent processes, such as weaving. For example, a collected roving consisting of 10-15 yarns is wound together into a multi-filament roving package.

Continuous glass fibers (the first type of fiber used in modern composites) are made by drawing molten glass (at about 1300˚C)

through dies with a diameter of 0.8-3.0 mm and then stretching it at high speed to a diameter of 3-19μm [8].

The operating principle of a radioisotope level meter

The gamma source unit of the level gauge uses a Cs-137 source with the radionuclide ^{137}Cs ($T_{1/2}$=30.17 years), which undergoes beta decay, as a result of which the isomer ^{137m1}Ba ($T_{1/2}$=2.552 min) is initially formed, which with a probability of 94.4% [9] is converted into the stable isotope ^{137}Ba:

$$^{137}Cs \rightarrow {}^{137m1}Ba + e^{-} + \nu e; \quad (1)$$

$$^{37m1}Ba \rightarrow {}^{137}Ba + \gamma \quad (2)$$

In 94.4% of cases, the ^{137m}Ba radionuclide by nuclear reaction (2) transforms into the ground state of the stable isotope ^{137}Ba with the emission of γ - rays with an energy of 661.7 keV (by nuclear reaction 3), which are recorded by the detection block.

The operation of radioisotope devices (radioisotope densitometers, level meters and gamma relays) is based on the reaction (1,2), when gamma-radiation (γ -electromagnetic radiation) passes through the control object, is weakened as a result of absorption by a technological product and registered by a scintillation detector, amplified and converted into electric current, processed in the information processing block and displayed on the device display with information about the density or level of the measured product.

Figure 2 shows the schema of operating principle of a radioisotope level gauge.

As can be seen from Figure 3, gamma rays emanating from a Cesium-137 source initially have an intensity of 100%, and after passing through the first layer of fireclay brick, their intensity drops, for example, to 90%, and after passing through the secondary layer of fireclay brick, their intensity drops, for example, to 80% (due to absorption by 2 layers of fireclay brick. In this case, the liquid glass level (L), measured by the detection unit, should be accurate to ±1 mm.

If the glass mass level is below or above this calibration level, then the intensity of gamma quanta detected by the device changes, that is, when the glass mass level is above this level, the intensity of γ quanta decreases due to their absorption by the glass mass, and when the glass mass level is below this level, the intensity of γ quanta increases due to their absorption only by air, and in both cases, the device shows a deviation from the technological norm of the glass mass level.

According to the «Code of Conduct on the Safety and Security of Radioactive Sources» of IAEA [10] and to regulations [11, 12], after the expiration of the specified service life, each closed ionization radiation source must undergo a leak test and a lifetime extension or must be buried in a specialized facility for the disposal of radioactive sources. This is due to the fact that during operation under extreme conditions (high humidity, temperature, pressure) the tightness of a closed source of ionizing radiation may be compromised. The radioactive source of ionizing radiation cesium-137 has a designated service life of 15 years, after which it is necessary to check its tightness and extend its service life.

Figure 3 shows a diagram of a closed radioactive source of ionizing radiation Cs-137.

The tightness of the radioactive source Cs-137 was checked using 3 different methods and the loading of the sealed source of Cs-137

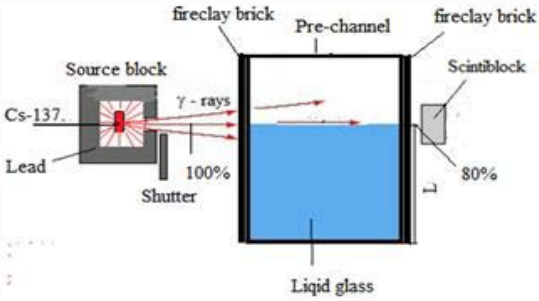

Figure 2: Schematic diagram of the operating principle of a radioisotope level gauge.

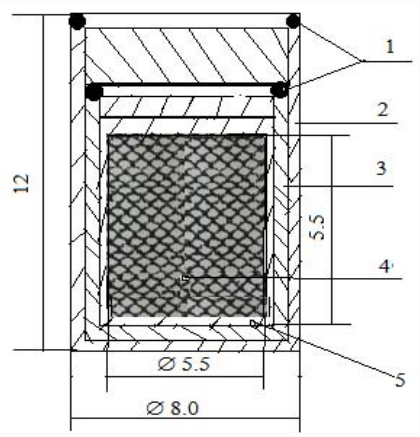

Figure 3: Structural diagram of a sealed source of ionizing radiation Cs-137. 1-hermetic welding; 2-outer capsule; 3-internal capsule; 4-radionuclide Cs-137; 5-glass.

into the gamma source block of the radioisotope level gauge was carried out in a special protective box using a remote method, which eliminates overexposure of personnel.

The Cs-137 ionizing radiation source can be tested by 3 leak testing methods.

Method 1 was a immersion radiometric method for monitoring the tightness of a source of any type with a stainless-steel capsule is carried out by immersing the source in an immersion liquid, for which the manufacturer recommends using a 7-10% solution of nitric acid heated at a temperature of 60-90°C for 1 hour [13]. But the use of HNO_3 can corrode the end-of-life radioactive source. The source is immersed in a liquid that does not act on the capsule material, but effectively leaches radioactive substances. The immersion liquid (aqueous 10% solution of Trilon B-2-aqueous solution of disodium salt of ethylenediaminetetraacetic acid) or 10-15% aqueous solution of H_3PO_4 is heated to boiling for 10 minutes and cooled to room temperature. The cycle is repeated 2-3 times [14]. The activity of radionuclides that have passed into the liquid should not exceed 185 Bq (5 nCi). The results showed that the radiometric immersion method, where a 10-15% aqueous solution of H_3PO_4 was used as an immersion liquid, is the most appropriate for testing the leak tightness of sources with expired designated service life because when using this method an aqueous solution of H_3PO_4 exhibits a passivating property and forms a protective film on the source surface that protects the source capsule from corrosion, because phosphate coatings are formed on the surface of steel products due to the reaction between the metal

surface and solutions of phosphoric acid [15].

The activity of the immersion extract is measured according to the method of measuring the specific activity of gamma-emitting radionuclides in countable samples using a CANBERRA semiconductor gamma spectrometer with a germanium detector and Genie-2000 software for quantitative analysis of gamma spectra of radionuclides or the gamma-beta spectrometer "RADEK" MKGB-01 (Russia). The activity (A) of the measured acid extract is calculated by the formula:

$$A = Ac\ (N_1/N_2) \qquad (3)$$

where: Ac is the activity of the control solution with the radionuclide Cs-137 with known activity; N_1 is the acid extract counting rate; N_2 is the counting rate of the control solution.

If the activity of the immersion liquid does not exceed 185 Bq (~5 nCi), then the source is considered sealed [16, 17].

Method 2 was a vacuum-liquid (bubble) method. The source of ionizing radiation is immersed in a liquid (ethylene glycol, alcohol, silicone oil or water) in a vacuum chamber, where a vacuum of 15-25 kPa is created. The absence of bubbles within 1 minute indicates the tightness of the source.

Method 3 was a smear radiometric method, which was based on the removal of possible contamination with radionuclides from the surface of the source with a wet or dry swab. The swab can be moistened with water, a dilute solution of nitric acid, or another solution that does not act on the capsule material, but actively removes radioactive contamination. When checking the tightness of sources by the smear method, the activity of radionuclides on a swab should be no more than 185 Bq (~5 nCi).

The leak test of the Cs-137 ionizing radiation source (serial number #413-04-01) with activity 3.33 1010 Bk (0.9 Ci) showed that Cs-137 source is leak-proof and can be used in the radiation source block of the radioisotope level gauge. A sealed Cesium-137 source was loaded into the radioisotope level gauge source block and was installed in the radioisotope level mounting axis in the preliminary channel.

The level gauge detector consists of a scintillator, a photomultiplier, and a signal processing block. A scintillation detector consists of a scintillator crystal (NaI (Tl), CsI, SrI, BGO, etc.) coupled to an electronic light detector, which is usually a Photomultiplier Tube (PMT). The incoming gamma radiation flux causes flashes of light in the scintillator. The latter converts each photon of light emitted by the scintillator into an electrical pulse that provides meaningful information about the energy released by the incident radiation. In the level gauge detector gamma radiation is converted into a flow of electrons and then amplified. The photomultiplier converts these flashes into electrical pulses and amplifies them. The pulse frequency (the number of pulses per second) is a measure of the intensity of the gamma radiation. In the detection block, the gamma radiation flux of source Cs-137 is converted into a sequence of statistically distributed pulses with an average repetition rate depending on the density of the measured pulp, and the density of the emulsion pulp is displayed on the displays of the information processing and analysis block and on the computer monitor in real time.

Figure 4 shows a general scheme of the operating principle of the level gauge.

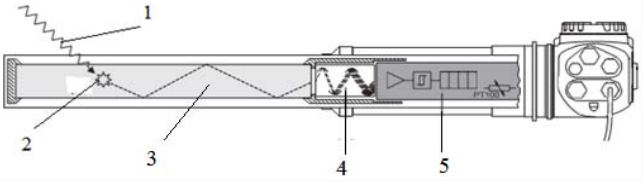

Figure 4: General scheme of the operating principle of the level gauge detectors.
1-gamma ionization radiation source Cs-137 (high energy photons); 2-primary electron (low energy photon); 3-scintillator; 4-secondary electrons and their strengthening; 5-information processing block that calculates the measured density value based on the pulse frequency.

The number of primary electrons (Figure 4) is proportional to the energy of the incident high-energy gamma radiation (Eγ=661.7 keV) from the radioactive source Cs-137. The primary electrons move toward the first dynode and are accelerated by the electric field. Each of them arrives a kinetic energy of ≈100 eV, transferred by the potential difference. When hitting the first dynode, more low-energy electrons are emitted, which in turn are accelerated toward the second dynode. The geometry of the dynode chain is such that the cascade occurs with an exponentially increasing number of electrons produced at each stage. If at each stage an average of 5 new electrons are produced for each incoming electron, and if there are 12 dynode stages, then at the last stage one would expect for each primary electron about $5^{12} \approx 10^8$ electrons. Current gain coefficient $k_i = \sigma^n$. For example, if $\sigma = 10$ and n = 8, then $k_i = 10^8$. This large number of electrons reaching the anode results in a sharp current pulse [18].

The sensitivity of the radioisotope level gauge M7213 scintillation probe is 20-50 times higher than the sensitivity of the Geiger-Muller counter.

The technical data of the scintillation probe are given in Table 3.

It should be noted that, detection block of radioisotope level gauge is explosion-proof and has an explosion-proof level of explosion protection type "explosion-proof enclosure".

To calibrate the radioisotope level gauge, a model solution was prepared whose density corresponded to the density of liquid glass. Usually petroleum ether, gasoline, benzene (ρ=650-860 g/dm^3), water-alcohol solutions (ρ=870-950 g/dm^3), sulfur-wine solutions (ρ=960-1010 g/dm^3), sulphur-water solutions (ρ=960-1830 g/dm^3), Thule solutions (ρ=1840-2000 g/dm^3) can be used as a model of the measured medium of a certain density in laboratory conditions, however, they have aggressive properties and are highly toxic to human health [19].

Liquid simulators based on a mixture of tribromomethane (bromoform) and ethyl alcohol to calibrate radioisotope devices were used [20]. To prepare liquid simulants with different densities, tribromomethane $CHBr_3$ stabilized with resorcinol and ethyl alcohol (C_2H_5OH) n 5.0 L glass containers in the following ratios were mixed *i* (Table 4).

The radioisotope level gauge - M7213 scintillation probe was calibrated by use special calibration stand with liquid simulators based on a mixture of bromoform and ethyl alcohol with a density of 1799 g/dm^3. In the laboratory conditions, a full-size metal preliminary channel stand with walls made of fireclay bricks was manufactured, into which a detector was installed on one side, and a source block

Table 4: The ratio of the components of liquid simulators of a controlled environment.

Density value, g/dm³	Composition of simulators, in % by volume	
	bromoform	ethyl alcohol
1800	48.0	52.0
2000	57.5	42.5
2200	67.0	33.0

with a Cs-137 source was installed on the diametrically opposite side.

The calibration stand was made by stainless steel in accordance with the dimensions shown in Figure 5 in the form of a square container with an internal lining of fireclay bricks.

Figure 6 shows the diagram of the front preliminary channel for glass mass and the installation axis of the device.

As can be seen from Figure 5, a radioisotope level gauge is installed on one axis to measure the level of the glass mass, i.e., a radioisotope level gauge detector is installed on one side of the channel, and a gamma source unit with a Cs-137 source is installed on the other side of the channel (diametrically opposite to the side of the channel).

In the line for the production of optical fiber, liquid glass at 1088 0C flows through a preliminary channel that has the following size: internal dimensions - (230x510x230) mm; external dimensions- (500x940x500) mm; dimensions of wall – (170x280x170) mm. The preliminary channel for glass mass is made of fireclay bricks, which are used for laying furnace furnaces, chimneys and other structures and have direct contact with fire and withstand temperatures up to 1800°C. The fireclay brick SHA-9 (straight) type has dimensions - (300x150x65) mm and density of 1.9 g/cm³, so it absorbs of gamma radiation of radionuclide ^{137}Cs very well. Taking this into account, before installing the scintillation sensor, one fireclay brick was removed symmetrically to the left and right (on both sides) of the measuring device installation axis from the preliminary channel wall body, and the resulting voids (100 mm) were filled on both sides with kaolin wool for thermal insulation of the level sensor.

Figure 6 shows detector of radioisotope level gauge M7213 scintillation probe installed in the liquid glass channel of optical fiber production.

From Figure 6it can be seen, that between the detector (1) and the fireclay brick (3) there is kaolin wool (2). When in-stalling the radioisotope level gauge in the preliminary channel, one of the two fireclay bricks was removed and the freed space was filled with glass wool.

Thus, the detector of a radioisotope level gauge, having a casing with a cooling water system, with a scintillation crystal length of 35 mm (Ø =38 mm, H=38 mm, Table 3) was calibrated to the permissible level of the γ - radiation flux of the ionizing radiation source Cs-137 at a level of 192.5 mm (1 mm) from the bottom of the pre-channel, where the intensity of γ - quanta is 1660 pulses/sec. In case of above or below this calibrated level (e.g. 210 mm or 175 mm) a decrease in the γ - quanta intensity to ≤120 counts/sec is observed.

Conclusion

The tightness of the Cs-137 source with activity of 3.33·1010 Bq (0.9 Ci) was checked and into the gamma source block was loaded.

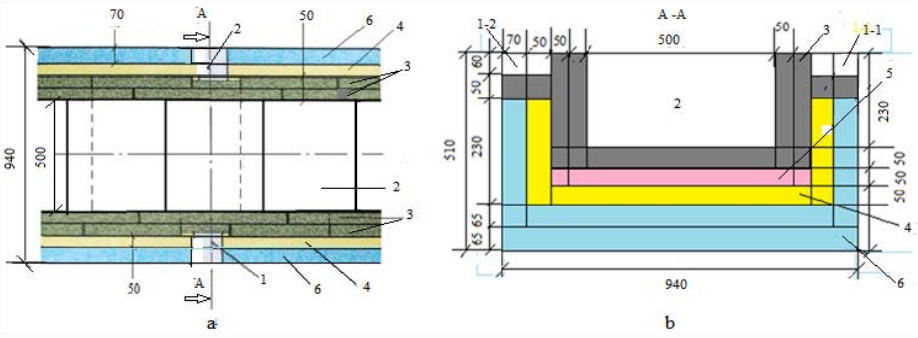

Figure 5: Scheme of the preliminary channel for glass mass. Top view (a) and cross-sectional view (b): 1-1-mounting axis of radioisotope level gauge detector; 1-2-mounting axis of radioisotope level gauge source block; 2-glass mass channel; 3-fireclay brick; 4-thermal insulation; 5-heater; 6-frame.

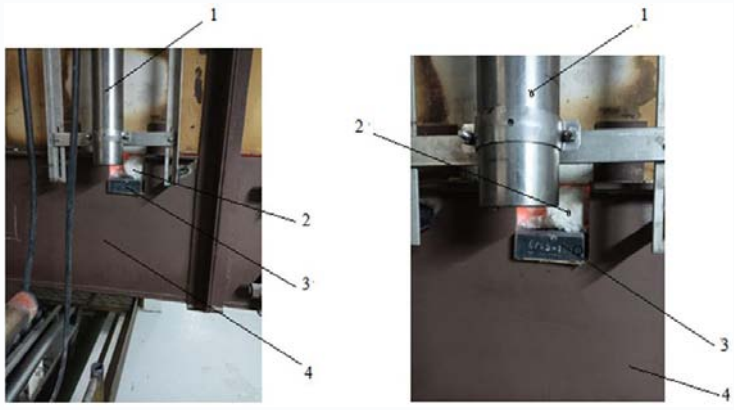

Figure 6: Detector of radioisotope level gauge M7213 scintillation probe installed in the liquid glass channel of optical fiber production. 1-scintillation probe detector; 2-kaolin wool; 3-fireclay brick; 4-metal body of the preliminary channel for liquid glass mass.

To calibrate preliminary level of gauge detector M7213 scintillation probe metal simulator and liquid simulators with density ρ = 1799 g/dm^3 were used. A calibrated radioisotope level gauge was installed in a liquid glass pre-channel of technological production line for continuous measurement of the liquid glass level in online mode. Between the detector and the fireclay brick there is kaolin wool to prevent heating of the detector.

Acknowledgment

The work was carried out using basic funding allocated to the Institute of Nuclear Physics of the Academy of Sciences of the Republic Uzbekistan.

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