ELEMENTS OF ULTRASONIC FLOWMETER INSTALLATION, MODEL OMNI TDI 200H WITH TEST WORK RESULTS

PROFESSIONAL PAPER

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ABSTRACT:
Ultrasonic flowmeter works on the principle of transmitting and returning ultrasonic waves that pass through the liquid, ie. fluid, and is used to measure the speed of fluid movement through a pipeline or some other structural form of fluid movement. By knowing the velocity of the fluid and the cross-sectional area of the pipeline or other system, the value of the volumetric or mass flow can be obtained indirectly. Fluid flow measuring device model OMNI TDI 200H owned by the laboratory of the Biotechnical Faculty was used for the first time to measure the flow of purified water at the outlet of the plant device of the training center "Grmeč", built as a pilot plant. The paper will describe the role and importance of flow measurement by the conventional method and present the results of the trial operation of an ultrasonic flow meter, model OMNI TDI 200H.

KEYWORDS: ultrasonic meter, installation elements, flow

INTRODUCTION

Nowadays, due to the greater complexity of technical systems in the manufacturing and process industry, we perform measurements, and the act of measurement itself can be presented as an experimental process of obtaining one or more values of a measured quantity. The measurement aims to determine the value of the measured quantity, while the purpose of each measurement is to obtain the value of the measured quantity. By comparing the measurement results about the given quantities, we control the process quantities, for which we use many information and technical aids. Measurement of non-electric quantities by electrical measuring procedures is realized with the help of measuring transducers, which convert non-electric to electric quantities. Thus, e.g. measures displacement, velocity, angular velocity, acceleration, mechanical power, pressure, flow, fluid level, temperature, volume, time, humidity, flow rate and composition of gases and liquids, pH value, etc. Converting non-electrical quantities into electrical ones is a very important step in process control and regulation systems because in this way different physical quantities can be measured by one method or one type of instrument, very small changes of measured non-electric quantity can be displayed and measured, very fast changes of non-electric size and perform remote measurements (online).

FLOW AS A PHYSICAL SIZE

Flow measurement, as a variable basic quantity, determines the energy and material balances of process changes (flow chart) based on which the movement of materials and fluids at the inlet, through conversion operations, as well as at the outlet of the process is monitored. The measurement of the flow of fluids, gases, multiphase liquids, and suspensions is complex, subject to numerous errors, and therefore a large number of different measuring procedures have been developed for accurate and reliable measurement. Basic flow values are given through the following expressions [1]:

- volume / volume flow Q_V [m^3/h], [l/s]
- mass flow Q_M [kg / s], [t/h]), [kg / s]
- molar flow Q_m [mol/h], [mol/s]

Mass flow is the mass of a fluid that passes a point in a unit of time and can be given through the equation:

$$Q_M = \frac{\Delta m}{\Delta t}, \text{ [kg/s]} \quad (1)$$

Otherwise, the mass flow in the pipe is determined by the limit of the ratio of the mass of the fluid flowing through the cross-section of the pipe in the time interval when the interval becomes infinitesimally small:

$$Q_M = \frac{dm}{dt}, \text{[kg/s]} \quad (2)$$

Where is:
Δm - change in mass flowing through a space (eg inside a pipe), [kg]
Δt - duration of fluid flow flowing through a cross-section, [s]

Ultrasonic waves with frequencies from 100 kHz (for gases) to 2 MHz (for liquids) are used to measure the volume flow. The relationship between frequency f, speed of sound c, and wavelength λ can be given by the equation [2]:

$$f = \frac{c}{\lambda}, \text{[Hz]} \quad (3)$$

Where is:
f- frequency, [Hz]
c - speed of sound, [m/s]
λ - wavelength, [m]

Because ultrasonic signals can also penetrate solid material, in addition to placing the transducer inside a pipeline or other object, they can be placed on the outside of the pipe offering completely non-contact ultrasonic measurement, eliminating chemical compatibility problems, pressure limitation, and pressure loss.Its functionality is not affected by (a) whether the measuring object is transparent or opaque, metallic or non-metallic, liquid, rigid or powdery, (b) external environmental influences.However, the quality of the device can be affected by the acoustic properties of fluids, changes in temperature, density, viscosity, porosity, and the content of suspended particles.One of the technological quantities that is important for the operation of the water purification system, and thus the plant device, is the volume flow through the pipe, based on the obtained speeds [3]. By knowing the velocity of the fluid and the cross-sectional area of the pipeline or other system, and the density of the fluid, it is possible to calculate both the volumetric flow and the mass flow mathematically. From the continuity equation, we calculate the volume flow through the pipe. Volume flow and mass flow are determined by the following equations:

$$Q_V = \frac{\Delta V}{\Delta t}, \text{[m}^3\text{/s]} \quad (4)$$

$$Q_M = \rho \cdot v_t \cdot A = \rho \cdot Q_V \text{ [kg/s]} \quad (5)$$

Where are:
ΔV - change in volume / volume of fluid [m^3], flowing through a cross section (eg pipes)
Δt - duration of fluid flow flowing through a cross-section, [s]
ρ - fluid density, [kg/m^3]
vt - velocity of fluid in the pipe, [m/s]
A - pipe cross section, [m^2]
Q_V- volume flow, [m^3/s]

ABOUT FLOW MEASURING DEVICE MODEL OMNI TDI 200H

GENERAL CHARACTERISTICS OF THE DEVICE

Today, there are several ultrasonic flow measurement methods in use, of which the following stand out: the transient time measurement method, the pulse method, the cross method, and the Doppler effect flow measurement method. A flow meter based on the passage of time uses two transducers that act as both an ultrasonic transmitter and a receiver. A measuring transducer is a technical element that converts the output size of a sensor into an analog physical quantity suitable for transmission and visual display, while the sensor is a technical element that directly receives and registers changes in the process and gives a response at its output that is analogous to the input physical measured quantity.

Ultrasonic meters are used to measure the flow of various suspensions, fluids with added air, and fluids with little or a lot of suspended particles. They can be used in measurements related to sewerage infrastructure, activated sludge, groundwater, chemical suspensions, as well as for fluids containing particles of solid material, which is the case with sanitary wastewater of the training center "Grmeč". Ultrasonic flowmeter works on the principle of transmitting and returning ultrasonic waves that pass through the liquid, ie. fluid, and is used to measure the velocity of movement v_t [m/s]. These devices are also the most popular devices that measure the flow inside the pipeline, used in pipelines with a diameter of 2 to 300 [cm], and for flow rates from 1 to 10 [m/s]. Ultrasound is produced by piezoelectric crystals. Piezo elements send and receive sound (range from 40 to 300kHz).The speed of ultrasound c is different in some media.

For example, in water it is 1500 [m/s], in metals 3000 - 6000 [m/s], in glass 5500 [m/s], in styrofoam only 500 [m/s]. This is taken into account in the sensor design phase because the sensor is built for a specific purpose.When there is no flow, the travel time (Q_V=0) upstream and downstream is the same (Δt=0), ie. the frequencies of the ultrasonic wave sent to the pipe and its reflection is the same. When we have a flow (Q_V>0), the upstream waves will travel more slowly and will need more time than the downstream wave, ie. the frequencies and times of the transmitted and reflected waves are different ($\Delta t>0$) (Figure 1). As the fluid moves faster, the difference between upstream and downstream time increases.

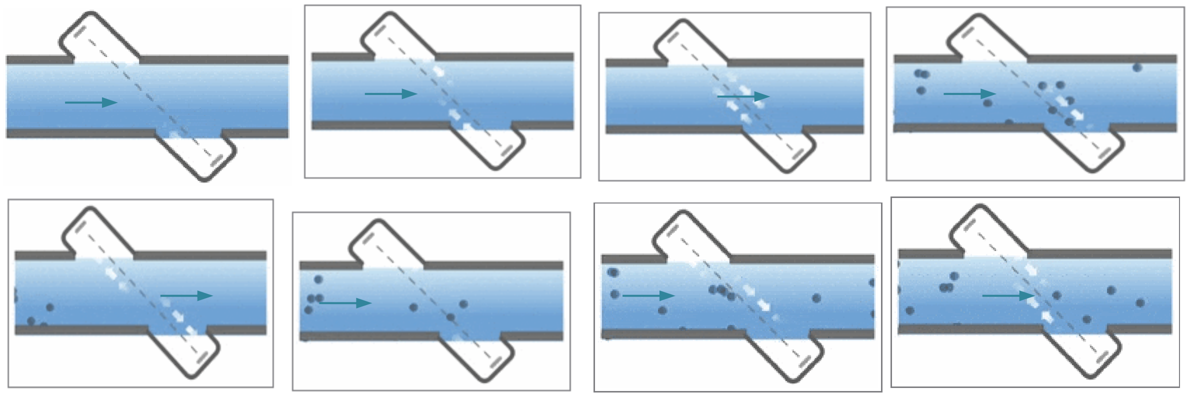


Figure 1. Illustration of the movement of a fluid through a pipe without and with impurities with the directions of propagation of waves sent downstream and reflected along with the flow of fluid

TECHNICAL CHARACTERISTICS OF THE OMNI TDI-200H HANDHELD ULTRASONIC FLOW METER

The measured flow can be displayed in several units of mass and volume display: [l/s], [l/min], [l/h], [m^3/s], [m^3/min], [m^3/h]. The measurement results are obtained based on data on the internal cross-section of the pipe D, the distance between the transmitter and receiver d, and the positions of the transducer about the pipe (ϑ - sound wave propagation angle relative to the direction of the fluid velocity vector *vt*) (Figure 4). Unlike most flow meters, ultrasonic measuring devices do not include moving parts, allowing for more flexible and maintenance-free operation, as is the case with the OMNI TDI 200H flow meter.

Figure 2. OMNI TDI-200H HandheldUltrasonic Flow Meter, set of parts, examples of transducer installation [4]

Details OMNI-TDI-200H [4]

The compact, light-weight design makes the Omni TDI-200H handheld flowmeter truly portable. The main unit weighs only 514g. The rugged case allows the flowmeter to be used in harsh environment. The unique clamp-on fixture design makes the installation very simple and no special skills or tools are required. Due to the non-intrusive nature of the clamp-on technique, there is no pressure drop, no moving parts, no leaks and no contamination.

Portable, Ultrasonic, Non-invasive, Clamp-on Flow Meter. Built-in datalogger for over 2,000 lines of data.
Power Supply: Built-in rechargeable battery.

Technical data and performance:
Linearity 0.5%
Repeatability 0.2%
Accuracy ±1% of reading at rates >0.6ft/s. ±0.5% with on-site calibration.
Response Time 0-999 seconds, user-configurable

Velocity ±0.03 - ±105 ft/s (±0.01 - ±30m/s), bi-directional
Power Supply: Built-in rechargeable battery.
Mains adaptor 110-240V AC. Output: RS232.
Supplied with TDI-S1 (for pipe diameter 15-100mm), TDI-M1 (50-700mm) and TDI-L1 transducers (300-6000mm),
Pipe Material All metals, most plastics, concrete, lined pipe
Rate Units Meter, Feet, Cubic Meter, Liter, Cubic Feet, USA Gallon, Imperial Gallon, Oil Barrel, USA Liquid Barrel, Imperial Liquid Barrel, Million USA Gallons. User configurable.
Totalizer 7-digit totals for net, positive and negative flow
Liquid Types Virtually all clean liquids and liquids with minor solids
Security Setup Lockout. Access code needed to unlock
Display 4x16 letters
Computer Interface RS232, baud-rate: 75 to 115,200bps.
Supplied Transducers As requested
Transducer Cable Standard 10m. Contact sales for longer cables, up to 500m
Power 3 x AAA Ni-mH built-in batteries. When fully recharged it will last over 10 hours of operation.
100-240vAC Adapter supplied for charging and continuous use.
Data Logger Over 2000 lines of data
Operating temperature range 0-90 °C.
Handset Weight 1.2lbs (514g)

TRANSMITTER AND RECEIVER MOUNTING METHODS

Depending on the cross-section of the pipe, the transducers can be placed on the pipe in two ways: next to each other or on opposite sides of the pipe (Figure 3) depending on the size of the inner diameter of the pipe. The transducers can be mounted in the V-method for pipe diameters from 1″to 12″, in which case the ultrasound crosses the pipe twice, in the W-method for pipe diameters less than 1″, in which case the ultrasound crosses the pipe four times, or in the Z method for pipe diameters greater than 12″, in which case the transducers are mounted on the opposite side of the pipe and the ultrasound crosses the pipe only once.

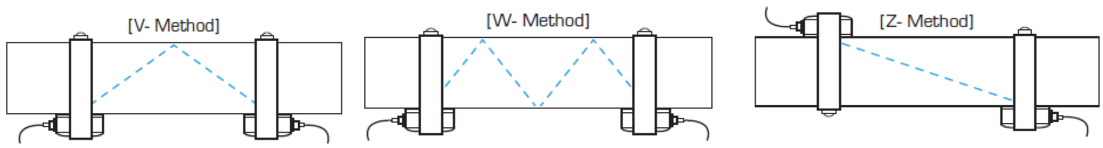
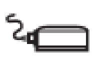
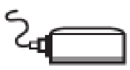
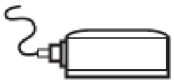


Figure 3. Methods of installing a flow transducer on a pipe according to the recommendation of the manufacturer of the ultrasonic device [4]

According to the design of the plant device, the diameter of the outlet pipe is D = 65 [mm] (2 0.5 ") and in the test work of flow measurement, the Z method will be applied. The choice of installation method depends on the characteristics of the pipe and fluid.The Omni TDI-200H has pairs of transducers that can measure flows in pipes from 15 [mm] to 6,000 [mm] at temperatures between 0 and 90 [°C].

Table 1. Transducer Options[5]

		
Type S Small size transducer (magnetic for pipe size 0.5"-2" (DN15-DN100 mm)	Type M Medium size transducer (magnetic for pipe size 2"-8" (DN50-DN700 mm)	Type L Large size transducer (magnetic for pipe size 11"-40" (DN300-DN6,000 mm)

CALCULATION PARAMETERS OF ULTRASONIC METER BASED ON PASSAGE TIME

When the flow meter is operating, the two transducers emit and receive an ultrasonic signal that travels first downstream and then travels upstream.Because ultrasound travels faster downstream than upstream, a time difference (Δt) occurs. As long as there is a change in the amount of suspension or water, ie. as long as we know the time of passage downstream and upstream, we can calculate the time difference and then the fluid flow rate (*vt*) and the flow volume (*QV*). The passage time flow meters measure the difference in the passage time of ultrasonic waves in the direction of fluid flow and the direction opposite to the fluid flow through the pipe (Figure 4).

Transceiver pairs are used for the measurement, each of which contains a piezoelectric crystal. The fluid flow rate in the pipe [6]:

$$v_t = \left(\frac{t_2 - t_1}{t_2 \cdot t_1}\right) \cdot \left(\frac{d}{2\cos\vartheta}\right) \quad \text{.......} (6)$$

Where is:

t_1 - time of passage of the ultrasonic wave in the direction of fluid flow, [s]

t_2 - time of passage of the ultrasonic wave in the direction opposite to the direction of fluid flow, [s]

d - ultrasonic wavelength, the ie distance between transceivers, [m]

ϑ - the angle of the passage of the ultrasonic wave about the longitudinal axis of the pipe, [radians]

Δt - a difference in ultrasonic wave passage times, [s]

ϑ- the angle between transmitted ultrasonic beam and fluid velocity vector, [radians]

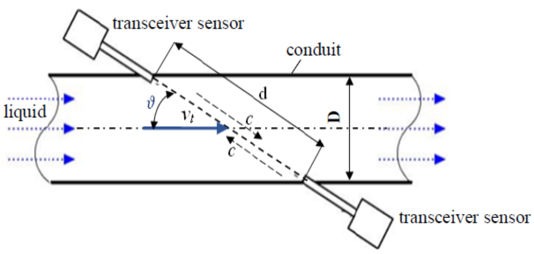


Figure 4. Principle of operation of the ultrasonic transducer with transmitter and receiver outside the pipe, Z method

When there is no flow, the frequencies of the ultrasonic wave sent to the pipe and its reflections are the same, ie. the velocity of the fluid is zero and the time difference (Δt) is zero. If we denote by the sign c the speed of propagation of the ultrasonic wave, we have such a state that the duration of the acoustic wave through the current of the liquid is shorter in relation to the time of return with the current of the liquid. If the angle ϑ enclosed by the direction of the acoustic wave with the direction of the velocity of the fluid (Figure 4) is equal to zero, then we obtain the following expressions for times [6]:

$$t_1 = \frac{d}{c + v_t}\ ; \quad t_2 = \frac{d}{c - v_t} \quad \text{.......} (7)$$

The difference in duration is the time spent:

$$\Delta t = t_2 - t_1 = \frac{2d \cdot v_t}{c^2 - v_t^2} \quad \text{.......} (8)$$

Provided that *vt* is much less than the speed of propagation of the acoustic wave *c* (for water *c*≈1500 m/s) then it is:

$$\Delta t = \frac{2d \cdot v_t}{c^2} \Rightarrow v_t = \frac{c^2}{2d} \cdot \Delta t \quad \text{.......} (9)$$

With the ultrasonic flow meter, the Omni TDI-200H transducers are not in contact with the fluid but are placed in one of the given positions and on the outside of the pipe, and are located at a certain angle. When transmitting sound signals in the transmission and the return, ie. down and along with the fluid flow, a phase difference φ occurs which is taken as the basis for flow measurement:

$$\varphi = \omega \cdot \Delta t \Rightarrow \Delta t = \frac{\varphi}{\omega} \approx \frac{2d \cdot v_t}{c^2} \quad \text{.......} (10)$$

Where is:

c - speed of acoustic wave propagation in the pipe, [m/s]

ω - frequency of the ultrasonic wave, [Hz]

As the fluid moves faster, the difference in frequency increases linearly. It is important to point out that ultrasonic devices that measure flow work with a frequency that is higher than 50 [kHz] to several [Mhz]. If the angle ϑ which closes the direction of the acoustic wave with the direction of the velocity of the fluid is greater than zero then we use the following expression for the time difference:

$$t_1 = \frac{d}{c + v_t \cdot \cos\vartheta}\ ; \quad t_2 = \frac{d}{c - v_t \cdot \cos\vartheta} \quad \text{.......} (11)$$

$$\Delta t = t_2 - t_1 = \frac{2d \cdot v_t \cos\vartheta}{c^2 - v_t^2 \cos^2\vartheta} \quad \text{.......} (12)$$

In case $v_t \ll c$ then:⇒ $\Delta t = \frac{2d \cdot v_t \cos\vartheta}{c^2}$

so the velocity of the fluid is:

$$v_t = \frac{c^2}{2d \cdot \cos\vartheta} \cdot \Delta t \quad \text{.......} (13)$$

For a pipe of circular cross-section and by setting the equation of volumetric flow with the entry of the corresponding values, we will obtain the equation for volume flow [6]:

$$Q_V = A \cdot v_t = \frac{D \cdot \pi \cdot c^2}{8d \cdot \cos\vartheta} \cdot \Delta t \quad [\text{m}^3/\text{s}] \text{.......} (14)$$

Where is:
D- inner diameter of the pipe, [m]

MUNICIPAL WASTEWATER FLOW ANALYSIS IN N.C. "GRMEČ"

CONSTRUCTED WETLAND AS A RESEARCH OBJECT

When designing constructed wetlandsfor wastewater treatment, the characteristics of the wastewater to be treated up to the limit values prescribed by the normative acts for the given waters have been taken into account. The main characteristics of wastewater take into account the concentration of solutes and solid organic compounds, ie. biochemical oxygen demand (BOD), suspended solids, nitrogen, and phosphorus compounds, heavy metals, pathogenic bacteria, and/or viruses. Technical data of the constructed wetlandin N.C. "Grmeč": active area field I 4 [m^2], field II 16 [m^2], total: 20 [m^2], active length 10 [m] and average depth: 0.75 [m]. Device design involves determining the hydraulic capacity, load level, retention time (retention), plant species [7]. The hydraulic retention time of HRT [day] can be calculated by the following formula [7]:

$$HRT = \frac{V}{Q_v} = \frac{L \cdot B(d_m \cdot n + d_t)}{Q_V} = \frac{A \cdot d_m \cdot (n + d_t)}{Q_V} \quad \text{.............} (15)$$

where is:
V - the volume of water in the constructed wetland, [m^3]
QV - mean flow through the constructed wetland, [m^3 / day]
A - surface of the constructed wetland, [m^2]
L - length of the constructed wetland, [m]
B - width of the device, [m]
dm- thickness of the medium through which water passes, [m]
dt - depth of water from the surface of the medium, [m]
n– porosity, [-]

Hydraulic capacity can be defined as the ability of a plant device to purify a certain volume of wastewater at a given time. This period is called the hydraulic retention time (HRT), depending on the amount of pollution and the given level of purification.

FLOW MEASUREMENT BY VOLUMETRIC METHOD

The method for determining the flow is usually chosen depending on the conditions in which the flow is measured and the required accuracy.In this case, a volumetric method was used to measure water flow. Volumetric flow measurement is simple, but also relatively accurate, so it is often used to calibrate other instruments. Volumetric measurement is based on measuring time (*t*), so that the amount of water represented through the flow (Q_V), which flows through a system, fills a vessel of exactly known dimensions, ie volume (*V*). The flow is defined by equation 3. To drain the purified water from the constructed wetland, a round plastic pipe with a diameter of *D* = 60 [mm] is placed under a smaller drop to ensure free flow into the natural watercourse. Constructed wetlandsare mainly used as a function of the second stage of purification and in most cases, before reaching the billets (bodies of the constructed wetland), the wastewater is subjected to preliminary and/or primary treatment. During the experimental work, 12 samples of wastewater and 12 samples of purified water were taken. Examination of samples was done in the laboratory of the Biotechnical Faculty.According to the work plan for processing purified water samples and measuring the flow of communal water on the constructed wetland N.C. "Grmeč" there was a variation in the flow that changed during the day and week, depending on the daily load, ie the number of users (students and other persons).

MEASUREMENT RESULTS AND DISCUSSION

One of the important parameters for efficient operation of the constructed wetlandis the control of the amount of wastewater at the inlet and treated water at the outlet of the device [8]. In a constructed wetland, water flows almost horizontally at low speed and the length of the entire system. During the research period, the flow varied, and based on the measured values and process parameters (Table 2), it was calculated that the total effective field volume, in which water will flow, represents approximately 30[%] of the total volume and amounts to 4.20 [m^3].

The retention time in the plant device itself is 84 [h], and in the sedimentation tank for municipal wastewater as well as in the sedimentation tank for laboratory wastewater is 50 [h/sedimentation tank]. The total retention time is thus 134 [h], ie 5.58 [days], which is sufficiently long retention of water, which is the basis for the treatment of municipal wastewater, up to the required limit values of wastewater emissions. Table 2 shows the average values of municipal wastewater flow in the teaching center "Grmeč" by volumetric method during the year.

The hydraulic retention or retention time of water (HRT) in the constructed wetlandwas 5 days, but in the summer the retention time increased to 6 days due to evapotranspiration. This period depends on the amount of pollution and the given level of purification.

The parameters were monitored for 5 days, with the flow varying depending on the weekly workload of students in the lecture halls and laboratory. The flow ranged from 4.34x10^{-6} [m^3/h] to 2.86x10^{-5}[m^3/h]. The final recipient was the stream Drobinica, which is located near the training center. During the operation of the plant device, it was not clogged and the hydraulic conductivity was very good and stable.

Table 2. Average results of measuring the flow of municipal wastewater in the teaching center "Grmeč" by volumetric method during the year

Days of the week	Flow [m^3/s] average			
	Spring	Summer	Autumn	Winter
Monday	1,33x10^{-5}	2,49x10^{-5}	2,53x10^{-5}	2,48x10^{-5}
Tuesday	2,01x10^{-5}	1,98x10^{-5}	4,13x10^{-6}	2,60x10^{-5}
Wednesday	1,26x10^{-5}	2,60x10^{-5}	4,73x10^{-6}	2,86x10^{-5}
Thursday	7,02x10^{-6}	5,62x10^{-6}	2,66x10^{-5}	4,34x10^{-6}
Friday	2,72x10^{-5}	3,1x10^{-5}	3,17x10^{-5}	1,86x10^{-5}

FLOW MEASUREMENT WITH ULTRASONIC DEVICE OMNI TDI 200H

Preparation of measuring devices

Figure 5: Flow measurement with an Omni TDI 200H ultrasonic meter on site

Before starting work, the device is prepared for measurement to avoid interruptions or irregularities in operation. For these reasons, field (location) and technical preparations for working with the device have been previously made, following the device manufacturer's instructions [9]. Figure 5 shows the measurement of water flow at the outlet pipe of the plant plant with an on-site ultrasonic meter Omni TDI 200H.

After mounting the converter, the cable connections were connected and the device was connected to the power source, after which the data for configuring the measuring sensor was entered, ie. setting parametric quantities, which provided the conditions for the start of the trial measurement.Table 3 shows the measurement results and the average values during the day. The distance between the transducers (sensors) is d = 60 [mm].

Table 3. Measurement results

Days	Monday	Tuesday	Wednesday	Thursday	Friday	Note
Measured flow values, average [m^3/h]	0,120	0,009	0,019	0,110	0,118	During the day, the water outlet from the pipe was interrupted
Addition:	Non-contact flow measurement. Period: autumn, October 2020, average values during the day. The measurement was done during the day from 9^{00} to 14^{00}.					

Measurement results with measurement problems

The flow unit is determined based on the flow value. At lower flows, it is better to set the measuring device in [m^3/h] whose value index is 3.6 times higher than when measured in [l/s] [10]. To measure correctly with any ultrasonic flow meter, care must be taken that the pipe must be filled with water. The flow measurement technology is based on the conventional flow measurement method, but also the control flow measurement at the outlet of the device using ultrasonic measurement technique gives significant results. The flow measurement results are shown in Tables 2 and 3. Problems in the trial operation of this device are variable measurement results, minor interruptions of measurements, or "silence" of the device, which can be explained by the appearance of interruptions in the flow of water, ie. discontinuous intensity of water flow through the pipe, possibly insufficiently purified water or a problem in installation and assembly. Measurement results are not officially taken as valid indicators. For correct flow measurement with any ultrasonic flow meter, care must be taken that the pipe must be filled with water. This issue as well as other observed problems can be solved by activating the services of an authorized service technician regarding the operation of the device on-site in the given field conditions and through maintenance. By eliminating the observed shortcomings in the coming period and with the support of an authorized service technician, it is to be expected that the device will work efficiently.

CONCLUSION

The constructed wetland for wastewater treatment was built in 2018 on the land surface of the Teaching Center "Grmeč" of the Biotechnical Faculty in Bihać, to treat wastewater of various origins through research and conduct experiments. Omni TDI-200H Handheld Ultrasonic Flow Meter was procured through the project "Efficiency testing of constructed wetland with different types of wastewater", a project funded by the Cantonal Ministry of Construction, Physical Planning and Environmental Protection of the USC (2016). During the trial operation of the device, it was concluded that any change in flow, and indirectly changes in the operation of the constructed wetland, affect the intensity, consistency, and amount of purified water, which directly affects the quality of flow meters. For correct flow measurement with any ultrasonic flow meter, care must be taken that the pipe must be filled with water. This issue, as well as other observed problems, will be resolved through the services of an authorized service technician regarding the operation of the device on-site in the given field conditions and through maintenance. Due to problems in the operation of the flow measuring device, the current volumetric flow measuring method is currently used to obtain more accurate results. Research on a pilot plant constructed wetland has shown that the device can work efficiently at different flows. By regulating the inflow of water to the device, optimal results can be obtained and at the same time meet the standards and legal regulations related to wastewater.

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