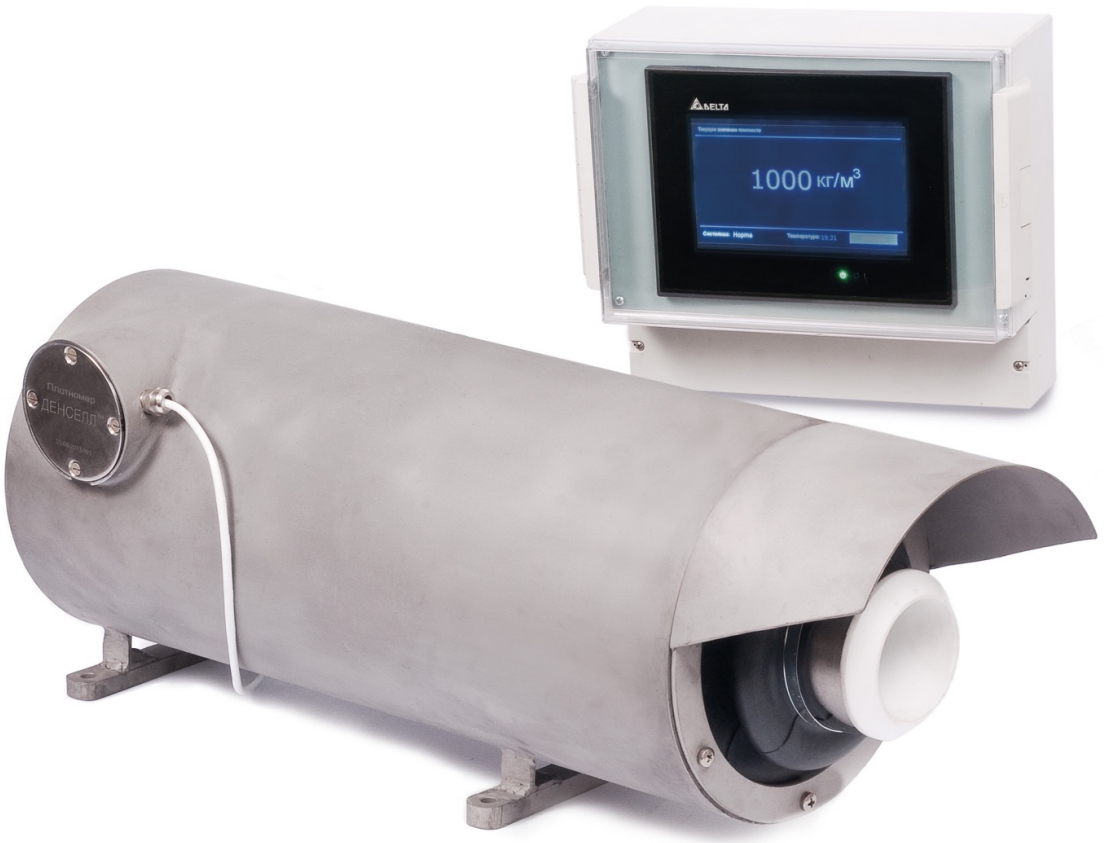


DENCELL® MUD-4 - Key Benefits:

Safety
DENCELL® MUD-4 Density Meter is based on a safe non-radioactive technology.

Direct Measurement Principle
Not sensitive to changes in process conditions. The density is measured rather than predicted.

High Accuracy
0.3%FS for light slurries and 0.5%FS for dense slurries.

Linear Scale
Simple to calibrate. Provides valid and accurate results in the range of 800 to 3500 kg/m^3 after calibration with a single data point.

Reliability and Durability
Designed to last for the complete projected lifespan in harsh environments. Stainless Steel body and sensor. Highly abrasive resistant polyurethane and PVC lining.

Low Maintenance Cost
Projected lifespan of the lining is up to 10 years for most applications. No cost associated with handling and replacement of radiation sources.

Designed for Safety and Accuracy

A Safe non-nuclear density meter
MUD-4 Density Meter implements a weight-based measurement principle, which is not only safe and accurate, but also is extremely well suited for measurements of multi-phase fluids.

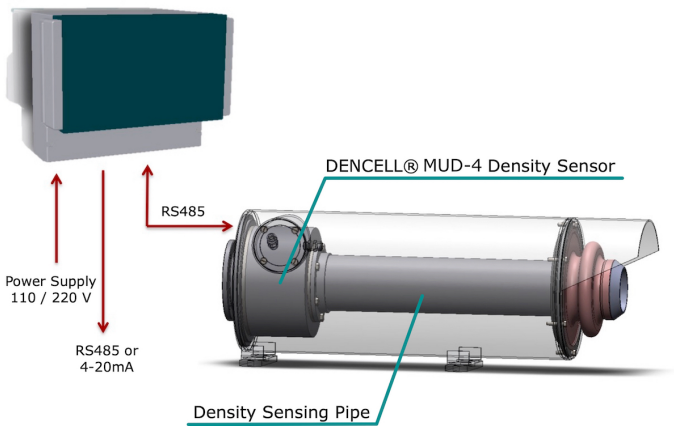
A direct method with a linear scale
MUD-4 Density Meter employs a direct method of density measurement with a linear scale. The principle of operation is based on weighing of a constant volume of fluid flowing through the Density Sensing Pipe. DENCELL® MUD-4 Density Sensor is **highly accurate**. Linear scale of the meter equates to the **ease of calibration** and a **wide operating density range**.

Highly accurate on slurry
DENCELL® MUD-4 Density Meter measures the integral density of the volume of fluid flowing through the density meter, which makes it extremely well suited for slurries with their wide distribution of densities within the volume. DENCELL® MUD-4 Density Sensor provides extremely high accuracy ranging from 0.3%FS to 0.5%FS depending on the fluid.

Easily calibrated at the installation point
MUD-4 Density Meter can be accurately calibrated with just 2 data points, one of which is an empty instrument disconnected from the fluid flow, and the other data point – the actual current density of the slurry. The second point can be calibrated with a water stream or with a real-time density of sludge or slurry measured with alternative means.

Wide operating density range
Once calibrated, MUD-4 Density Meter can measure sludge and slurry with densities ranging from 800 to 3500 kg/m^3 without the need to re-calibrate the meter.

Fast Response Time
MUD-4 Density Sensor provides up to 300 density readings per second with configurable filtration that enables accurate averaging with the response time as fast as 0.85 seconds.



Key Highlights:

- A safe online non-nuclear density meter
- A direct method with a linear scale
- Highly accurate: 0.3%FS to 0.5%FS depending on the slurry, well-suited for sludge and slurry
- Wide operating density range from 800 to 3500 kg/m^3
- Fast response time of 0.85 seconds
- A weight-based instrument that works

How MUD-4 Density Meter is different from other Weight-based Density Meters?

In MUD-4 Density Meter **we solves the key issue of all the weight-based density meters**, which is: in order to measure the weight of the fixed volume of fluid, the density sensing pipe must be decoupled from the rest of the pipeline so that it can move freely in a vertical direction. Any joint introduced to connect the pipe adds a measurement error in the range of 2 to 5%FS due to changes in temperature, pressure or internal stress relaxation in the material of the joint. This error is of random nature and is impossible to compensate for with additional sensors.

MUD-4 Density Sensor solves this problem by incapsulating the joint into the sensor so that the internal forces resulted from changes in pressure, temperature or relaxation of material are fully controlled and auto-compensated. This enables the accuracy of the sensor as high as 0.3%FS.

MUD-4 Density Meter is **the only online weight-based densitometer that works.**

Built for Durability and Reliability

DENCELL® MUD-4 is the 4th generation of weight-based densitometers developed by our team over the course of 20 years of research and field application. This model of the densitometer has a **proven industry track record since 2012.**

We designed a durable product to withstand extreme external conditions and to work with highly abrasive slurries. We carefully selected the materials, learned from the use cases and built a product that can last years.

DENCELL® MUD-4 Density Meter features:

- **Stainless steel sensor and body**
- **Highly accurate density sensor**
- **Premium abrasive resistant lining with a projected lifespan of up to 10 years**
- **Integrated and sealed electronics**
- **Open discharge**

The recommended lifespan of the densitometer is 8 years.

Low Maintenance Cost

One of the key benefits of DENCELL® MUD-4 Density Meter is its low maintenance. The instrument itself is very robust and only requires scheduled visual inspections with external cleanup. Compared to x-ray density meters, that require substantial cost to handle and replace radiation sources, MUD-4 sensor is designed to last for the complete lifespan of the meter. The lining of the densitometer is built to last for the full lifespan of the meter. In rare cases of faster wear, the lining can be replaced.

To increase durability and operability MUD-4 Density Meter has an external Control Unit with a Touch Screen HMI that enables easy on-the-spot calibration of the instrument. The Touch Screen HMI is housed in ABS enclosure with IP 65. The Control Unit communicates with the Sensor via RS-485 interface.

Ease of Use and Integration

The external Control Unit with a Touch Screen HMI provides an easy way for the operator to configure and calibrate the densitometer with on-screen instructions and wizards.

The system can be connected to the Control Room via RS-485 interface or 4..20mA.

Direct on-site calibration is available with just two data points: point zero or an empty pipe, and and the actual current density of the slurry measured with alternative means, such as weighting a fixed volume of a slurry sample with electronic weights. In subsequent calibrations only the 2nd data point is required while point-zero could be assumed unchanging.

IoT and Cloud Ready

DENCELL® MUD-4 Density Meter can be supplied with GPRS/GSM modem that enables remote maintenance of the meter and data collection in the cloud with the capability to delivery data reports via the web or on a mobile device.

Advantages of DENCELL® MUD-4 Density Meter over Nuclear and Ultrasonic Density Meters

DENCELL® MUD-4 Density Meter	Nuclear and Ultrasonic Density Meters
PROS: DENCELL® MUD-4 implements a direct measurement method and therefore does not depend on the changes in process conditions.	**CONS: Nuclear and Ultrasonic meters are correlational and are susceptible to error due to changes in process conditions.**
DENCELL® MUD-4 Density Meter measures the integral weight of the fixed volume of slurry, which is a **direct** method of density measurement that **does not depend** on various parameters of the slurry, such as viscosity, particle size distribution, shape and composition of particles. As a result, MUD-4 is immune to changes in the upstream process conditions or the underlying material properties.	Nuclear and Ultrasonic instruments are **correlational**, which means that they **predict** what the slurry density is **instead of measuring it directly.** Prediction leads to error when process conditions change. For example, if the size distribution of solids has changed due to a change in the upstream process. Or when the density and composition of the solids has changed if the ore is sourced from multiple sites.
PROS: DENCELL® MUD-4 has a linear scale and therefore maintains its accuracy within full scale.	**CONS: Nuclear and Ultrasonic meters are calibrated to a narrow density range and are inaccurate outside of this range.**
DENCELL® MUD-4 Density Meter can be calibrated with just 2 points: point zero corresponding to the empty pipe and the the actual current density of the slurry. Once calibrated with the 2nd data point, the instrument will provide valid measurements in the full range of 800 … 3500 kg/m³.	Nuclear and Ultrasonic instruments are typically calibrated in a narrow range of densities, for example 1200 to 1600 kg/m³. However, if the density of the slurry goes below or above the calibration range, the error of the instrument will increase beyond the 0.5-1.0% outlined by the manufacturer of the instrument.
PROS: DENCELL® MUD-4 measures density of the complete volume of slurry passing through the meter and therefore is immune to the density distribution across the pipe section.	**CONS: Nuclear and Ultrasonic meters use a narrow beam (x-ray or ultrasound wave) and achieve subpar performance on materials with a wide size distribution.**
Slurries are multi-phase fluids that have significant variation of properties, such as density, viscosity and particle size distribution across the section of the pipe. DENCELL® MUD-4 Density Meter is well suited for slurries as it measures the complete volume of the slurry passing through the meter regardless of specific parameters of the slurry in any cross-section of the Density Sensing Pipe.	Nuclear and Ultrasonic meters determine the dissipation of the energy of the signal (x-ray or ultrasound wave) that passes through the center of the pipe. This measurement is only representative f the complete volume under the assumption that the slurry if perfectly mixed, which is rarely true. This leads to measurement error. This issue is most prominent when the meters are installed on horizontal pipelines.

Specifications

Description	Value Range	
Full operating density range	800 .. 3500 kg/m³	50 .. 220 lb/ft³
Density Accuracy		
• Light slurries	0.3%FS	
• Heavy slurries	0.5%FS	
Temperature Accuracy	0.5°C	1.0°F
Maximum sampling frequency	300 measurements per second	
Response / Decay time	0.85 .. 60.0 seconds	
Filtering	Configurable Moving Average	
Number of measurement channels:	2	
• Channel 1	Density	
• Channel 2	Temperature	
On-screen indication	Density, Temperature	
Density Digital output	RS-485	
Density Analogue output	Isolated 4..20mA	
Density Resolution:		
- on-screen, kg/m³	1.0 kg/m³	1.0
- analogue/digital output, kg/m³	0.01 kg/m³	0.01
Power Supply:		
• voltage	110-230VAC	
• power consumption	10W	
Process Connection	Bypass	
• Inflow diameter, mm (in)	76..100 mm	3..4 in
• Internal diameter, mm (in)	65 mm	2.5 in
• Outflow diameter, mm (in)	60 mm	2.35 in
Ambient temperature, °C (°F)	0..70 °C	32..158 °F
Process temperature, °C (°F)	0..70 °C	32..158 °F
Dimensions:		
• Sensing Unit (WxHxL)	204x225x660 mm	8x8.9x26 in
• Control Unit (WxHxD)	320x300x145 mm	12.6x11.8x5.7 in
Weight:		
• Sensing Unit, kg (lb)	16.2 kg	35.7 lb
• Control Unit, kg (lb)	3.5 kg	7.7 lb

Process Connection

DENCELL® MUD-4 Density Meter is typically connected via bypass of 80 to 100mm in diameter.

The Density Meter is supplied with a stainless steel polyurethane or PVC lined inlet pipe with external diameter of 76 mm (3 inches) ready to connect to a heavy-duty abrasive resistant rubber hose. An adapter to a 100mm (4 inch) hose is also available.

The bypass is connected to the main pipeline, a chute or equipment directly. In some cases rubber intake devices are used to redirect the stream of slurry into the bypass. In some cases gate valve may be used to close the bypass.

An outlet pipe with internal diameter of 200mm (8 inches) is installed at the outlet of the MUD-4 Density Meter to collect the slurry flowing from the instrument.

Maintenance Requirements

DENCELL® MUD-4 Density Meter is design to last for the complete projected lifespan of the instrument in harsh conditions of processing plants in constant contact with slurry.

Infrequent visual inspection is required to assess the wear of the system and is easy to perform due to the open outlet of the Density Meter.

About Us

DENCELL® MUD-4 Density Meter is the 4th generation of weight-based density meters developed in Ukraine by a group of researches at KVAR Scientific and DENCELL,LLP since 1999.

Over 20+ years of R&D we have refined the density measurement method used in MUD-4 Density Meter and completed a full instrument lifespan testing with our partnering processing plants.

Our installation base is in Ukraine, Russia, Kazakhstan, and Armenia. MUD-4 Density Meter has been in commission since 2012 with extremely solid reviews. It has become the density meter of choice for sludge and slurry in Ukraine.

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