

Application Brief
TROXLER MODEL 3430
Roadreader™
Nuclear Moisture Density Gauge

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Introduction

The Troxler Roadreader™ nuclear moisture / density gauge, Model 3430, can quickly and precisely determine the moisture and density of soils, soil bases, aggregate, concrete, and asphalt without the use of core samples or other destructive methods. This model offers two test modes for density determination of construction materials. The operator chooses either backscatter or direct transmission mode to perform tests depending on the thickness and type of material being tested. This application brief will describe the operation, application and features of the Model 3430 Roadreader™ Surface Moisture / Density Gauge.

Background

The Model 3430 gauge is a simpler version of the Troxler Model 3440 nuclear moisture / density gauge. The ASTM standard numbers D 6938 (replaced D 2922 and ASTM D 3017 as of November 2006), D 2950, and C 1040 are met or exceeded by these gauges. These two gauges are similar in size, weight and function but the 3430 has fewer features. The storage and printing capabilities available with the Model 3440 gauge are not available with the Model 3430. Fewer features and ease of operation as well as a lower price make the Model 3430 gauge desirable for many operators.

Measurement Technology

The Troxler Roadreader™, Model 3430 uses the interaction of gamma radiation with matter to measure density through direct transmission or backscatter. This gauge determines the density of material by counting the number of photons emitted by a cesium-137 source that are read by the detector tubes in the gauge base. In direct transmission, the source rod extends through the base of the gauge into a predrilled hole to position the source at the desired depth, a maximum 30 cm (12 inches) deep. Photons from the source travel through the material in the test area, colliding with electrons present in the material, to reach the photon detectors in the gauge. During a backscatter measurement, the source is lowered near the surface of the test material, in the same plane as the photon detectors. The gamma photons that enter the test material must be scattered at least once to reach the detectors in the gauge. Photons emitted from the source penetrate the test material and the scattered photons are measured by the detectors. A backscatter reading measures material from the surface to a depth of approximately 10 cm (4 in.).

A material with a high density increases the number of collisions between the gamma photons and the electrons present in the material. Therefore, the number of photons reaching the detector tubes is reduced. In short, the lower the number of photons reaching the detector tubes, the higher the material density. The opposite is true for material with a lower density; fewer collisions occur between the gamma photons and electrons present in the material. More photons will reach the detector tubes, increasing the density count. A microprocessor in the gauge converts these counts into a density reading.

The moisture determination occurs in much the same way as the backscatter density reading. The Americium-241: Beryllium (Californium-252 in the Model 3430 M) source is located inside of the gauge base. Fast neutrons from this source enter the test material and are slowed by collisions with hydrogen atoms present in the material. The helium 3 detector in the gauge base counts the number of thermalized (slowed) neutrons. This number (known as the moisture count) is directly related to the amount of moisture in the tested area.

Gauge Operation

The Troxler Model 3430 offers two user specified modes of operation to determine the moisture and density of construction materials: Soil and Asphalt. Although all gauge moisture and density systems are active during each test, the microcontroller processes and presents data differently for each mode.

Soil mode is designed for measurement of soils, stone or other materials where both density and moisture content measurements are desired. Measurements can be made in either direct transmission or backscatter position. Direct transmission typically offers better precision and control of depth of measurement and is the preferred method. When taking a measurement in soils mode the information provided by the gauge will be Dry Density, Wet Density, Moisture, Percent Moisture, Percent Proctor, Percent Air Voids and Void Ratio.

Asphalt mode is used on full depth asphalt (10 cm [4 in] or greater). Typically the source rod is in the backscatter position, on top of the asphalt, alternatively direct transmission may be used if a hole is drilled in the asphalt. The asphalt mode displays the Wet Density, Percent Marshall and Percent Voids.

Surface preparation for soil testing can be critical to gauge performance and test results. The scraper plate accessory provided can be used to prepare surfaces that are not smooth by moving it back and forth across the area. Small voids, cracks, or holes can be filled with sand or native fines. This is most critical when testing in the backscatter position. When performing density tests on coarse open graded asphalt, surface voids may be filled with soft sand, cement powder or native fines. The asphalt surface should remain bare so that the gauge base makes contact with the surface. It is also important that the gauge sit flat on the asphalt surface and does not “rock”.

Offsets

The Roadreader™ Model 3430 gives the user the ability to input offsets to gauge readings to correct for non-standard conditions. In soil mode, a moisture offset may be needed to adjust for the presence of chemically bound hydrogen or the presence of neutron absorbers. Offsets available in both soil and asphalt modes are: a density offset to correct for material composition or for material with a density outside of the calibration range (1100-2700 kg/m³ / 70-170 PCF)

and a trench offset to correct for errors due to large above surface masses near the measurement area.

Keypad

The Model 3430 keypad consists of 10 keys. Above the keypad is a 2 line by 16 character Liquid Crystal Display screen. Up and Down arrow keys allow scrolling through various information displayed on the LCD screen. This gauge is equipped with a “beeper” to verify each keypress. If the “beep” is not heard the keypress should be repeated.

Batteries and Power Consumption

The Model 3430 gauge runs on a rechargeable NiCad battery. Under normal conditions (8-hour day) a fully charged battery will remain operational for approximately 8 weeks. When the “BATTERY LOW” warning appears, there are a few hours remaining before the battery must be recharged. A full charge (16 hours) is recommended at that time, but a 30 minute recharge will provide several hours of use if necessary. Two adapters are included as standard accessories with this gauge: a 115/230 VAC 50/60 Hz and a 12 VDC charger. Alkaline batteries (D size) can be used temporarily in the event that recharging is not an option. A separate battery case is supplied for this purpose.

Additional Features

The Roadreader™, Model 3430 includes several functions that ensure correct gauge operation. A daily reference standard count is performed by the operator to account for source decay and natural background factors, such as naturally occurring radiation and hydrogen. To verify gauge stability, the operator compares the daily standard to the average of the last four standard counts. The new counts must be within a stated limit of the counts to which it is compared. A statistical stability test, or stat test, may be performed to validate the normal operation of the gauge. A stat test may be executed if readings are “suspect”. The drift test can be performed to check the long term drift of the gauge if the stat test has been performed (and passed).

Five language displays are supported by this gauge. English, French, Chinese, German and Spanish display, keypad inserts and manuals are available options with the Model 3430 gauge. The units of measurement can be set to display in either metric or U.S. units. The recall function allows the user to view the data from the last reading. These are some of the options available with the Model 3430 gauge to assist the user in quick and efficient moisture and density testing of construction materials.

Summary

The Troxler Roadreader™ Model 3430 can be used for moisture and density testing of soil, asphalt, concrete and aggregate. Two testing modes are available for use: backscatter and direct transmission. The operator selects the mode depending on the material type and the thickness of the material being tested. The Model 3430 offers single keystroke function access and direct readout of test results. This gauge is lightweight, powered by rechargeable NiCad batteries or backup alkaline batteries and is available with keypad, display and operator’s manual in five languages (English, Chinese, Spanish, French and German). No other moisture / density gauge offers the benefits and proven performance of the Model 3430 at such an attractive price. This is definitely the best value in the industry!

Comparison of Measurement Precision

Model 3430 Nuclear Moisture / Density Gauge

<u>Direct Transmission</u> (6" / 150mm)	<u>15 sec.</u>	<u>1 min.</u>	<u>4 min.</u>
Precision at 125 pcf 2000 kg/m ³	+/-0.42 +/-6.8	+/-0.21 +/-3.4	+/-0.11 pcf +/-1.7 kg/m ³
Composition error at 125 pcf 2000 kg/m ³	+/-1.25 +/-20	+/-1.25 +/-20	+/-1.25pcf +/-20kg/m ³
Surface error (0.05", 100% Void) pcf (1.25mm, 100%Void) kg/m ³	-1.1 -17	-1.1 -17	-1.1pcf -17kg/m ³
<u>Backscatter</u> (98%) (4" / 100mm)			
Precision at 125 pcf 2000 kg/m ³	+/-1.00 +/-16	+/-0.50 +/-8	+/-0.25pcf +/-4kg/m ³
Composition error at 125 pcf 2000 kg/m ³	+/-2.5 +/-40	+/-2.5 +/-40	+/-2.5pcf +/-40kg/m ³
Surface error (0.05", 100% Void) pcf (1.25mm, 100%Void) kg/m ³	-4.7 -75	-4.7 -75	-4.7pcf -75kg/m ³
<u>Moisture</u>			
Precision at 15 pcf 250 kg/m ³	+/-0.64 +/-10.3	+/-0.32 +/-5.1	+/-0.16pcf +/-2.5kg/m ³
Surface error (0.05", 100% Void) pcf (1.25mm, 100%Void) kg/m ³	-1.12 -18	-1.12 -18	-1.12pcf -18kg/m ³
Depth of measurement at 15 pcf = 8.5" 250 kg/m ³ = 212.5 mm			