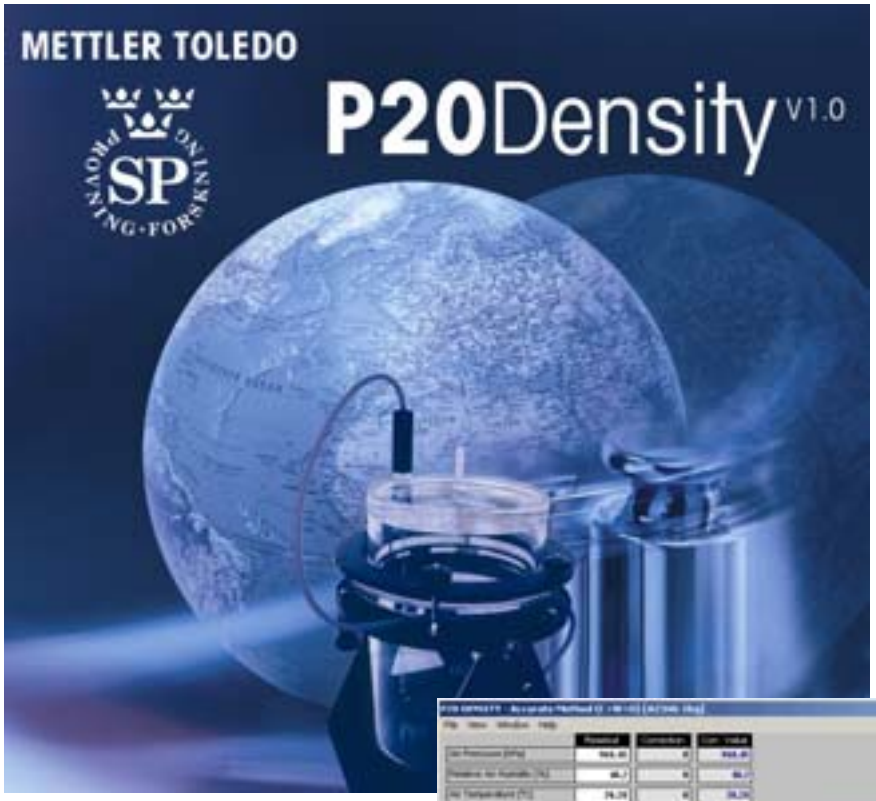
METTLER TOLEDO

Product outline



Software designed by

The efficient density determination from 2 up to 20 kg

Mettler Toledo

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1 Introduction

Thank you for showing a keen interest in our P20 Density – a simple and practical device for density determination from 2 kg up to 20 kg weights for the OIML accuracy classes E1, E2 and F1.
With its communication capability and the filling station, the efficiency is brought to top level at low investment cost.
With the extensive manuals, the operating instruction, the full theory of the system and all the required information's for the validation are included.

Among P20 Density numerous remarkable features, let us highlight the essentials

- Density determination for 2 to 20 kg weight with low uncertainty
- Two density determination methods available
- Highly efficient filling station for accurate volume adjustment
- High accuracy temperature sensor included
- Expert software calculating according OIML R111, density determination method D
- Detailed uncertainty analysis
- Password protected database for sensitive data
- Rugged design
- Low operational cost

Should you desire further information on P20, please do contact us

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2 P20Density

The P20Density is consisting of constant volume vessel, the high performance filling station and the control software, which is developed by SP, the Swedish national and research institute.
In combination with optional mass comparators, standard weights and distilled water, a highly accurate density determination system is achieved with low investment cost.
The volume of the test weight is determined with the displaced water volume of the test weight according the volume determination method D of OIML R111 .
The software includes two processes, which allow verification (fast method) or calibration (accurate method) of test weights density under complete process guidance and direct data communication to the balance.

3 P20Density hardware

The P20Density hardware was developed by METTLER TOLEDO under consideration of accuracy, volume stability and usability. With the divided body of the Pycnometer, the loading of the test weight is simplified and high volume stability can be achieved.

Picture 1 P20Density hardware

Picture 2 Syringe and gloves

Picture 3 Water temperature sensor

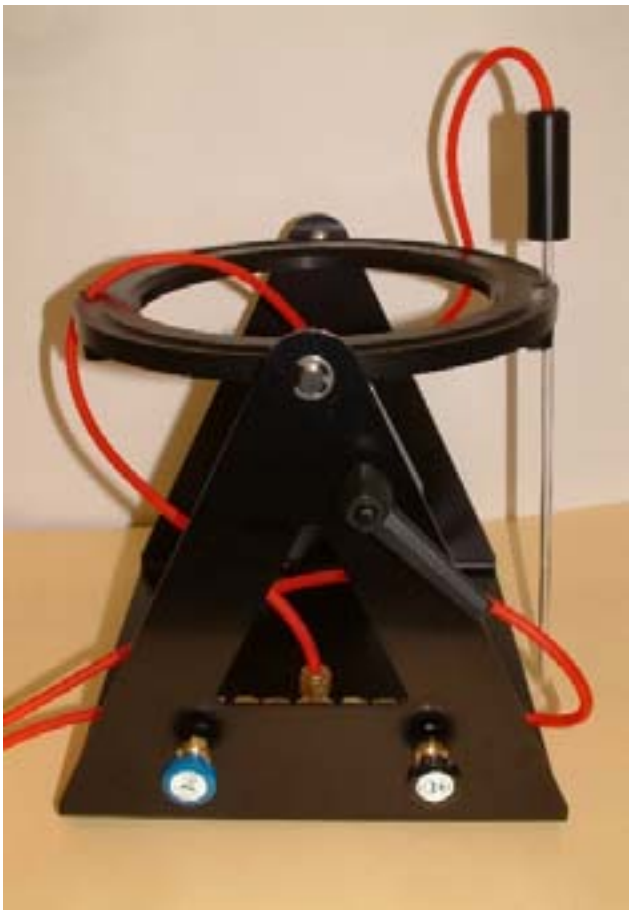
The level indicator on the top lid allows detection of smallest water level differences to obtain equal levels in the measurements. To adjust the water levels, a surgical syringe is supplied to for small volume differences.
The special leather gloves allow loading of the test weight without warming up the material significantly and disturbing the thermal stability of the system. With the special temperature sensor, water temperature is measured for water density determination.

With the tightening ring a homogeneous compression of the seal is achieved. The vessel volume is constant for the measurement repetitions

Picture 1 Tightening ring

With the special design of the top lid and glass vessel no edges are present to catch air bubbles and distort the measurement result.

Picture 2 Top lid



Picture 3 Filling station

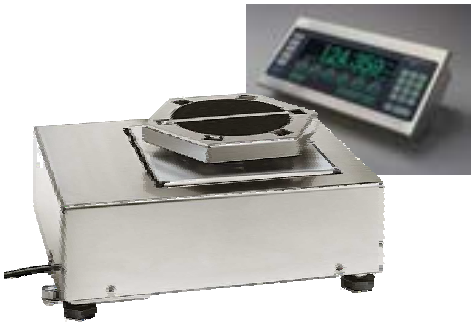
Picture 4 Glass vessel

The new designed swivel system with flow control allows accurate filling of the vessel under consideration of lowest air enclosure. The Device to test is placed into the vessel and secured with a support holder. The vessel with the supported weight is swiveled to 45° to eliminate traps for the air. With the gravitational pump the water flows gentle into the vessel and prevented to build air bubbles on the surface and edges of the weight.
The filling process is automated and does not require continuous supervision. After the filling the P20 Density is disassembled from the filling station and placed on the mass comparator for mass determination. After the mass determination, empty the vessel is as simple as the filling. The P20 Density is placed into the filling system and the Filling pipe is introduced inside the vessel. With opening the valve the water is drawn out.

3.1 Equipment required for operation

The P20 Density does not contain equipment, which is used by standard in mass laboratories. Additive to the contents of delivery are required:

Mass Comparator	Resolution	<=50 mg	
	Weight range	0 .. > 30 kg for P20 Density	
	Control	Terminal ID7MC	
Reference weights	Mass Range	For Vessel measurement	10 200 g with weights combination
		For 2 kg measurement	12 000 g with weights combination
		For 5 kg measurement	14 600 g with weights combination
		For 10 kg measurement	19 000 g with weights combination
		For 20 kg measurement	27 750 g with weights combination
	OIML Class	Equal or better than F1;	
		The special P20Density disc weights set. With the 2 x 10kg F1 weights a save and easy stacking of the reference weights is possible. For order information please inquire	
Water tanks	Volume	≥ 20 litter with water connection 4 mm	
Fluid	Distilled water		
Laptop	Min. requirements	PIII 500 MHz, min. 64 MB RAM, serial interface RS232, HD space >10MB, Windows 98SE, Me, NT4.0, 2000 or XP	



Picture 5 Mass comparator

Picture 6 Stack with standard reference weights & disc weights

Picture 7 Reference weights

Picture 8 Optional 10kg Disc weights

4 P20 Density software

The P20 Density software is the calculation and control interface for the P20 Density hardware.
In combination with the optional mass comparator, the P20 Density software allows direct communication between the mass comparator and the calculation tool. With the comprehensive process guidance, the operator can perform density measurements at high accuracy with little experience.

Features

- Includes reference database
- Includes sensors database with correction factors
- Pre selections of sensors, balance and references for each nominal
- Use of multiple Pycnometers
- Automated communication to ID7MC terminal
- Password protected database section for sensitive data
- Write protected data files including all parameters of process
- Online help with details of the software

Advantages

- Only reliable data of references and corrected sensors data is used for calculation
- No influence of operator to sensitive data
- Traceability of results
- Efficient process due to semiautomatic readings from mass comparator

Benefits

- Reliable data
- Report files easy to process
- Efficiency
- Data safety and traceability

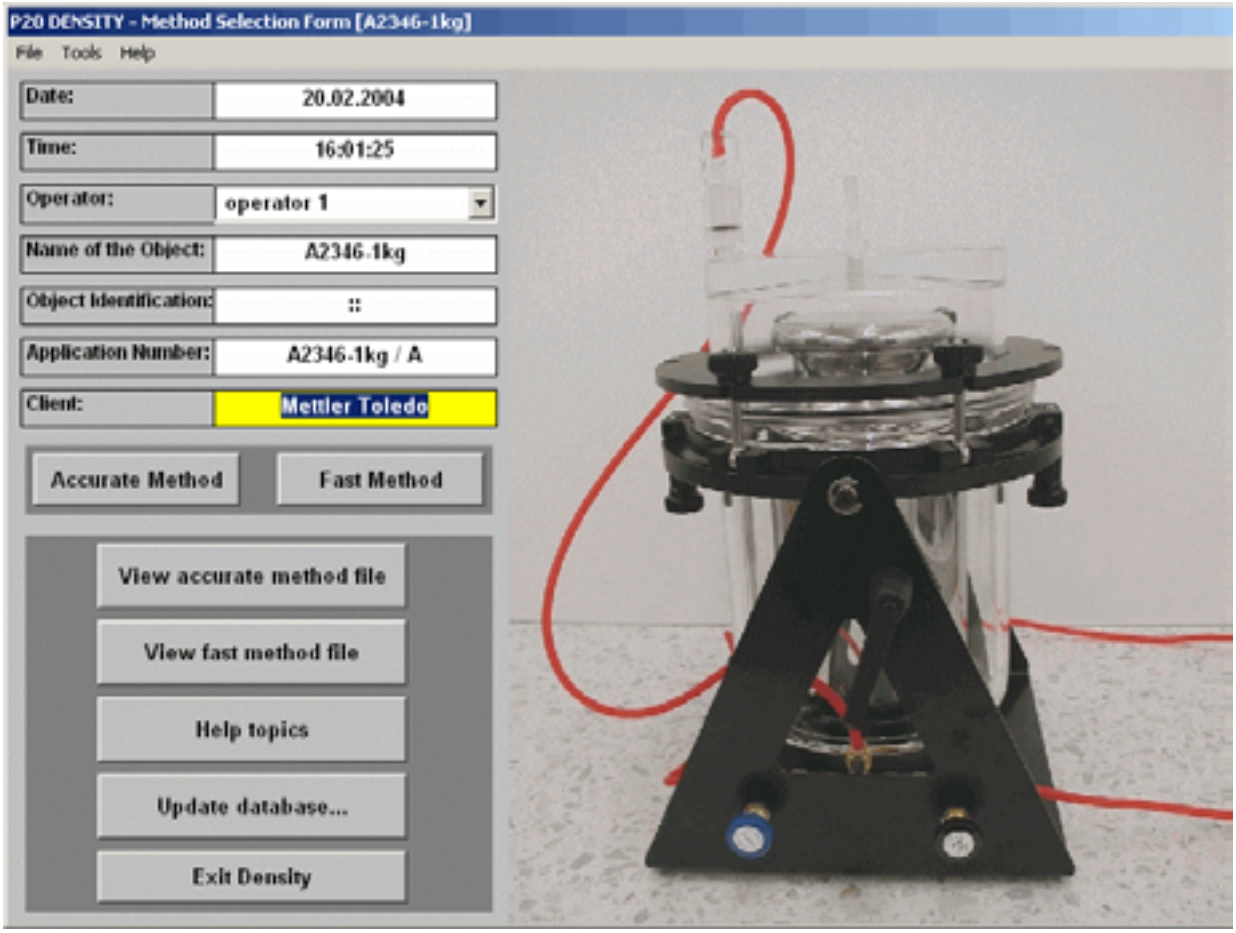
4.1 P20 Density software structure

The P20 Density software is divided in 5 main sections and subsections.

Section	Meaning
Method selection	Start up screen; Definition of Operator, weight ID, Client data
Accurate method	
Sensor selection form	Definition of object; container, sensors, balance, communication
CWO measurement	Definition of environmental parameters; balance readings
CW measurement	Definition of environmental parameters; balance readings
Calculation	Definition of volume expansion factor, calculation; results
Uncertainty analysis table	Table with standard unc, probability, sens coefficient, unc component
Fast method	Definition of object, mass value CWO + CW, water temp, calculation
Viewing previous reports	
Accurate / Fast method	Viewing in details previous reports
Database	
Air and water uncertainties	Definition of air and water density uncertainty contributions
Balance data table	Definition of balance data and communication parameter
Pycnometer data table	Definition of Pycnometer volume, volume uncertainty and mass
Reference weights data table	Definition of reference weights mass, density with uncertainties
Operator data table	Definition of specific operator influence
Pressure, Temperature and humidity sensor data table	Definition of correction factors for environmental sensors
Input limits fields	Definition of working limits for the software

4.2 Method selection

The method selection is the start up screen of the P20 Density software. Clicking the accordant buttons activates all the functions. The customer and weight identity fields are filled and the required method is selected to start the measurement. The given data is integrated in the report files for traceability of the data.



Picture 9 P20 Density method selection screen

With the integrated online help, topic specific details can be searched and explanations are given.
Topics discussed are

- Program overview
- Fast method
- Accurate method
- Database handling
- Theoretical basis

4.3 Accurate method (12 Steps)

The accurate method is more detailed compared to the fast method. With more accurate mass determination and other additive measured parameters,

Measurement course

Step 1	Mass determination of test weight
Step 2	Definition of test weight and customer details
Step 3	Definition of weights parameters
Step 4	Selection of environmental sensors and balance to use
Step 5	Definition of environmental parameters for Pycnometer and test weight
Step 6	Differential mass determination (3 ABBA) of Pycnometer with test weight and water
Step 7	Definition of water temperature Pycnometer with test weight
Step 8	Definition of environmental parameters for Pycnometer
Step 9	Differential mass determination (3 ABBA) of Pycnometer with water
Step 10	Definition of water temperature Pycnometer with test weight
Step 11	Definition of volume expansion factor
Step 12	Calculations

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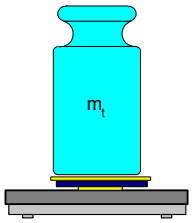

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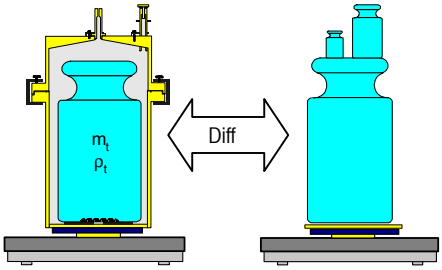

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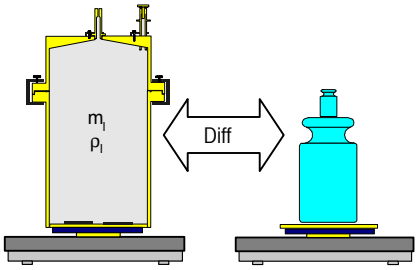


Features

- 3 ABBA differential measurements for mass determination P20 Density with test weight
- 3 ABBA differential measurements for mass determination P20 Density only
- Calculation of the air density during the mass determinations
- Water density calculated according to the formula of Tanaka, Girard, Davis, Peuto, Bignell under consideration of the ITS 90.
- Air density calculated according the CIPM 81/91 formula
- Correction of the volume expansion with definable factor
- Detailed uncertainty analysis for all significant influence factors
- Detailed process report as Excel sheet.
- Density specified at measurement temperature and 20°C

Advantages

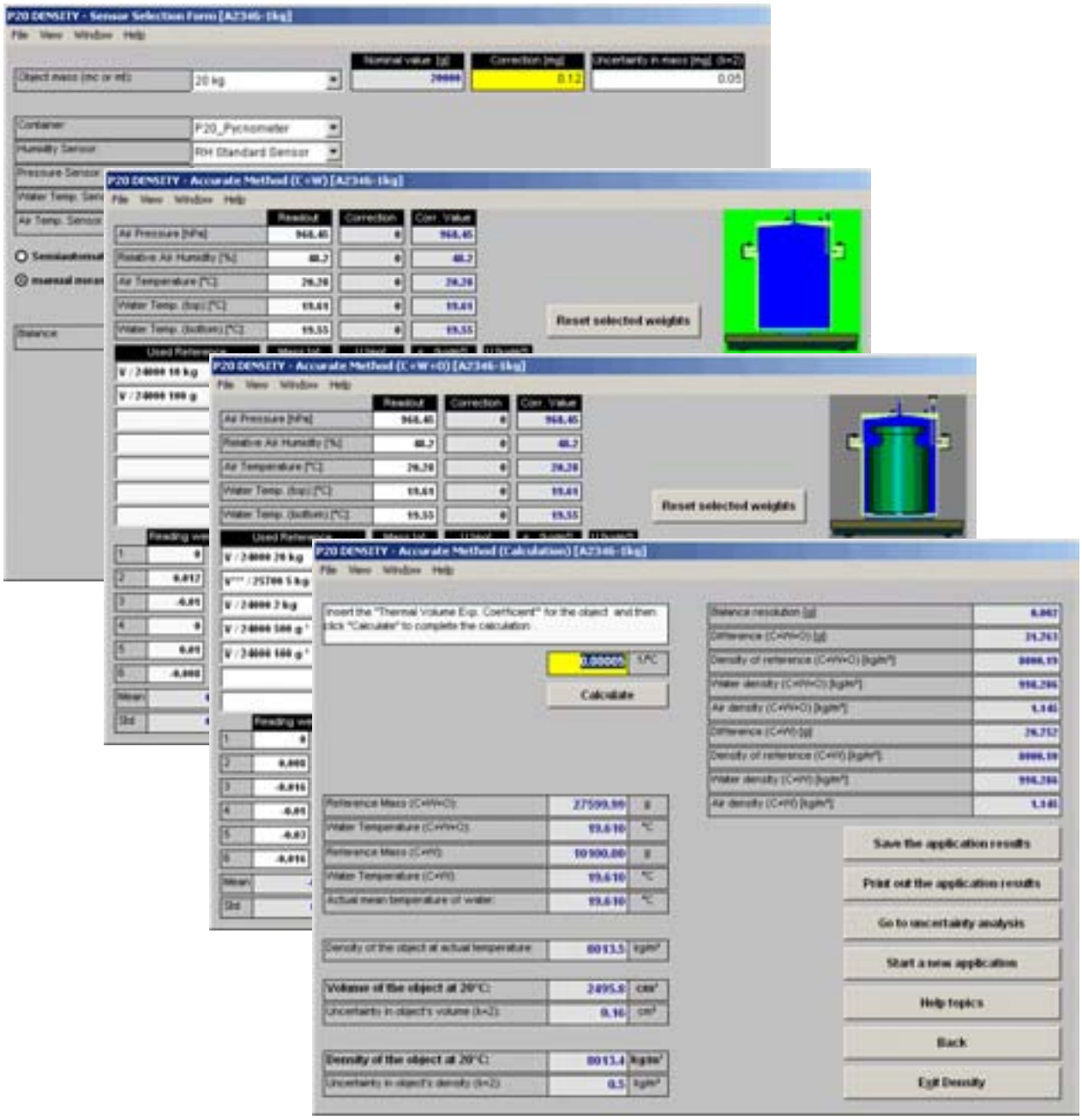
- High accuracy mass determination of P20 Density for more accurate results
- Detailed calculation of environment influences
- Best uncertainty estimation including all major influencing factors

Benefits

- Detailed uncertainty influences are measured and calculated
- Requirement of uncertainty for E1 density determination fulfilled
- Suitable for verification and calibration

Specification

• Density uncertainty (k=2), ND	1 .. 15 kg / m^3
• Process time	< 2 hours



Picture 10 P20 Density accurate method Sensor selection, CWO, CW and result screen

With the sensor selection form all the parameters of the test weight, used sensors and mass comparator are selected. With the checkbox the user can select the semiautomatic process, which reads the balance data directly from the terminal via the serial interface. When proceeding to the CWO (container, water and test weight) measurement, the serial communication is established.
For the air density calculation the environmental parameters are entered and the required references are selected from the database table according the pre-calculated mass of t the test weight and the P20 Density. When the required references mass is achieved, the process starts automatically. The 3 ABBA mass measurements are performed to determine the accurate mass of the 20 Density with the test weight. For the accurate water density calculation, the temperature inside the vessel is measured and the values entered in the table. With the CW (container and water) measurement the same process is repeated. As final step, the volume expansion factor is entered and the calculation is started. The result sheet indicates the volume and density of the test weight as measured and calculated to 20 °C standardized temperature. Included in the results is the combined measurement uncertainty of the test weight volume and the density.

4.3.1 Uncertainty Analysis

With the accurate method a detailed uncertainty calculation is performed. The standard values are defined within the administration database. To achieve practical data, the single uncertainty factors are calculated and the sensitivity factor is defined according the mathematical standards. With this feature, the calculated uncertainty is closer to the reality than the standard calculation of the root sum squares. See below attainable uncertainties with suitable accessories. Uncertainty factors included are

Common section

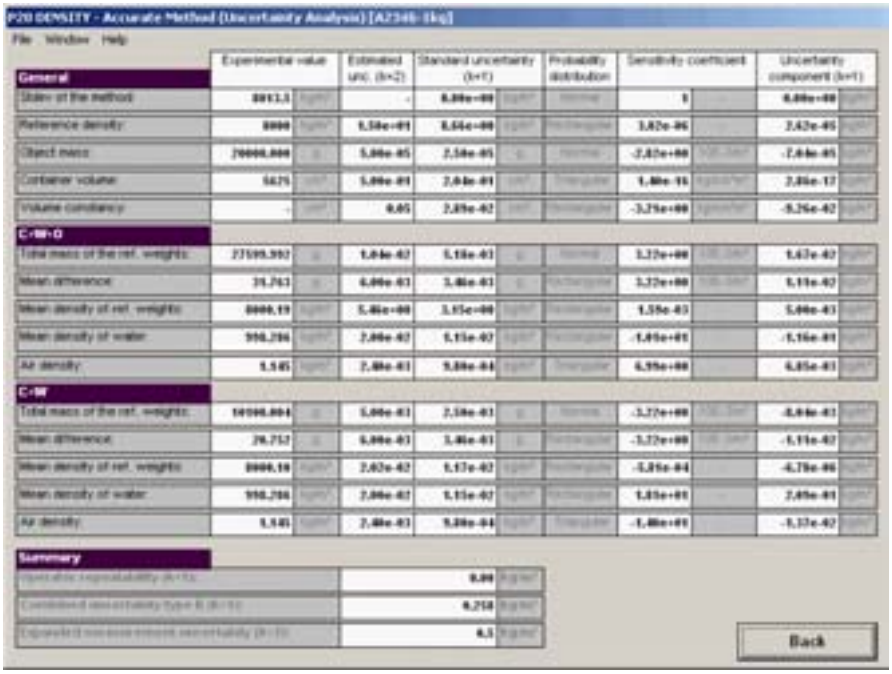
- Standard deviation of the method / Operators repeatability
- Balance calibration references density uncertainty
- Test weight mass uncertainty
- P20 Density volume uncertainty
- P20 Density volume constancy

CWO (container, water and object) measurement

- Mass uncertainty of reference weights
- Mass difference uncertainty / Balance repeatability
- References density uncertainty
- Water density uncertainty
- Air density uncertainty

CW (container and water) measurement

- Mass uncertainty of reference weights
- Mass difference uncertainty / Balance repeatability
- References density uncertainty
- Water density uncertainty
- Air density uncertainty



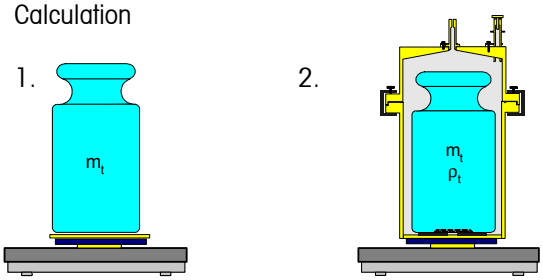
Picture 11 P20 Density uncertainty analysis accurate method

4.4 Fast method (4 Steps)

With the standard process according OIML R111-2 Density determination method D, a fast and reliable density verification is performed. The testing time is limited to a minimum with an accuracy satisfying the lower classes specifications. The uncertainty is determined once with repetitive measurements and introduced in the result with a safety factor.

Measurement course

Step 1	Test weight mass determination
Step 2	Absolute mass measurement P20 Density with test weight and water
Step 3	Definition of water temperature P20 Density with test weight
Step 4	Calculation



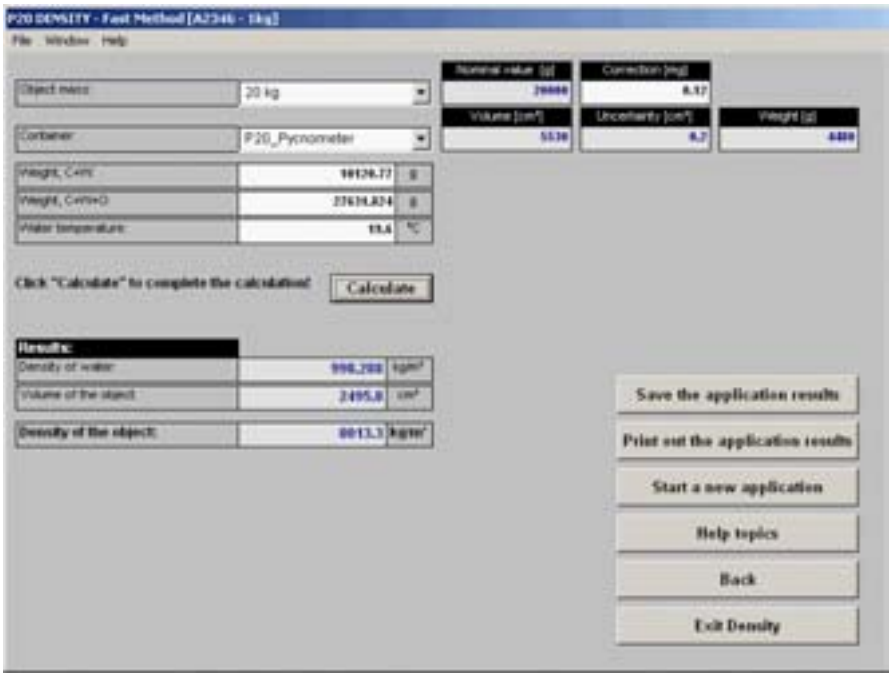
Features
- One absolute measurement of P20 Density with test weight only
- Predefined Pycnometer mass for process time reduction
- Density specified at measurement temperature
- Detailed process report as Excel sheet

Advantages
- Efficiency, less time consuming

Benefits
- Method D of the OIML R111 is fulfilled
- Suitable for verification

Specification

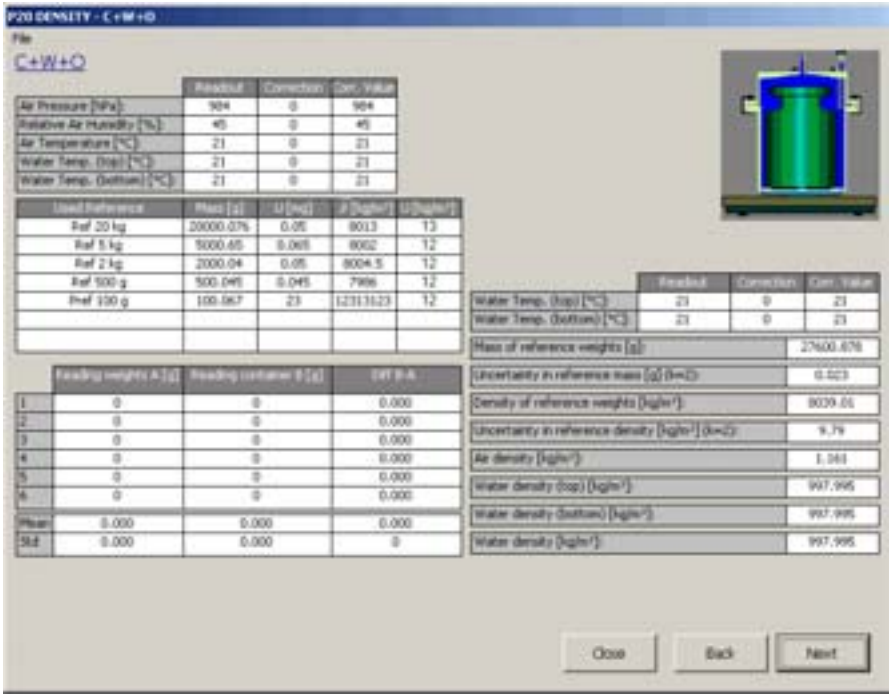
• Density uncertainty (k=2), ND	2 .. 25 kg/m^3
• Process time	<30 min



Picture 12 P20 Density fast method

4.5 Viewing previous reports

The P20 Density software includes the feature of viewing previous produced data sets. This allows the user to reproduce the process performed and analyze influences of factors.
The read data file cannot be edited to ensure the consistency of the data for later traceability or verifications.



Picture 13 View accurate

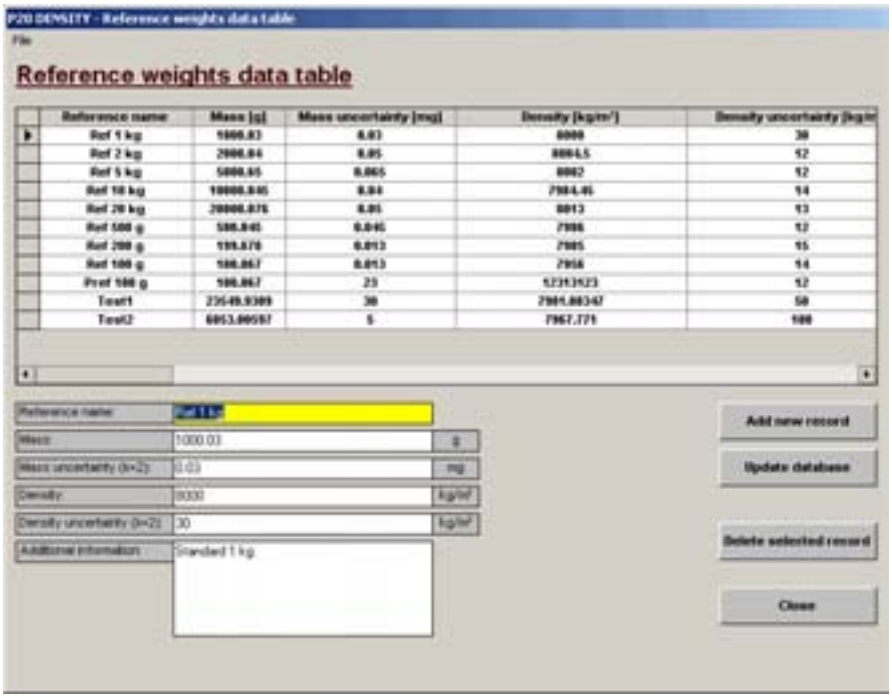
4.6 Database

Within the password protected database section all the sensitive data is defined. The process section of the P20 Density software then retrieves this data to the calculations without allowing editing this data.

The database is subdivided in the sections

- Water and air density uncertainties
- Balance data table
- Pycnometer data table
- Reference weights data table
- Operator data table
- Pressure sensor data table
- Temperature sensor data table
- Humidity sensor data table
- Input limits fields

Within the administration manual all the required information's are included to define all the parameters according specific situations at the users laboratory.



Picture 14 References database table

All the database tables are built up in similar character with easy editing capabilities.
See sample above for references data table.

5 Manual

The P20 Density is supplied with a complete documentation. All the required information's for process and validation are included and samples given for explanation of specific topics.

Operator's manual comprises

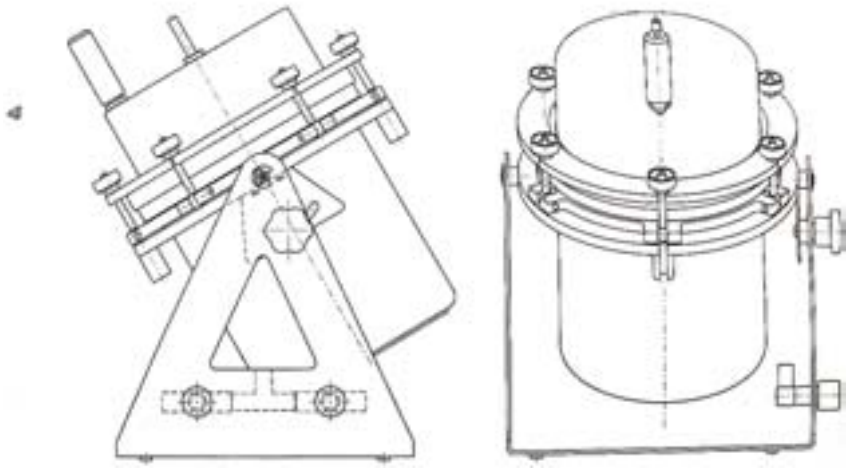
- Introduction measurement method accurate and fast
- Detailed process guidance accurate method
- Detailed process guidance fast method
- Trouble shooting

Administrator manual comprises

- Installation of P20 Density
- Handling of P20 Density database section
- Trouble shooting
- Theoretical basis
- Density calculation formulas
- Uncertainty calculation details
- Technical specification
- Terms and warrants

6 Technical Data

P20 Density mechanical dimensions



L x W x H	250 x 300 x 470 mm

Test weight geometrical dimension

Maximum permissible dimensions of weights to be tested

Diameter	127	mm
Height	255	mm

The supports have defined diameters for Mettler Toledo Standard OIML weights from 2 to 20 kg.

Measurement data

Specification recommended Balance KA30-3/P; KA50-2/P

	KA30-3/P	KA50-2/P	
Readability	0.002	0.005	g
Max capacity	30	52	kg
Taring range	0 .. 30	0 .. 52	kg
Repeatability	0.006	0.015	g

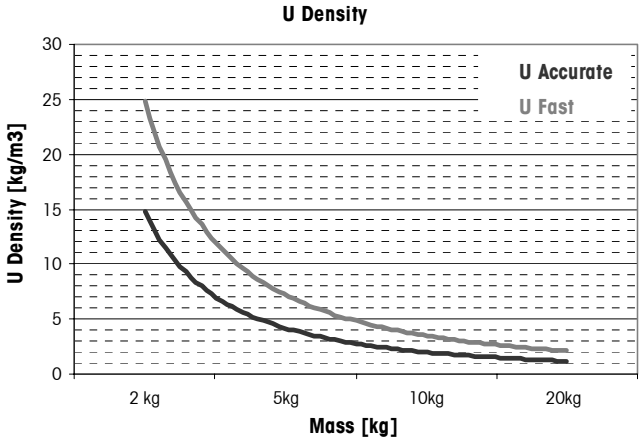
Specification as P20 Density used in combination with KA 30–3/P

Accurate method (12 Steps)

Density uncertainty (k=2)	1 .. 15 kg / m^3
Process time	< 2 hours

Fast method (4 Steps)

Density uncertainty (k=2)	2 .. 25 kg/m^3
Process time	<30 min



Product outline is subject to changes and to the availability.

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Release	22. March 2004
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