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Continuous On-line Measurement of Water Content in Petroleum (Crude Oil and Condensate)

First Edition, October 2010

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This technical report (TR) is intended to provide a performance basis for the use of on-line measurement of water content in petroleum (crude oil and condensate) in real-time using an On-line Water measurement Device (OWD) and to collect consistent data. However, it is not intended to preclude the use or development of any other technologies or methods. To gain a better understanding of the methods described in this standard, the reader should review in detail the latest editions of the publications, standards, and documents referenced herein.

SI units are used throughout this publication as the primary units of measurement since this system is commonly used in measurement and sampling. However, U.S. Customary (USC) units continue to be used in some applications. Therefore, both SI and USC units are shown (with USC in parentheses).

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Contents

Introduction

The purpose of this technical report is to provide guidance for the installation and operation of an On-line Water measurement Device (OWD) for on-line measurement of water content in petroleum (crude oil and condensate) in real-time. Guidance is also provided for the collection of consistent data to allow for long term performance assessment. Applications for the OWD include pipeline and marine applications, use as an operational tool for allocation of production, or other forms of non-custody transfer process management.

OWDs can be used in conjunction with other methods of water determination or as a stand-alone method. However, automatic sampling may be essential for determining other petroleum fluid properties and when the retention of samples is required for audit.

The OWD should be tested for acceptance as described in this technical report, and go through an on-going verification program as described in this technical report. Operation with different crude oils and different conditions may require additional testing and verification. This technology should be viewed as one of several methods to determine the water in petroleum and petroleum products. The method for measuring water in petroleum should be selected with consideration given to installation, application, and properties of the product(s) being measured.

Continuous On-line Measurement of Water in Petroleum (Crude Oil and Condensate)

1 Scope

This technical report will provide guidance for the application, installation, operation, verification, and proving of OWDs for use in the non-custody transfer measurement of water in crude oil and condensate.

2 References

API *Manual of Petroleum Measurement Standards*

API *MPMS*, Chapter 5, Metering

API *MPMS*, Chapter 7, Temperature Determination

API *MPMS*, Chapter 8, Sampling (all sections)

API *MPMS*, Chapter 9, Density Determination

API *MPMS*, Chapter 10, Sediment and Water

API *MPMS*, Chapter 13, Statistical Aspects of Measuring and Sampling

API *MPMS*, Chapter 20.1, Allocation Measurement

API *MPMS*, Chapter 21.2, Flow Measurement Using Electronic Metering Systems

API Recommended Practice 87, *Recommended Practice for Sampling and Analysis for Crude Oil Streams Containing from 2 % to 50 % Water by Volume*

ISO Guide 98 [1], *Uncertainty of Measurement*—Part 3: Guide to the Expression of Uncertainty in Measurement (GUM: 1995)

ISO 3171*, Petroleum Liquids – Automatic Pipeline Sampling*

NFOGM [2], *Handbook of Water Fraction Metering*

NFOGM, *Handbook of Uncertainty Calculations—Fiscal Metering Stations*

3 Definitions

For the purposes of this document, the following definitions apply:

3.1
dissolved water
Water in solution in petroleum and petroleum products.

[1] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org.
[2] Norwegian Society for Oil and Gas Measurement, P.O. Box 252, 1326 Lysaker, Norway, www.nfogm.no.

3.2
emulsion
An oil/water mixture that does not readily separate.

3.3
entrained water
Water suspended in oil. Entrained water includes emulsions but does not include dissolved water.

3.4
flow proportional water measurement
The flow weighted average water content over a fixed time period or batch volume determined from the OWD measurement and the liquid flow rate through the pipe during the time or batch period.

3.5
flow weighted average (FWA)
The average of a variable weighted by the flow rate or incremental volume. It can be the average of the variable values sampled at uniform volume intervals, or it can be the average of variable values sampled at uniform time intervals and weighted by the incremental volume that occurred during that time interval.

3.6
footprint verification
A number, a set of numbers, a table, an equation, or a curve representing the raw measurement (usually a frequency) of the meter, with a specific, uniquely defined content in the sensor section. The footprint should be recorded as part of factory calibration, so that it can later be used as a reference during a reproducibility check to verify that the meter has not changed its response.

3.7
free water
Water that exists in a separate phase.

3.8
homogenous
When a liquid composition is the same at all points in the container, tank, or pipeline cross section.

3.9
measurement location
Point where the OWD measures the water content of the petroleum stream.

3.10
on-line water measurement device (OWD)
A real-time measuring device that uses electronics to detect and calculate water concentrations in petroleum and petroleum products.

3.11
OWD system
An OWD system may be comprised of one or more OWDs, stream conditioning, other measurement devices (e.g., temperature, pressure, density, flow, etc.), and a computer to assimilate, compile, and report the data.

NOTE In this document, OWD and OWD system may be used interchangeably. The technical report does not preclude any technology that meets the scope. An OWD may require additional measurement instruments, may be full bore, or an insertion device installed directly in the main pipeline or within an analyzer loop.

3.12
pacing
The method of proportioning the measurement interval.

3.13
range
The maximum and minimum values attainable from a measurement device. When applied to an OWD, the units will be percent water in oil by volume (e.g., 0 % to 5 %, or 0 % to 100 %). Units of percent water in oil by mass are also allowed if the OWD is suitably calibrated.

NOTE In this document OWD and OWD systems are not designed to measure ppm of oil in water (i.e., very small amounts of oil in essentially 100 % water).

For convenience, the following definitions from API *MPMS* Chapter 8.2 (2nd Ed Oct 1995) are included.

3.14
representative sample
A portion extracted from a total volume that contains the constituents in the same proportions that are present in that total volume.

3.15
sample
A portion extracted from a total volume that may or may not contain the constituents in the same proportions that are present in that total volume.

3.16
sample loop
analyzer loop
“fast” loop
slipstream
A low volume stream diverted from the main pipeline which may be dedicated to analyzers, a sampling system or part of a power mixing loop.

3.17
static mixer
A device that utilizes the kinetic energy of the flowing stream to achieve stream conditioning.

3.18
stream condition
The distribution and dispersion of the pipeline contents, upstream on the sampling location.

3.19
stream conditioning
The mixing of a flowing stream so that a representative sample may be extracted.

4 Significance and Use

The OWD provides instantaneous water percent readings. When coupled with a pacing device (e.g., meter) the total amount of water can be determined (net oil). OWDs may be used in different applications. Annex A shows some examples of common OWD applications.

5 OWD Operating Criteria

5.1 General

5.1.1 To use an OWD, it is recommended that the instrument be evaluated with respect to Sections 6 and 7. Annex B shows two typical OWD installations.

5.1.2 If used to determine net oil, the OWD output must be flow weighted over the batch or time period if continuous. To accomplish this, the OWD sample period must be flow proportional. This requires the use of a flow meter (preferably a custody transfer quality meter). If a custody transfer meter is not available, a secondary meter (e.g. one used for pacing an automatic sampling system) may be used.

5.1.3 To improve the confidence in the OWD system, it is recommended that an uncertainty evaluation be made. The evaluation can include the uncertainties of the quantities input to the OWD and the functional relationships used within the system. An example of uncertainty calculations can be found in *ISO Guide 98—Uncertainty of Measurement*.

5.1.4 Table 1 lists some items that may influence the results of the OWD. The impact of these may be dependent on the instrument technology and the manufacturer of the OWD. Consult the manufacturer for additional information.

Table 1—Potential Uncertainty Influencers

Ambient pressure variation	Non-homogeneity of the flow
Ambient temperature variation	Pressure loss
Cavitation (if device is intrusive)	Salinity variations
Chemicals	Sand
Crude properties	Scaling or wax
Density of oil	System noise
Free gas	Vibrations
Installation effects	Viscosity variations

5.1.5 The evaluation should be properly documented and all information necessary for audit should be available to others.

5.1.6 This requires references to sources and background material, and detailed outlining of the evaluations with respect to Sections 6 and 7 where engineering judgment has been utilized. For more details about documentation, please refer to the *Handbook of Uncertainty Calculations—Fiscal Metering Stations* or the *ISO Guide 98—Uncertainty of Measurement*.

5.2 Measurement Criteria

5.2.1 To obtain a representative measurement from a flowing stream, free and entrained water should be well-mixed, dispersed, and distributed at the measurement point as described in API *MPMS* Chapter 8.2.

5.2.2 If sediment is part of the measurement, then a separate representative sample from an automatic sampling system should be taken and analyzed for the sediment value.

5.2.3 The Karl Fischer coulometric titration method is the most practical and timely method for the analysis of samples taken in the calibration and verification of OWDs that are used for pipeline and marine applications. If the water content is greater than 5 %, other test methods should be used.

5.2.3.1 For some applications, other test methods may be more appropriate.

5.3 Installation Requirements

5.3.1 The OWD system should be installed per the manufacturer's recommended installation guidelines and API *MPMS* Chapter 8.2, *Automatic Sampling*, as applicable.

5.3.1.1 For an OWD installed in an analyzer loop, the stream through the loop should be representative of the main piping stream.

5.3.2 Verification of OWDs requires spot samples from the pipe for analysis. Samples withdrawn from the pipe should be taken near the OWD sample point and be representative of the flowing stream. Follow the guidelines for manual sampling of pipeline streams in API *MPMS* Chapter 8.1 for the probe location, position, and size.

5.4 Auxiliary Instrumentation

5.4.1 OWD's may use an input from one or more auxiliary measurement devices (e.g. for measuring temperature, pressure, density, salinity, viscosity, etc.). The accuracy of these auxiliary measurement devices should be verified frequently. The required frequency of verification (and recalibration as necessary) is dependent upon the application, the OWD manufacturer's recommendations, site requirements, and oversight requirements such as control charts.

5.4.2 The output from the OWD will need to be input to a flow computer, or similar device, to flow weight average the water content. As an alternative, some OWD instruments will accept the flow reading to compute the flow weighted average water content.

6 Initial Acceptance Testing of OWD Systems

6.1 General

6.1.1 This section describes the method for the initial acceptance testing of OWD systems that are installed on pipelines and at marine loading/off-loading terminals. Other applications may not require initial acceptance testing.

NOTE All components of the OWD system should be calibrated per manufacturer's guidelines prior to initial acceptance testing as this section does not address calibration.

6.1.2 The method consists of the following parts (based on API *MPMS* Chapter 8.2, Appendix A).

1) Establish the baseline water volume percent by analyzing several instantaneous samples.

2) Conduct a water injection test.

3) Confirm stability of baseline by repeating step 1.

4) Repeat steps 2 to 3 at the same water injection rate.

5) Repeat steps 2 to 3, but change the water injection rate by at least 25 %.

6) Compare the OWD FWA (Flow Weighted Average) water content to the calculated water injection, for agreement within acceptable tolerance for all three tests.

NOTE In locations where a Water Injection Test is not practical, a decision needs to be made as to what will constitute an acceptable acceptance test. Possibly an extended period of utilizing the Verification Process described on Section 7 will suffice.

6.2 Water Injection Test

6.2.1 General

For test preparation see API *MPMS* Chapter 8.2 Appendix A. Also see Table 1 for other possible sources of uncertainty.

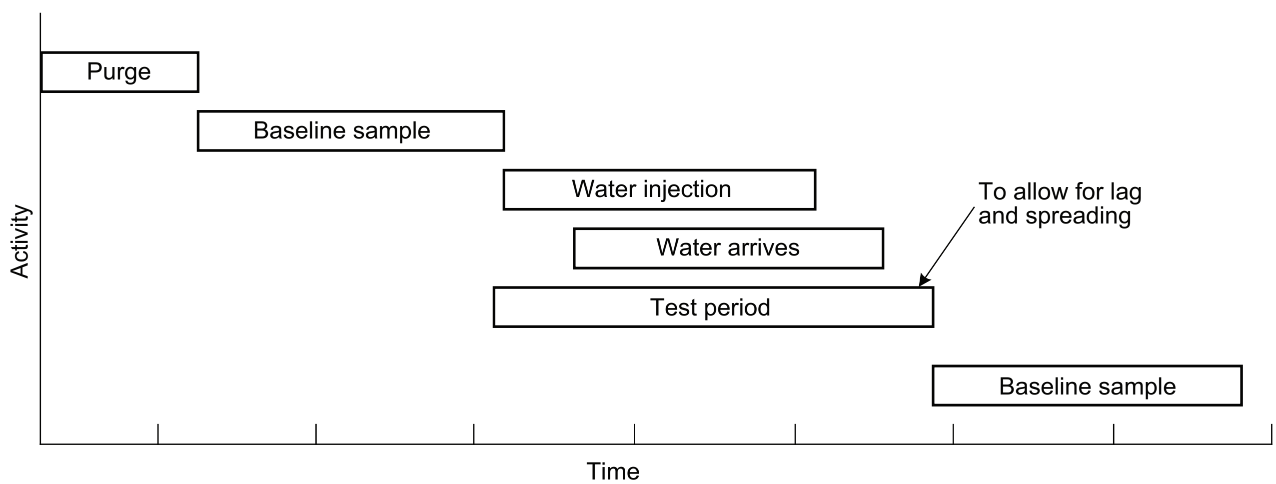
6.2.2 Test Procedure

6.2.2.1 The Test Procedure is the standard API *MPMS* Chapter 8.2, *Water Injection Test*, with the addition of a third test. Oil meters are recommended to provide the total test volume, but tank gauges may also be used. The OWD can be utilized to monitor the passing of the last of the injected water through the instrument. Repeat the water injection test at the same injection rate. Then change the water injection rate by at least 25 % and conduct a third test to verify that the OWD responds properly to the change in water content. The OWD should pass all three tests sequentially (i.e. no tests in the sequence may be rejected in the evaluation process).

6.2.2.2 During each test, at the start of the Test Period (Figure 1), the OWD FWA readings should be initiated at the same time as the oil meters are read and the sampler accumulation is begun. At the end of the Test Period, the OWD FWA is read at the same time as the oil meters are read, and the sampler accumulation is ended. Under some circumstances, it may be necessary to do a higher rate purge, but still be part of the total test volume, after the water injection to assure that any water traps are swept clear.

6.2.2.3 If a manual sampling point will be used as part of the ongoing verification of the OWD, it should be verified during the Water Injection Test. Multiple baseline samples should be taken at the sample point, analyzed, and compared to the OWD reading. When the reading reaches steady state (stabilizes) after the injection of water, additional samples should be taken from the sample point, and compared to the OWD instantaneous readings. If the sample results agree with the OWD readings, within the tolerance listed in Table 2, the sample point may be used for future verification testing. The documentation of this testing should be retained.

Figure 1 shows the timing of one of the three duplicate tests, and Figure 2 provides a flow diagram of the test procedure.



NOTE Times are calculated based on minimum oil flow rate and distance between the injection and the sample point.

Figure 1—Typical Timing Diagram for One OWD System Test Run

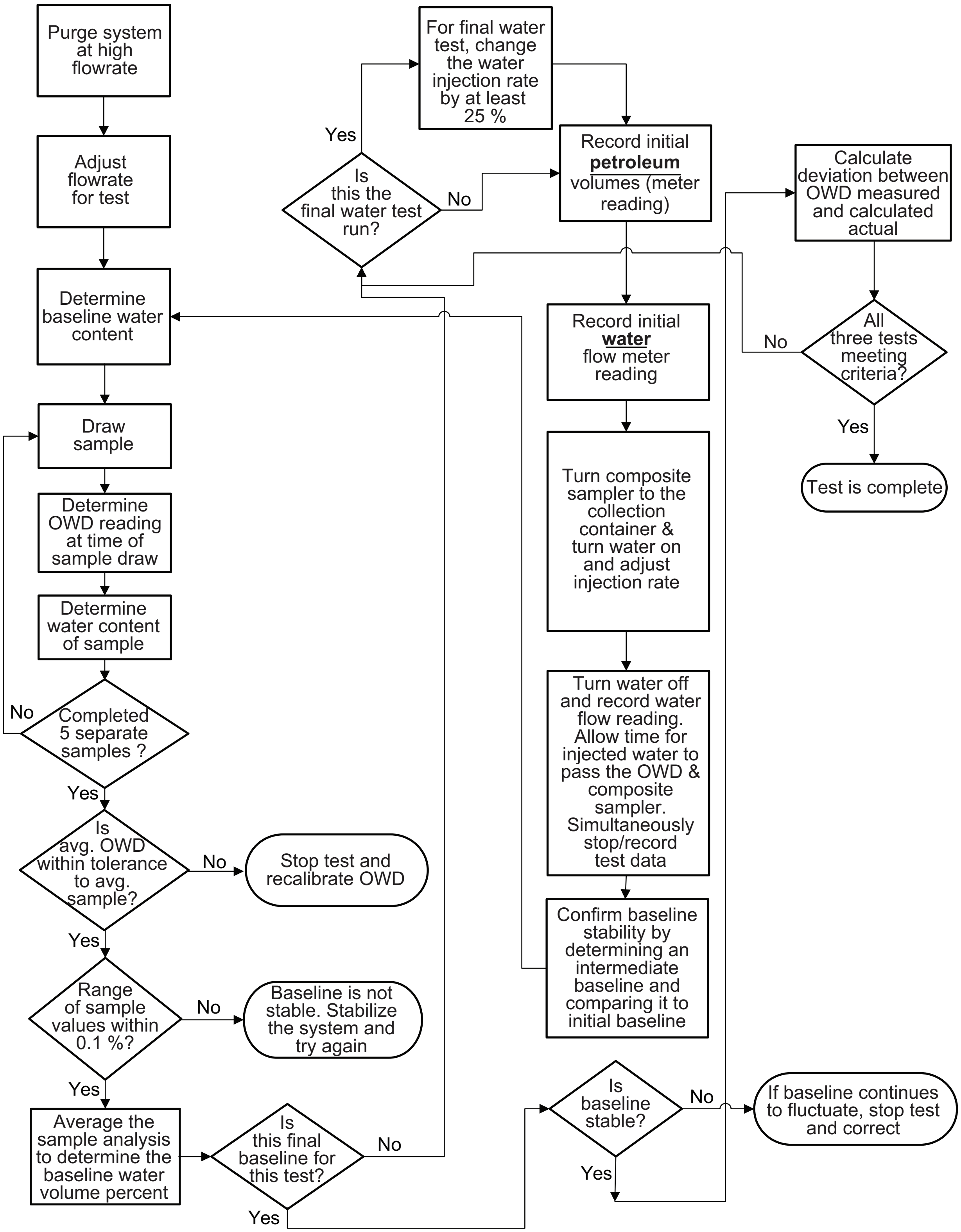


Figure 2—Flowchart of Procedure for OWD System Initial Acceptance Testing

Table 2—Typical Deviations for the OWD, System Acceptance Tests

Measurements in volume percent

	Typical Deviation	
Total Water (W_{bl} + W_{inj})	**Using Meters**	**Using Tank Gauges**
0.5	0.09	0.13
1.0	0.11	0.15
1.5	0.12	0.16
2.0	0.13	0.17
2.5	0.14	0.18
3.0	0.15	0.19
3.5	0.16	0.20
4.0	0.17	0.21
4.5	0.18	0.22
5.0	0.19	0.23

NOTES:

a) Basis for the above Table 2 and the following notes is API *MPMS* 8.2, Second Edition (or latest) Table A-1.

b) W_{bl} is the percentage water baseline and W_{inj} is the percentage water injected.

c) The reference to meters refers to the method used to determine the volume of crude oil or petroleum in the test.

d) Deviations shown reflect use of the Karl Fischer test method described in *MPMS* Chapter 10.9 for water.

e) Interpolation is acceptable for water concentrations between values shown in the table. For example, if the total water is 2.25 %, the allowable deviation would be 0.135 % if using meters.

f) The reproducibility standard deviation calculated based on the data, at a 95 % confidence level, has been used for the values "Using Meters" shown in Table 2 in the water range 0.5 % to 2.0 %. Assigning these values to the meter is based on a model that was developed to predict standard deviations for volume determinations by tanks and meters. As there is insufficient test data for water levels over 2.0 %, values shown in the table above 2.0 % have been extrapolated on a straight-line basis using the data in the 0.5 % to 2.0 % range.

7 Ongoing Verification

7.1 General

7.1.1 This section discusses on-going verification of on-line water measurement devices (OWDs). Calibration requirements for OWDs are covered in general terms as it is assumed that each manufacturer should provide detailed calibration procedures specific to their OWD, based on the guidance provided within this section.

NOTE A footprint verification of the OWD using air and a single fluid component such as kerosene may be used to confirm that the basic operating parameters of the meter meet those recorded during factory acceptance testing.

7.1.2 In-situ verification should be performed by one or more of the following procedures:

a) against a continuous flow proportional sampling system, meeting the requirements of API *MPMS* Chapter 8.2;

b) against multiple spot samples, sampling to meet requirements of API *MPMS* Chapter 8.1;

c) by water injection test, for test preparation see 6.2.

Verification procedure "a" should only be considered for installations where the baseline water-in-oil concentration is both low and stable. Such conditions are normally not associated with crude oil production sites unless active dewatering systems are employed.

7.1.3 After the initial setup and calibration verification establish a program for the on-going calibration verification of the OWD system. The frequency will vary depending on which verification procedure is chosen. If choosing option “a”, the flow weighted average from the OWD should be compared to the automatic sampler result each time. The frequency for options “b” and “c” will vary depending on operational conditions.

7.1.4 The calibration of all measurement components of the OWD system should be verified at a frequency that is consistent with the calibration verification frequencies used for other measurement components of the metering system. If operating experience confirms stable performance, the calibration verification schedule may be extended accordingly based on agreement between all parties and sufficient supporting data.

7.1.5 On-going verification of the OWD sensor system is required to monitor the effect of long term variables that include the following.

- Contamination of sensor components by deposition of water formed scale, asphaltenic compounds etc.
- Changes in fluid composition due to both hydrocarbon and non-hydrocarbon components, such as oil density, water phase salinity, production chemicals and sand. Consult the OWD manufacturer for additional information on the effects of these items on the OWD.
- Mechanical damage to sensor components due to abrasive contaminants.

7.1.6 If OWDs are used for measuring water during continuous oil production from a single reservoir, rapid changes in fluid composition are unlikely to occur. However significant composition changes may be experienced in batch loading and discharge systems in which crudes may be from widely varying sources and to a lesser extent in metering systems measuring the production from several reservoirs. See API 87 for guidance on sampling higher water content streams.

7.1.7 All verification and performance records for the OWD system should be available for review by all interested parties.

7.2 Calibration of OWD System Secondary Components

Calibration procedures should be written giving due consideration to the specific equipment manufacturer’s recommendations for calibration procedures and frequency.

All dedicated secondary measurement devices associated with the OWD should be calibrated at the same frequency and to the same tolerance as equivalent devices within the same measurement system.

All instruments used in the OWD measurement calculation should be calibrated to agreed standards and procedures.

All test equipment used in the calibration should be certified by accredited calibration facilities and traceable to NIST, or appropriate national standards agency.

Guidance on calibration requirements is also given in other API *MPMS* Standards, e.g. Chapters 7.2, 7.3, 9.1, and 9.2.

7.3 Verification of OWD Sensors

The verification tolerance of OWDs should reflect the repeatability of both the OWD and the water-in-oil analysis method used to determine the reference water content during the OWD verification.

NOTE 1 The verification tolerance is a function of:

- the repeatability of both the OWD and the water-in-oil analysis method used to determine the reference water content;
- the absolute uncertainty of the water-in-oil analysis method used to determine the reference water content during the OWD calibration;
- the uncertainty of the water-in-oil content of each of the subsamples analyzed by the OWD and laboratory procedure with respect to the main flow line.

NOTE 2 The published precision data for water-in-oil laboratory analytical methods show a non-linear relationship between absolute water content and relative percentage repeatability. Therefore the tolerance value used when comparing OWDs and laboratory analysis should be a function of the average water content reported during the verification procedure.

7.3.1 Verification by Continuous Automatic Sampler

If verification is by continuous sampling system the performance of any continuous sampling system used for verification of OWDs should meet the requirements of API *MPMS* Chapter 8.2.

If no dedicated mixing device has been installed, the continuous sampler probe location should comply with the requirements of API *MPMS* Chapter 8.2 or ISO 3171.

7.3.1.1 Verification should be by comparison of a FWA water value reported by the OWD under test with the water content reported for a continuous flow proportional sample taken over the same time period. The analysis of the proportional sample must only be for water (not to include any sediment).

The duration of any verification trial between the OWD and continuous flow proportional sampler may vary according to specific site operational conditions.

Guidance is given in API *MPMS* Chapter 8.2 on the design and operational requirements for flow proportional sampling systems.

7.3.1.2 The flow proportional control of the continuous sampler should be by means of an electronic controller deriving its flow signal directly from the total station flow of the measurement system. The station flow signal may be analog or digital. If an analog flow signal is used then the associated DAC (Digital to Analog Converter) and ADC (Analog to Digital Converter) devices will form part of the OWD system secondary components and be calibrated accordingly.

7.3.1.3 The number of comparative tests undertaken between the OWD and continuous sampler should be statistically significant. Guidance on statistical interpretation is given in API *MPMS* Chapter 13.2.

The data set used for statistical comparison should not include data examples for which the recorded sampler performance does not meet the sampler performance acceptance criteria.

7.3.1.4 If an OWD and continuous sampler are installed in series, all on-going verification of the OWD should be by continuous comparison with the sampler system over each accounting period or batch transfer.

7.3.1.5 If an OWD is intended as the primary, routine water measurement device, on-going verification checks against a continuous sampling system should be undertaken periodically. Typically, the frequency of on-going verification should also depend on batch size or monthly volume.

The frequency of such verification checks will depend on the length of the accounting period or frequency of batch transfers as well as the practical considerations of site location, such as remote and normally unmanned installations. Again, should also depend on monthly volume.

The frequency of initial on-going verification checks should be 3 monthly for normally manned sites in continuous operation. The minimum initial frequency for all sites should be biannual.

If acceptable stability is achieved, a reduced verification frequency can be implemented. The minimum frequency should be annual.

If no guidance is offered by commercial or statutory requirements regarding acceptable agreement (or allowable deviation) between the OWD and flow proportional sample, then the stated reproducibility of the laboratory analytical method should be used as guidance.

7.3.1.6 Control charts should be used to compare and document the performance of the OWD against the continuous automatic sampler system.

7.3.2 Verification by Online Manual Spot Sample

If verification is by manual spot sampling the design and operation of the sampling system should meet the requirements of API *MPMS* Chapter 8.1.

If no dedicated mixing device has been installed the sample probe location should comply with the requirements of ISO 3171.

7.3.2.1 Verification should be by comparison of the average water value recorded by the OWD during the duration of sampling for each manual spot sample.

A minimum of two values should be recorded from the OWD during sampling.

7.3.2.2 The time taken to obtain each manual spot sample after purging the sample system dead volume should be no longer than three minutes.

Sampling should only take place when the OWD indicates that the water-in-oil level is stable.

A minimum of the number of comparative tests undertaken between the OWD and manual spot sampler should be statistically significant. Guidance on statistical interpretation is given in API *MPMS* Chapter 13.2.

On-going verification checks should consist of a minimum of three comparative tests.

Each comparative test consists of a minimum of two manual spot samples and two sets of OWD readings.

7.3.2.3 The data from comparative tests should be rejected and the test repeated if:

$$\frac{\sum_{0}^{n} ABS(OWD_n - MSS_n)}{n} < 1.5 \times R$$

where

OWD_n is the average OWD reading during manual sample n,

MSS_n is the analysis water result for manual sample n,

R is the stated reproducibility of the laboratory procedure used to determine the water content of the manual spot samples,

ABS is the absolute value.

7.3.2.4 The frequency of initial on-going verification checks should be three monthly for normally manned sites in continuous operation. The minimum initial frequency for all sites should be biannual. Frequency should depend on batch size or monthly volume.

If acceptable stability is achieved a reduced verification frequency can be implemented, the minimum frequency should be annual.

7.3.3 Verification by Water Injection Test

The procedure for undertaking a water injection test is detailed in 6.2.

If this procedure is solely used for on-going verification, then it should be undertaken on a monthly basis for the first six months of operation to establish OWD stability. If acceptable stability is achieved, a reduced verification frequency can be implemented. The minimum frequency should be annual.

7.4 Control Charts

7.4.1 Regardless of the method of verification, the data should be retained and the difference between the OWD and the verification value (sample test result) should be plotted on control charts.

7.4.2 For systems that handle different commodity grades, separate control charts for each grade and varying operating condition (temperature, pressure, etc.) may be required to show how the OWD responds to the different conditions.

7.4.3 Establish tolerances for the Controls Charts according to the performance of the OWD and not to exceed the tolerances established in Table 2.

8 Audit Trail and Security

8.1 Audit Trail

8.1.1 An OWD system should be capable of establishing an audit trail by compiling and retaining sufficient information to verify the OWD results. Since the accuracy of an OWD system is affected by the verification and calibration of the device and the commodity characteristics the device is registering, the audit trail should include the quantity of transaction, configuration logs, and event, alarm, and test records. All changes to the OWD and access should be documented.

8.2 Security

8.2.1 Restrict access to authorized personnel responsible for the OWD. All access should be recorded and made available for review by internal or external auditors.

Annex A
(informative)

OWD Applications

OWDs may be used in different applications. Below are some examples of common applications.

A.1 Pipeline

Pipeline water content is generally within a range from 0.02 % to 5 %. If the water content occasionally exceeds the 5 % range, use an OWD system with wide range capability. If the OWD system is not capable of the required accuracy over the expected range, the system must have a multiple range capability.

A.2 Marine

Applies to portable (shipboard) or stationary systems (refer to API *MPMS* Chapter 8.2, Section 9 for more detail). Installation requirements for shipboard OWDs are the same as those discussed in API *MPMS* Chapter 8.2, Section 17.

A.3 Process

Depending on the actual process application, the installation, calibration, and certification procedures for an OWD may be relaxed from the requirements listed in this technical report.

A.3.1 Refining

OWDs can be used to monitor the water content of crude oil or other feedstocks to minimize process upsets, damage to equipment, and contamination of catalysts in refinery operations. The operation of equipment, like desalters, can be monitored and optimized with an OWD.

A.3.2 Production

A.3.2.1 Allocation Measurement

OWDs can be utilized to measure the total dry oil from various production facilities that would be used when the total production is allocated back to the individual wells and facilities. This application may also include the use of OWDs on well test separators.

A.3.2.2 Well Test

OWDs can be utilized as part of well test facilities. After the gas is flashed in the separator, the total liquid can be measured and then the OWD used to quantify the amount of water in the stream. Often these streams will have high water content. This technical report is applicable to oil continuous operations. For water continuous operations refer the API *MPMS* Chapter 20.

A.3.2.3 Water Separator Facilities

OWDs can be used in production facilities to monitor the operation of the water separators to maximize separation while also maximizing throughput.

A.3.2.4 Crude Oil Gathered by Tank Truck

OWDs can be mounted on production gathering trucks to be used as a tool to monitor the water content of crude oil loaded onto or discharged from the trucks.

Alternatively, OWDs can be ground mounted at the crude oil discharge metering points.

The main concern with this application is the range of crude oil types encountered.

A.3.3 Marketing

OWDs can be utilized to monitor the water content of petroleum products in a marketing terminal to assure that water in excess of specifications is not shipped in or out of the facility. The OWD can be used to quantify the water transferred or as an indicator to stop a transfer if water above a specified level is detected.

Annex B
(informative)

Typical OWD Installation Diagrams

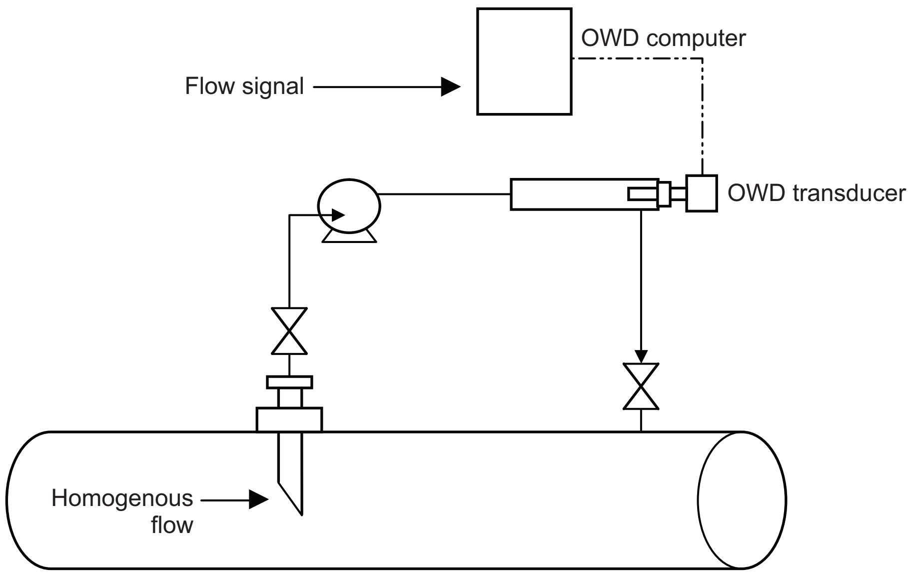


Figure B.1—Typical Fast Loop OWD Installation
(Refer to vendor recommendations for further detail.)

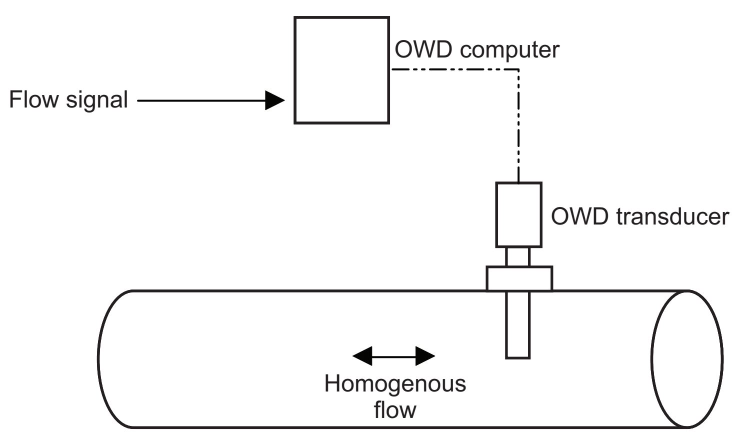


Figure B.2—Typical In-line OWD Installation
(Refer to vendor recommendations for further detail.)

Annex C
(informative)

EXAMPLE Worksheet for OWD Acceptance Testing Using an Average of Instantaneous Samples

Equipment Functional Tag:

Date: ____________________ Start Time: ________________ End Time: ________________________

Avg. Temp.: _______________ Avg. Gravity: _______________ Water Analysis Method: _____________

Baseline

Sample #	Time (hh:mm:ss)	Sample Result (Vol % Water)	OWD Result (Vol % Water)
1			
2			
3			
4			
5			
6			
Baseline Average			

Water Injection Test

Sample #	Time (hh:mm:ss)	Sample Result (Vol % Water)	OWD Result (Vol % Water)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
12			
Averages			

Results ____

% Difference ____

Acceptance: Pass/Fail ____

BY: ______________________ DATE: ________________

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