Recommended Practice for Field Analysis of Crude Oil Samples Containing from Two to Fifty Percent Water by Volume

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Introduction

This Recommended Practice addresses analytical methods for determining water content in crude oil streams for production allocation measurement applications, where the relative water fraction is higher than those normally encountered in custody transfer measurement applications. Generally, the measurements in these applications are made on the liquid outlet of two-phase (i.e. gas and liquid) separators. However, they may also be made on the oil outlet of three-phase (i.e. gas/oil/water) separators which also may experience high water contents in the oil outlet. In all cases the water content amounts encountered are generally much higher than the water content amounts in custody transfer measurement situations.

Other than the API *Manual of Petroleum Measurement Standards* (*MPMS*), Chapter 20.1, measurement standards have focused on sampling and analysis for custody transfer applications with relatively low water content (0.1 to 2 % by volume). Likewise, ASTM sediment and water (S&W) analysis procedures have specifically targeted low water content applications (less than 2 % by volume) since this has been considered to cover most fiscal measurement situations.

However, with the higher financial risks and construction costs associated with offshore deep water production installations or production fields in late-life, most facilities, at some point in the life of the field incur fiscal allocation situations whereby the streams are commingled prior to final oil/water separation. In order to minimize costs, these installations are forced to install fiscal allocation metering and sampling at non-ideal locations. Consequently, fiscal allocation measurements are often made on crude oil streams with water content levels up to 50 %. For this reason the API Upstream Allocation Task Group instituted a project to conduct tests and make the recommendations contained herein.

Summary of Project

In order to facilitate these recommendations the API Upstream Allocation Task Group undertook a project to research the subject and perform tests under controlled laboratory conditions. Following is a summary of the project:

Phase I—Research

The primary outcome of this phase was the review of a published report [*Hi Water 2: The Measurement of Hi Water Content Oil/Water Mixtures by Electronic Methods* from the National Engineering Laboratory (NEL)]. This report was used as a guide for sampling in the intended water content range.

Phase II—Testing

A limited amount of laboratory testing under controlled conditions was conducted on two crude oil types in order to establish analytical methods and application criteria. The two crude oil types were only categorized as a “light” and “heavy” crude oil respectively (see Table 6 in Annex A). Furthermore, only one laboratory and one operator conducted the tests.

For these reasons, the testing results should not be considered as providing a basis of precision and bias evaluation. These data are intended only as guidance in an area that has not been specifically addressed by any other recognized measurement standard. Furthermore, no widely-published industry tests (i.e. data) on stream mixing for water content applications above 2 % exist. Therefore, a procedure documenting the requirements for extracting a representative sample from the flowing stream does not exist. Excerpts from the final project report are included in Annex A.

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1 Scope

The purpose of this document is to provide the user with recommended 'field' methods of sampling, sample handling and analysis for high water content streams up to 50 % water on a volumetric basis. In particular, this RP was developed giving consideration to offshore installations (both floating and fixed platforms). These installations are generally subject to motion and vibrations, have minimal laboratory equipment, and perform S&W analysis with multi-skilled operations personnel as opposed to laboratory chemists. The techniques described, however, are also applicable to onshore locations.

This document provides design and operating guidelines for sampling, sample handling and sample analysis of high water content streams, up to 50 % water by volume. As a guide, this RP targets a relative accuracy of 5 % of reading up to a maximum of 50 % water content as a qualifier for the various methods described herein. For example, the corresponding absolute accuracy for a 10 % water content stream is ± 0.5 % and for 20 % water content is ± 1.0 %.

This recommended practice may involve hazardous materials, operations, and equipment. This RP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this RP to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

The laboratory testing contained within this RP (see Annex A) is based on a single laboratory—single operator set of results. As with other API standards for field S&W determination methods, no precision and bias calculation was performed and therefore, no inter-laboratory or round robin style testing was performed. The results of the testing of the various methods are primarily intended to provide a general comparison between different methods to facilitate operational choices.

2 References

2.1 Normative

API *MPMS* Chapter 8.2 (ASTM D 4177), "Automatic Sampling of Petroleum and Petroleum Products"

API *MPMS* Chapter 10.2 (ASTM D 4006), "Determination of Water in Crude Oil by Distillation"

API *MPMS* Chapter 10.3 (ASTM D 4007), "Standard Test Method for Water and Sediment in Crude Oil by the Centrifuge Method (Laboratory Procedure)"

API *MPMS* Chapter 10.7 (ASTM D 4377), "Standard Test Method for Water in Crude Oils by Potentiometric Karl Fischer Titration"

API *MPMS* Chapter 20.1, "Allocation Measurement"

ASTM D 95[1], *Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation*

2.2 Informative

[a] *API High Water Content Project—Phase II Analytical Test Methods—Final Report*, May 5, 2005.

[1]ASTM, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959, www.astm.org