# Manual of Petroleum Measurement Standards Chapter 11.3.2.1

## Ethylene Density

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## Introduction

The purpose of this standard is to provide an equation of state that can be used to obtain an accurate determination of ethylene density. Other thermodynamic properties can be calculated using the equation of state, but this standard is primarily concerned with the determination of ethylene density. Temperature and pressure can have significant effects on the accurate determination of ethylene density, and as a result, the means for temperature and pressure determination have to be assessed appropriately for these applications.

The previous edition of this standard, published in 1974, was in the form of a measurement manual and was not confined to calculating the physical properties of ethylene. The previous edition included orifice and turbine metering calculations, as well as data that were not in agreement with the current API *Manual of Petroleum Measurement Standards* (*MPMS*) that cover these metering devices. The original density lookup tables were based on FORTRAN code originally published in the mid-1960s as API 2565 Subroutine Ethyl. This Second Edition of API *MPMS* Chapter 11.3.2.1 is intended to replace the 30+ year old equations with references to more modern equations of state, limited to the physical properties of ethylene.

Typically, ethylene equations of state are used in custody transfer metering applications. Such is the case with modern flow computers, which have various options for selecting which equation of state is utilized in determining flowing ethylene density.

# Ethylene Density

## 1 Scope

This standard identifies an equation of state (EOS) suitable for use in custody transfer measurement of pure ethylene (>99 %) in the gaseous, liquid, and super critical phases. Given flowing temperature and pressure, an EOS is capable of calculating density and other thermodynamic properties used to calculate mass and volumetric flow of ethylene to custody transfer accuracy. All accuracy and uncertainty statements in this standard are limited to the EOS results and do not include the uncertainty added by the primary and secondary measuring equipment.

## 2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IUPAC-88 [1], *Ethylene (Ethene), International Thermodynamic Tables of the Fluid State, Volume 10* (1988)

## 3 Terms and Definitions

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

**3.1**
**critical region**
Thermodynamic state of a fluid in which phase boundaries cease to exist.

NOTE In the case of ethylene, a vapour-liquid critical region exists. Density determination is extremely sensitive in the critical region, as minor changes in flowing pressure can bring about significant changes in density for a given temperature.

**3.2**
**equation of state**
**EOS**
Thermodynamic equation describing the state of matter under a given set of physical conditions.

NOTE An EOS provides a mathematical relationship between two or more state functions associated with the material, such as its temperature or pressure.

## 4 Ethylene Equations of State

### 4.1 General

This standard provides a reference for an ethylene EOS:

— IUPAC-88, part of the *Ethylene, International Thermodynamic Tables of the Fluid State, Volume 10* (1988) publication.

IUPAC-88 is a publication that incorporates the work carried out by Jahangiri et al. [1] on ethylene. The paper “Thermodynamic Properties of Ethylene from the Freezing Line to 450 K at Pressures to 260 MPa” was published a year or so before IUPAC published lookup tables in 1988.

[1] International Union of Pure and Applied Chemistry, 104 T.W. Alexander Drive, Building 19, Research Triangle Park, North Carolina 27709, www.iupac.org.