COMMODITY SPECIFICATION
ACETYLENE

Doc 240/22

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Table of Contents

1 Introduction

Companies supplying acetylene will often have more than one grade or purity of acetylene. These different grades are often expressed in descriptive terms like “industrial or high purity”. The user of the acetylene needs to decide what grade, purity or impurities are appropriate to their need.

2 Scope

This publication provides specification requirements for gaseous acetylene. This publication does not attempt to recommend or establish end usage designations for specific types or grades of products. It is suggested that users requiring this kind of information contact individual acetylene gas suppliers.

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions

3.2.1 Filling batch

Examples of a filling batch include, but are not limited to the following:

- Acetylene supplied during a specified time period (e.g. one continuous work shift, daily, weekly)
- Acetylene supplied in one shipment
- Acetylene supplied in cylinders filled on the same manifold at the same time
- Acetylene cylinders filled in an uninterrupted filling sequence
- Other definitions based on an agreement between supplier and customer

3.2.2 Percent (v/v)

Parts per hundred by volume

3.2.3 ppmv

Parts per million by volume.

3.2.4 Pressure

In this document bar shall indicate gauge pressure unless otherwise noted –i.e., (bar, abs) for absolute pressure and (bar, dif) for differential pressure.

3.2.5 Sample tubes

Detector tube filled with colour reactive chemicals. The degree of accuracy is dependent on the precision of the measurements and the analytical bias of the tube.

4 Product classification

4.1 Range of products

The typical acetylene product range consists of different qualities and purity grades. Each product is defined in terms of its allowable level of impurity. The gas can be dissolved in Acetone or Dimethylformamide (DMF), or as a non-standard product distributed solvent-free.

Product name: “Acetylene” or “Dissolved Acetylene” (DA), or “C_2H_2“

4.2 Typical applications

Typical applications for industrial use of acetylene are:

- Welding
- Flame spraying
- Brazing and fusing of powder sprayed layers
- Heating (pre- and post-heating) in connection with welding
- Heating
- Hot forming
- Flame straightening
- Flame hardening
- Oxygen cutting and gauging
- Flame scarfing, cleaning and texturing
- Carbon coating
- Low pressure carburizing.

Higher purity grade acetylene needs to meet the requirements for applications such as:

- Atomic absorption spectroscopy
- Component in calibration gas
- Component in lung testing gas.

5 Acetylene product specifications

Companies supplying acetylene will often have more than one grade or purity of acetylene. Below is a description of how the supplier companies qualify grades.

The minimum amount of acetylene is shown as a two-digit number, where the first digit determines the number of 9’s at the front, and the second digit is the final significant figure:

Purity 1.8 = 98% acetylene
Purity 2.5 = 99.5% acetylene
Purity 2.6 = 99.6%

Then the impurities that make up the remaining parts of the 100% are described. And for different grades different constituents of those impurities are listed (or not).

Example 1:
A grade 1.8 might have a maximum PH_3, H_2S & AsH_3 ≤ 1000 ppmv and NH_3 ≤ 500 ppmv defined, but the total allowable impurities is 20 000 ppmv as that is what is defined by the 98% value.

Example 2:
A grade 2.5 might have ≤ 400 ppmv of moisture, ≤ 4000 ppmv N_2, < 50 ppmv PH_3, H_2S & AsH_3 and < 500 ppmv of NH_3. But, again, the total allowable impurities is 5000 ppmv as that is what is defined by the 99.5% value.

Example 3:
A grade 2.6 might have ≤ 400 ppmv of moisture, < 5 ppmv PH_3, H_2S & AsH_3 and < 500 ppmv of NH_3. But, again, the total allowable impurities is 4000 ppmv as that is what is defined by the 99.6% value.

These values reflect acetylene produced by the calcium carbide process. Other impurities such as longer chain hydrocarbons will be the typical impurities found in acetylene that has been "cracked" during a chemical production process.

It is important for the user to be aware that any or all of these grades might be described as Industrial or High Purity or Electronics grade. There is no legal definition of such terms. If a particular purity or impurity is of importance to the user of the acetylene, they must enquire of the supplier what they are proposing to provide.

It is also important for the user to recognize that the supplier does not, normally, test or validate the purity of individual cylinders. The supplier tests the acetylene being put into the cylinder, not what comes out. This is particularly important when considering the higher purity grades of acetylene as the impurities found in a cylinder can persist from one filling to the next. A high purity cylinder needs to have been filled with high purity acetylene for a number of cycles (customer uses) to purge itself of any impurities.

6 Quality verification

Gaseous acetylene samples shall be representative of the acetylene supply. Samples shall be obtained with one of the following:

- By connecting the gas stream being sampled directly to the analytical equipment.
- By selecting a representative cylinder from the cylinders filled in a batch. If a single sample does not contain a sufficient quantity of acetylene to perform all quality checks required, additional samples shall be taken from the same filling batch under comparable conditions.

7 Impurities in Acetylene

7.1 Air / Nitrogen

Air may enter the system by:

- charging carbide into the generator when generator and / or hopper is not purged properly
- creating a vacuum when the generator cools down and the vacuum relief system of the generator does not work properly
- creating a vacuum on the suction pipework of the acetylene compressors
- using fresh mains water for the generator
- forgetting to close sample valves or drain valves
- Failure to adequately purge equipment being returned to service

Air may enter acetylene cylinders by

- Leaving the cylinder valve open or when it is removed for repairs
- New cylinders which have been evacuated and filled with solvent can draw in air if the valve leaks or if the valve is inadvertently opened before the cylinder is connected to the charging rack.

Purge gas (nitrogen) may enter the system by

- purging procedures for charging carbide into the generator
- purging procedures before and after maintenance works
- leaking purge gas equipment.

NOTE It has been determined that for each 0,1% volume increase in the level of air or nitrogen contamination the settled pressure of a filled acetylene cylinder will increase by 0,4 bar i.e. a high-pressure in the final cylinder may indicate contamination in the production process.

Recommended test methods:
- Volumetric gas absorption in acetone (“Quick-Test”)
- Gas chromatograph
- Mass spectrometer
- ppmv O_2 analyser

Recommended sampling point:
- Just after the purification unit
- Test for ppmv O_2 and ppmv N_2 in acetylene

7.2 Ammonia (calcium carbide plants)

The ammonia content of generated acetylene results from the reaction of calcium cyanamide with water. Ammonia promotes the formations of undesirable polymers in the acetylene cylinders and should be controlled by water scrubbers or spray towers.

The production staff needs to perform quality checks after the acetylene has passed the ammonia scrubber to:
- control formation of undesirable polymers
- control carbide quality

Sources of impurities:
- ammonia present in the raw acetylene depends on the reaction of atmospheric nitrogen with the hot surface of freshly poured carbide while cooling down after carbide production.

Recommended test methods:
- sample tubes

Recommended sampling point:
- Just after the ammonia scrubber
- Test for ppmv ammonia in Acetylene

7.3 Phosphine (calcium carbide plants)

Phosphorous compounds in the calcium carbide react to form phosphine gas during generation of the acetylene.
Purification may be required to satisfy some customer requirements. The phosphine content of purified acetylene is typically lower than 10 ppmv, but a target as low as 1 ppmv is not uncommon.

NOTE Phosphine and potential self-ignition of an acetylene air mixture
Increased phosphine content in an acetylene air mixture reduces the minimum temperature of ignition. With no phosphine the minimum ignition temperature is approximately 330°C, and it steadily decreases with increased phosphine, so that at 2.6% phosphine the minimum ignition temperature has decreased to 225°C. In reality phosphine content does not introduce an ignition hazard as there is no reduction in minimum ignition temperature of a stoichiometric acetylene-air mixture with up to 2000 ppmv (2000 ppmv of phosphine is more than a commercial carbide-based production process creates) and the highest temperature (140°C) in the generation of acetylene from carbide as found in dry generators.

In order to
- maintain safe working and operating conditions (phosphine is toxic, in contact with air self-ignition is likely),
- minimise customer complaints
- meet product specifications

the production staff needs to
- specify carbide quality / control carbide quality upon receipt

- perform quality checks after the acetylene has passed the purification units and / or from ready filled cylinders.

Sources of impurities:
- phosphine present in the raw acetylene depends on the purity of raw materials used for carbide production.

Recommended test methods:
- sample tubes (phosphine and arsine could not be differentiated; use tubes without cross-sensitivity to hydrogen sulfide)
- Gas chromatograph
- Mass spectrometer

Recommended sampling point:
- Just after the purification unit and / or from ready filled cylinders.
- Test for ppmv phosphine in Acetylene

7.4 Hydrogen sulfide (calcium carbide plants)

Sulphur compounds in the calcium carbide react to form hydrogen sulphide gas during generation of acetylene. The amount of hydrogen sulphide generated depends on the purity of the raw materials used in the manufacture of calcium carbide, but the generator scrubber and water sprays or the ammonia scrubber removes most of this contaminant.
The hydrogen sulphide content of purified acetylene is typically lower than 10 ppmv.

The production staff needs to perform quality checks after the acetylene has passed the purification unit. In order to
- maintain safe working and operating conditions
- minimize customer complaints
- meet product specifications

Sources of impurities:
- incomplete reaction in wet purification units.

Recommended test methods:
- sample tubes
- Gas chromatograph
- Mass spectrometer
- Electrochemical cell-type sulfur ion analyzer; the range used should not be greater than ten times the specified sulfur compound content.

Recommended sampling point:
- Just after the purification unit.
- Test for ppmv hydrogen sulfide in Acetylene

7.5 Water / Moisture

Acetylene generated from calcium carbide is saturated with water vapour at the temperature and pressure conditions existing in the system upstream of the drier.

Because the solubility of acetylene in water is lower than in a solvent like acetone, a higher pressure in the cylinder is expected if there is water. This increased pressure will increase with the amount of water in the cylinder.

In order to
- maintain safe working and operating conditions (mixture of water with solvent in the cylinders reduces capability to dissolve acetylene),
- minimize customer complaints
- meet product specifications
- to prevent damage of the porous material within the cylinders

- to prevent corrosion of the inner cylinder shell

the production staff needs to
- specify solvent quality / control solvent quality upon receipt
- perform moisture control checks after the acetylene has passed the drier units.

Sources of impurities:
- Wet acetylene entering the cylinder when the performance of the drier system is insufficient.
- rainwater which can enter the cylinder when the valve has been left open. This is particularly true of cylinders with concave heads since water can build up above the level of the valve inlet.
- Solvent diluted with water.

Recommended test methods:
- H_2O analyser

Recommended sampling point:
- Just after the (high-pressure) drying unit
- Test for ppmv H_2O in Acetylene