



SAFE FILLING OF ACETYLENE CYLINDERS, BUNDLES AND BATTERY VEHICLES

Doc 26/25

Revision of Doc 26/21

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Published in February 2025

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Amendments to Document 26/21

This document has been completely rewritten.

The latest version of this document from 2021 was titled 'Permissible Charge / Filling Conditions for Acetylene Cylinders, Bundles, Battery Vehicles'. It was covering the theoretical aspects for filling. In this new version the scope has been extended to include operational aspects for filling.

Section	Change
4	'Ownership and responsibility for safe filling' has been added
5	'Scales for acetylene packages' has been added
6	'Pre-fill inspection' has been moved forward in the document
7	'Solvent replenishment/Weigh-in' has been moved forward in the document

1 Introduction

This document has been prepared by the European Industrial Gases Association (EIGA) to give guidance on the safe filling of acetylene cylinders, bundles and battery vehicles.

The previous publication of this document covered the theoretical aspects of permissible charge. In this new version the scope has been extended to include operational aspects for filling.

2 Scope and purpose

2.1 Scope

The scope covers single cylinders, bundles and battery vehicles containing different porous materials and different solvents.

As constant rate filling of cylinders is much more common than constant pressure filling the description of the filling process and requirements in this document is generally applicable to and intended for constant rate filling.

2.2 Purpose

This document provides guidance on safe filling practices.

3 Definitions and symbols

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 and Need not

Indicate 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 Acetylene bundle

Transportable unit consisting of two cylinders up to usually not more than 16 cylinders permanently manifolded together and contained within a rigid frame equipped with all necessary equipment for filling and use.

The following notes are directed to constructors of bundles and are required for safe filling:

- Cylinders need to have the same dimensions
- Cylinders need to have the same water capacity
- Cylinders need to contain the same porous material and the same porous material type approval for use in bundles
- Cylinders need to contain the same solvent
- Cylinders need to have the same working pressure.

3.2.2 Acetylene cylinder

Pressure vessel, manufactured and suitable for transport of acetylene, containing a porous material and solvent for dissolving acetylene (or solvent-free where applicable) with valve and other accessories fixed to the cylinder.

3.2.3 Acetylene battery vehicle type A

Vehicle where cylinders or bundles are removed from the vehicle for the purpose of filling individually.

3.2.4 Acetylene battery vehicle type B

Vehicle where cylinders or bundles are filled and emptied at prescribed number of times without removal from the vehicle.

3.2.5 Constant pressure filling

(alternative names are Individual Scale Filling, Simpleo Filling, Fast Filling)

A single cylinder is placed on a filling scale and connected to a filling point. Acetylene is supplied to the filling point at a constant high pressure. This allows high fill rate initially. The filling rate slows down as the pressure in the cylinder increases. The weight of the cylinder is constantly monitored. Some systems monitor the gas mass-flow into the cylinder, rather than the cylinder weight. During this process, solvent may also be added to the cylinder at various stages of the cycle. When the cylinder contains the correct amount of gas, the acetylene supply is stopped.

Filling times can be as short as 40 minutes for a single cylinder.

3.2.6 Constant rate filling

(alternative names are Manifold Filling, Rack Filling, Conventional Filling, Parallel Filling)

A number of cylinders are connected to a common manifold (or rack) and filled at the same time from the same source. The filling rack is usually supplied with a constant flow of acetylene. Cylinders are filled by pressure allowing the gas to dissolve into the solvent over time. During the filling cycle, sample cylinders are removed from the manifold and weighed to check the mass of acetylene in the cylinders. When the correct weight is achieved, all the cylinders are disconnected from the rack, and individually checked for the weight of gas in each cylinder.

Filling times are typically between 4 hours and 20 hours for a rack of cylinders – restricted by the absorption rate of acetylene into the solvent slowing down as the solvent warms up during the fill.

3.2.7 Porous material

Single or multi component material introduced or formed in the cylinder shell filling the entire cylinder volume and that, due to its porosity, allows the absorption of the solvent/acetylene solution.

3.2.8 Saturation gas

The amount of acetylene required to saturate the solvent at atmospheric pressure and 15°C.

3.2.9 Solvent replenishment

Procedure for filling solvent into an acetylene cylinder up to the specified solvent content.

3.3 Symbols

3.3.1 a_1

Specific increase in volume of solvent due to dissolving acetylene in l/kg

3.3.2 a_2

Specific volume of the pure solvent in l/kg

3.3.3 L Solvent loss

The amount of solvent loss from an acetylene cylinder per filling and emptying cycle in kg/l

3.3.4 m_{A0} Maximum acetylene content

Maximum permissible mass of acetylene including saturation gas in the cylinder in kg

3.3.5 m_A Acetylene content

Actual mass of acetylene including saturation gas in the cylinder in kg

3.3.6 m'_A Acetylene filling ratio

Acetylene content per litre of cylinder water capacity in kg/l

3.3.7 m_{S0} Specified solvent content

Specified mass of solvent in the cylinder necessary for the specified maximum acetylene content in kg

3.3.8 m_S Solvent content

Actual mass of solvent in the cylinder in kg

3.3.9 m'_S Solvent filling ratio

Solvent content per litre of cylinder water capacity in kg/l

3.3.10 N Number of bundle or battery vehicle fillings

Maximum number of consecutive fillings of an acetylene cylinder bundle (battery vehicle type B) without disassembly

3.3.11 P Porosity

Porosity of the porous material in % determined according to EN ISO 3807, *Gas cylinders – Acetylene cylinders – Basic requirements and type testing* [1].

3.3.12 S_{min} Minimum solvent filling ratio

Minimum solvent filling ratio in an acetylene cylinder within a bundle in kg/l

3.3.13 S_{max} Maximum solvent filling ratio

Maximum solvent content in an acetylene cylinder within a bundle in kg/l

3.3.14 t Solvent safety margin

Solvent safety margin for bundle filling conditions in kg/l

3.3.15 V_a Available volume

Volume in the cylinder which is not occupied by porous material and can hold solvent and acetylene in l

3.3.16 V_A Volume increase

Increase of the volume of the solvent due to dissolving acetylene in l

3.3.17 V_F Free volume

Volume of free space in the cylinder in l

3.3.18 V_S Volume of the solvent

Volume of the solvent in the cylinder in l

3.3.19 V_w Water capacity

Water capacity of the empty cylinder shell in l

4 Ownership and responsibility for safe filling

Where the ownership of the cylinder is established the approval of the owner shall be obtained before filling. Cylinder owners may request that their authorization be obtained prior to their cylinders being filled. Hence, cylinder owners may refuse the permission to fill their cylinders.

The filler shall take responsibility for establishing the suitability of the cylinder before filling.

5 Scales for acetylene packages

Scales shall be selected with a range suitable for the type of cylinder to be replenished and to maintain safe filling conditions.

For example, a scale should not be the same for a small cylinder type (5 litres) as for a large one (50 litres).

Small Cylinder volume = $\leq$ 6l Scale division 20g	Medium Cylinder volume >6 and $\leq$ 20l Scale division 50g	Large Cylinder volume >20l Scale division 100g	Bundles Scale division 1kg
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Scales shall be checked daily before use with standard calibration weights. This may be a cylinder whose weight is known. It is not mandatory, but good practice to record this daily check. Additionally, the scales should be calibrated annually by a person qualified to check for accuracy.

If the scale division is greater than above, then the filling ratio shall be reduced to compensate for the increase in scale division.

For battery vehicles type B an assessment of the required accuracy of the scale shall be completed to ensure the trailer will not be overfilled.

6 Pre-fill Inspection

Acetylene cylinders need pre-fill inspection to ensure they are:

- Physically in a condition that is safe for filling, and
- Comply with the legal requirements for filling

6.1 Pre-fill inspection for single acetylene cylinders

The cylinders are visually inspected according to EN ISO 11372, *Gas cylinders – Acetylene cylinders – Filling conditions and filling inspection* before they are considered for solvent replenishment or filling. [2]

Filling plant procedures shall include examples of cylinders that are not fit for service. These cylinders shall be quarantined for further investigation.

The following are examples of cylinders that shall not be directly replenished with solvent or filled with acetylene.

- Cylinders which cannot be clearly identified as being dissolved acetylene cylinders;
- Cylinders with evidence of the cylinder having been immersed in a liquid, e.g. water, oil;
- Cylinders having accumulated material in the cylinder base or foot-ring that may affect the cylinder weight (concrete, bitumen, mud, epoxy etc.);
- Cylinders with a loss of solvent of more than 10% of the nominal solvent quantity. See also 7.1.3.

NOTE Site operations may find that it is easier for operators to understand this rule (10%) if it is expressed as follows:

- a) a maximum kg of solvent by cylinder type.
- b) a maximum kg of solvent per litre volume of the cylinder.

- Cylinders with a sign of decomposition (soot in the valve outlet, paint damage by heat, ...)
- Cylinders returned from customers with open valves or without residual pressure; In this case, see 7.1
- Withdrawn cylinders (where filling is no longer authorised)
- Unknown design types, not familiar to the plant personnel
- Cylinders suspected of base corrosion. Refer to EIGA Safety Information SI42, *Acetylene Cylinder Base Corrosion* [3]

More detail on cylinder defects can be found in Doc 26.1, *Acetylene Cylinder Pre-fill Checks*. [4]

6.2 Pre-fill Inspection of acetylene bundles

Prefill inspection shall be done according to EN ISO 13088, *Gas cylinders - Acetylene Cylinder Bundles – Filling conditions and filling inspection*. [5]

Bundles with defects shall be quarantined for maintenance.

6.2.1 Documentation at time of pre-fill

Some countries have local requirements for bundle documentation. Where required, plants shall follow their local requirements.

Records (also known as "bundle file", "bundle pass", "filling list", etc.) shall be retained for every bundle. The records shall include details of the complete design and filling data. The records shall be retained by the owner or at the filling plant. The records may be held electronically on a database.

The following data shall be available for the bundle:

- The number of consecutive fillings since the last replenishment of solvent.
- The serial numbers of all cylinders manifolded in the bundle.

If the bundle file is not available or incomplete, the bundle shall not be filled until the bundle file or the missing data is obtained.

6.2.2 Check marking with documentation

In addition to the information on single cylinders in accordance with the relevant marking regulations of the countries of use (see ISO 13769, *Gas cylinders — Stamp marking*), the relevant manufacturing, operational and certification data for bundles shall be clearly identified on a corrosion-resistant plate permanently fixed on the outside of the bundle [6]. For information see EN ISO 10961, *Gas cylinders - Cylinder bundles - Design, manufacture, testing and inspection*. [7]

The identification data on the bundle identification plate and in the bundle file shall match.

NOTE If there are any changes on a bundle during its lifetime (e.g. use of different valves with different weight, exchanging cylinders of the bundle cylinder set with different tare weights), the bundle identification plate needs to be replaced with the modified data. It needs to be stamped by the competent authority. The bundle records need to be updated.

6.3 Pre-fill Inspection of acetylene battery vehicles

The requirements for pre-fill inspection for battery vehicles can be found in EN 13720, *Transportable gas cylinders – Filling conditions for acetylene battery vehicles* [8]

7 Solvent Replenishment / Weigh-In

During use, an acetylene cylinder will lose some of its solvent for the following reasons:

- *The solvent's volatility.* Some solvent loss is normal. For acetone, in a country with a temperate climate, the average loss rate is approximately 60 g/kg of acetylene used. In the warm climate, the loss rate can increase to 100 g/kg of acetylene used.

The volatility of acetone is greater than that of Dimethylformamide (DMF). Acetone is generally used for single cylinders and DMF is used for cylinders in bundles and battery-vehicles.

However, in some cases, single cylinders may also use DMF for certain applications and acetone may be used for bundles (either for specific applications or where National Regulations forbid the use of DMF).

- *The so-called "spitting" phenomena.* Spitting occurs when solvent is expelled in liquid form when gas is withdrawn from the cylinder during use. Solvent spitting is not a normal phenomenon. It can be caused by an excessive withdrawal rate during use, defects in the porous material or excess solvent in the cylinder. If spitting occurs the solvent loss may be significantly greater than 100g/kg of acetylene used.