



SAFE OPERATION OF ACETYLENE GENERATOR SYSTEMS

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Prepared by WG12 Acetylene

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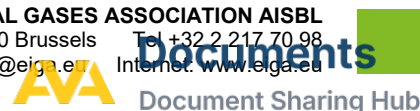


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1 Introduction

This document has been prepared by the European Industrial Gases Association (EIGA) to provide guidance for the safety requirements in acetylene generation.

2 Scope and purpose

2.1 Scope

This publication is intended to provide general guidelines for safe operation of acetylene generator systems.

This publication is limited to acetylene generation systems using calcium carbide added to water known as wet generation.

The scope includes:

- the carbide supply from receipt at site to entry into the generator
- the generation of acetylene to the pipe leaving the generator
- the control of temperature via water supply into the generator
- the control of level via the discharge of lime out of the generator
- gasholders and buffers

The scope does not include:

- water utilities
- lime handling after discharge from the generator
- response to emergency or abnormal situations (refer to EIGA Doc 231, *Response to Operational Issues in Acetylene Plants*) [1]

3 Definitions

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 generator

Equipment in which acetylene is generated from the reaction of calcium carbide with water.

3.2.2 Backflow prevention device

Double check valve arrangement device used to ensure proper backflow prevention of water/acetylene.

3.2.3 Bridging

When a solid material, such as calcium carbide, gets jammed/compacted and blocks/restricts flow of material.

3.2.4 Calcium Carbide containers

Vessels normally made of sheet steel with a rectangular or cylindrical shape. They are water-tight and are handled either by forklift or crane. The containers can be classified into intermediate bulk container (IBC) with a capacity up to 3 m³ or 2,5 t other containers up to 22m³ or 20 t.

3.2.5 Calcium Carbide island

Unreacted calcium carbide floating on the liquid surface in the generator.

3.2.6 Calcium Carbide conveyor

Mechanical device for the controlled transfer of calcium carbide from the feed hopper to the generator tank.

3.2.7 Calcium Carbide hoist.

Hoist that is intended to lift Carbide to the top of the generator. Terms that are used for the object lifted are skip, container, fill cart, flow bin, turn bin.

3.2.8 Closed charging hopper

The closed charging hopper is permanently mounted on top of the feed hopper and is separated from it by an isolation valve. It is fitted with an isolation valve on top to which a charging turn bins / flow bins can be connected. It has connections so that it can be purged with nitrogen and the gas contents analysed.

3.2.9 Drums

Drums are vessels manufactured from sheet steel with a capacity up to 400 kg but usually not exceeding 110 kg. They are water-tight and, depending on the design, drums can be used for one or multiple trips. Larger drums are sometimes referred to as barrels.

3.2.10 Feed hopper

Permanent part of the generator and provides a continuous supply of calcium carbide to meet the demand of the acetylene production.

3.2.11 Feed hopper cover

device which isolates the feed hopper from the atmosphere. It is only used in the open charging systems of generators.

3.2.12 Fill cart

Calcium carbide transport vessel, typically conical (funned) shaped, with a bottom valve. This unit is used to transfer calcium carbide for transportation packages to the generator feed hopper. See figure 1 for an example of a fill cart.

NOTE Also referred to in the industry as buggy, skip, cart, transfer hopper/cart.

3.2.13 Flash back arrestor

Device to stop a flame front and the flow of gas in the case of acetylene decomposition. This device can be activated either by a pressure shock wave or by a temperature sensing device.

3.2.14 Generator carbide isolation valves

Carbide isolation valves separate the various permanent and removable parts of the generator system. They are gastight and can be operated by hand or remote control. In generators with a closed charging system the isolation valve takes the place of the feed hopper cover/lid.

3.2.15 Generator feed hopper

Conical shaped vessel permanently installed on the generator and used to supply calcium carbide to the generator for acetylene production.

3.2.16 Grain size

The grain size defines the dimension of the calcium carbide pieces. The specification for the grain size of calcium carbide will depend upon the requirements of the generator system.

3.2.17 Hot spot

Phenomenon where calcium carbide accumulated under water and the reaction with the water allows it to potentially exceed the ignition temperature of acetylene inside a generator.

3.2.18 Open charging hopper

Is permanently mounted on top of the feed hopper and is separated from it by an isolation valve. It is used as an intermediate storage for the calcium carbide and is filled from either a charging skip or a turn bin / flow bin.

3.2.19 Turn Bins and Flow Bins

Bulk container (approximately 1.5 tonnes) which has only one opening at the base which is used for filling and emptying. The bin is turned at the carbide manufacturers to enable it to be filled.

Flow Bin is a bulk container (approximately 1.5 tonnes) which is filled from the top and emptied from the bottom.

Both systems reduce the amount of handling required when recharging the generator hopper and can be fitted with a pull out slide valve or with flaps to release the calcium carbide. The turn bin / flow bin is normally sealed to the plant hopper by a soft seal to ensure that there is no release of gas or dust.

Both flow bins and turn bins are fitted with quick connectors to allow a nitrogen supply and a vent line to be connected for the purpose of purging the turn bin / flow bin.

3.2.20 Wet generation

Process of making acetylene gas where calcium carbide is added to water.

3.2.21 Turnplate

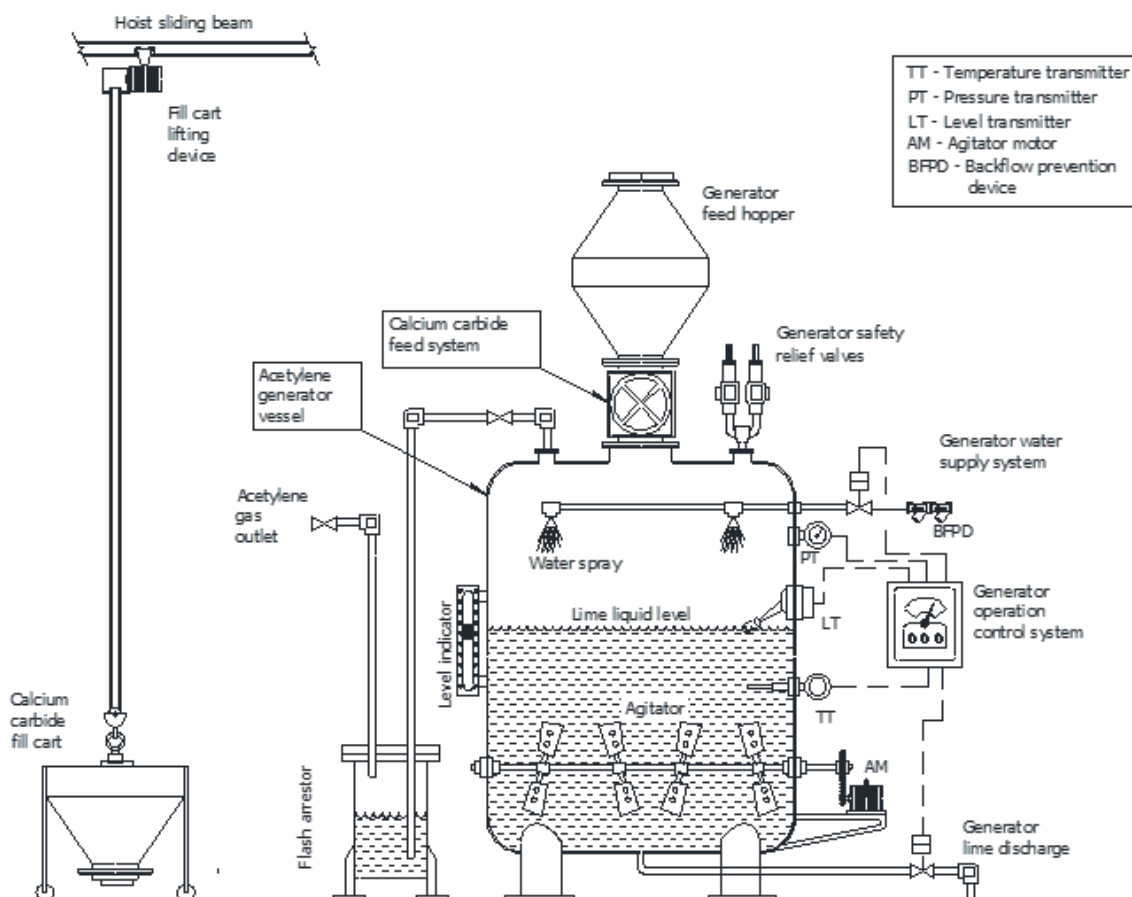
Grid in the generator body that holds the calcium carbide to improve the gas generation process. Once the calcium carbide has completely reacted, the grid is turned over to remove the calcium carbide residues from the grid.

4 Acetylene generator

4.1 Description of the equipment

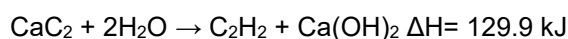
The generator system typically consists of the following components:

- Calcium carbide fill cart
- Carbide hoist (fill cart lifting device).
- Carbide feed hopper.
- Calcium carbide feed system, typically a screw feed, gravity feed or vibrators.
- Acetylene generator vessel
 - Generator carbide feed control system
 - Generator agitator
 - Generator safety relief system
- Acetylene piping
 - Acetylene flash-back protection.
- Generator water supply system
 - Generator temperature control system
 - Reverse flow protection.
- Generator lime discharge system
 - Generator level control system
- Inert gas supply system for
 - The acetylene generator when doing cleaning/maintenance.
 - The carbide supply when recharging the carbide feed hopper.
 - Handling emergencies on the acetylene generator (e.g. fire).



4.2 Acetylene generation chemical process

Acetylene is generated by the reaction of calcium carbide with water. This reaction is expressed by the formula:



Pure calcium carbide would liberate 2028 kJ per kg at 18° C and 1 bar. Commercial calcium carbide (typically about 80 % purity) would generate 1793 kJ of heat per kg of calcium carbide.

Calcium carbide reacts rapidly with water or even moisture in the atmosphere to generate acetylene and a carbide lime residue. This reaction creates considerable heat (exothermic reaction). The heat of reaction in the generator is controlled by use a large excess of water so that the heat can be dissipated.

The water to carbide ratio is approximately 8:1, but may vary between 7:1 and 10:1.

Calcium carbide is a grey rock-like solid that comes in irregular sized pieces, typically ranging from 5 mm–80 mm depending on customer specifications. The colour could be different when some of the minor impurities dominate (e.g. if there is a high content of ferrous oxide the colour can be browner).

Calcium carbide typically contains 15-20% impurities. The main impurities are un-reacted lime (7-14%) and coke (0, 4-3, 0%). Additionally, there are a minor number of chemical compounds containing iron, silicon, aluminium and magnesium. The impurities present also depend on the source and quality of the raw materials used.