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# **GB/T** 34526-2017

# **Rules for filling of gas mixture cylinder**

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# GB/T 34526-2017

**Preface**

This standard was drafted in accordance with the provisions of GB/T 1.1-2009.

It shall be noted that some contents in this document may involve patents. The issuing body of this document shall not be responsible for the identification of any or all such patent rights.

This standard is proposed by and under the centralized management of China Gas Cylinders Standardization Technical Committees (SAC/TC 31).

This standard was drafted by Hangzhou New Century Mixed Gas Co., Ltd., Beijing AP BAIF Gases Industry Co., Ltd., Beijing Praxair Utility Gas Co., Ltd., and China Industry Gases Industry Association.

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# **Rules for filling of gas mixture cylinder**

**1 Scope**

This standard specifies the terms and definitions, basic conditions, personnel requirements, equipment, facilities and technical requirements, filling of gas mixture cylinder, emergency management, packaging, marking, storage and transportation for filling stations of gas mixture cylinder.

This standard is applicable to the filling of cylinders for preparing gas-gas mixture and liquid-liquid mixture. Filling of gas mixture cylinders with other special purposes can refer to this standard.

**2 Normative references**

The following documents are essential to the application of this document. For dated references, only the dated versions shall be applicable to this document. For any undated references, the latest version (including all amendments) is applicable to this document.

GB 190 Packing symbol of dangerous goods

GB/T 5099 Seamless steel gas cylinders

GB/T 5274 Gas analysis - Preparation of calibration gas mixture - Gravimetric method

GB/T 5275 (All parts) Gas analysis―Preparation of calibration gas mixtures using dynamic volumetric methods

GB/T 7144 Coloured cylinder mark for gases

GB/T 11640 Seamless aluminum alloy gas cylinders

GB/T 13005 Terminology of gas cylinders

GB/T 14070 Gas analysis--Preparation of calibration gas mixtures--Manometric method

GB/T 14193 Rules for filling of liquefied gas cylinders

GB/T 14194 Rules for filling of permanent gas cylinders

GB 15258 General rules for preparation of precautionary label for chemicals

GB/T 15383 Connection types and dimensions for gas cylinder valve outlets

GB/T 16804 Precautionary labels for gas cylinders

GB/T 27550 Safety specification for filling station of gas cylinders

GB 50016 Code of design on building fire protection and prevention

GB 50030 Code for design of oxygen station

GB 50057 Design code for protection of structures against lightning

GB 50140 Code for design of extinguisher distribution in buildings

GB 50184 Code for acceptance of construction quality of industrial metallic piping engineering

GB 50235 Code for construction of industrial metallic piping engineering

HG/T 20675 Rules of design of static grounding for enterprises in chemical industry

TSG R0006 Supervision regulation on safety technology for gas cylinder

TSG R4001 Gas cylinder filling licensing regulation

**3 Terms and definitions**

The following terms and definitions and those defined in GB/T 13005 are applicable to this document.

**3.1 Filling quantity**

Weight of gas filled in the cylinder.

**3.2 Intermediate analysis**

Analysis to confirm the quantity of filled components at a certain step in the whole process of filling gas mixture into one cylinder (or multiple cylinders).

**3.3 Premix**

A kind of gas mixture used as the gas supply source during the filling of gas mixture.

**3.4 Compatibility**

There is no reaction between gas and gas, between gas and gas cylinder or between gas and cylinder valve and its safety accessories.

**4 Classification of gas mixtures**

Gas mixtures can be divided into combustible, oxidizing, toxic, corrosive and non-combustible gas mixtures.

**5 Basic conditions**

Filling stations shall meet relevant requirements specified in TSG R4001.

**6 Personnel requirements**

6.1 Relevant personnel of the filling station of gas mixture cylinder shall be familiar with the physicochemical properties (inflammable, explosive, oxidizing, toxic and corrosive, etc.) of the filled medium, safety protection measures and the compatibility of each component gas with the cylinder and its safety accessories.

6.2 The director (station master) shall be familiar with the relevant laws and regulations on the safety management of filled medium and have relevant professional knowledge on cylinder filling.

6.3 The technical director shall be familiar with the relevant laws and regulations, safety technical specifications and professional technical knowledge of medium filling, and have the technical title of relevant professional engineer (inclusive) or above.

6.4 The safety officer shall have a high school education (inclusive) or above and pass the professional and technical training, and be familiar with the technical and safety requirements for filling of gas mixture cylinders.

6.5 Personnel engaged in filling operations (including filling of gas mixture cylinders and inspection before and after filling) shall obtain the qualification certificates of corresponding special equipment operators.

6.6 Quality inspectors and analysis and inspection personnel suitable for filling medium shall have a high school education (inclusive) or above and obtain corresponding qualification certificates of product quality inspection according to relevant regulations.

**7 Equipment, facilities and technical requirements**

7.1 The necessary filling equipment for gas mixture cylinders shall be as follows:

a) The accuracy of pressure gauge for filling device prepared by manometric method shall not be less than Class 0.4, and its range shall be 1.5 ~ 3 times of working pressure; meanwhile, the indication error of the pressure gauge should be less than 2% (relative) of the minimum gas distribution concentration, and the diameter of the pointer dial should not be less than 150 mm. The periodic calibration period of pressure gauge shall not exceed one year. The pipeline shall be provided with an interlock device for overpressure alarm or automatic cut-off of gas source.

b) The accuracy of the measurement weighing apparatus prepared by gravimetric method shall meet the technical requirements of the prepared products, and its maximum weighing value shall be within 80% of the full scale used. The preparation of liquid-liquid gas mixture shall be equipped with special re-measurement weighing apparatus and interlock device for over-filling alarm or automatic cut-off of gas source. The periodic calibration period of weighing apparatus shall not exceed 1 year, and shall be reviewed before daily use.

c) The treatment before filling of gas cylinders shall be equipped with heating and evacuation devices and devices to automatically block the oil field flow of vacuum pump, and meet the pretreatment requirements of gas cylinders.

d) Gas cylinder filling device shall be equipped with independent blow-down pipe and replacement interface for inert gas as required.

e) Analytical instruments suitable for gas mixtures shall be equipped to analyze raw materials, premixes and final products.

f) Gas mixing equipment shall be provided.

7.2 The filling of gas mixture cylinders shall meet the following necessary technical requirements:

a) If the gas distribution cabinet is used for filling (preparing) gas mixture, the design and manufacture of the gas distribution cabinet shall conform to the relevant regulations of the state and industry.

b) The following requirements shall be met if the gas mixture is filled by confluence method:

1) The process and equipment of the gas mixture filling station are consistent with the design and are suitable for the filling medium and quantity. Combustible gas and oxidizing gas, as well as acidic gas and alkaline gas, shall not be filled in the same confluence device;

2) Installation and testing of filling pipes shall conform to GB 50184 and GB 50235;

3) Filling equipment, pipelines, valves, instruments and fittings shall be made of materials that do not react with the filling medium;

4) The pipe diameters of combustible gas and combustion-supporting gas pipelines shall be designed according to the maximum flow rate, pressure and safe flow rate of the pipeline gas during operation;

5) Pipelines with oxidizing gas components shall conform to GB 50030, and pipes with other special gases shall conform to relevant technical requirements.

7.3 The gas distribution device and its related equipment shall be provided with good grounding protection.

7.4 Filling stations shall comply with relevant regulations of GB/T 27550, GB 50016, GB 50057 and HG/T 20675.

7.5 The filling station shall be set independently. Full gas cylinders and empty gas cylinders shall be stored in different areas and marked properly.

7.6 The filling room should be equipped with appropriate forced ventilation facilities and harmful gas alarm devices suitable for gas, and oxygen gas detection alarm shall be installed in the enclosed space.

7.7 For the preparation of gas-gas mixture, the partial pressure of liquefied gas components in the mixture shall meet the relevant requirements specified in GB/T 5274 at the lowest service temperature.

7.8 Weighing apparatus room in filling room prepared by gravimetric method shall meet relevant requirements.

7.9 The gas mixture cylinder and cylinder valve used for filling shall meet the requirements of gas mixture distribution. Their materials shall not have any chemical reaction with the components in the gas mixture and shall not affect the quality of the gas.

7.10 For the cylinder valves of oxygen and strong oxidizing gas, the sealing materials shall be grease-free flame retardant materials.

7.11 If the gas mixture cylinder is filled for the first time, the cylinder shall be dried and evacuated, and replaced with qualified supplementary dilution gas. Residual pressure shall be reserved for refilling, and it shall be cleaned and vented on the confluence device.

7.12 In the process of filling gas mixture, low-concentration component gas (or liquid component) should be filled first, followed by high-concentration component gas; during the filling process, the pressure in the filling device shall not be lower than the pressure in the cylinder. The total pressure should rise slowly when approaching the required pressure.

7.13 The gas mixture prepared by manometric method can be corrected and used in combination with the analysis results of analytical instruments.

7.14 Raw gas for gas distribution (including premix and supplementary dilution gas) shall be fully analyzed for purity before filling, including purity and impurity indexes, and shall meet the quality requirements.

**8 Filling of gas mixture cylinder**

**8.1 Preparation before filling**

**8.1.1 Selection of filling method**

**8.1.1.1 Static methods**

The gas mixture is produced by directly filling quantitative component gas into the gas cylinder.

There are usually two filling methods for gas mixture cylinders: manometric and gravimetric methods. These methods can be combined when filling the gas cylinder with the required gas mixture. These static methods are as follows:

a) Manometric method

According to the requirements of GB/T 14070, the component gas is filled into the gas cylinder according to the calculated pressure, and the static pressure in the gas cylinder is measured after each filling. The concentration of the gas mixture is expressed as pressure, which is equal to the ratio of the partial pressure of the filled component gas to the total pressure of gas mixture. The calculated pressure shall take into account the compression factor of the components and the temperature change after the cylinder is filled, so as to ensure that all component gases will not liquefy during the filling of gas mixture and its subsequent use.

b) Gravimetric method

According to the requirements of GB/T 5274, the gas cylinder is weighed before and after the gas cylinder is filled with component gas with a certain known concentration, and the mass of the gas component filled in the gas cylinder is determined by the difference between the two weighed mass. Various component gases are filled according to this method to complete the filling of gas mixture. The mass concentration (molar concentration) of each component in the gas mixture is the ratio of the mass (molar number) of the component gas to the sum of the mass (molar number) of all the component gases. These calculated masses shall be accurate to ensure that all component gases will not liquefy during gas mixture filling and its subsequent use.

**8.1.1.2 Dynamic methods**

According to the requirements of GB/T 5275, the gas mixture is filled in a dynamic manner through accurate calculation results before the medium is filled into the cylinder.

Under normal circumstances, dynamic mixing is carried out at low pressure, and then filled into the gas cylinder by pressurization. Measures shall be taken in the system to ensure that it is impossible to continue preparation and filling under the condition that the flow control fails, so as to ensure that the component gas will not liquefy after the gas mixture is pressurized and the product quality of the pressurized gas mixture will not change.

**8.1.2 Preparation and approval of operation instructions**

**8.1.2.1 Contents of operation instructions**

The operation instructions for filling of gas mixture cylinders shall at least include:

a) Details of gas cylinders and valves and other preparatory work (including handling and inspection);

b) Determination of gas components to be filled into gas cylinders and filling sequence;

c) Measurement methods, quality requirements and filling equipment for gas components filled into gas cylinders;

d) Any special restrictions related to the speed of filling components into the cylinder (e.g. minimizing temperature rise);

e) Method for mixing various gas components;

f) Any requirements for intermediate analysis;

g) Quality control methods;

h) Review opinions to confirm the rationality, correctness and safety of operation instructions.

**8.1.2.2 Approval of operation instructions**

8.1.2.2.1 The operation instructions can be in handwriting format or computer-aided format.

8.1.2.2.2 The personnel preparing the operation instructions shall have relevant professional technical experience, and shall master the relevant physicochemical properties, working principle and safe operation encountered in the filling of gas mixture cylinders.

8.1.2.2.3 The technical director of the filling unit is responsible for reviewing the operation instructions, and the director is responsible for approving the operation instructions.

**8.1.2.3 Adjustment and modification of operation instructions**

The operation instructions shall be adjusted and modified regularly according to the actual situation to ensure its safety and effectiveness.

**8.1.3 Confirmation of filling equipment, facilities, instruments, etc.**

The filling equipment, facilities and instruments at the filling site are confirmed according to the approved operation instructions, and the safety system is confirmed to meet the requirements.

**8.2 Inspection and handling before filling**

8.2.1 The cylinder before filling shall be in the charge of specially assigned person and inspected one by one.

8.2.2 Gas mixture cylinders are prohibited from filling under any of the following circumstances:

a) Gas cylinders are produced by units that do not have "special equipment manufacturing license";

b) Imported gas cylinders have not been approved by the safety supervision and administration department of special equipment;

c) The filled gas is inconsistent with the name or chemical formula of the filled gas in the cylinder manufacturing stamp mark;

d) The name and chemical formula of the filled gas printed on the warning label made according to GB/T 16804 are inconsistent with the steel seal mark of the cylinder;

e) The cylinder to be filled is not the cylinder owned by the filling station or the cylinder managed by other filling stations;

f) The color mark on the outer surface of the cylinder does not conform to GB/T 7144 and is not clear and easy to recognize;

g) The thread type of the outlet of the cylinder valve does not conform to GB/T 15383, i.e. the outlet thread of cylinder valve for combustible gas is not left-handed; the outlet threads of cylinder valves for other gases are not right-handed;

h) There are cracks, serious corrosion, obvious deformation and other serious external damage defects on the outer surface of the cylinder;

i) The gas cylinder is not within the stipulated validity period of inspection;

j) Safety accessories of gas cylinders do not meet safety requirements;

k) The cylinder body and valve of the cylinder filled with oxidizing gas mixture are contaminated with grease or other combustible materials;

l) The gas cylinder has exceeded its service life.

8.2.3 For gas cylinders with color marks and outlet thread of cylinder valve that do not conform to the regulations of the gas filled and with unknown residual gas, the filling behavior is not allowed, and the cause shall be found out for treatment.

8.2.4 For the gas cylinder with residual pressure on the confluence device, the confluence device shall be replaced or evacuated with qualified gas, and then the residual gas in the cylinder shall be vented.

8.2.5 For gas cylinders that have no residual pressure, are newly put into use, or are filled for the first time after internal inspection, they shall be vacuumized or replaced with qualified gas before filling to remove air and moisture in the cylinders, and filling can only be carried out after analysis is qualified.

8.2.6 For gas cylinders that are found to have major defects or have doubts about the internal conditions during the inspection validity period, or for gas cylinders, cylinder valves and other accessories transported on vehicles in case of traffic accidents during the inspection validity period, they shall be sent to the inspection organization approved by relevant departments for technical inspection and evaluation according to regulations, and can be reused only after passing the inspection. Cylinders that have been in storage and out of service for more than one inspection cycle shall be inspected regularly before use.

8.2.7 When gas cylinders imported from abroad are required to be filled in China, they should be inspected by the inspection agency approved by the special equipment safety supervision agency.

8.2.8 Cylinders that fail to pass inspection (including those to be treated) shall be isolated from qualified cylinders with obvious marks.

**8.3 Filling**

8.3.1 The content of components or impurities in gas mixture cylinder shall meet the requirements of corresponding gas standards.

8.3.2 When filling gas mixture, the following regulations shall be strictly observed:

a) It should be confirmed that the gas cylinder has passed the inspection and records shall be kept before filling;

b) When filling various incompatible raw gases of gas mixture, sufficient safety distance and isolation measures shall be provided;

c) When filling with the anti-misloading joint, checking that the outlet thread of the cylinder valve is consistent with the thread type specified by the filled gas, and all parts of the anti-misloading joint shall be flexibly matched;

d) The operation of opening the cylinder valve shall be gently, and attention shall be paid to monitor the abnormal sound in the cylinder;

e) It is prohibited to knock the cylinder valves and pipelines with wrenches and other metal appliances;

f) The filling flow of gas cylinder shall not be greater than 8m3/h (gas in standard state);

g) It is forbidden to insert empty cylinders for filling during the filling of gas cylinders.

8.3.3 The filling quantity of gas cylinders should be strictly controlled and excessive filling is prohibited.

The filling quantity of various gases shall be accurately determined according to the following methods:

a) The filling quantity of gas-gas mixture shall ensure that the gas pressure in the cylinder does not exceed the nominal working pressure of the cylinder at the reference temperature (20℃) after the cylinder is filled.

The final filling pressure shall be determined according to different filling gas temperatures during filling.

b) The actual filling quantity of liquefied gas mixture shall not be greater than the product of the volume of the gas cylinder and the gas filling coefficient, nor shall it be greater than the prescribed filling quantity of the gas cylinder. The maximum limit value of filling coefficient of high-pressure liquefied gas mixture is determined according to formula (1):



Where:

Fr-Filling coefficient of high-pressure liquefied gas mixture, in kg/L;

P-Allowable pressure (absolute pressure) of the gas cylinder, and the nominal working pressure of the gas cylinder shall be taken according to relevant standards, in MPa;

M-Relative molecular mass of gas;

Z- Compression coefficient of gas at the pressure (P) and temperature (T);

R-Gas constant, R=8.314×10-3MPa•m3 (kmol•K);

T- Maximum service temperature of gas cylinder, in K.

The liquid density of gas mixture at the highest service temperature (60℃) shall be determined through tests, and then the filling coefficient of the low-pressure liquefied mixed gas (liquid-liquid mixture) shall be calculated and determined according to formula (2).



Where:

Fr-Filling coefficient of low-pressure liquefied gas mixture, in kg/L;

C-Maximum minus deviation of liquid density, C is 0 ~ 3 in general;

ρ-Liquid density of low-pressure liquefied gas at the highest liquid phase gas temperature, in kg/L.

For determining the filling coefficient of liquid-liquid gas mixture whose critical temperature is close to (slightly higher than) 65℃, it should also be ensured that when the gas temperature in the cylinder reaches 65℃, the cylinder is not full of liquid.

8.3.4 The filling quantity of the liquid-liquid mixture gas cylinder shall not be greater than the calculated value of the product of the total volume of the gas cylinder and the filling coefficient, nor shall it be greater than the prescribed filling quantity of gas cylinder.

8.3.5 It should be confirmed that the gas mixture to be filled this time should be included in the filling operation instructions of gas mixture before filling.

**8.4 Inspection after filling**

8.4.1 Gas cylinders shall be inspected one by one after filling. The inspection shall at least include the followings:

a) The filling quantity (pressure or quality) shall meet the requirements of safety technical specifications and relevant standards;

b) Cylinder valve and its connection with cylinder mouth shall be sealed well;

c) No serious defects such as bulging, deformation or leakage shall occur after the cylinder is filled;

d) The temperature of cylinder body should show no signs of abnormal increase;

e) Safety accessories for gas cylinders shall be complete;

f) The filling labels and warning labels of gas cylinders shall be complete.

8.4.2 The causes shall be promptly found out and corrective measures shall be formulated for the nonconformities.

**8.5 Verification and analysis**

8.5.1 The gas mixture contained in the gas cylinder shall be a batch of products continuously filled at one time or produced by an operation shift. The gas mixture contained in the gas cylinder shall be tested by random sampling of 2% of the batch of products, and the sampling quantity shall not be less than 2 cylinders or more than 5 cylinders. When any index in the inspection results does not meet the requirements of this standard, the sampling inspection shall be re-conducted and doubled for the batch of products. If any index still does not meet the requirements of this standard, the batch of products is unqualified. For those with product standards, samples shall be taken according to the sampling requirements specified in the product standards.

8.5.2 The gas mixture filled by cylinder bundle shall be inspected frame by frame. If any of the inspection results does not meet the requirements of this standard, the product is unqualified.

8.5.3 Concentration alarm devices for combustible, toxic or other gases should be set up and effective ventilation facilities should also be set up according to the characteristics of the gas in the gas analysis room.

8.5.4 Tail gas from the analysis of gas mixture samples shall be safely treated before being discharged into the atmosphere.

8.5.5 Gas shall be treated with proper mixing before product analysis, and analysis shall be carried out after mixing is uniform.

**8.6 Filling record**

8.6.1 Filling personnel shall fill in the filling records of gas mixture cylinders:

a) The record contents of gas-gas mixture shall at least include: filling date, cylinder number, product name, filling medium, content of each component, starting and ending pressure (or weight) of each component during filling, nominal working pressure, starting and ending time of filling, filling temperature, room temperature, volume, presence or absence of abnormal conditions, filling personnel and inspectors;

b) The record contents of liquid-liquid gas mixture shall at least include: filling date, cylinder number, product name, filling medium, net weight of gas cylinder, content of each component, starting and ending weight of each component during filling, filling time, room temperature, volume, re-weighted total weight of gas cylinder after filling, presence or absence of abnormal conditions, filling personnel and inspectors.

8.6.2 The filling unit shall be responsible for properly keeping the filling records of gas mixture cylinders, which shall be kept at least for 1 year.

**9 Emergency management**

9.1 The filling station shall prepare the emergency rescue plan for the filling accident of gas mixture cylinders in line with the actual situation of the unit, determine the technical methods for emergency disposal, specify the command and coordination mechanism for emergency rescue, the division of labor and responsibilities of emergency rescue personnel, emergency equipment and facilities, emergency disposal, personnel evacuation, emergency rescue, medical and other emergency measures, social support rescue, training and exercises of the emergency rescue plan, etc.

9.2 Emergency plans shall be regularly drilled according to regulations, and the effect of drills shall be carefully evaluated and summarized. Relevant records and documents of drills shall be kept.

9.3 The emergency plan should be revised and improved in time to ensure its effectiveness and operability.

**10 Packaging, marking, storage and transportation**

10.1 The filling, storage and transportation of gas mixture shall comply with the relevant provisions of GB 190 *Packing Symbol of Dangerous Goods* and TSG R0006 *Supervision Regulation on Safety Technology for Gas Cylinder*.

10.2 The gas cylinder for packaging gas mixture shall comply with the provisions of GB/T 5099 or GB/T 11640, the connection type of the gas outlet of cylinder valve shall comply with the provisions of GB/T 15383, and the label of the gas cylinder shall comply with the requirements of GB/T 16804 and GB 15258.

10.3 Pollution and leakage of cylinder mouth shall be prevented.

10.4 The color of gas mixture cylinders shall meet the requirements specified in GB/T7144.

10.5 When the gas mixture contained in the gas cylinder is at 20℃, the maximum pressure shall not exceed the nominal working pressure of the cylinder; the residual pressure of cylinder to be filled when returning to the factory shall not be less than 0.2MPa. The accuracy of the pressure gauge used for measurement shall not be less than Class 1.6 or the digital display pressure gauge shall be used.

10.6 The gas mixture shall be accompanied by a quality certificate when leaving the factory, which shall at least include:

-Product name;

-Content of each component;

-Finished product pressure (MPa, 20℃) (or weight);

-Name and address of the manufacturer;

-Production date or batch number;

-Implemented standard number, filling personnel number and inspector number, etc.

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