The Procedures for Cleaning Gas Cylinders

It is occasionally desirable to change gas cylinders from one gas service to another. Certain of these service changes can be made quite easily, while others require a careful inspection of the interior and exterior of the cylinder to detect the presence of corrosion products or contaminants, which must be removed for safety reasons or to avoid undesirable contamination of the contained gas.

This International Standard has been prepared to assist those engaged in the filling of gas cylinders for changing cylinders from one gas service to another. Part of the standard covers the “The Procedures for Cleaning Gas Cylinders”. Evergreen Midwest has enclosed those procedures for your convenience, known as, Annex A.
Annex A
(informative)

Procedures for cleaning gas cylinders

This annex is for information only. Other acceptable methods may be employed. The methods suggested herein for removing the most frequently encountered contaminants have been found to produce satisfactory results. These contaminants should be removed either for reasons of safety or to prevent product contamination when the cylinder is again filled with a different gas.

A.1 General

A.1.1 Identification of contaminant

Gas cylinders may become contaminated, by filling operations or in service, with various materials. The selection of the appropriate method of cleaning should be based, when possible, on an identification of the contaminant. A sample of the contaminant should be tested to determine whether it is combustible, water soluble, organic-solvent soluble, etc. If a sample cannot be obtained, all clues to the nature of the material should be considered such as odour, appearance (i.e. rusty, oily, discoloured spot, etc.), the previous service of the cylinder and the method of filling, e.g. oil-lubricated compressors.

A.1.2 Selection of cleaning procedure

Almost all hydrocarbon-based contaminants can be removed by either aqueous-solution washing (A.2.1) or organic-solvent washing (A.2.2), either in the liquid phase or in the vapour phase. However, some contaminants become very difficult to remove by any method if an organic solvent is used first; since this solvent converts them to insoluble gums. The cleaning solution must, of course, be compatible with the intended gas service, in particular for oxidizing gases, and must be removed without leaving any harmful residue. Its environmental impact should also be considered. The flow chart given in figure A.1 shows various methods used to clean gas cylinders. These methods are discussed in the following subclauses.

![Flow chart for cleaning gas cylinders]

Figure A.1 — Methods used to clean gas cylinders

CAUTION — Aluminium-alloy cylinders are normally manufactured using heat treatment to obtain the final mechanical properties of the cylinder. Thereafter, the temperature for any operations has to be limited. In no case may the temperature used exceed that recommended by the manufacturer. For cylinders manufactured from heat-treated alloys with tempering, the maximum temperature is 150 °C.
A.2 Solvent cleaning

A.2.1 Aqueous-solution washing

There are a number of aqueous solutions which may be used for removing organic materials from cylinder interiors. Almost all of them are based upon an alkaline solution of sodium metasilicate, although some use a straight potassium or sodium hydroxide solution at approximately 8° Baume concentration. An alkaline detergent does not dissolve oil, grease or similar contamination. Cleaning solutions have high wetting properties which enable them to emulsify oil films and coat all objects with a film of detergent so that the oil floats free in the solution. Some means of removing surface films should be provided, as the cleaning action brings much of the foreign material to the surface of the liquid. The preparation and use of one such solution is described below.

A.2.1.1 Alkaline-solution cleaning

CAUTION — Alkaline solutions are caustic, particularly when hot, as they are generally used. They can therefore cause severe burns to the skin and eyes. Personnel working with these materials should wear suitable protective clothing, including goggles or face mask, rubber gloves, rubber apron and alkali-resistant footwear. An eyewash and safety shower should be available nearby.

If the cleaning solution comes in contact with the skin, as evidenced by a burning sensation, rinse the area immediately with water, preferably warm. Vinegar applied to the area will aid in neutralizing the effect of the alkali.

If the cleaning solution comes in contact with the eyes, immediately flush with copious quantities of fresh water and see a physician.

Do not use caustic paint stripper to clean aluminium cylinders. Some detergents, alkaline solutions and organic solvents may react destructively with aluminium and other non-ferrous materials. The use of such solvents for the external or internal cleaning of such non-ferrous materials could render them unsafe for further use. Check with the cylinder manufacturer for recommended cleaning compounds.

A.2.1.1.1 Preparation of cleaning solution

To prepare a maximum-concentration cleaning solution, for every 20 l of clean water add 1 kg of sodium metasilicate and 30 g of sodium dichromate. This produces about a 5% concentration. Use clean, hot water. Water from the plant boiler should not be used as it may be contaminated.

The strength of the cleaning solution should not be greater than that required for effective cleaning. For example, if the contamination is a light oil, a solution of 150 g to 200 g of sodium metasilicate in 20 l of water will generally be sufficient.

Sodium metasilicate forms insoluble precipitates with the mineral salts in water. If the water used is exceptionally hard, these precipitates should be removed from the cleaning solution by filtration to avoid clogging the equipment. The alkaline solution used for cleaning should be freshly prepared and shall not have been previously used.

A.2.1.1.2 Cleaning procedures

A.2.1.1.2.1 External cleaning

Cylinders coated with dirt, oil or grease, but showing no evidence of such contamination on or in the vicinity of the valve outlet, may be cleaned externally only. The above solution, applied with a brush or rag, will effectively remove most contaminants. Care should be observed that none of the solution or dirt gets on or into the valve outlet. After all contamination has been removed, rinse the cylinder thoroughly with clean, warm water.

NOTE — Alkaline solvents may remove or damage the paint. Cylinders should be inspected, and if necessary repainted, before being returned to service.
A.2.1.1.2.2 Internal cleaning

Cylinders which show evidence of internal contamination must be cleaned internally.

Procedure 1

a) Remove the valve. Fill the cylinder to slightly over half its capacity with a hot alkaline solution, and then plug the neck opening.

b) Lay the cylinder on the floor, and roll it back and forth for about 15 min. Preferably use a cylinder roller, positioning the cylinder horizontally and allowing the cylinder to rotate for 15 min.

c) Immediately upon completion of the rolling, stand the cylinder up, remove the plug and completely fill the cylinder with clean tap water. Be sure the cylinder is full, as the interior walls must be kept wet until the cylinder is rinsed.

d) When ready to rinse, drain the solution by inverting the cylinder. While the cylinder is inverted or inclined with the neck down, rinse the inside with fresh, clean running tap water, making sure that the rinse water reaches all interior surfaces. Continue rinsing until all traces of the cleaning solution have been removed. This may require a rinsing period of at least 10 min.

e) Dry the cylinder immediately after cleaning and perform a visual inspection to determine that the cylinder is clean and free of defects.

f) Install a plug or the proper valve as soon as practicable after inspection.

Procedure 2

Alternative procedures using alkaline solutions for the internal cleaning of cylinders are equally effective. Among those which have been found to result in satisfactory cleaning are the following:

a) A steam lance is inserted to the bottom of the cylinder which has been filled with an alkaline solution. Clean, oil-free steam is injected into the solution through the lance to keep it boiling for 15 min to 30 min. During the boiling process, enough excess boiling water or steam is injected through the lance so that the solution overflows from the cylinder, carrying away the contaminants which have floated to the surface.

b) The cylinder is positioned with the open neck pointing downward. A mixture of high-pressure steam and a cleaning solution, such as the one described above, is injected into the cylinder through a steam lance. The lance should be moved up and down and sideways so that the cleaning fluid will contact the entire inside surface of the cylinder. Rotating the cylinder may be helpful.

c) The cylinder is positioned with its open neck downward, over a short length of tubing. Heated alkaline cleaning solution is injected, through the tubing, upward into the cylinder so that it impacts the bottom of the cylinder and runs back down the cylinder walls, contacting all the interior surfaces of the cylinder.

d) After cleaning with any aqueous or alkaline solution, the cylinder must be thoroughly rinsed with clean water.

e) Thoroughly dry the cylinder immediately after rinsing, and perform a visual inspection to determine that the cylinder is clean.

f) Install a plug or the proper valve immediately to avoid contamination by atmospheric moisture.

A.2.2 Organic-solvent washing

A.2.2.1 General

In these procedures, an organic solvent is introduced into the cylinder using a method that will assure that all interior surfaces are effectively contacted by the solvent. Experience has indicated that, most of all, cylinders which are oil
or hydrocarbon contaminated can be adequately cleaned by organic solvents to render the cylinder suitable for use in oxygen or any other gas service.

This method of cleaning depends upon the ability of the solvent to dissolve organic materials in a short period of time, to leave only a small amount of non-volatile residue on the walls of the cylinder, and not to react chemically with the cylinder material. There are many commercial solvents on the market that meet these requirements.

CAUTION — Since almost all solvents are harmful if breathed to excess, cylinder cleaning with these solvents should be done only in an area with good, positive ventilation, and only by persons wearing adequate protective equipment.

Carbon tetrachloride should not be used for cleaning cylinders, due to its extreme toxicity.

A.2.2.2 Organic solvents may convert some water-soluble contaminants to insoluble gums. If the internal inspection of a cylinder indicates the possible presence of both water-soluble and water-insoluble materials, the cylinder must be washed first with an alkaline solution in accordance with one of the procedures given in A.2.1.1.2.2 and then, if necessary, washed with an organic solvent in accordance with the procedure described below.

A.2.2.3 Cold-solvent procedure

a) Pour clean solvent into the cylinder until it is slightly over one-half full, then plug the neck opening. Lay the cylinder on its side and rotate for approximately 15 min. The cylinder can be rotated either with a mechanical rotating machine or by rolling it back and forth on the floor.

b) Empty the cylinder and observe the discarded solvent. If the solvent is dirty, repeat the cleaning procedure using fresh solvent. Do not use the original solvent as it could redeposit contaminants. If a solvent-reclaiming procedure is available, some solvents may be reclaimed by boiling and condensing the vapours. Otherwise, the solvent must be discarded or used only for routine cleaning of machinery or another non-critical use.

c) After cleaning, dry the cylinder, purge with oil-free air or nitrogen to remove residual solvent and vapours, and visually inspect the interior to determine that the cylinder is clean and free of defects. Install a plug or the proper valve as soon as practicable after drying.

A.2.2.4 Solvent vapour procedure

This solvent-cleaning procedure uses a tank with immersed heaters to vaporize the solvent. The solvent vapour is discharged upward through an injection tube over which a cylinder is inverted. The hot vapours condense on the internal walls of the cylinder being cleaned, dissolve the oil contamination, and return to the tank by gravity. The solvent in the tank thus becomes contaminated. However, the vapour driven off by the heating is free of contaminants and the cylinder is thus washed at all times with clean condensate.

CAUTION — Because of the large volume of organic-solvent vapours generated, the equipment should be constructed, maintained and operated in a manner which will avoid hazardous concentrations of the vapours in the work area.

NOTE — Cylinders with loose scale, paint or dirt inside or outside should not be placed in a vapour degreaser until the loose particles have been removed. This will prevent fouling of the boiler, contamination of the solvent and overheating the coils.

The details of the procedure are as follows:

a) Rinse the cylinder with water, both internally and externally, to remove water-soluble materials, and then dry.

b) Invert the cylinder using an appropriate hanger and lower it over the injection tube of the vapour cleaner. The injection tube shall almost reach the base of the cylinder. Various lengths of tube should be available for use with various cylinder sizes.

c) Leave the cylinder on the cleaner for 15 min to 45 min after vapour has started to issue from the neck of the cylinder. The time required depends upon the neck tube opening and the quantity of contamination.
d) Remove the cylinder from the injector tube and immediately purge it with at least 3 m³ of oil-free compressed air or nitrogen. The exhaust from the cylinder should be piped to the outside of the building, if the cleaning is done indoors.

e) Immediately dry the cylinder.

f) Perform a visual inspection to determine that the cylinder is clean and free of defects.

g) Install a plug or proper valve as soon as practicable to avoid the entry of atmospheric moisture.

A.3 Mechanical cleaning

A.3.1 General

If the internal inspection indicates the presence of rust, mill scale or other foreign solids adhering to the walls, such material should be removed before the cylinder is again used or the interior is chemically cleaned. These materials can be removed by mechanical cleaning. A number of mechanical-cleaning procedures are described below.

A.3.2 Wire brushing

The interior of small cylinders or cylinders with large neck openings can be cleaned by inserting a wire brush of proper design through the valve opening and rotating it with an electric drill, lathe, etc., while forcing the brush against the wall of the cylinder and moving it up and down to contact all interior surfaces. The cylinder should be up-ended periodically to dump out any loose material.

NOTE — Cylinders containing flammable gas should be purged.

A.3.3 Tumbling

A quantity of hard abrasive material, such as angular chilled cast iron, short pieces of reinforcing rod, etc., are placed inside the cylinder. The cylinder is then rotated in a horizontal position for a sufficient period of time to loosen the material adhering to the walls. The preferred rotation should not be completely circular since such action would tend to make the abrasive material slide on the inner surface without the impinging action which gives superior cleaning. Rotation combined with a rocking or shaking motion which causes the abrasive materials to strike the inner walls of the cylinder is preferable.

A.3.4 Shot or sand blasting

Shot or sand blasting is a method of removing mill scale or corrosion products from cylinder interiors. Care must be taken not to remove an excessive amount of parent metal from the cylinder walls. This method works best when the cylinder is inverted so that the shot and loose material do not accumulate within the cylinder. The motion of the blast nozzle relative to the cylinder surface should be constant and uniform over the entire surface to be cleaned. The motion should never be stopped during the cleaning operation in order to avoid excessive local loss of cylinder wall.

A.3.5 Following any method of mechanical cleaning, the cylinder should be inverted to remove loose particles, then rinsed well with clean water and dried. Install a plug or the proper valve immediately after drying.