USE OF
RESIDUAL PRESSURE VALVES

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USE OF RESIDUAL PRESSURE VALVES

As part of a programme of harmonisation of industry standards, the Asia Industrial Gases Association (AIGA) has published AIGA 063, "*Use of Residual Pressure Valves"*, jointly produced by members of the International Harmonization Council, and originally published by European Industrial Gases Association (EIGA) DOC 64, "*Use of Residual Pressure Valves".*

This publication is intended as an international harmonised publication for the worldwide use and application by all members of Asia Industrial Gases Association (AIGA), Compressed Gas Association (CGA), European Industrial Gases Association, EIGA, and Japan Industrial and Medical Gases Association (JIMGA). Each association's technical content is identical, except for regional regulatory requirements and minor changes in formatting and spelling.

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1 Introduction

Cylinder valves that retain a residual positive pressure in a gas cylinder and some types of devices that prevent backflow of fluid by means of a non-return device, commonly referred to as residual pressure valves (RPV), have been available for many years. Important benefits of RPVs include preventing moisture ingress and contamination, which reduce the potential for internal cylinder corrosion. Additional benefits include productivity improvements in the cylinder fill operation, avoiding internal cylinder contamination that could create hazardous situations, and reducing cylinder maintenance.

In the past, industry relied on users not to allow backflow into cylinders. Fillers typically relied on prefill inspection procedures to identify potentially contaminated cylinders returned from customers. Despite these measures, incidents caused by backflow of contaminants into cylinders have occurred, which highlight the potential benefit from usage of RPVs. AIGA 062, *Methods to Avoid and Detect Internal Corrosion of Gas Cylinders and Tubes* describes methods to avoid and detect internal gas cylinder corrosion and EIGA Doc 908, *300 Bar Residual Pressure Valve Filling Connectors* standardizes the filling connector for 300 bar residual pressure valves. [1, 2]

The use of RPVs generally requires a special fill connector for filling, evacuation, or both.

2 Scope and purpose

2.1 Scope

This publication is intended for use by the compressed gas industry and provides guidelines for the use of RPVs. This publication does not describe any design qualification tests of RPVs.

2.2 Purpose

The purpose of this publication is to give guidance on the selection, operation, maintenance, and installation of these valves, so common practices are established across the gas industry and these valves are beneficial to both the end user and gas cylinder filling facilities.

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 Residual pressure device (RPD)

Device that is designed to prevent ingress of contaminants by maintaining a positive pressure within the cylinder relative to atmospheric by closing off its internal gas passages in the discharging direction. [PC 35474]

3.2.2 Residual pressure valve (RPV)

Valve that incorporates a RPD.

4 Residual pressure valve types

There are two types of RPVs: Type 1 and Type 2. Use of either Type 1 or Type 2 is dependent upon operational and gas quality requirements. Both types contain a residual pressure device to retain a positive pressure in the cylinder.

NOTE— Some cylinder valves with integrated pressure regulators (VIPRs) can have similar positive pressure and nonreturn functionality as RPDs.

4.1 Type 1 RPD

RPD that retains a positive pressure in the cylinder greater than the pressure downstream of the valve outlet and also incorporates a nonreturn feature to prevent backflow into the cylinder from a higher pressure on the valve outlet.

NOTE—Cylinders with RPVs with a Type 1 RPD located between the filling port and cylinder cannot be filled or vacuumed unless the RPD is neutralized or a special fill connector is used to overcome the nonreturn feature.

4.2 Type 2 RPD

RPD that retains a positive pressure in the cylinder greater than atmospheric pressure but will not prevent backflow into the cylinder if the pressure on the valve outlet is high enough to overcome the RPD mechanism and the residual pressure in the cylinder.

NOTE—Cylinders with RPVs with a Type 2 RPD can be filled with a conventional fill connector but, if located between the filling port and cylinder, cannot be vacuumed or vented at less than the closing off-pressure unless the RPD is neutralized or a special fill connector is used.

5 Benefits of residual pressure valves

RPVs provide several benefits over valves without RPDs. These benefits include:

- Maintaining positive pressure—A RPV will maintain positive pressure and prevent atmospheric contamination if the valve is left open;

Improving filling productivity—Depending on the gas purity required, the venting and evacuation stages during the fill process may be eliminated allowing for the top-fill of cylinders;

NOTE—Some regulations require venting and evacuation for certain products prior to filling regardless of the type of valve installed.

- Extending service life of the cylinder—Lifetime expectancy of a cylinder is extended by reducing the exposure of the cylinder internal surfaces to the atmosphere (moisture ingress), which can lead to corrosion;

- Preventing contaminants entering the cylinder— Where there is a possibility of backflow, the Type 1 RPDs with a non-return feature ensures that gas quality and the cylinder internal condition are not compromised. Type 1 RPDs can prevent the ingress of contaminants for example sea water, toxics, and flammable materials such as solvents, oils, gases, etc., which can lead to consequences on refilling or subsequent customer use.;

- Potential for reducing risk of cylinder failure—Moisture ingress into the cylinder can cause corrosion and stress corrosion cracking (SCC), which can lead to cylinder failure through leakage or burst. The likelihood of moisture ingress can be significantly reduced through the use of RPVs; and

- Potential for extending requalification period—As of 2015, the European Agreement concerning the *International Carriage of Dangerous Goods by Road* (ADR) has a provision for a steel cylinder requalification period of 15 years for certain gases provided the cylinder has been equipped with a RPV Type 1 throughout the retest interval [3]. [1]

  NOTE—At the time of publication, this only applies to the signatories of the ADR [3].

  Transport Canada has issued an equivalency certificate that authorizes an extension of the cylinder requalification period of certain TC specification and DOT specification cylinders to 15 years.

6 Applications

RPVs should be considered for the following:

- Applications where there is the possibility of internal corrosion due to the ingress of a fluid. For example, sea water and moisture. This would benefit carbon steel cylinders used in marine service;

- Applications where the cylinder is used in a service where the possibility of backflow contamination from the end users process can create hazardous conditions for the end user or fill plant operator. Examples include beverage dispensing, industrial nitrogen used in agricultural applications to pressurize toxic chemicals, nitrogen used in oil and gas industries for inerting and blanketing applications;

- Applications where gas purity is important such as high purity argon, helium, and medical or food gas products; and

- Gases and gas mixtures such as those containing carbon monoxide in steel cylinders that are susceptible to SCC.

NOTE—RPVs are not adequate as the only safeguard to prevent SCC (see AIGA 065, *Avoidance of Failure of Steel Cylinders Containing CO and CO/CO2 Mixtures Cylinders* [4]).

[1] References are shown by bracketed numbers and are listed in order of appearance in the reference section.

7 Use of residual pressure valves—Filling facilities

7.1 Prefill inspection recommendations and requirements

As part of the prefill procedure, a check shall be made on the condition of the RPV based on the valve manufacturer's recommendations. This check may be performed in a number of different ways depending upon the type of the RPV.

7.1.1 Visual inspection

The valve shall be visually inspected to ensure that the RPV mechanism does not appear damaged or compromised. The visual inspection shall check that the RPV does not appear to have been removed or damaged by an end user or contaminated with dirt, debris, oils, or other contaminants. A cylinder with a compromised valve shall be removed from service.

7.1.2 Functional test

The functionality of the RPD of every valve shall be checked prior to each filling:

- Open the cylinder valve or bundle of cylinders main valve to check for residual pressure;
- If gas is emitted, the cylinder or bundle of cylinders may be filled;
- If no gas is emitted, the functioning of the RPD shall be checked;
- If the check shows that the RPD has retained pressure, the cylinder or bundle of cylinders may be filled;
- If the check shows that the RPD has not retained pressure, the internal condition of the cylinder or bundle of cylinders shall be checked for contamination;
- If no contamination is detected, the cylinder or bundle of cylinders may be filled following repair or replacement of the RPD; and
- If contamination is detected, a corrective action shall be carried out, for example set aside for further examination.

The functional test does not apply to new cylinders or cylinders that are returning to service from maintenance, where the valve was removed from the cylinder so there is no pressure in the cylinder.

NOTE—For VIPRs, this check of condition may involve establishing that residual pressure has been retained before the start of filling and that the pressure regulator is functional at the end of filling.

7.2 Fill connectors

The design dimensions of RPVs and fill connectors vary between manufacturers. Even minor dimensional differences of fill connectors or RPVs can result in the incompatibility of a connection.

The dimensions of the fill connector, including the pin, shall match certain critical dimensions of the valve outlet. See EIGA Doc 908 and CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections* [2, 8].

Fill connectors used to fill cylinders equipped with RPVs shall be mechanically compatible with the RPV (for example, pin characteristics including length) and chemically compatible with the gas in accordance with ISO 15996, *Gas cylinders—Residual pressure valves—Specification and type testing of cylinder*

valves incorporating residual pressure devices; ISO 11114-1, *Gas cylinders—Compatibility of cylinder and valve materials with gas contents—Part 1: Metallic materials;* and ISO 11114-2, *Gas cylinders—Compatibility of cylinder and valve materials with gas contents—Part 2: Non-metallic materials* [5, 6, 7].

The fill connector supplied or recommended by the valve manufacturer should be used unless the RPV and fill connector have been manufactured to standardized dimensions in accordance with national or international standards (for example, CGA V-1) [8].

Standardized RPV fill connectors and valves should be marked after the connection number, for example: 540R and 320R. In these examples, the "R" indicates the valve meets the standardized connection in CGA V-1 and any fill connector marked similarly (for example: 540R, 320R) can be used with the valve [8].

WARNING: *Use of an improper RPV fill connector could damage the RPV and/or fill connector or fail to fully actuate the RPD within the RPV. An improper fill connector in oxygen (or other oxidizer) service can lead to ignition that can result in property damage, personal injury, or death.*

7.2.1 Types of fill connectors

There are two basic types of RPV fill connectors: fixed pin and retractable pin. The fixed pin fill connector has a fixed actuation pin attached to the end of the filling nipple. The retractable pin design has a spring-loaded actuation pin incorporated in the filling nipple and for some designs the pin can be completely retracted for filling cylinders fitted with valves without RPDs (see Figures 1 and 2). When using retractable pin type fill connectors, care shall be taken in selection and use to prevent inadvertent disengaging of the retracted pin.

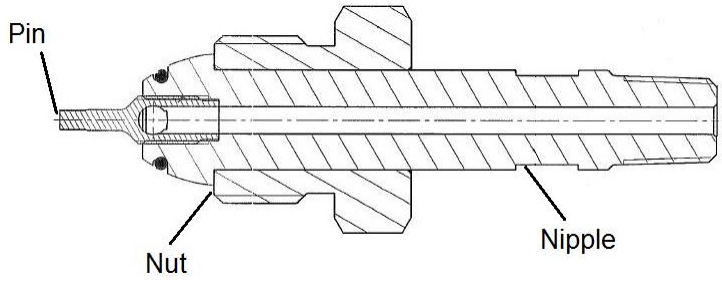

Figure 1—Example of a filling connector with a fixed pin

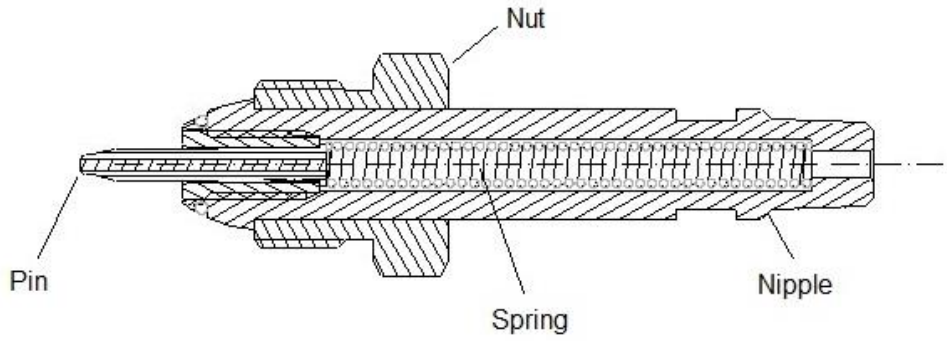

Figure 2—Example of a filling connector with a retractable pin

Note: Due to larger bore size of fill connector nipple to accommodate the spring and other components, the wall thickness of the nipple shall be designed to withstand both pressure and mechanical loads to prevent failure.

7.2.2 Materials of construction for pins

As the pin of the RPV fill connector is in the flow path of the gas, material selection and cleanliness is very important because mechanical loading and flow velocities around the pin are higher than through standard fill connectors. Therefore, materials compatible with oxygen and other oxidizing gas services shall be selected for these conditions.

7.2.3 Precautions to be taken when handling fill connectors

When connecting the fill connector to the cylinder valve outlet, ensure the fill connector pin is not damaged during insertion and that the pin does not score the outlet thread and/or sealing surface.

When fill connectors are not in use, ensure there is protection from impact damage to prevent bending of the pin. In addition, ensure the fill connector is protected from contamination such as dirt, debris, and oils.

7.2.4 Condition, maintenance, and inspection of fill connectors

Prior to using a RPV fill connector, it shall be inspected for significant wear and damage of all components especially for the condition of the actuation pin. Any fill connectors with a bent or broken actuation pin shall be repaired or replaced before next use.

If polymeric or elastomeric seals are used on the fill connector, these seals shall be inspected before each use and replaced when visibly worn, frayed, cracked, or otherwise damaged.

7.2.5 Filling mixed loads

Care shall be taken when mixed populations of cylinders with both RPV and valves without RPDs have to be filled together on the same manifold. This can result in the transfer of potentially impure gas from those cylinders fitted with valves without RPDs to those that are protected in use by a RPV. One measure that can be taken to avoid such cross contamination is to vent cylinders without RPVs before connecting to the manifold.

7.3 Installing residual pressure valves into cylinders

RPVs shall be installed in accordance with established operating procedures (for example, ISO 13341, *Gas cylinders—Fitting of valves to gas cylinders*) [9]. In order not to compromise the functionality and to obtain the benefits of a RPV, an internal visual inspection of the cylinder shall be performed to ensure that the cylinder is in good condition and free of all contaminants such as debris and visible moisture.

7.4 Devalving cylinders equipped with residual pressure valves

For all devalving operations, care needs to be taken to ensure that the cylinder contains no pressure. The devalving guidelines in CGA P-38, *Guideline for Devalving Cylinders;* EIGA Safety Information 18, *Devalving Gas Cylinders*; or ISO 25760, *Gas cylinders—Operational procedures for the safe removal of valves from gas cylinders* shall be followed [10, 11, 12].

A particular concern when removing valves with RPVs from cylinders is that the operator falsely believes that the cylinder is empty after venting because no gas is being emitted from the open valve. After venting, it is necessary to use a suitable device that will allow the residual pressure to be released from the cylinder.

Before devalving, the operator shall confirm that the cylinder is empty of all pressure. A small amount of inert gas or air shall then be introduced into the cylinder through the valve outlet using a suitable pin connector to verify whether or not the gas flows unhindered into the cylinder. For recommendations on blocked or inoperable valves, see AIGA 025, *Pressure Receptacles with Blocked or Inoperable* Valves or CGA P-38 [13, 10].

7.5 Inspection and maintenance

RPVs can be subjected to specific maintenance operations. Such operations may, for example- occur either:

• at the time of periodic inspection of the gas cylinder on which the RPV is installed; or
• when a change of gas service is performed.

ISO 22434, *Gas cylinders — Inspection and maintenance of valves* provides minimum requirements for the inspection and maintenance of valves [14].

8 References

Unless otherwise specified, the latest edition shall apply.

[1] AIGA 062, *Methods to Avoid and Detect Internal Corrosion of Gas Cylinders and Tubes,* Asia Industrial Gases Association. www.asiaiga.org

NOTE—This publication is part of an international harmonisation programme for industry standards. The technical content of each regional document is identical, except for regional regulatory requirements. See the referenced document preface for a list of harmonised regional references.

[2] EIGA Doc 908, *300 Bar Residual Pressure Valve Filling Connectors*, European Industrial Gases Association. www.eiga.eu

[3] *International Carriage of Dangerous Goods by Road* (ADR), United Nations Economic Commission for Europe. www.unece.org

[4] AIGA 065, *Avoidance of Failure of Carbon Monoxide and of Carbon Monoxide/Carbon Dioxide Mixtures Cylinders,* Asia Industrial Gases Association. www.asiaiga.org

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[5] ISO 15996, *Gas cylinders—Residual pressure valves—Specification and type testing of cylinder valves incorporating residual pressure devices,* International Organization for Standardization. www.iso.org

[6] ISO 11114-1, *Gas cylinders—Compatibility of cylinder and valve materials with gas contents—Part 1: Metallic materials,* www.iso.org

[7] ISO 11114-2, *Gas cylinders—Compatibility of cylinder and valve materials with gas contents—Part 2: Non-metallic materials*, International Organization for Standardization. www.iso.org

[8] CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections,* Compressed Gas Association, Inc. www.cganet.com

[9] ISO 13341, *Gas cylinders—Fitting of valves to gas cylinders,* International Organization for Standardization. www.iso.org

[10] CGA P-38, *Guideline for Devalving Cylinders,* Compressed Gas Association, Inc. www.cganet.com

[11] EIGA Safety Information 18, *Devalving Gas Cylinders,* European Industrial Gases Association. www.eiga.eu

[12] ISO 25760, *Gas cylinders—Operational procedures for the safe removal of valves from gas cylinders,* International Organization for Standardization. www.iso.org

[13] AIGA 025, *Pressure Receptacles with Blocked or Inoperable Valves*, Asia Industrial Gases Association. www.asiaiga.org

[14] ISO 22434, *Gas cylinders—Inspection and maintenance of valves provides minimum requirements for the inspection and maintenance of valves*, International Organization for Standardization. www.iso.org