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EHEDG Update

Hygienic design and safe use of double-seat mixproof valves

This article is adapted from a paper prepared by the Valves Subgroup of the European Hygienic Equipment Design Group (EHEDG) and is the 20th in the series published in *TIFS*. The paper provides guidelines for the design and safe use of double-seat mixproof valves in food processing . This type of valve prevents intermixing of ingredients or cleaning fluids during normal use. A summary of basic hygiene requirements for this design is given, along with an outline of its benefits and applications.

Introduction

To guard against leakage of cleaning liquids into food products in piping systems in food processing plants, single-body double-seat mixproof valves (DSMV) are used. These valves have been used in brewing, beverage, food and milk plants in Europe for 20 years. About 1 million DSMV are in use. Integration of several functions in these valves drastically reduces risks and cuts costs. Dead spaces are minimized and wastage of product, cleaning fluids and water is reduced. Simultaneous operation of multiple flow paths can also substantially increase effective plant capacity. As a result, installation, operation, validation and maintenance tend to be faster, cheaper and safer.

This paper provides guidelines for the basic hygienic design and the safe use of DSMV. The valves should be easy to clean in-place, prevent intermixing during normal use, be easy to install and be reliable. In addition, the accepted requirements on mixproof valves in Europe are summarized.

General hygienic design requirements

In Europe the valve design must meet:

- Council Directive 98/37/EC
- CEN EN 1672-2 requirements
- ISO 14159 hygiene requirements for the design of machinery
- Requirements set out in the following EHEDG guidelines (see Box):
  - Doc. 8: Hygienic equipment design criteria, 1993
  - Doc. 9: Welding stainless steel to meet hygienic requirements, 1993
  - Doc.10: Hygienic design of closed equipment for the processing of liquid food, 1993
  - Doc.13: Hygienic design of equipment for open processing, 1996
  - Doc.14: Hygienic design of valves for food processing, 1996
  - Doc.16: Hygienic pipe couplings, 1997

Typical design

Most DSMV operate on the same principle, a valve housing with two chambers (see Fig. 1). Each chamber has at least one port connected with a pipeline in the piping system. Between the two chambers there are two seats, usually one atop the other with a separation cavity in between. The seats consist of an upper and lower closure device, typically a disc, which are connected to independent upper and lower shafts for opening, closing and individual seat lifting. The cavity between the two seats is open to atmosphere (vent) and is used for leak detection of these seals.

Safe design

In DSMV, the closed valve position must be detectable and provide an electronic alarm signal when not properly seated in the block position. The valve seats must be moved into the closed position and held there by a spring. This is to ensure correct control of the shafts and a fully blocked 'safety' position of the valve in case of loss of air or power. If one seal is worn or breaks, the fluid must go out of the vent so that pressure does not build up in the cavity area.

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Hygienic and aseptic designs

Different valve constructions are used for hygienic and aseptic processes in food production. For hygienic process lines, the reciprocating shaft can be sealed by an elastomeric or polymer lip seal. This seal is easily cleanable and prevents excessive microbial contamination of product. In aseptic process lines where ingress of micro-organisms must be prevented, the shaft must be sealed by a continuous barrier, for example a membrane or bellows, and a steam or sterile barrier may be applied to the vent. See Fig. 2 for details.

Balanced valves

As the distance between the two valve seats is only some millimetres, pressure shocks above the normal operating pressure may cause unexpected opening of the seats. Pressure shocks in the pipelines can be caused, for example by the quick closing of manually operated butterfly valves or an emergency stop of a filling machine.

Leakage free valves must be equipped with the relevant balancers (see Fig. 3a and b) as it is not possible for this type of valve to relieve pressure into the cavity area in the event of a pressure surge of sufficient magnitude to open the valve against the spring tension.

Leak detection

Defined leakage paths designed to provide immediate detection must be in place for all process seals, such as housing seals, seat seals and shaft seals. These leakage paths must also ensure minimum effect on production operations, while providing an immediate indication of seal service requirements. The valve seal designs should also minimize any ingress of contaminants.

Use of double-seat mixproof valves

The DSMV allows simultaneous transfer of product and cleaning liquids across the valve ports. Typical applications are valve manifolds in multifunctional flow systems, CIP connections to process lines, storage tanks

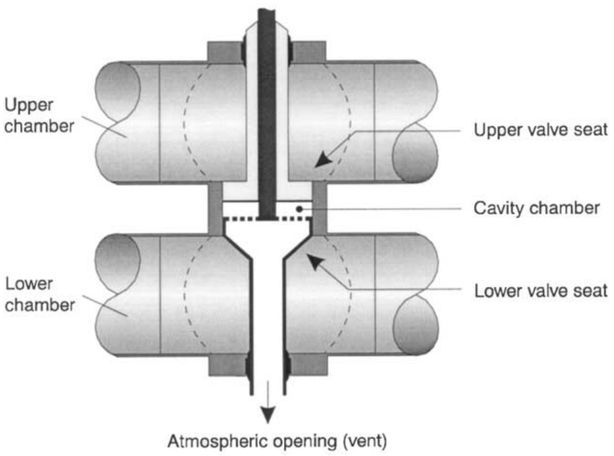

Fig. 1. Typical double-seat mixproof valve.

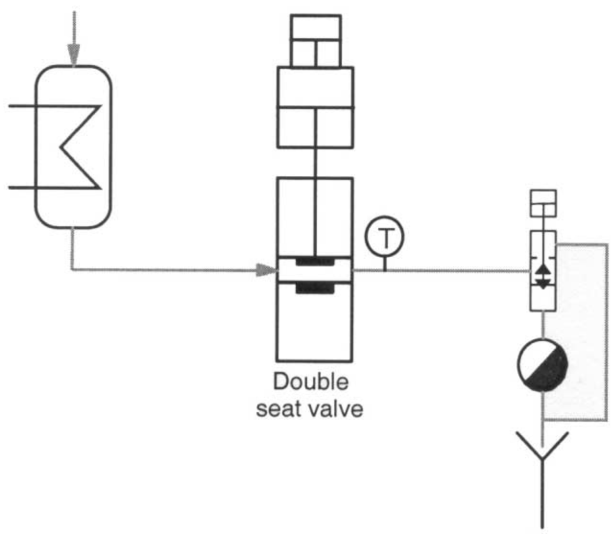

Fig. 2. Control of vent on double-seat mixproof valve for aseptic lines.

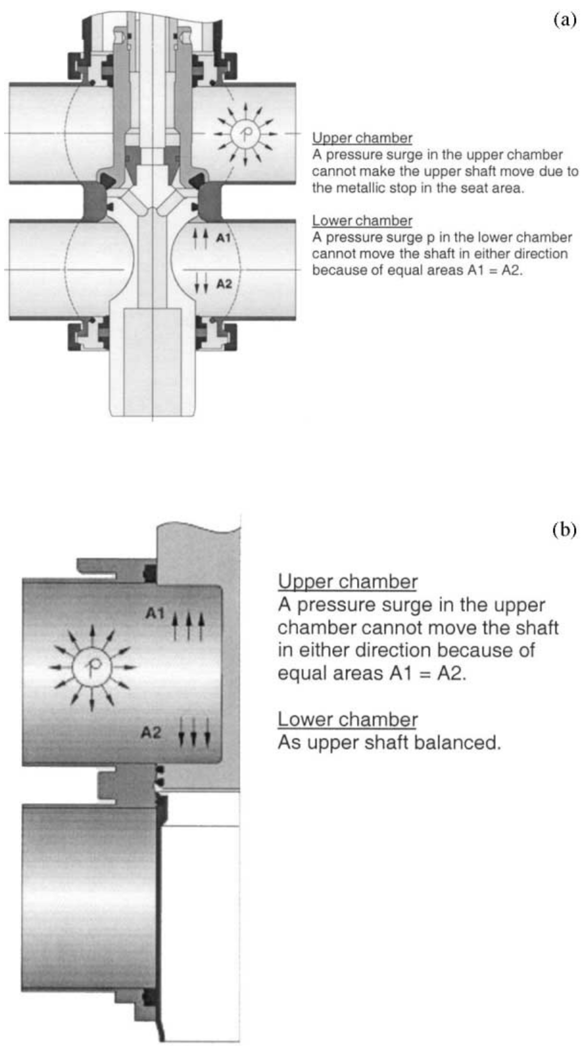

Fig. 3. (a) Mixproof valve with single balanced shaft; (b) mixproof valve with double balanced shaft.

and fillers; one line including the connected valve chamber can then be cleaned while the others still handle product. Similarly, after filling a tank, the connecting fill lines can be cleaned directly.

If there is an alarm indicating improper valve seating in the block position, the system should stop the flow of CIP solution. No manual overrides are allowed. Controls must be secured to prevent unauthorized changes. If there is a product safety risk, an additional flush with hot water or steam for the whole piping system is required.

Cleaning

Typical methods of cleaning surfaces soiled with product residues are:

- Pipeline CIP for independent cleaning of the housing chambers limited by the shaft seal on the one side and the seat seal on the other side.
- Seat (plug) lifting to flush the seat seal c/w metallic stop, the cavity and the drain pipe
- Cavity spray cleaning to reach the leakage chamber up to the seat seals and the drain pipe
- Shaft cleaning to reach the shaft surface and the area behind the shaft seals

Seat lift cleaning and cavity spray cleaning must be carried out at virtually zero static pressure because in this operating mode there is only one seat seal between the product in the pipeline and the CIP liquid in the leakage area.

Summary of requirements

- Basic hygienic requirements are described in the Standards and EHEDG guidelines
- Valve seats must be moved into the closed position and held there by a spring, also in case of loss of air.
- Failure of the independent valve seat to close must be detected and alarmed.
- The valve disc seals must be individually pressed into their closed positions.
- The design must ensure that unintended movement of one disc cannot be transferred to the other.
- The neutral area must be drainable by gravity.
- The neutral area must be at virtually atmospheric pressure during every operating condition, such as:
  - product run in both pipelines with valve open or closed
  - CIP in one pipeline with seat cleaning of the related seat
  - cleaning of the cavity in the closed position of the valve.
- The valve must retain its closed position also during vacuum in the connecting upper or lower pipelines.
- Care must be taken of pressure surges, for instance by using valves with balanced shafts or designing the installation to prevent the valve seats from opening.
- Both seats must be in the closed position before the pipeline CIP or cavity spray process can be activated. Only on tank applications it is necessary to open the valve to drain the tank via the CIP-return-line.

Summary of the benefits of Mixproof valves

	Mixproof valves
Process safety	Ensured by two serial seat seals and neutral area in-between. Isolation chamber sealed during product flow—no risk of contamination.
Suitability for multifunctional plant operation	Independent CIP cleaning of the cavity possible in the closed valve position by seat lifting or cavity spray cleaning.
Space requirements	Compact valve manifolds possible. Minimal elevation requirement.
Installation	Controlled fabrication under factory conditions possible. Pre-fabrication of large valve manifolds done routinely.
Maintenance	Low number of parts and seals. Only one actuator. Easy to service due to top pullout of mixproof inserts.
Operating costs	Comparatively low. Minimal product losses on low leakage operation valves.
Process flexibility	Easy to create manifolds, fully automated lines possible. Easy to realise future modifications.
Continuous flow	Continuous flow management possible.
Water/chemical product loss	Minimal
Human error	Easy to fully automate. No safety issues as CIP fluid losses are minimal through isolation cavity.

This paper provides an extended summary of the guidelines recommended by the Valves Subgroup of the European Hygienic Equipment Design Group (EHEDG). Copies of the full report (EHEDG Doc. 20) by F. Baumbach (Chairman), R. Cocker, G. J. Curiel, W. von Davier, D. C. Harrison, K. A. Lindholm, B. Maraud, P. Peschel, J. Quente, V. Reinsch, W. Schmid and T. Tuuslev, are available from CCFRA (pubs@campden.co.uk). For information about the EHEDG, visit the website (www.ehedg.org).

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