

Technological Features of Valves Installation on the Natural Gas Transmission Pipelines – Part I

Gheorghe Zecheru*, Ilie Lața**, Andrei Dumitrescu*

* Universitatea Petrol – Gaze din Ploiești, Bd. București 39, 100680, Ploiești
e-mail: gzecheru@upg-ploiesti.ro

** SNTGN “TRANSGAZ” S.A., Pta. Constantin I. Moțaș 1, 551130, Mediaș
e-mail: ilie.lata@transgaz.ro

Abstract

This paper presents the main requirements regarding the technical features of the valves intended to be used as equipment components for the natural gas transmission systems. The main technological problems regarding the valves installation on the pipelines belonging to these transmission systems are analysed, commented and answered. The paper, due to its topic, constitutes a practical guide extremely useful for those dealing with the design, construction, testing and quality checking of some new natural gas transmission pipelines, and also for those who design or perform maintenance, rehabilitation or modernisation works for such pipelines.

Key words: *natural gas transmission pipelines, pipeline valves, valves installation and testing.*

Introduction

The valves are one of the most important components of the natural gas transmission systems, their mounting on the transmission pipelines or on the pipes from the technological installations belonging to these systems aiming at isolating or blocking some pipelines sections, venting or controlling the transported gas pressure, serving the launching / receiving stations for the PIG type devices (used to perform periodically some cleaning or technical state inspection works for the pipelines), managing and controlling the natural gas flowing regimes (flow rates, pressures, flow velocities) from the pressure regulating and metering stations and from the natural gas compressor stations etc. The usage share of these components within the natural gas transmission systems is very important, a statement which is supported by the images and information included in Figures 1-3 and in Table 1, and the most frequently used types of valves are gate valves, plug valves, ball valves and check valves, manufactured in various structural – operational versions [1-4]; for some applications, special valves are used too: special ball valves, used also as launching / receiving traps for devices of the type cleaning PIG, having the constructional – operational features presented in Figure 4; sandwich valves, used with the hot-tapping and stopping equipments for the in-service (under pressure) pipelines; insert valves, which can be installed on in-service pipelines [5, 6].

Due to their large sizes and complicated structure (in direct correlation with the diameters of the pipelines on which they are mounted and with the conditions imposed by their safe operation), the acquisition and installation costs of the valves are important and therefore when

manufacturing such equipment and when installing it on the pipelines one must rigorously fulfil all the technical requirements which confers them high performances of reliability and maintainability. The present paper describes the main requirements that are needed and the main technological solutions that are recommended to guarantee the quality of the installation works of the valves on the pipelines of the natural gas transmission systems.

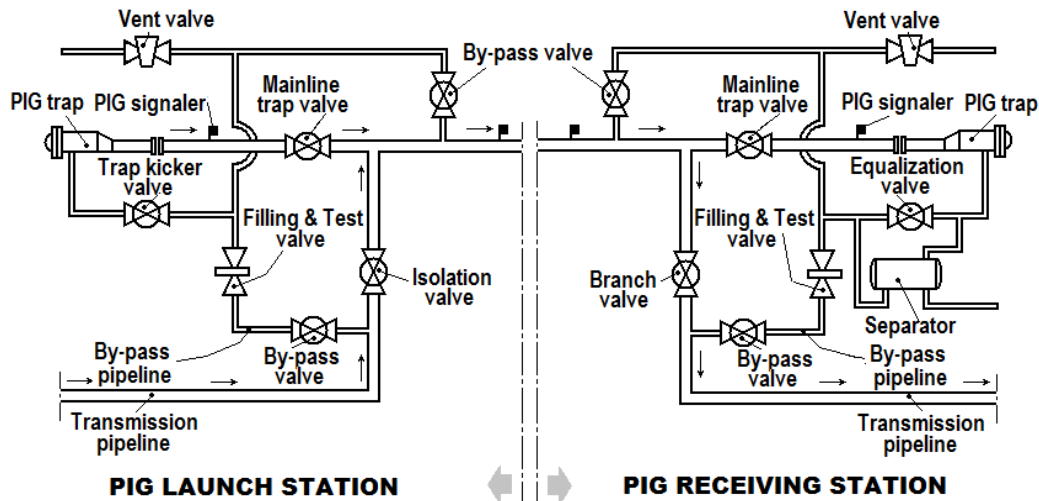


Fig. 1. Valves which are used within the launching / receiving stations for PIG equipment

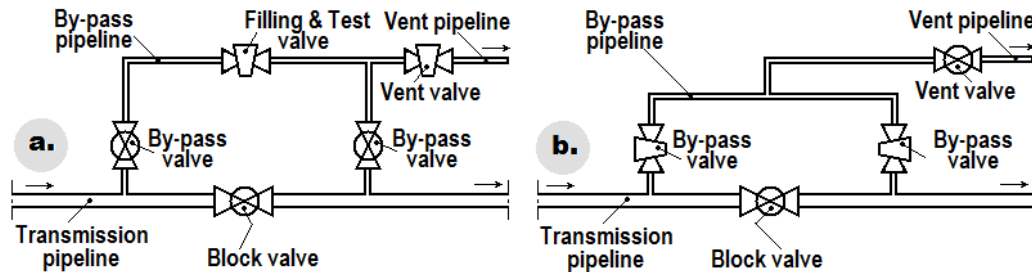


Fig. 2. Mounting of the block / isolating valves with by-pass and vent pipeline:
a. scheme from [10]; b. scheme from [1]

Technical Requirements Regarding the Selection and Installation of the Valves

The valves are installed on the pipelines of the natural gas transmission systems only if they fulfil the following technical requirements:

- the type and configuration of the valve shall correspond to the functional role that it has to fulfil and they must be compatible with the pipeline on which the valve is mounted; for the pipelines that has to allow for their periodical cleaning and internal inspection with PIG type devices, only full-opening valves shall be used;
- the nominal diameter and nominal pressure class of the valve shall correspond to the mechanical loading conditions (pressure, temperature, forces and/or moments applied during operation, additional loadings etc.) under which it is used; the fulfilment of this requirement is warranted if the valve is designed in compliance with a recognised Code or standard, for instance [7-9];
- the valve ends shall correspond to the mounting method specified in the technical documentation of the pipeline: with flanges at both ends, with ends for welding to the pipe or combined (one flanged end and one welding end) etc.;

- the valve which is mounted on a buried pipeline shall be a one-piece top-entry valve, with welding ends, and must have the operating device located above ground; the valve which is placed above-ground or is mounted in a pit can be with welding ends or with flanged ends;
- the face-to-face or end-to-end dimension of the valve shall correspond to the mounting distance which is specified in the technical documentation of the pipeline;
- the valve shall have an anti-static device, that is it must be manufactured so that the electrical resistance between the valve body and the obturator / closure element, respectively the stem connecting the obturator with the operating device, measured on the dry valve, using a D.C. power source with 12 V maximum voltage, shall not exceed 10 Ω ;

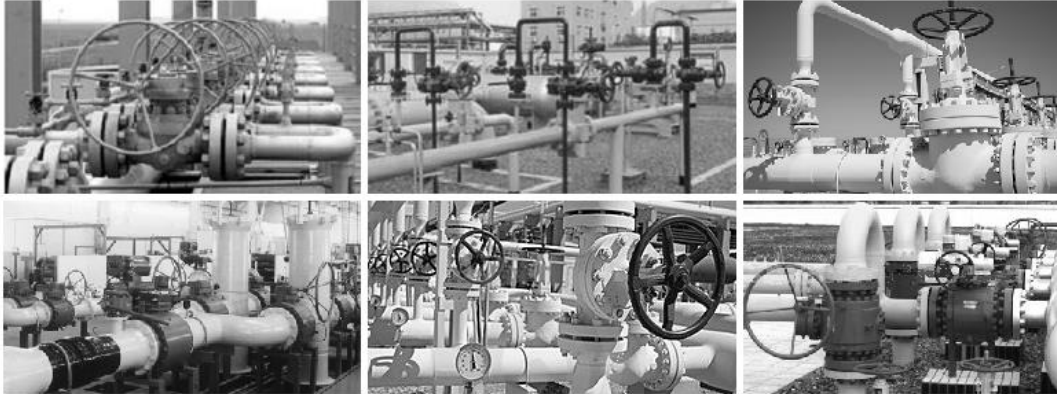


Fig. 3. Examples of valves mounted on the pipelines of the technological installations used within the natural gas transmission systems

Table 1. The maximum distances between the isolating valves mounted on the natural gas transmission pipelines

The minimum distance between the isolating valves in the areas situated within location class ^{a)} :			
Class 1	Class 2	Class 3	Class 4
32 km	24 km	16 km	8 km

a) location classes are defined and settled based on the requirements from [1]; the number of isolating valves which are mounted on a pipeline is established by taking into account the distances between valves specified in the table, which can be adjusted (within the limits of $\pm 25\%$ from them) in order to locate the isolating valves in places with good accessibility and where their operation in full safety can be performed [1].

- the valve shall be fire-resistance designed, qualified by the manufacturer by means of the results of the fire type-testing, performed in compliance with the requirements from the standard [11] or from other equivalent Norms or with similar content;
- the valve shall have the mechanical strength and tightness guaranteed, verified at delivery by means of specific testings, performed in compliance with the requirements from the standard [3] or from another equivalent Norm or with similar content;
- if the nominal size is DN200 or greater, the valve shall be provided with lifting points (corresponding to the whole assembly of the valve with the operating device);
- the valve (manually operated or provided with an actuator) shall be equipped with a visible indicator for the open and closed positions of the obturator; for the gate valves and ball valves, the lever and/or the position indicator must be parallel with the pipeline axis when the valve is open and perpendicular on the pipeline axis when the valve is closed.

The valves which are intended to be installed on the natural gas transmission pipelines or on the pipelines of the technological installations belonging to the natural gas transmission systems must be made by applying qualified manufacturing procedures, using appropriate materials in order to achieve the imposed technical features.

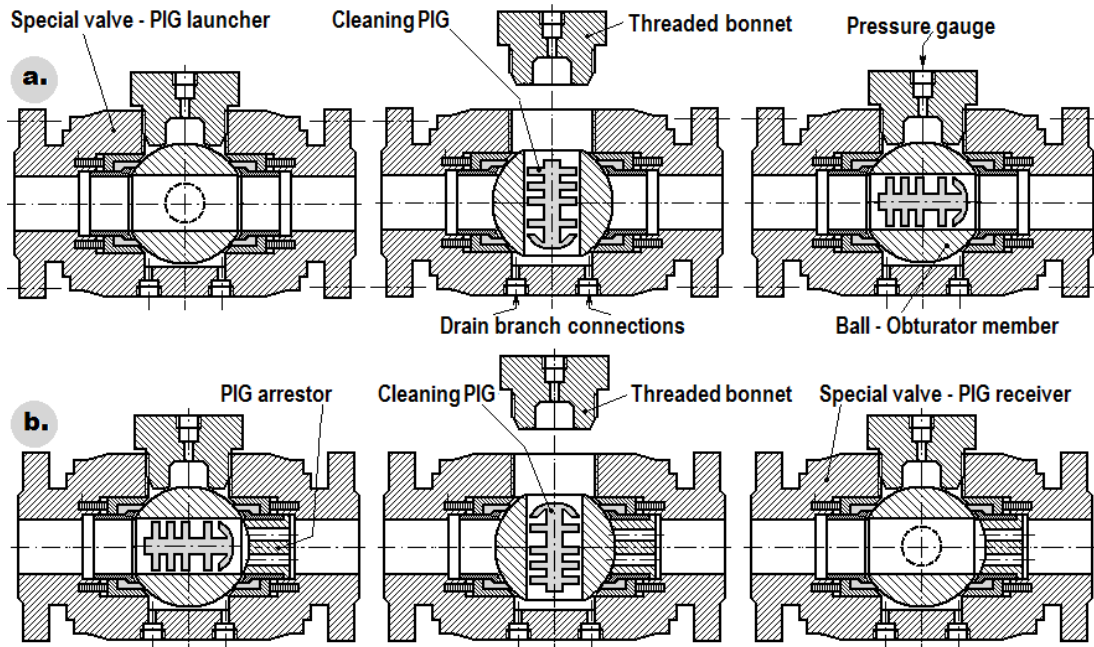


Fig. 4. Structural and operational features of the special ball valves:
a. PIG launcher valve; b. PIG receiver valve

Initial / Basic Data Needed for the Valves Installation

The issues which are analysed and commented, as well as the technical requirements and the technological solutions which are formulated and/or described in the present paragraph of the paper and in the following ones, concern the installation of valves, with steel body, belonging to the structural and functional types used with the highest weight on the pipelines of the natural gas transmission systems or within the technological installations which serve these systems: valves with flanges at both ends, valves with butt welding ends or valves with one flanged end and one butt welding end. The technical requirements and technological solutions from the present work can be yet easily adapted in order to be also applied for the installation of other types of valves (less or barely used on the pipelines of the natural gas transmission systems) or of valves belonging to some auxiliary circuits / pipelines, with small diameters and/or reduced operating pressures, from the layout of such pipelines or from the technological installations serving such transmission systems: valves provided with socket welding ends, valves with threaded ends, valves having capillary ends, valves provided with compression ends etc.

The first step of the installation process of a valve on a pipeline intended for natural gas transmission consists of setting the initial / basic data required for the elaboration of the technological process of installation, divided in the categories mentioned in the followings.

A. The category of the constructional and operational features of the valve which is installed is constituted by taking from the valve technical documentation all the characteristics that condition or influence the selection of the technological solutions for its installation:

- the nominal size and nominal pressure class of the valve;
- the type of valve from the point of view of its closure system (with gate, with ball, with check, with plug etc.) and of its opening (with full-opening or with reduced-opening); the indications of the valve manufacturer regarding the necessity of safeguarding a certain flow direction of the gas through the valve and regarding the position (closed or open) in which the obturator / closure element must be maintained while performing the valve installation operations shall also be included here;

- the type of valve from the point of view of the manner of installing it on the pipeline: with flanges at both ends, with welding ends or combined (one flanged end and one welding end);
- the overall dimension which conditions the installation of the valve on the pipeline, L , i.e. the face-to-face dimension or the end-to-end dimension for the valves having identical ends (flanged or welding), respectively the arithmetic mean of these dimensions for the valves with combined ends;
- the valve mass, the type of lifting elements existing on the valve body and the manner of their location; the main types of lifting elements (lugs, bolts, eyes etc.) and the possibilities for their location on the valves body are indicated in Figure 5; as a function of the type and position of the lifting elements, the handling solution of the valve during installation is selected, using the suggestions from Figure 6, with the remark that, for large size valves, some parts (for instance, the actuator system) can be provided with individual lifting elements, which are used only for the valve assemblage and cannot be used as all-purpose lifting elements;
- the type of valve from the point of view of the means of unloading the mechanical action produced by its weight (see figure 7): valve mounted freely on the pipeline (for which the own weight acts as a transversal force upon the pipeline) or valve provided with supporting elements – plates or armed concrete foundations, with or without intermediary metallic structures (for which the own weight is unloaded to the soil and does not represent a mechanical load for the pipeline);
- characteristics (dimensions, angles etc.) describing the configuration of the surfaces of the valve welding ends and the quality of the steel from which these ends are made (chemical composition, structural state and mechanical strength and toughness properties);

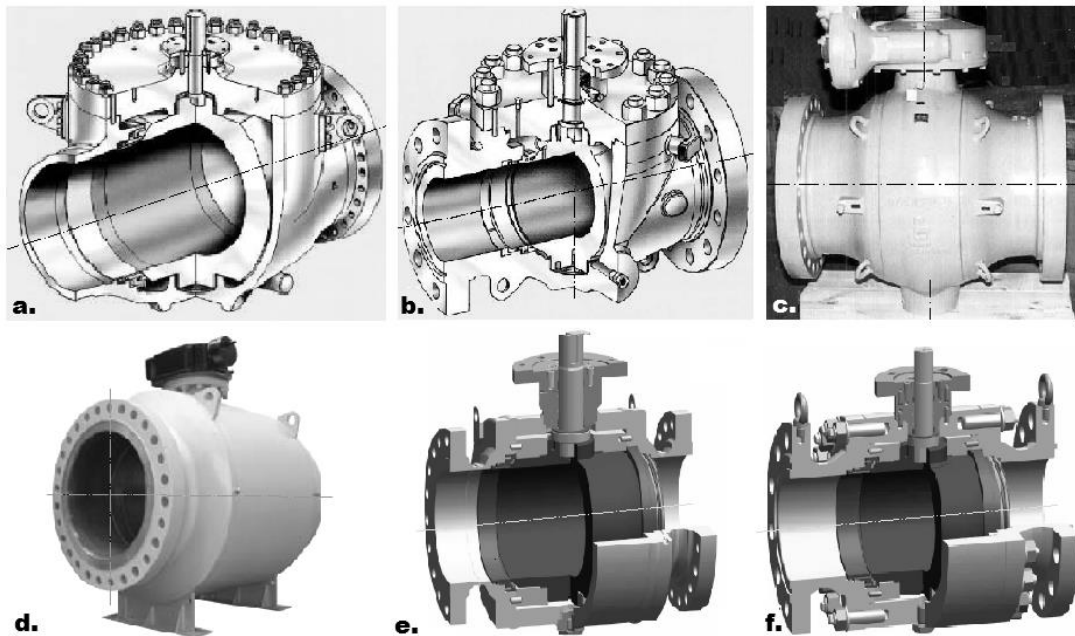


Fig. 5. Types of lifting elements mounted on the valves body:
 a. lugs mounted with screws; b. lifting bolts; c...e. lugs mounted by welding;
 f. lifting eyes mounted by threading on the end flanges of the valve.

- features of the end flanges and of the flanged joints for the installation of the valve on the pipeline: type of seating surfaces of the flanges, packings type and dimensions, diameter and number of bolts or studs needed to execute the connections, quality of materials (chemical composition, structural state and mechanical properties) from which the flanges, bolts or studs, nuts and packings which are part of the flanged joints are made and the torsional moment prescribed for screwing the bolts or studs when making the flanged joints.

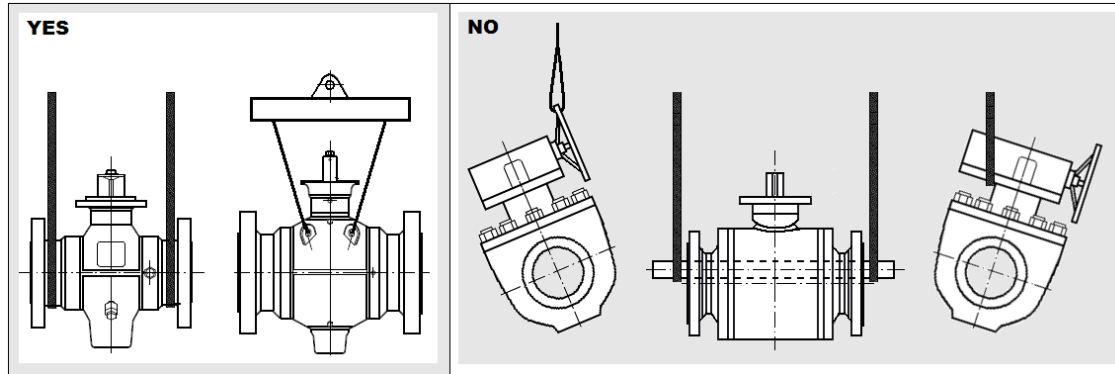


Fig. 6. Indications regarding the selection of the solution for lifting and handling the valves.

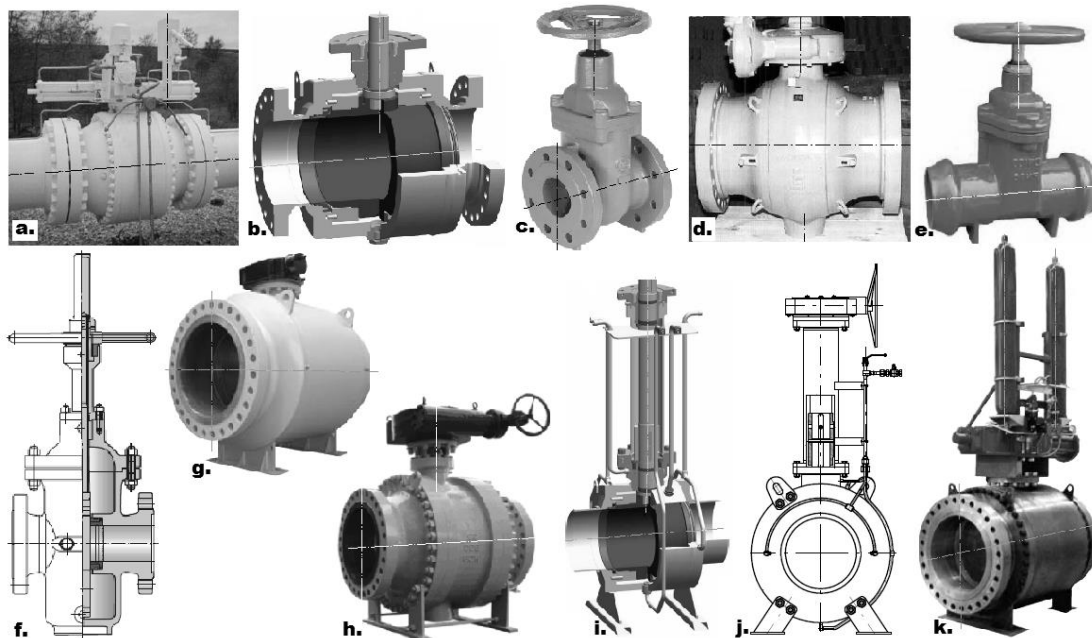


Fig. 7. Types of valves from the point of view of the way of unloading the mechanical action produced by their own weight:

- a. b. valves which are mounted freely on the pipeline; c...f. valves with one-piece body and supporting elements (of the type ribs, eyes etc.); g...k. valves with supporting elements, of the type metallic structures, attached to the body by welding or using threaded connections.

B. The category of the data regarding the features of the valve installation on the pipeline is constituted by taking from the technical documentation of the pipeline (if the valve is installed on a new pipeline) or from the technological programme for the execution of the maintenance works (if the valve is installed on a pipeline that is repaired) all the relevant information for the development of a suitable installation technology:

- the location place of the valve on the pipeline (underground or above ground, buried, in a pit, within a closed precinct etc.; the customary location alternatives for the valves are suggested in Figure 8);
- the location position of the valve on the pipeline; the most used mounting positions for the valves on the pipelines are indicated in Figure 9, with the remark that the preferred position (taking into account both the criterion of securing the best working conditions during installation and the criteria of ensuring the easiest operation, the safest functioning and the highest levels of reliability and maintainability) is the horizontal position;

- the requirements regarding the mounting distances and the weld bevels for the installation by welding of the valve or of the flanges connecting the valve with the pipeline; the mounting distances that must be known and the requirements regarding the configuration and dimensions of the weld bevels that shall be guaranteed when installing the valves are illustrated in Figure 10 (for the case of the valves which are mounted underground and are operated from the surface, being provided with extensions for the stems of the actuator), and the requirements from [12] regarding the weld bevels for valves installation are shown in Figure 11.

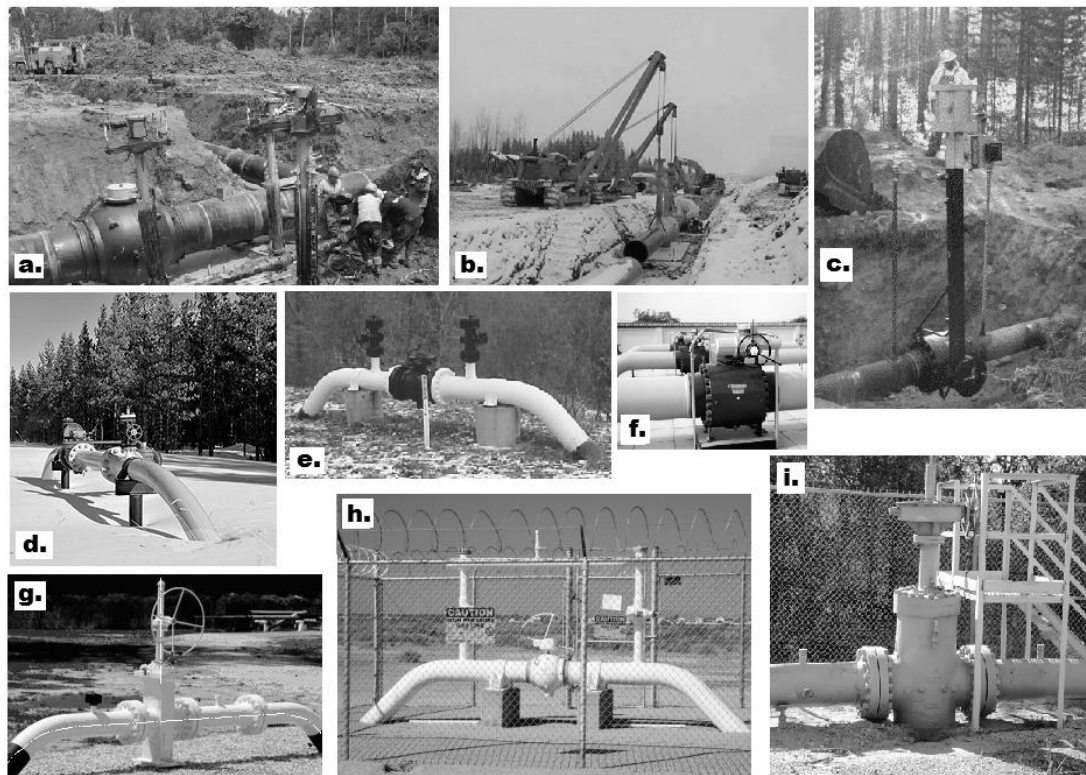


Fig. 8. Location alternatives of the valves on the pipelines:
a...c. underground location; d...i. above ground location.

Preparation of the Valves Installation on the Pipelines

Whatever is the type of valves which has to be installed, before performing the technological operations for the installation itself, the following **preparation activities / works** shall be executed:

- analysing the initial / basic data needed for the elaboration of the technological process of the valve installation;
- checking the technical state of the valve that is to be installed and approving its installation (if all the initial data from the categories of the constructional and operational features of the valve correspond to the characteristics marked on the valve prepared for installation);
- settling and marking the place for the installation of the valve and executing the preparation works for installation (checking the foundation, locating and checking the position of the supporting elements, checking the pit etc.);
- preparing the ends of the pipeline on which the valve is to be installed and guaranteeing the mounting distance L_{mr} , defined as a function of the valve type (from the point of view of the method of installation on the pipeline) as it will be described in the second part of the paper;

		POSITION OF INSTALATION		
		HORIZONTAL POSITION	VERTICAL POSITION	INCLINED POSITION
VALVES WITH FLANGED ENDS				

Fig. 9. Typical positions for the installation of the valves on the pipelines

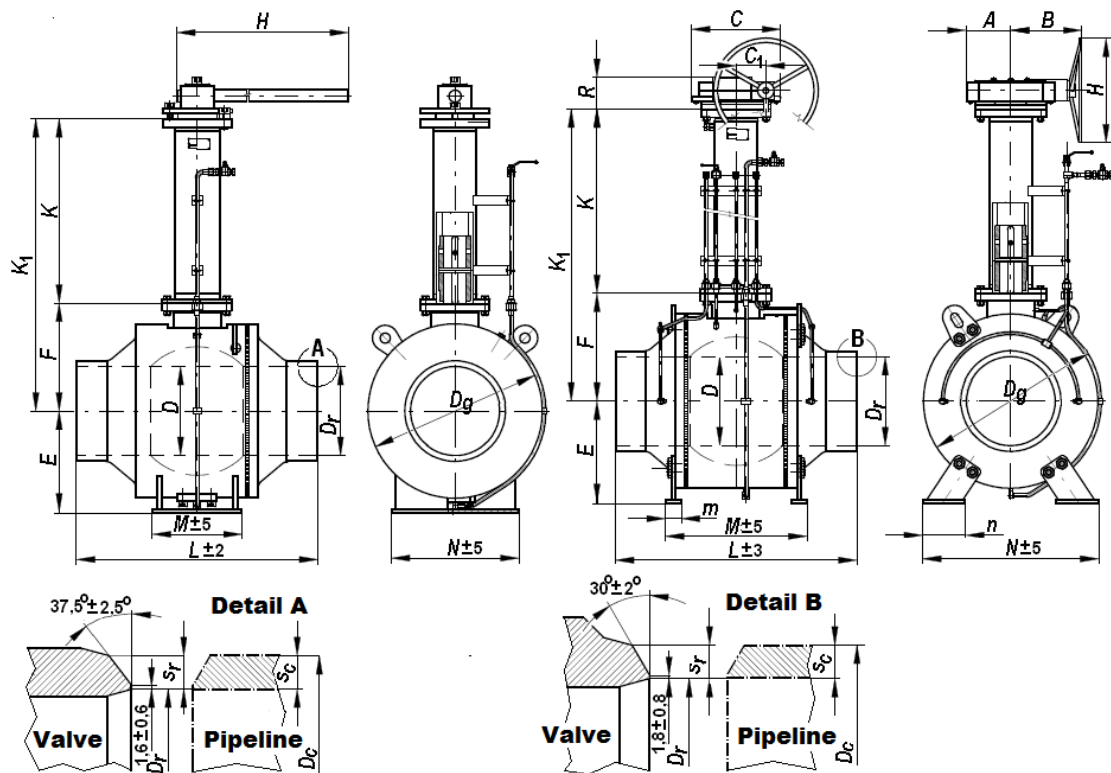


Fig. 10. Dimensions which must be known when installing the valves and the configuration of the welding ends of the valves

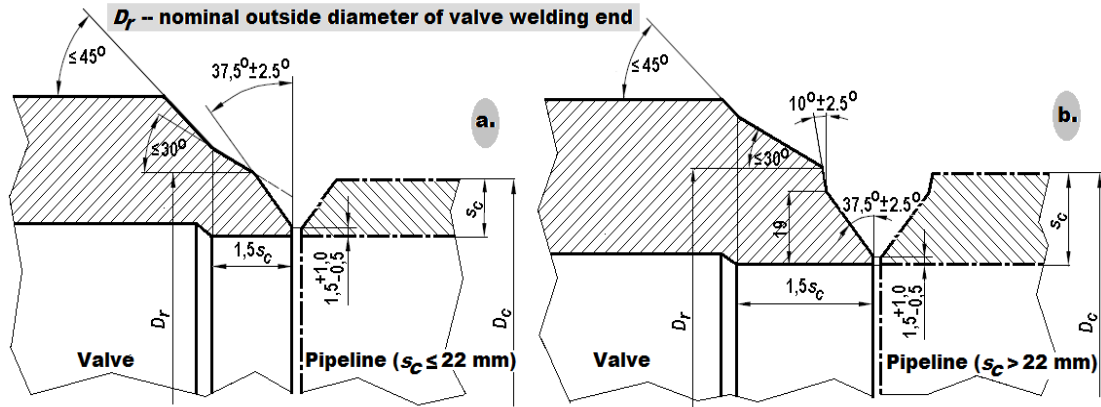


Fig. 11. Requirements [12] regarding the weld bevels for installing ball valves :
 a. valve welding ends for connection to a pipeline with the wall thickness $s_c \leq 22$ mm;
 b. valve welding ends for connection to a pipeline with the wall thickness $s_c > 22$ mm.

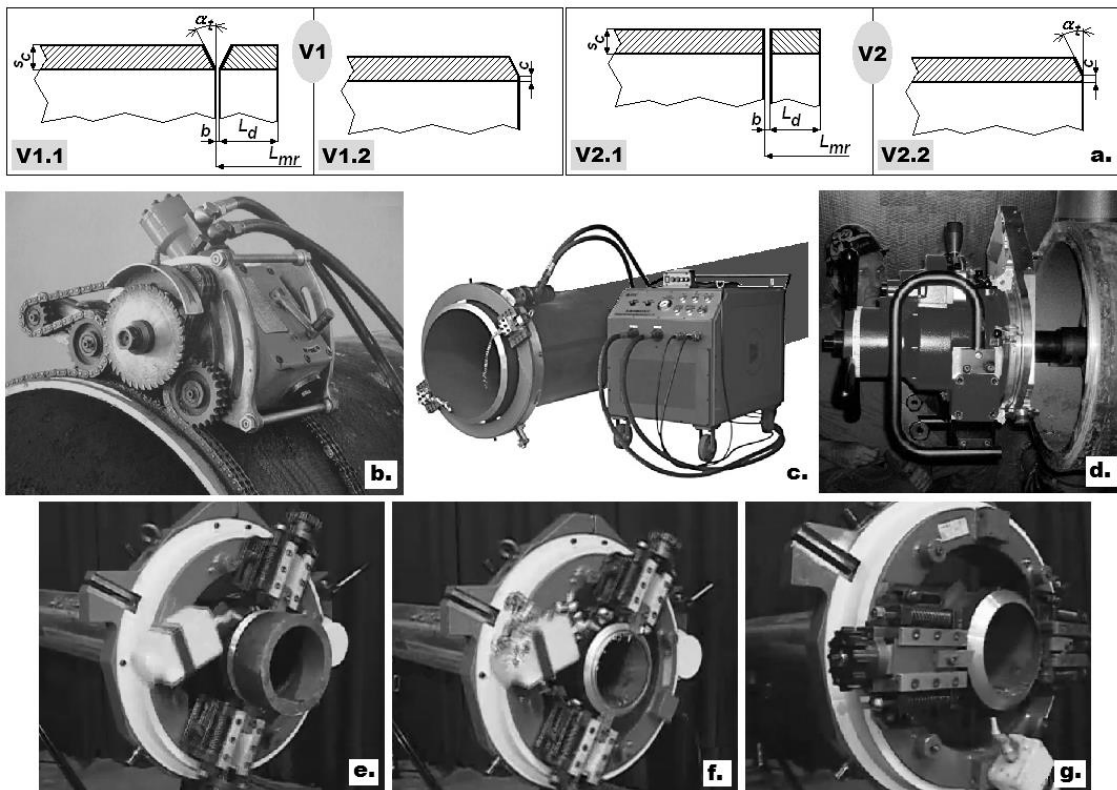


Fig. 12. Technological solution for the preparation of the pipes ends for valves installation:
 a. alternatives for the technological process of preparing the pipes ends; b...d. types of devices
 for cutting and machining the pipes ends; e...g. manner of using a device to prepare
 the pipes ends in view of installing a valve.

Figure 12 presents the operations that must be executed and the optimum mode of performing them (which ensures the maximum levels imposed for the dimensional precision and quality of the pipes ends surfaces and the minimum impairing of the structure and mechanical properties of the pipes ends), using adequate devices for cutting and processing the pipes ends surfaces only by machining (without cutting and/or processing the surfaces using thermal procedures), the technological processes for the preparation of the pipeline ends comprising the following processing steps: alternative V1: step V1.1 – angle cutting of the pipe, with an angular milling cutter or with a chamfer tool, ensuring the angle α_i of the end surface; step V1.2 – frontal machining of the pipe end, ensuring the size c , corresponding to the root of the

weld bevel (of the valve or of the flange for mounting the valve); alternative V2: step V2.1 – frontal cutting of the pipe end with a slitting mill or with a parting tool; step V2.2 – machining of the pipe end in order to obtain the surface inclined at the angle α_r and to ensure the size c , corresponding to the root of the weld bevel (of the valve or of the valve mounting flange);

- ensuring the placement in the correct reciprocal position of the components which are assembled by welding when installing the valve: the pipes and the flanges which are welded at the pipes ends, if the valve that is to be installed is provided with flanges at its ends, respectively the pipes and the welding ends of the valve, if the valve which shall be installed is of the type with welding ends.

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Particularitățile tehnologice ale instalării robinetelor pe conductele destinate transportului gazelor naturale – Partea I

Rezumat

În lucrare sunt prezentate principalele cerințe privind caracteristicile tehnice ale robinetelor care trebuie utilizate ca echipamente componente ale sistemelor de transport al gazelor naturale și sunt analizate, comentate și soluționate principalele probleme tehnologice privind instalarea robinetelor pe conductele aparținând acestor sisteme de transport. Prin conținutul său, lucrarea constituie un ghid practic deosebit de util pentru cei care se ocupă cu proiectarea, construirea, probarea și verificarea calității unor noi conducte de transport al gazelor naturale, precum și pentru cei care proiectează sau efectuează lucrări de mentenanță, reabilitare sau modernizare a unor astfel de conducte.