Journal of Engineering and Applied Sciences 13 (14): 5885-5889, 2018
ISSN: 1816-949X

Sleeve-Actuated Hose Valves: Novel Design Diagrams

Vladimir P. Koltsov, Victor V. Yolshin and Aleksandr G. Kunitsyn
Irkutsk National Research Technical University, Lermontova Street 83, Irkutsk, Russia

Abstract: To date, one of the tasks of the government is to provide the country population with quality products, one of which is water. The problem is that most post-soviet countries use old pipeline fittings. This leads to significant losses of purified water which in turn impacts companies as they suffer substantial losses. With this in mind, the study seeks to present new design diagrams of sleeve-actuated hose valves. Designs of elastic-shell-based hose valves proposed below provide outstanding features and benefits including principal novelty, lower cost, remarkable operation and performance efficiency and eliminate the need for expensive or sophisticated parts. To achieve this goal, we used the method of comparative analysis, summarization of domestic and Foreign experience concerning the issue. The new designs applying elastic materials and shells are highly prospective and have remarkable operation advantages owing to their manufacturability, wide-range performance attributes, efficiency and lower price.

Key words: Design diagrams, hose valve, elastic shells, operation advantages, pipeline fittings, attributes

INTRODUCTION

Contemporary hose valves represent a class of devices designed for shutting off or regulating fluid flow in pipeline systems. As a rule, the valves are comparatively unsophisticated devices with mechanical, electric, pneumatic or hydraulic actuators. Actuators can be automatic or remote-operated (Peret *et al*., 2011; O'Connor, 2006; King *et al*., 2016).

In recent decades, designers developing new models of pipeline valves give more attention to the use of elastic materials and shells instead of traditional hard constructive elements. This is highly relevant because a large part of the treated water does not reach the end user due to obsolete pipeline fittings in distribution networks (Zaytseva, 2012). This in turn leads to financial losses, labor and resource costs (Matveev *et al*., 2016). This situation is especially, characteristic for post-soviet countries where a significant portion of pipeline fittings was installed in the soviet era and today they are outdated both physically and technologically.

A considerable data bank of such designs has been created by the present moment (King *et al*., 2016). Among them are valves, stop valves and other pipeline fittings (Neilands *et al*., 2013). Analysis of information on the use of elastic-shell materials in pipe fittings has shown that new items are of principal novelty, lower cost and have remarkable operation advantages.

The closure and force functions of the valve member in devices manufactured using elastic shells can be combined (Morsbol and Sorokin, 2015). Their actuators can operate using either external sources of energy or the energy and pressure of the fluid product transported through a pipeline. The modifications proposed can be applied for regulating the flow rate and pressure and can be used as shutoffs or check valves for shutting off pipelines that transport fluids. The aim of the study is to present new design diagrams of sleeve-actuated hose valves.

MATERIALS AND METHODS

To achieve this goal, we have used a range of complementary methods relevant to the subject among which the most widely used methods are comparative analysis, synthesis, conceptualization. The study also used mechanical, hydraulic and hydrodynamic approaches that allowed considering the pipe fittings. The study summarizes the experience of domestic and Foreign experts who have studied this issue.

Let us consider the construction of hose valves as they are described by Koltsov and Chupin. Straight-through hose 2 is installed in cylindrical casing 1 lengthwise with ends sealed (Fig. 1 and 2). The closure of the valve which is pinch hose 3 with a diameter larger than that of hose 2 is installed angle-wise to the casing axis 1 at the widening point of the casing. The stiffness of hose 3 exceeds that of hose 2. Valve inlet 4 is connected by fitting pipe 5 through three-throw tap 6 to hose 3 whereas valve outlet 7 is connected by fitting pipe

Corresponding Author: Vladimir P. Koltsov, Irkutsk National Research Technical University, Lermontova Street 83, Irkutsk, Russia

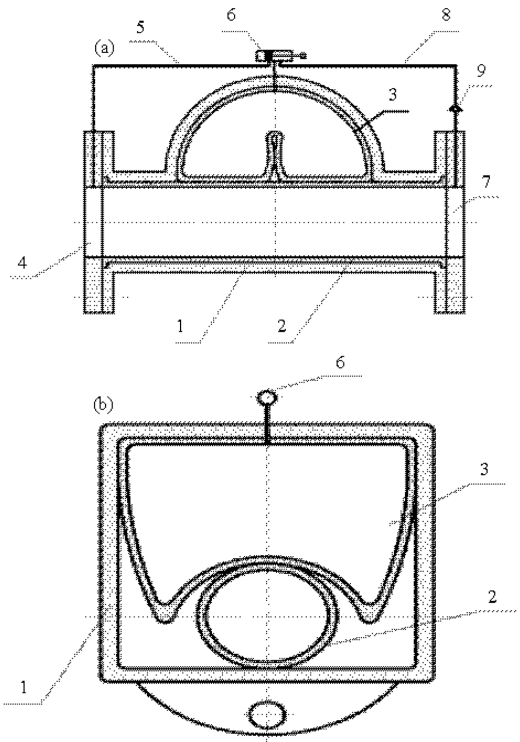

Fig. 1a, b: Valve in open position

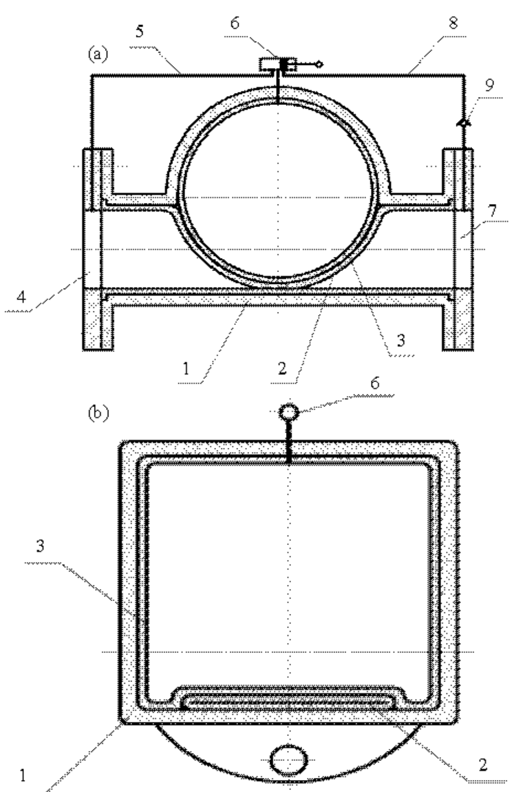

Fig. 2a, b: Valve in closed position

8 through tap 6 to that same pinch hose 3. Regulated check valve 9 is installed in fitting pipe 8. The hose valve operates the following way.

Figure 1 shows the valve in the open position in which the working medium can freely pass through it. Closing of the valve is effected by tap 6 which connects hose 3 to valve inlet 4. The fluid from inlet 4 through fitting pipe 5 and tap 6 enters hose 3.

With pressure in hoses 2 and 3 equalized, hose 3 stretches and pinches hose 2. The working passage of the valve is closed. Pressure drops at valve outlet 7 and in the adjoining pipeline. Opening of the valve is effected by tap 6 which connects hose 3 by fitting pipe 8 to valve outlet 7, i.e., the empty pipe (or the lower pressure pipe). Under pressure of hose 2 the fluid from hose 3 pours out into the empty pipeline and opens flow area in hose 2. To prevent spontaneous closing of the flow area, check valve 9 is installed in fitting pipe 8.

Figure 3 and 4 show the valve with straight-through hose 2 and pinch hose 3 installed along the valve axis in casing 1. Its construction resembles that of the valve shown in Fig. 1 and 2. Straight-through hose 2 is installed in casing 1 lengthwise with ends sealed. The closure of the valve which is hose 3 is unlike the first one installed along the axis of casing 1. The stiffness of hose 3 exceeds that of hose 2. Valve inlet 4 is connected to hose 3 by fitting pipe 5 through tap 6 whereas valve outlet 7 is

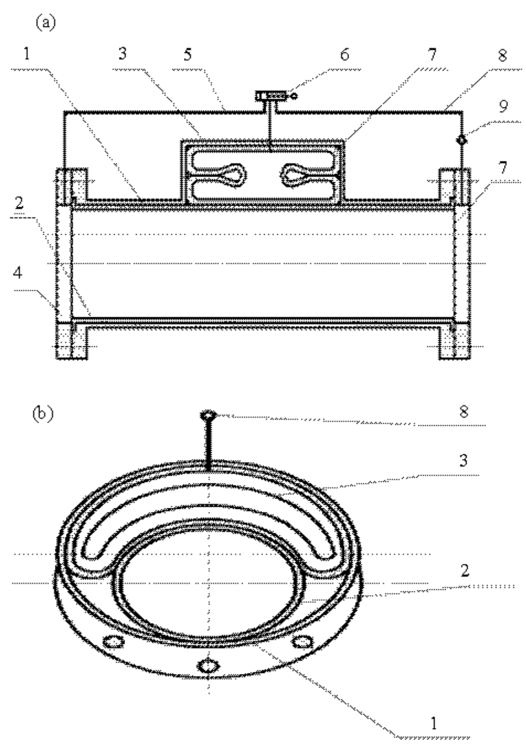

Fig. 3a, b: Valve in open position

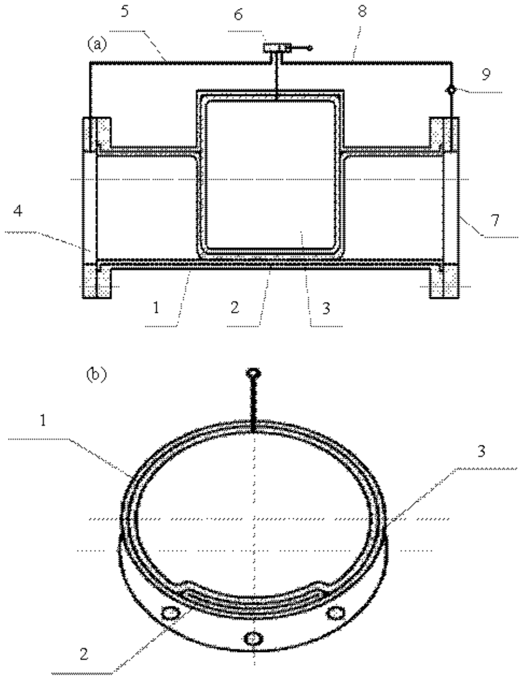

Fig. 4a, b: Valve in closed position

connected by fitting pipe 8 through tap 6 to that same hose 3. Check valve 9 is installed in fitting pipe 8. The operation of this device is the same as the operation of the valve shown above and is as follows.

Figure 3 shows the valve in the open position, so, the working medium freely passes through it. Closing of the valve is effected by tap 6 which connects hose 3 to valve inlet 4. The fluid from inlet 4 is delivered through fitting pipe 5 and tap 6 to hose 3. With pressure in hoses 2 and 3 equalized, hose 3 stretches and pinches hose 2. The working passage is closed (Fig. 4). Pressure drops at valve outlet 7 and in the adjoining pipeline. Opening of the valve is effected by tap 6 which connects hose 3 by means of fitting pipe 8 to valve outlet 7, i.e., the empty pipe. Under pressure of hose 2 the fluid from hose 3 pours out into the empty pipeline, opening the flow area. To prevent spontaneous closing of the flow area check valve 9 is installed in fitting pipe 8.

Figure 5 shows the construction of a hose valve with two pinch hoses disposed on both sides of the straight-through hose. The left figure shows the valve in the open position, while the right one shows it closed. The valve's construction resembles that of the valve shown in Fig. 1 and 2. Straight-through hose 2 is installed in casing 1 lengthwise with ends sealed. The closure of the valve composed of two hoses hoses 3 which as distinct from the previously mentioned valve are disposed on both sides of the straight-through those of casing 1.

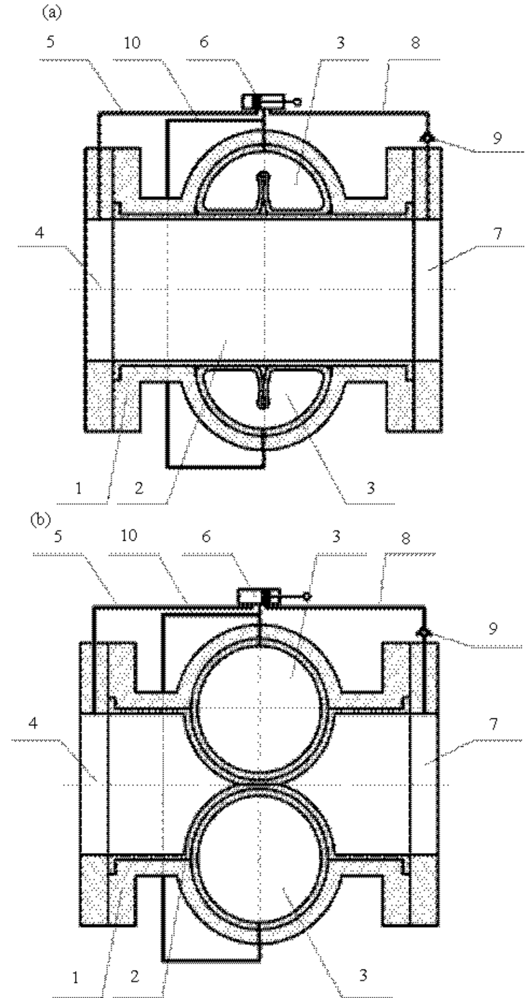

Fig. 5a, b: Valve with two pinch sleeves

The stiffness of hoses 3 exceeds that of hose 2. Valve inlet 4 is connected by fitting pipe 5 through tap 6 to hoses 3 and valve outlet 7 is connected by fitting pipe 8 through tap 6 to those same hoses 3. Check valve 9 is installed in fitting pipe 8. Fitting pipe 10 connects pinch hoses 3.

The hose valve operates the following way. Figure 5 (left) shows the valve in the open position. Closing is effected by tap 6 which connects hoses 3 to valve inlet 4. The fluid from valve inlet 4 through fitting pipe 5 and tap 6 is delivered to hoses 3. With pressures of hoses 2 and 3 equalized, hoses 3 fill out and pinch hose 2. The working passage of the valve is closed (Fig. 5b). Pressure drops at valve outlet 7 and in the adjoining pipeline. Opening of the valve is effected by tap 6 which with fitting pipe 8 connects hoses 3 to valve outlet 7, i.e., empty pipe. Under pressure of hose 2 the fluid from hoses 3 pours out into the empty pipeline,

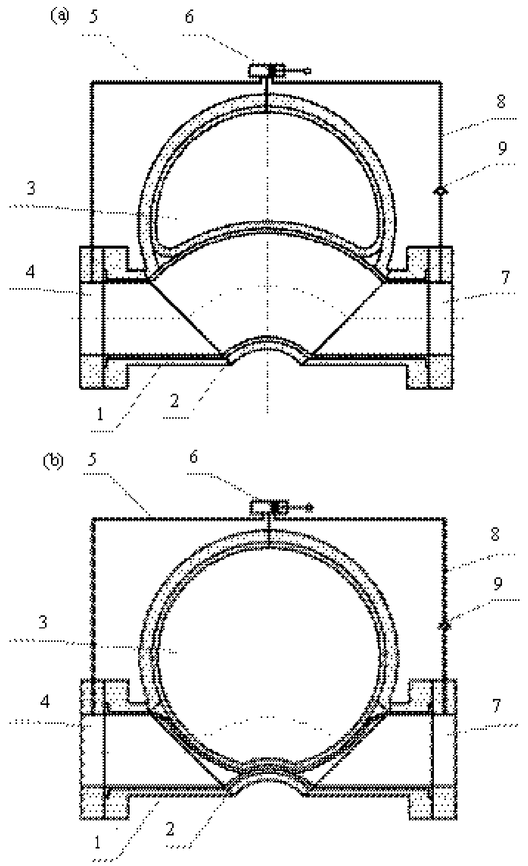

Fig. 6a, b: Valve with curvilinear casing

opening the flow area. To prevent spontaneousclosing of the flow area check valve 9 is also installed in fitting pipe 8.

Fitting pipe 10 ensures equal pressure in hoses 3. Figure 6 shows a valve with curved casing and straight-through hose in the open and closed positions. The curved casing facilitates shutoff without stretching the straight-through hose. The hose can go down without stretching from the upper point of the curve to the opposite side of the hose blocking the flow area. The construction of the valve is as follows.

Straight-through hose 2 is installed in curvilinear casing 1 lengthwise with ends sealed (Fig. 6). The closure of the valve which is pinch hose 3 with a diameter larger than that of hose 1 is installed angle-wise to the casing longitudinal axis 1 at the widening point of the casing. The stiffness of hose 3 exceeds that of hose 2. Valve inlet 4 is connected to hose 3 by fitting pipe 5 through three-throw tap 6 whereas valve outlet 7 is connected by fitting pipe 8 through tap 6 to that same pinch hose 3. To prevent spontaneous closing of the flow area check valve 9 is installed in fitting pipe 8. The hose valve operates the following way.

Figure 6b shows the valve in the open position when the working medium can freely pass through it. Closing of the valve is effected by tap 6 which connects hose 3 to valve inlet 4. The fluid from inlet 4 is delivered through fitting pipe 5 and tap 6 to hose 3. With pressure in hoses 2 and 3 equalized, hose 3 stretches and pinches hose 2. The working passage is closed (Fig. 6a). Pressure drops at valve outlet 7 and in the adjoining pipeline. Opening of the valve is effected by tap 6 which connects hose 3 by fitting pipe 8 to valve outlet 7, i.e., the empty pipe. Under pressure of hose 2 the fluid from hose 3 pours out into the empty pipeline, opening the flow area. To prevent spontaneous closing of the flow area, regulated check valve 9 is installed in fitting pipe 8. Regulation of valve 9 allows one to change pressure difference between inlet and outlet of the hose valve which in its turn, makes it possible to control the flow rate of the medium passing through the hose valve.

RESULTS AND DISCUSSION

Depending on the control method and system, the hose valves presented in this study can be used as closure or regulating devices as well as shutoff or check valves shutting off the pipeline in case of excessive flow or flow direction shift.

Summing up, the devices proposed make it possible to use the energy and pressure of the fluid transported for the valve switch-over excluding application of mechanical systems and thus, eliminating the need to manufacture expensive or sophisticated parts. This enhances its reliability, decreases steel intensity and size, facilitates application in pipelines of large diameter, easy maintenance and efficient operation and performance. Replacement of valves for the samples presented in the work bears the following advantages.

Prevents leaks of fluid which in turn saves costs of the company by eliminating the financial costs. Significantly lower wear of physical parts that provides long-lasting productivity and reduces maintenance costs replacement of pipeline fittings as a factor of reducing water losses is also one of the recommendations of the International Water Association (Rathnayaka *et al*., 2016). The principles underlying the proposed design diagrams are based on laws of mechanics, hydraulics, hydrodynamics and etc.

CONCLUSION

Despite quite an impressive number of similar devices recently devised in Russia and abroad today only those are used in practice which were created and widely implemented in the first half of the previous century. In our opinion, the situation stems from the existing standards and codes strictly regulating the use of pipeline fittings, established system of diagnosing, maintenance and servicing of the pipeline control valves and finally, the prevailing conditions of the world market in the given sphere. Thus, there is a necessity of modernization of the current legislation in this sphere and improvement of the level of technical requirements to the pipeline fittings. The pipe line fittings presented in the study are able to significantly increase the level of the liquid conduction and reduce the costs of manufacture and maintenance.

REFERENCES

King, T.A., D.K. Smith and D.L. Kirk, 2016. Pipe fittings with insert retaining seals and related methods. US9297486B2, King Technology of Missouri, Inc., O Fallon, Missouri. https://patents.google.com/patent/US9297486B2/en?oq=Patent+9297486

Matveev, Y.V., E.N. Valieva, O.V. Trubetskaya and A.G. Kislov, 2016. Globalization and regionalization: Institution aspect. Intl. Electron. J. Math. Educ., 11: 3114-3126.

Morsbol, J. and S.V. Sorokin, 2015. Elastic wave propagation in curved flexible pipes. Intl. J. Solids Struct., 75: 143-155.

Neilands, K., I. Sarenkovs and J. Rubulis, 2013. Particle accumulation in water distribution networks comparing fittings and straight sections of a pipe. Water Sci. Technol. Supply, 13: 1-8.

O'Connor, T.M., 2006. Control system for regulating liquid flow. US Patent No. US8615329B2, WaterOptimizer, LLC., Tampa, Florida. https://patents.google.com/patent/US8615329B2/en?oq=Patent+8615329

Peret, B.D., B.H. Yoo, D.G. Kane, D. Kamen andC.H.Murphy *et al*., 2011. System, method and apparatus for monitoring, regulating or controlling fluid flow. US Patent No. US 9372486 B2, DEKA, Manchester, New Hampshire, USA. https://patents.google.com/patent/US9372486B2/en?oq=Patent+No.+13%2f834%2c030+

Rathnayaka, S., R. Keller, J. Kodikara and L. Chik, 2016. Numerical simulation of pressure transients in water supply networks as applicable to critical water pipe asset management. J. Water Resour. Plann. Manage., 142: 04016006-04016006.

Zaytseva, S.G., 2012. The introduction of modern valves as a method of reducing water losses and increasing energy efficiency. Water Supply Sanitary Tech., 3: 61-65.