EXPERIENCE IN SETTING UP AND DEVELOPING
THE MANUFACTURE OF FITTINGS FOR THE GAS
AND OIL INDUSTRY

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Starting with 1985, in a short time the design and technological services of the M. V. Frunze Sumy Machine Construction Scientific—Production Association (SMNPO) Joint Stock Company (AO) developed and mastered series production of a new form of fittings, which had previously been purchased abroad. The technical characteristics of those fittings were on a par with those of its foreign analogs and indeed some characteristics were superior. This had been made possible by an entirely new approach to designing a technique and putting it into production. New fittings are designed by employing modern methods, including simulation, and computer-aided automated experimental studies and developmental work.

The automated design system developed by M. V. Frunze SMNPO AO is intended to automate all stages of the design work to produce the working documentation for ball valves and back-pressure valves and includes the following stages: analysis of the initial requirements made by the customer; organization of the initial requirements; analysis of existing domestic designs of the fittings and comparison with the best in the world; organization of the technical problem; design of the product; verification by computation; diagnosis of errors, elimination of the errors, and so forth.

Using the latest designing methods, for the first time in our country designers created and launched commercial production of DN 500, PN 80 ball valves (Fig. 1) with a forged and welded casing (consisting of two hemispheres), having a vertical joint along which closing seams are welded after the final assembly of the casing and testing of the valve. The forged-welded design of the valve uses less metal than does a demountable design.

The gate seal is of original design. In the course of development of the DN 500, PN 80 ball valve for gas trunk pipelines an analysis was made of the designs of the seals of domestic and foreign fittings. As a result for the first time in our country, polyurethane was used as the sealing material; in comparison with other elastomers, polyurethane has considerably better physicomechanical characteristics (hardness, elastic modulus, wear resistance, cyclical strength).

The gate seal is designed so that the seal is fixed rigidly, setting up a prestressed-strained state, thereby eliminating the possibility of the seal being "torn out of" the seat when the valve is actuated and also improving its technical characteristics and operating reliability. Moreover, inspection and control of the degree of compression of the seal in the valve seat were required during the mechanical assembly of the seal. The valve design allows the seal unit to be replaced.

The seal unit and the valve assembled with various drives were studied experimentally both comprehensively on a hydraulic stand and on a gas stand for testing gas compressor units under conditions as close as possible to actual conditions. The experimental data were processed on a computer, using a mathematical model of the deformation of the seal in the contact zone. The optimal values of the parameters thus found ensure that the seal is leakproof at the total pressure drop and minimum moment of friction of the seal against the plug.

The use of a polyurethane seal combined with a twin-support plug decreased the torque necessary to turn the gate of the ball valve several times and as a result the drive power is decreased substantially and, hence, so are the weight and overall dimensions of the ball valve. The most advanced design and technological solutions used in developing the design of the DN 500, PN 80 valve enabled the designers to use 2.5 times less metal for the products, to increase reliability considerably, and also to ensure good maintainability under operating conditions.

On the basis of the experimental data and experience gained in designing the DN 500, PN 90 ball valve, M. V. Frunze SMNPO AO developed DN 300, 400, PN 80 valves with different drives for above-ground and underground installation and brought them into serial production. At present measures are being taken to start production of the DN 700, 1000, 1200, 1400 PN 80 ball valves.

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Fig. 1. DN 500, PN 80 ball valve with a pneumatic-hydraulic drive (underground model).

Retrieval of patent information coupled with an analysis of the operation conditions preceded the development of the design of the back-pressure valve DN 700, PN 80. Models of different designs of the valves were studied experimentally to obtain the optimal hydroaerodynamic characteristics. The result was a back-pressure valve design with a pneumatic damper and a biplane—tandem type aerodynamic wing on the gate disk. The aerodynamic wing ensures that the gate disk is taken out of the stream and pressed against the casing seat in the velocity head operating range, thus cutting the hydraulic loss more than ten times and enhancing the operating reliability of the back-pressure valves. The pneumatic damper is a new rotatable device, in which the natural gas pumped through the pipeline is used as the working medium.

Back-pressure valves DN 400, PN 125 and DN 400, 1000, PN 80 (Fig. 2) were designed and brought into commercial production by the company on the basis of the experimental data and the experience gained from designing the DN 700, PN 80 back-pressure valve.

Moreover, protective lattices for the DN 700, 1000, PN 80 were developed and brought into production according to compressed schedules; the purpose of those lattices is to prevent any extraneous hard objects that might remain in the pipeline after assembly from entering the flow part of centrifugal compressors of gas-compressor units. The protective lattices constitute a stamped and welded spherical structure with connection pipes to be welded to the pipeline. Set up in the casing is a filtering element, made of a perforated steel plate, which is installed and removed through a hatch in the upper part of the casing. The design of the protective lattice also ensures a low hydraulic loss in the pipeline since the flow area of the lattice openings is larger than the pipeline flow area, which is keeping with world analogs.

During preparations for the production of truck-mounted gas-compressor stations it became necessary to complete them with a small valve for 32 MPa pressure. Ball valves DN 15, 25, 32, PN 320, with manual or pneumatic drives, were developed, prototypes were tested, and production was launched at the Kurgan, Konotop, and Krolevec Fittings Works.

In the course of designing pneumatic piston actuators for the valves it became necessary to solve the fairly complicated problem of providing the actuator—valve system with acceptable dynamic characteristics, especially when the valve is opened at a total pressure drop of 32 MPa in the valve. At the present time PN 500 valves for compressor stations are being developed on the basis of a typical series of PN 320 valves.

The following forms of fittings have been put into production in order to complete the equipment produced by the company for the gas and oil industries: DN 50, 100, 300, PN 125 ball valves with manual pneumatic actuators; DN 200, 300, PN 125 back-pressure valves; and DN 25, 32, 50, 80, PN 16, 25 valves designed to operate with the working medium temperature up to 400°C.

DN 6-100, PN 16-160 ball valves and DN 50-150, PN 10-140 back-pressure valves are being developed in order to raise the technical level of the gas-compressor units.

Besides developing new kinds of fittings, the company is paying much attention to the development of new automatic actuators for valving and control fittings. Instead of the customarily used pneumatic-hydraulic actuators, experimental pneumonic actuators are used, eliminating hydraulic systems. Those actuators are smaller and more reliable to operate. The new drives do not have any foreign analogs and are activators of the new generation.