Generalization of Experience Gained from Operation of Hot-Water Boilers Produced by OAO Dorogobuzhkotlomash

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Abstract—Information on how the manufacture of hot-water boilers was established and developed at the Dorogobuzh Boiler Construction Works in the period from 1962 to 2010 is presented. Main lines in which the designs of boilers produced at the enterprise were improved and modernized are pointed out. Data on the production of boilers in different years for the above-mentioned period of time are given together with the predicted volumes of production and capacities of boilers expected in 2011.

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The Dorogobuzh Boiler Construction Works was established by Decree No. 441 of the Economic Council of the Smolensk Economic Administrative District issued on December 9, 1961 as a specialized enterprise for production of steel hot-water boilers for district heating purposes and for production of spare parts for these boilers. V.G. Kuz’min, who previously worked as head of the Dorogobuzh district power station’s workshop, at which 10 hot-water boilers with a thermal output of 125 GJ/h (30 Gcal/h) were manufactured in 1961, was appointed to the post of director of the newly established enterprise. From January 1962, the enterprise began to issue production, and for a year of operation it manufactured and supplied to consumers 36 PTVM-30, TBGM-30, and PTVM-50 steel hot-water boilers intended for operation on natural gas and fuel oil with thermal outputs equal to 125 and 209 GJ/h (30 and 50 Gcal/h), respectively. The combined thermal output of these boilers totaled 6285 GJ/h (1500 Gcal/h).

The above-mentioned boilers, as well as PTVM-100 and PTVM-180 boilers, the production of which was commenced later, were constructed as a result of investigations and design development works carried out at the Tsentroenergomontazh trust’s design office, at the special design office of the All-Union Thermal Engineering Institute, and at the Moscow branch of the Orgenergostrroi Institute. Doctors of Technical Sciences E.F. Buznikov and N.I. Zhirnov led this work.

In 1964, the enterprise mastered manufacture of PTVM-100 gas-and-oil-fired boilers, and in 1976 it began to manufacture PTVM-180 boilers intended for operation on natural gas. Type PTVM boilers were intended for covering both peak loads in cogeneration systems and basic loads in district heating systems. The use of these once-through apparatuses, which served for directly heating the water of heat networks, was reasonable only in the case if these apparatuses themselves and boiler houses in which their installation was supposed were essentially cheaper and the reliability and economic efficiency of their operation was at least as good as those of boiler houses equipped with steam boilers. Therefore, the PTVM boilers were constructed with a view to ensure the maximally simple design, cheap manufacturing technology, and cheap repair and maintenance.

The staff of the enterprise carried out a large volume of work on preparing technical documentation, furnishing the shops with technological equipment, and organizing production of the above-mentioned boilers. The designs of boilers were constantly improved during their manufacture. Specialists of the enterprise carried out numerous examinations of boiler houses at which its boilers were installed, during which performance indicators of the boilers were analyzed and possibilities of improving their designs were revealed, based on which measures were introduced for making the boilers more reliable and for achieving better quality of their manufacture.

In September 1965, the Council of Ministers of the Russian Soviet Federative Socialist Republic issued Decree No. 1122 “About Improving the Technical Level, Quality, and Reliability of Boiler and Auxiliary Boiler Equipment.” In accordance with this decree, money were allotted to the Dorogobuzh Works from the Moscow Economic Council’s Fund for Development of New Technologies for providing financial support for experimental design works on construction of boilers, for carrying out measures on radically increasing the service life and improving the operational reliability of the main components and units of the produced hot-water boilers. In addition, an office for designing hot-water boilers with a thermal capacity
of 10 Gcal/h (11.63 MW) and higher was established in 1965–1966 under the financial support from this fund.

In December 1961, a Department of Industrial Power Engineering (Department No. 8) was established at the Polzunov Central Boiler–Turbine Institute (TsKTI), and Doctor of Technical Sciences N.S. Rassudov was recommended for the post of head of this department. In December 1965, V.D. Terent’ev was assigned to this post, and the department was renamed to become the Department of Heat-Recovery Boilers and Boiler Units for Power Engineering and Industrial Applications. In 2002, the department was again renamed to become the Division of Industrial Boiler Units and Energy Conservation, after which V.N. Shemyakin became its head.

Starting from 1965, the Dorogobuzh Boiler Construction Works began to cooperate with the TsKTI’s Department No. 8 on development of hot-water boilers suitable for mass-scale production. A set of preliminary examinations of boiler houses and cogeneration stations equipped with hot-water boilers produced by the Dorogobuzh Works was carried out.

Series of standardized steel hot-water gas- and fuel oil-fired boilers with heat capacities equal to 17, 27, 42, 84, 125, 209, and 419 GJ/h (4, 6.5, 10, 20, 30, 50, and 100 Gcal/h) for operation on natural gas and fuel oil and solid-fuel (coal-fired) boilers with heat capacities equal to 17, 27, 42, 84, and 125 GJ/h (4, 6.5, 10, 20, and 30 Gcal/h) were developed in 1968–1982 as an outcome of investigations and design works carried out jointly by employees of the TsKTI’s Department No. 8 and the Dorogobuzh Boiler Construction Works [1–4].

Coal-fired boilers were fitted with TLZ and TChZ retraction-grate furnaces produced by the Kusinsk Machinery Construction Works. Subsequently, these furnaces were modernized to become Type TChZM furnaces. The coal-fired boilers with heat capacities ranging from 17 to 125 GJ were installed (through supports attached to the lower headers) on the frame of the modernized furnace for which a foundation was made. In that case, no special foundation had to be designed for the boiler.

In view of successful results obtained from tests of a TChZM-2.7/8.0 furnace intended for use in the boiler with a heat output of 125 GJ/h, a decision was made to develop a coal-fired boiler with a heat capacity equal to 209 GJ/h equipped with a TChZM-4.92/8.0 furnace, the bed surface area of which is the ultimate one for firing solid fuel in a bed. Concurrently, the basic design of a KV-TK-50-150 boiler with a heat capacity of 209 GJ/h for chamber combustion of coals was developed.

Along with the standardized series of boilers, specialists of the Dorogobuzh Works, working jointly with TsKTI specialists, developed technical documentation for a KV-D-10-150 hot-water boiler with a heat capacity of 42 GJ/h operating on wood wastes and a KV-TS-20-150A boiler with a heat capacity of 84 GJ/h operating on anthracite and equipped with a furnace and a forward-stroke grate, and prototype models of these boilers were produced. The efforts as a result of which the standardized series of boilers and the KV-D-10-150 and KV-TS-20-150A boilers were constructed laid down the basis for their mass-scale production at the Dorogobuzh Boiler Construction Works.

Specialists of the Polzunov NPO TsKTI, working jointly with the Special Office for Designing Industrial Automatic Devices (the city of Cheboksary) developed and put in operation a full automation system for the standardized series of boilers, which was constructed on the basis of KSU-30-GM and KSU-T sets of control facilities [5]. Since the logic devices used in these sets had hard (unchanged) control algorithms, due to which an individual object-oriented device had to be developed for each technological unit, a set of microprocessor control facilities (MP KSU) was subsequently worked out, which was a further development of a Lomikont L-110 logic microprocessor controller and was intended to replace the KSU-GM and KSU-T sets [6].

All of the developed boilers had designs tailored for supplying them in the form of highly prefabricated units, and their pressurized elements had a decreased metal intensity.

External deposits precipitated on the convective surfaces of boilers were removed from them by means of iron shot (shot-jet cleaning), the use of which simplified the cleaning process as compared with washing used in PTVM boilers. In addition, the washing water, which contained acid, had to be neutralized before being removed from the boiler house.

In the late 1980s, shot-jet cleaning was replaced by a more advanced gas-pulse cleaning system, the use of which allowed the cleaning process to be automated, and which differed from shot-jet cleaning in being simpler and more convenient for use during operation of boilers.

In the early 1970s, specialists of the enterprise, working jointly with the Energomontazhproekt Institute, the All-Union Extramural Polytechnic Institute, and the NPO TsKTI, developed and mastered the production of combined district-heating boilers producing steam and hot water (steam-and-hot-water boilers) [7–10]. Serially produced hot-water boilers with heat capacities equal to 125, 209, 419, and 754 GJ/h (30, 50, 100, and 180 Gcal/h) were used as a basis for construction of the combined boilers. Part of water-walls used in the hot-water boiler was connected to a steam separation loop serving to produce weakly