MUNICIPAL DEPARTMENT

THE FLOW OF WATER THROUGH VALVES.*

The most casual observer in looking at an ordinary valve must have noticed the contracted and tortuous passages of the globe-valve, and the breakwater-like projections in the passageway of a gate valve. While engineers are universally of the opinion that a gate-valve will pass more water at a given pressure than will a globe-valve of the same nominal size under like condition, yet, so far as is known to the writer, no one has attempted accurately to compare their relative flows. Considered from the point of view of design, the hydraulic engineer readily perceives that the reasons for the above opinion are the losses of head due to hydraulic friction at no less than eleven places in globe-valves and at a less number in angle and gate-valves. Referring to the sectional elevation of a globe-valve, you will notice that hydraulic losses are occasioned by: (1) The enlargement of the steam as it leaves the pipe for the body of the valve—always providing that the end of the pipe has been finished and the burrs produced in cutting have been removed; (2) the contraction of the steam as it goes through the passageway to the underside of the valve seat; (3) the enlargement at the underside of the valve seat; (4) the contraction in passing through the valve-orifice; (5) the still further contraction in passing between the valve-seat and the valve; (6) the enlargement in passing through the top of the body of the valve; (7) the enlargement or contraction, as it goes through the passageway towards the the pipe from the top side of the valve-seat; (8) the enlargement of the stream just before meeting the end of the pipe; (9) the contraction of the stream on entering the pipe; (10) skin-friction, due to rough surfaces and unfilleted angles; (11) by the turning its main direction of flow through at least 360 degrees of arc.

Referring to the diagram of the straightway or gate-valve, you will perceive that its hydraulic losses are due to the first, second, third, fourth, eighth, and ninth of these reasons or their equivalents, and also to a less extent to the tenth. The angle and cross valves have losses due to the first, fourth, sixth, seventh, ninth and tenth, and to the turning of its main direction of current through ninety degrees.

In these three classes of valves, the area of valve-orifice is never as large as the actual area of the pipe connected to it. With most valves the diameter of the valve-orifice is the same as the nominal diameter of the pipe, while with some valves the area of the orifice is even less than the area due to the nominal size of the pipe. With many globe and angle-valves the valve-disk does not rise sufficiently high to give equal areas through the orifice and between the valve seats and valve-disk, and in many of even the smallest of the older designs of valves the valve is guided to its seat by lugs projecting down into the orifice, thereby decreasing its area and causing additional eddies. In some of the forms of globe and angle valves of the latest designs, it will be found that the disk does not lift high enough for a free passage, but that the nut of the valve-disk hangs down like a uvula in the throat of the passageway; and similarly with gate-valves, that, while the orifice is always much less in area than the actual area of the pipe, it is sometimes still further decreased by the projecting lugs used to screw the valve-seats into their places; and, furthermore, that the vavle-discs of some gate-valves, not lifting high enough, hang down into the passageway, and so obstruct the flow of the water.

The investigation to which your attention is called is one suggested by the writer and made under his direction. It formed the graduating thesis for the degree of M. E. in 1897 of Mr. C. W. Damron and Mr. Horace Judd, of this city (Columbus), and to them much credit is due for their patient and painstaking experimentation and the care with which they worked up the results, which cover fifty-one pages of tabulated figures and plates of forty four curves graphically illustrating the same. For your understanding of the results of this investigation, the discharge curves of the different valves tested have been redrawn to a scale of five gallons equal to one inch and one pound pressure equal to .266 inch. From the diagram before you you will perceive that five sizes were tested of seven makes of valves, each at six different pressures. Some of the more instructive data have been tabulated with reference to the weights of the valves with and without hand wheels—the actual interior diameters and the equivalent areas of the standard black pipe, the actual areas of the valve-orifices, and the pressure of the gauge at the valve for each size and make of valve corresponding to a pressure of eighty pounds at the standpipe.

The investigation was made in the hydraulic laboratory of the department of Mechanical Engineering at the Ohio State University. Water from one, two, or three pumps was led into a twenty-four-inch standpipe twenty-four feet high, closed at the top, whence it passed through a fifteen-inch opening into one

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*Paper read by W. T. Magruder, Professor Mechanical Engineering, State University, Ohio, at the nineteenth annual convention of the American Water Works Association, Columbus, Ohio, May, 1899.