Experiment and Research upon Dribbling Type Water Meter

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Abstract: This paper described the researching work of dribbling type water meter. The research is from two problems, e.g. dribbling flowing without measurement and measuring without using water that popularly exist in the field of tap water. We can get the conclusion by analyzing experiment data and characteristic curve: the two problems can be solved by means of the technique of pressure-difference-activated film.

Keyword: Water meter, dribbling

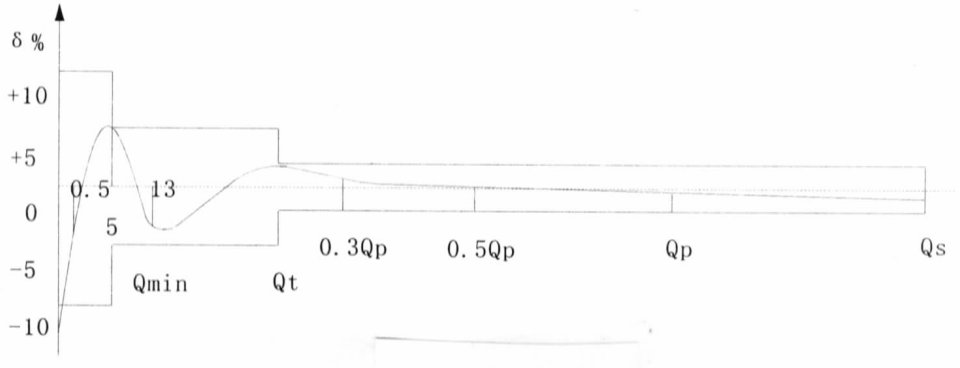
1. What is a dribbling type water meter?

A dribbling type water meter refers to a water meter that is still able to measure the water flow rate even if water dribbles, and is composed of 2 parts: the pressure-difference-activated film subassembly and water meter.

2. Relations among initial flow rate and startup flow rate as well as minimum flow rate under the Standard GB778-1996

Startup flow rate refers to the flow rate value observed when the pointer (or character wheel) liable for indicating the startup flow rate runs continuously, after the flow rate shown on the water meter starts from zero and climbs up slowly. GB778-84 and JJG162-85 have defined the startup flow rate in the same way. As ISO40464 was revised, GB778-1996 has been revised too. Four measurement levels were worked out according to the transitional flow rate and minimum flow rate, respectively A, B, C and D. As the minimum flow rate became lower, those former stipulations upon the startup flow rate indicator were thus eliminated. In fact, the requirement upon the "DN15, N1.5A" level concerning the minimum flow rate was changed to be 60L/h, instead of the former 45L/h, which indicates that the requirement has been eased. Requirements upon levels B, C and D are respectively 30L/h, 15L/h, and 11.25L/h; among others, level C and level D govern on volumetric water meters.

3. Dribbling type water meter flow rate ~ error characteristic curve (see details in the attached table of experimental data)

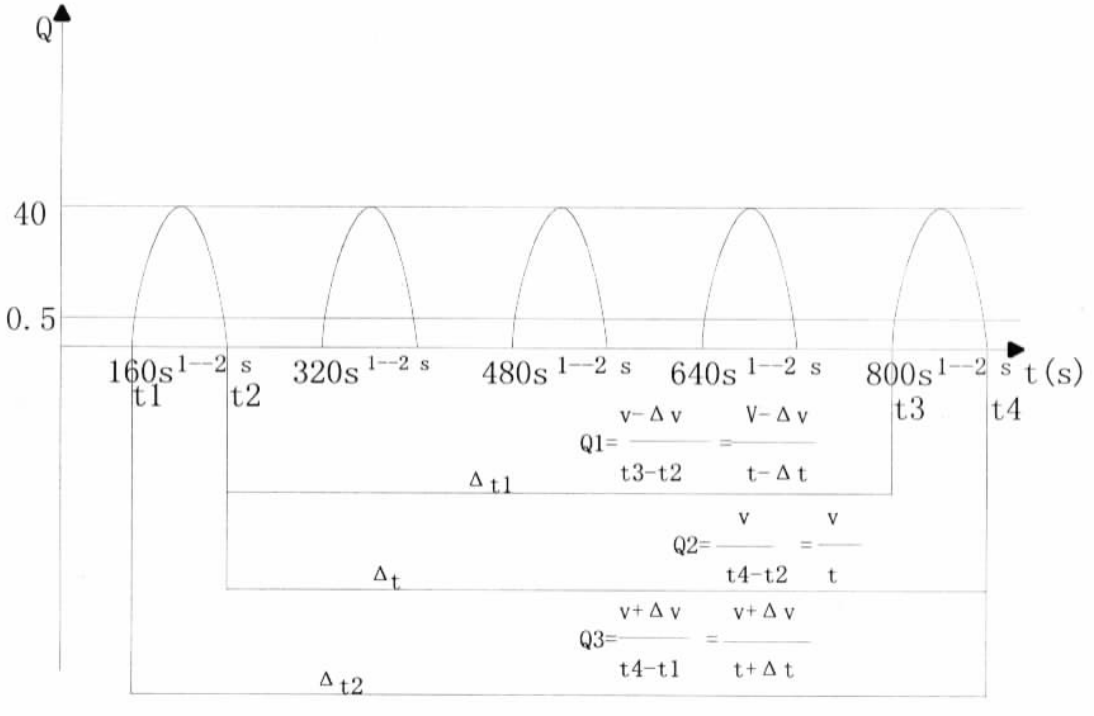


Comparison table of water meter performance

Diameter (mm)	Class		GB778-96				JJG162		LXSD-15C(E)~20C(E)					Remarks
			Overload flow rate (L/h)	Permanent flow rate (L/h)	Transitional flow rate (L/h)	Minimum flow rate (L/h)	Startup flow rate		Overload flow rate (L/h)	Permanent flow rate (L/h)	Transitional flow rate (L/h)	Minimum flow rate (L/h)	Startup flow rate (L/h)	
							Wet type	Dry type						
New type water meter	Error limit		±2%			±5%	---		±2%			±5%	±10%	Seeing from data on the left column: 1) LXSD startup flow rate is brought down to 0.5L/h initial flow rate 2) minimum flow rate is brought down to 5L/h 3) no error is counted below the former minimum flow rate; the current 5L/h~120L/h all subject to ±5%, 0.5L/h~5L/h subject to ±10% 4) range ratio is 3,000: 5=600. Better than the range ratio of Level B (3,000: 30=100)
	15	A	3000	1500	150	60	14	16	3000	1500	120	5	0.5	
		B			120	30	10	12						
		C			22.5	15	4	4						
		D			1725	1125								
	20	A	5000	2500	250	75	19	20	5000	2500	200	10	0.5	
		B			200	50	14	16						
		C			37.5	25	4	4						
		D			2875	1875								
Water meter in use	Error limit		±4%			±10%	---		±4%			±10%	±20%	
	15	A	3000	1500	150	60	168	192	3000	1500	120	5	0.5	
		B			120	30	12	144						
		C			22.5	15	4.8	4.8						
		D			1725	1125								
	20	A	5000	2500	250	75	228	24	5000	2500	200	10	0.5	
		B			200	50	168	192						
		C			37.5	25	4.8	4.8						
		D			2875	1875								

Seeing from the flow rate~error curve, the pressure-difference-activated film subassembly begins to act from 0.1L/h~13L/h or so, and the water meter starts to intermittently measure the water flow rate in an accumulative way. At around 13L/h~18 L/h, the valve subassembly comes away, the original curve of the water meter governs. Minimum flow rate is different from transitional flow rate by ±5%, and transitional flow rate is different from overload flow rate by ±2%. The dribbling type water meter brings the original flow rate~error curve down to 0.5 L/h at the time of initialization of measurement, which is a major breakthrough to the traditional measuring technology of water meter. As the pressure-difference-activated film subassembly is also to make adjustments, so long as the manufacturing craftsmanship is fine enough, the error of initial flow rate can be controlled to meet the requirements upon error of minimum flow rate; actually, this has been an issue in concern for the water works and water consumers. Seeing from the experiment data available, the dribbling type water meter of the day is not only able to realize the

measurement of flow rate in an accumulative manner in the range from 0.5 L/h to minimum flow rate, but also able to reach the 3 measurement error bursts from 0.5 L/h to overload flow rate. Namely, the high burst from overload flow rate to transitional flow rate features ±2%, the low burst from transitional flow rate to minimum flow rate features ±5%, and the ultra-low burst from minimum flow rate (5L/h) to startup flow rate (0.5L/h) features ±10%. Seeing from the experiment data too, the error of actually measured value between 5L/h and 120L/h is ±5%, with a range ratio up to 600 times. Compared to the Standard ISO4064, this is better than the lower-end indicators upon level N1.5 C and level D; the error rate on Level C from 15L/h to 22.5L/h is ±5%, and the error rate on Level D from 11.25L/h to 17.25L/h is ±5%. During the experiment, it was found that the pressure difference generated after about 100 water drops fell down reached 30~40 kpa, which started up the water meter for once; about 23 ml/160s; namely, the accumulated flow rate is 0.5 L/h. The time length of each startup lasted 1~2 seconds, equating to an instantaneous flow rate between 40 L/h and 80 L/h, which falls in the low burst scope of normal measurement of water meter.



From the figure above, we can know:

$V=Qt=0.51/h \times 1800 \div 3600=0.25$ L/h ; $\Delta V=0.023L$

$\delta = \pm \Delta V/V = \pm \Delta V /Qt = \pm 9.2\%$;

As illustrated in the figure:

If t is big enough (e.g. $t \geqslant 24$ h), ΔV's influence on quantum is relatively small ($\delta \leqslant 0.19\%$), therefore the accumulated error of dribbling type water meter over a long period of time will not appear so eye catching.

4. Why was the dribbling type water meter developed?

1) Considering the actual conditions in China, water quality and installation circumstances, the ordinary volumetric water meter can hardly meet the needs; while the prevailing rotor speed type water meter fails to conduct measurement when the water flow rate falls below the startup flow rate. Under the existing standard, the requirement upon error scope was set down with no consideration

given to the flow rate below the minimum flow rate; and the requirement upon the water meter in use is brought down by 20% from that upon the startup flow rate on Level A. DN15 waters is 16.8 L/h (DN20 water meter is 22.8 L/h). In each day (24 hours), nearly 300L~500L of water is not measured. This exactly manifests that the water meters in current use can hardly meet the requirements upon measurement of the dribbling water in water pipes in many medium and small sized enterprises which use tap water. In a nutshell, the current national conditions in China have requested professional research institutes to develop the dribbling type water meter, so as to meet such measuring requirements as soon as possible.

2) Due to water loss as a result of dribbling, the measuring results of water meters have been 60% less than those that they should work out. In some regions, the water lost as a result of emission leakage, spillage and dribbling" in the tap water pipe network has constituted up to 80% in the total. Under market economy conditions, the failure in measuring the dribbled water and an excessive loss of water in the water pipe network in terms of tap water control have caused water works to sustain losses in business, push up water charges, or stipulate lower limits on water consumption quantities on a monthly basis, or supply water for only a limited number of hours in a day; and also incurred disputes in terms of water measurement among water consumers. This has appealed to common concern from the government and all walks of life, and been a major reason explaining why a fire-new type water meter which is able to measure the volume of dribbling water had to be developed as quickly as possible.

3) Dribbling type water meter is hardly available even outside China. Even the volumetric type water meter with purified water can not get geared to the tap water measurement conditions at home; what's more, the volumetric type water meter is expensive, and domestic tap water consumers cannot afford it at all. Someone suggested using water meters with measuring levels C and D, so as to get geared to the internationally accepted practices. Undoubtedly, it is a good idea. However, it is hard to use such meters in China, due to her unique national conditions. The only way out is to develop a new type dribbling type water meter, pursuant to the actual conditions in China. Besides, it is possible to launch such a new type water meter onto the international market; by then, this new type meter will enable us to get well geared to the internationally accepted practices. Therefore, development of the dribbling type water meter has actually met the requirement upon advancement of water mater measurement technology in the global arena.

5. Structural principium of the dribbling type water meter

The dribbling type water meter is mainly composed of two parts: a pressure-difference-activated film subassembly and an ordinary water meter. Among others, the pressure-difference-activated film subassembly chiefly consists of a film-activation subassembly and value subassembly. As far as its working principle is concerned, the dribbling type water meter utilizes the storage function of the film activation subassembly to generate pressure difference to open the value in an intermittent way, and make the accumulated flow rate at each time to turn out bigger than the startup flow rate of the water meter, so that the water meter is able to measure the minute flow rate generated as a result of water dribbling.

6. Durability and compatibility of the dribbling type water meter

As the dribbling type water meter is composed mainly of a pressure-difference-activated film subassembly and an ordinary water meter. The ordinary water meter itself has been a product of mature technology. As the result of an accelerated attrition test has shown, the water meter itself has a service life of 15 years, under the circumstances of a normal water consumption quantity in a common

household environment. All the component parts of the pressure-difference-activated film subassembly have been made of wearable and environment-friendly materials. Therefore, this meter is able to meet the State requirement going as that "a household-use water meter must have a service life of 6 years". Furthermore, according to the findings of actual experiment on product and the report rendered by users after using the product, "after the dribbling type water meter has run for more than half a year in an environment where common tap water is supplied, the re-examination finds that its component parts has suffered little apparent abrasion, and borne little dirt or rust.

7. The dribbling type water meter will not cause users to suffer loss, or jeopardize the interests of tap water consumers

Under market economy circumstance, it is required to protect the interests of the seller and the buyer and make sure that they close a deal on an equitable footing. As far as tap water measurement is concerned, it is necessary to ensure accurate measurement by "measuring each drop consumed, and not counting any drop unconsumed". The dribbling type water meter is able to measure the volume of dribbling water accurately, prevent water from flowing back, and resist interference caused by the fluctuations of water pressure as well. Seeing from the performance characteristics of dribbling type water meter, the measurement error can be adjusted. So long as the manufacturing craftsmanship is fine enough, the error of initial flow rate can be controlled to meet the requirements upon error of minimum flow rate. Thus, the dribbling type water meter is able to realize measurement of high and medium flow rates or dribbling water (incurred manually or loose control of the water faucet), so as to provide equitable, fair, accurate and reliable measurement figure for reasonable calculation of charges, and also ring an alarm to those derelict water resources managers and water stealers. Apparently, the dribbling type water meter is not only able to prevent water emission leakage, spillage and dribbling in the tap water pipe network, but also can serve as a "reliable notary public" that can be trusted by the water works, enterprises, community-level property management organs and water consumers.

8. Is the dribbling type water meter an accelerating unit?

Seeing from the flow rate~error curve of the water meter, the pressure-difference-activated film subassembly allows the water meter to measure the flow rate intermittently in an accumulative way from 0.1L/h~13L/h or so. Starting from 13L/h, it has come away, and started to measure as per the original characteristics of the water meter. So the pressure-difference-activated film subassembly will not generate any acceleration or interference below the minimum flow rate, and produce no external source of acceleration force. The pressure-difference-activated film subassembly only serves as a self- driven flow rate adjustment valve, and must work together with the water meter before being able to measure the volume of dribbling water. What's more, the new international standard on water meter and international specification have not formulated related stipulations, yet. It thus follows this has manifested the unique measurement characteristics of the dribbling type water meter, together with its competitive edges in technical terms compared to its counterpart products at home and abroad.