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Research on Technology Status and Development Direction of Large Diameter Water Flow Standard Facility in China

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Abstract

The performance of large diameter water flow facility will have a direct impact on the accuracy and value uniformity of detected flowmeter measurement results. In addition, ensuring the stability and reliability of facility performance has always been a key link in the traceability and transmission of value of large water flow. However, the application scale and measurement capability of existing large diameter facilities are difficult to fully meet social needs. In this paper, based on national institute of metrology(China), provincial metrology institutes and related flow enterprises, focusing on the domestic typical large diameter water flow standard facility has been built to carry out the investigation and research, comparative analysis of different types of device structure principle, measuring ability, technical characteristics and the regional distribution, etc. Based on this, the key technologies that may emerge in the field of large diameter water facility in the future are explored and the future development trend is summarized. The relevant research results of this paper have important practical significance for improving the measuring capacity of domestic large water flow facilities, standardizing and improving the construction of traceability system for large water flow measurement.

Key word：water flow standard facility; large diameter; measuring performance; technology development status; regional distribution

1. Introduction

The large diameter water flow standard facility is a key measuring equipment used to carry out the verification or calibration of various large diameter large-caliber liquid flow meters with water as the medium, verify the measurement performance of the flowmeter being tested, and provide accurate and stable flow value for it[1-2]. Its technical capability is usually defined as pipe diameter≥DN500, maximum flow rate≥5000m^3/h, and maximum pipeline flow rate≥10m/s. The large diameter water flow facility is widely used, it plays an important role in trade settlement, energy measurement, process control, environmental protection, medicine and health and other fields of instrument testing work, effectively promote and support the sustainable development of the national economy, but also an important basis for the development of flow measurement and testing technology[3-4].

China's water resources have always been very tight, and with the sustained and rapid development of economy and society, the acceleration of urbanization and the continuous improvement of people's living standards, water resources shortage and water environment deterioration and other problems have become increasingly prominent, the contradiction between supply and demand of water resources in many areas is sharp, saving and rational use of water resources has become a must. Accurate measurement of water flow is an important evaluation method for rational utilization, strengthening water resource management and improving water resource utilization rate. Especially in the current era of severe energy situation, water shortage and increasing awareness of environmental protection, accurate measurement of water flow and large water flow has become more significant in the national economy.

In recent years, domestic continuously improve ability construction in the field of water flow measurement, metering technology institutions at all levels, professional metering station and relevant traffic enterprises are according to the requirements of the business or research in the construction of a large number of flow measurement standard facility and testing flow meter number increased year by year, but under the background of "energy conservation and emissions reduction", "energy saving", etc. new environmental protection policy, the market has higher and higher requirements for the measurement accuracy of various in-use liquid flowmeters, and resource waste and measurement disputes occur from time to time in trade settlement[5]. And flow quantity traceability is a complicated system engineering, the whole process of traceability of high correlation and interaction of each link, the water flow, especially the water flow metering areas has not yet formed perfect quantity traceability system, industry the highest standards of measurement and characteristics of metrological verification has not been established, far cannot satisfy the huge demand for water mass flow measurement. In addition, some key technical problems unique to gulp discharge measurement (such as low measurement accuracy, difficult to ensure flow stability, low verification efficiency) have not been effectively solved[6-7], and relevant standards or norms are still missing. These unsolved technical difficulties seriously restrict the practical application of large-caliber flow facility and the traceability and transmission effect of large water flow value.

2. Social and market demand

The volume of flow metering involved in water conservancy industry is often very huge. With the development of water conservancy industry and the progress of metering technology in China, there are more and more types, models and quantities of flow metering instruments, and the size of measuring equipment is also getting larger and larger. The application of large-flow measuring instruments with nominal diameter larger than DN300 used in urban heating, water supply and power supply industries for trade settlement is increasing year by year; Secondly, most of the projects related to water flow are the backbone projects of the national economy, such as the Three Gorges Power Station, south-to-North water diversion project and other large national water diversion projects, the trade settlement of waterworks and water supply pipe network and the monitoring of factory wastewater discharge are inseparable from the accurate measurement of large diameter liquid flowmeter. In developed coastal areas, large-diameter electromagnetic flowmeters are widely used in various flow enterprises, with a large number of applications and huge potential verification demands[8]. It can be seen that the measurement of flood flow plays an important role in many projects related to national economy and people's livelihood, such as resource conservation, energy saving and consumption reduction, environmental protection and so on. Its accuracy is often involved in huge economic interests and social benefits. Once the measurement is inaccurate, it will cause huge economic losses to both sides of the trade. These unavoidable situations make the society increasingly urgent demand for large-caliber liquid flow measurement technology, and also make the construction and application of high-accuracy large water flow standard facility put on the agenda.

Although there is a huge and urgent demand for large flow measurement in all walks of life, and all parties of trade settlement attach great importance to the accuracy of measurement results, there are still some difficulties in the research and establishment of flow standard facilities for large diameter, large flow rate and high flow rate. Some of these difficulties are technical difficulties, while others are not allowed by economic conditions. The application scale and measurement capacity of existing devices are still difficult to fully meet social needs. Due to the large diameter of the measuring pipe, the instability effect of the flow field and the limitation of installation conditions, the final measurement result of the facility is often not ideal, which makes the declared uncertainty of the domestic large-caliber flow facility very high, which is different from the actual measurement level[9].

In order to further strengthen and standardize the construction of large water flow measurement value traceability system, improve the measurement value traceability and transfer method, improve the level of the existing large diameter water flow standard facility in China and ensure the accuracy and reliability of the facility measurement performance, Based on the resources of The National Institute of Metrology, provincial metrology institutes and well-known flow enterprises, this paper carried out a detailed investigation on the large diameter water flow facilities that have been built nationwide, and analyzed the principle types, distribution, measuring ability and technical characteristics of the facilities. On the basis of further explore the future water flow may emerge in the metrology area key or hot technology, analyze and summarize the water flow standard facility for the future development trend, the paper related research results for future domestic high precision, large flow, large diameter and high velocity of the liquid flow standard facility provides reliable reference and the suggestion for the design and implementation, It is of great practical significance to promote and realize the traceability and transfer of water mass flow measurement value.

3. Development status of large diameter water flow standard facility

3.1 Classification and structural characteristics

Strictly speaking, the large diameter water flow standard facility has no significant difference in structure and function with the common diameter flow facility. According to the different measurement standards, the large diameter water facility is also divided into three kinds: weighing method, volumetric method and master meter method. According to the working principle of weighing method and volumetric method flow facility, it can be further divided into static mode, dynamic mode and start-stop mode[5]. Original liquid flow standard facility such as the weighing method and volumetric method mainly include: flow standard, test line, voltage stabilizing fluid source, circulation system, the diverter, control equipment and data collection and processing system, the calibrator of weighing method facility mainly is weighing apparatus, and the calibrator of volumetric method facility mainly is calibrated measuring volumetric tank; The static liquid flow standard facility uses the reversing equipment has the diverter and the reversing valve, the dynamic liquid flow standard facility does not need the reversing equipment, and the start-stop method facility is directly controlled by the switch valve to start and stop the liquid, so that a start-stop process into the weighing apparatus or calibrated measuring volumetric tank.

In addition, the master meter method liquid flow standard facility is mainly by the master flowmeter, test pipeline, voltage stabilizing fluid source, circulation system, control equipment and data collection and processing system. Generally, it has a simpler structure, more convenient operation and higher verification efficiency than the original method liquid flow standard facility[10]. The core equipment of the facility is the master flowmeter with good repeatability and long-term stability, and the master liquid flowmeter can be connected with the test pipeline either by a single unit or by multiple units in parallel.

Figure 1 shows the schematic diagram of the typical static weighing method large-diameter water flow standard facility:

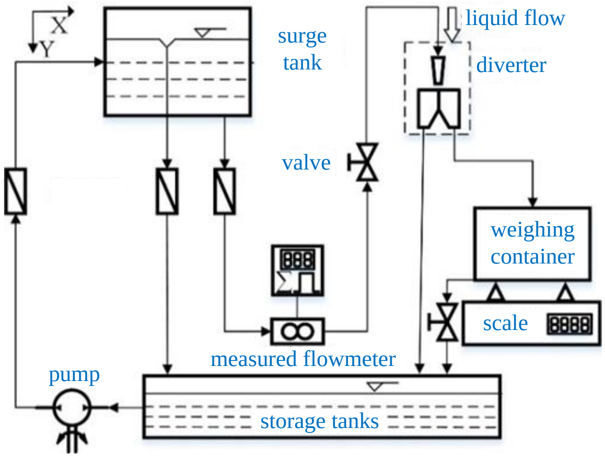


Figure 1: Schematic diagram of static weighing method water large flow standard facility

The specific classification of water flow standard facilities is shown in Figure 2:

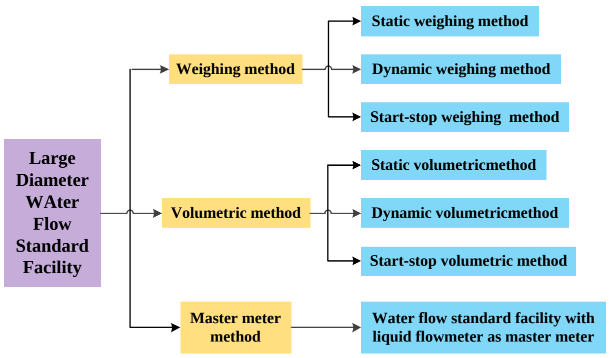


Figure 2: Schematic diagram of liquid flow standard facility classification

The flow measurement principles of various typical liquid flow facilities are as follows:

1) Static liquid flow standard facility
From the beginning to the end of the test, the flow at the test pipeline is always the same, the fluid uses the diverter to switch, and flow to the calibrated measuring volumetric tank(or the container on the weighing apparatus), the total amount of liquid during the test is read in the static state of the fluid.

2) Dynamic liquid flow standard facility
In the process of liquid flow to the calibrated measuring volumetric tank(or the container on the weighing apparatus), directly measure the total amount of liquid over a period of time to obtain the flow rate.

3) Weighing method liquid flow standard facility
The mass flow rate can be obtained by measuring the mass and time parameters of the liquid.

4) Volumetric method liquid flow standard facility
By measuring the liquid volume and time parameters, the volume flowrate can be obtained. The comparison of characteristics between the liquid flow standard facilities for dynamic and static volumetric methods and the liquid flow standard facilities for dynamic and static weighing methods is shown in Table 1 and Table 2 respectively:

Table 1: Comparison of technical characteristics of liquid flow standard facilities for dynamic and static volumetric methods

The Serial Number	**Static Volumetric Method**	**Dynamic Volumetric Method**
1	Measurement accuracy can reach ± (0.05% ~ 0.2%)	accuracy is not as good as static volumetric method, generally ± (0.2% ~ 0.5%)
2	No dynamic effect error	Dynamic effect error exists
3	System and random error introduced by diverter or valve	No error introduced by diverter or valve
4	The fluid flowing through the meter to be tested is equal to the value measured by the calibrated measuring volumetric tank in the same period	The fluid flowing through the meter being tested and the calibrated measuring volumetric tank may have different values in the same cycle
5	Not suitable for measuring corrosive, toxic and volatile fluids	Adaptable to corrosive, toxic and volatile fluids

Table 2: Comparison of technical characteristics of liquid flow standard facilities for dynamic and static weighing methods

The Serial Number	**Static Weighing Method**	**Dynamic Weighing Method**
1	Can be used as the highest original transmission standard, has the highest measurement accuracy, up to ± (0.05% ~ 0.1%)	Within a certain accuracy range as a transfer standard, due to the existence of dynamic effects, the measurement accuracy is generally ± (0.2% ~ 0.4%)
2	The fluid is weighed at stationary state and the weighing vessel has no mechanical connection with the pipeline	The fluid is dynamically weighed, and the weighing vessel has a mechanical connection with the pipeline, reducing the accuracy of the weighing
3	Need reversing equipment (diverter, valve, etc.) and will produce reversing error	No reversing equipment is required, and there is no such error
4	The liquid mass passing through the flowmeter is the same as the liquid mass at stationary state during the same measurement period	The liquid mass passing through the flowmeter being tested in the same measurement period is not equal to the liquid mass being dynamically weighed
5	The impact force of liquid jet has no effect on weighing	The impact force of liquid jet has an effect on weighing
6	The output signal of weighing device can follow the mass change of weighing vessel synchronously and is not affected by inertia lag	It can not follow the mass change of weighing vessel synchronously, and is affected by inertia lag, resulting in systematic error
7	Measurement accuracy is not limited by fluid velocity	High accuracy and reproducibility are achieved only at low velocity below 3m/s
8	When measuring volatile or cryogenic liquids, the measurement accuracy will be reduced; Take protective measures when measuring corrosive and toxic liquids	Measurement of volatile liquids without loss of accuracy; The facility itself is easily sealed, so it can be used to test flowmeters for harmful liquids

The above-mentioned typical large-diameter water flow standard facility(such as weighing method, volumetric method and master meter method) have been generally recognized and normalized by the society, and have corresponding metrological verification regulations. With the continuous development of economy and society, some flow enterprises have established large flow standard facilities of static volumetric method for high water tower with constant head pipe diameter over DN1000 according to their own needs. However, the construction investment of such large facilities is particularly huge, and the overflow set to maintain constant head needs to consume a lot of electric energy. Therefore, it is not realistic to build similar large-scale flow facilities in general.

In order to effectively solve the calibration problem of large-caliber flow instrument, promote water flow metering technology innovation, many technical institutions at home and abroad in recent decade were set up all kinds of variable water head (uncontrolled) large liquid flow standard facilities, construction investment and operation of this kind of facility maintenance costs are much less than the constant water flow standard facility. Although the standard system has not yet been formed and applied on a large scale, it has played a great role in the practical verification of the large-caliber flow meter.

3.2 Technology development status at home and abroad
The construction of large- diameter water flow standard facility is of great significance to ensure the accuracy and reliability of large flow value, effectively standardize liquid flow measurement activities, provide enterprises and institutions with trade settlement, water resources monitoring, energy conservation and emission reduction measurement services, and promote the development of flow business. Currently the world's major developed countries have established the corresponding large diameter water flow standard facility[11-12], among which western countries such as Europe and The United States have the highest capacity level in terms of construction technology and comprehensive

performance. China has also established a national large-diameter water flow measuring station as the legal national benchmark for large water flow.

The comparison of technical indicators of important large-diameter water flow standard facilities in the world is shown in Table 3:

Table 3: Comparison of indexes of large flow facilities of major metering institutions in the world

Institutions	**Principle**	**Maximum Diameter (mm)**	**Maximum Flowrate (m^3/h)**	**Velocity (m/s)**	**Extended Uncertainty (*k*=2)**	**Notes**
NIST	static weighing	DN406	2280	4.9	<0.1%	No water tower, pump direct circulation
PTB	static weighing	DN400	2100	4.6	0.02%	Physics laboratory
NMIJ	static weighing	DN1100	3000	/	<0.1%	overflow water tower, diverter has a variable nozzle
IMGC	static volumetric static weighing	DN500	740kg/s	/	measurement error<5×10^{-4}	water tower regulator
NEL	static weighing	DN760	5040	/	0.2%	Double weighing capacity (mechanical scale + electronic scale)
CENAM	static weighing	DN250	720	4.1	0.05%	
NWLFMS	static volumetric master meter	DN1600	16000	2.2	0.2%	The water tower is 27m in height and $50m^3$ in capacity

The corresponding measuring capability of the facilities are shown in Figure 3:

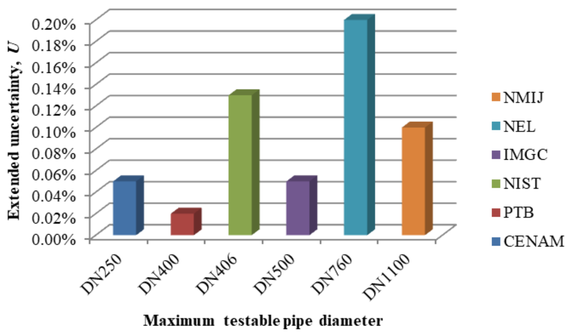


Figure 3: Comparison of measuring ability of typical large-diameter water flow standard facilities abroad

According to the data in the table, compared from the aspects of maximum detection capacity, measurement uncertainty and measurable caliber, the general technical level of water large flow facilities in the world at present is as follows: pipe diameter no more than DN800, standard flowrate no more than 8000 m^3/h, and extended uncertainty of about 0.1%(*k*=2). It is worth noting that foreign water facilities do not excessively pursue or focus on the three core technical indicators of "large flow rate, high flow velocity and wide range of testable diameter", but they have unique advantages in the aspects of facility construction technology, flow stability, avoiding potential measurement errors and anti-interference ability. In addition, it is found that with the increase of the calibre and the maximum flow rate, the principle of the facility gradually changes from the weighing method and volumetric method to the master meter method and variable head method. Most of the maximum flow rate is less than $10000m^3/h$, and the accuracy level is generally 0.1% ~ 0.2%. At present, some other flow production enterprises and metering institutions in China also have some flow standard facilities, but there is still a lack of large water flow facilities specially used for the detection or calibration of large caliber meter, especially the flow facilities above DN1000 pipe diameter are few.

Generally speaking, most of the flow standard facilities commonly used in the world are independently used and highly targeted facilities, while the existing flow standard facilities in China basically adopt static weighing method, static volumetric method and variable head dynamic volumetric method, among which the classical static weighing method and static volumetric method are the main. The master meter method started late, but many advantages of master meter method make it widely used in the field of large water flow measurement in recent years. However, in the actual calibration process of the large diameter liquid flowmeter, because of the large working flow, high flow velocity, more prone to flow instability, pump and pipeline vibration, electrical interference and other external factors, the measurement accuracy of the general facility is relatively low.

Therefore, in the research and establishment of the standard facility for large water flow, how to make the technical indicators of the facility reach the advanced level, and at the same time give consideration to its detection efficiency and anti-interference ability, is the key problem that technicians need to consider and overcome in the next stage.

4. Review on the present situation of large water flow standard facilities in China

4.1 Distribution of existing large flow standard facilities

With the continuous development of water conservancy and environmental protection in China, the large caliber flow meter has been popularized and used on a large scale. In order to meet the verification demand of large flow liquid flowmeter in the region, many flow technical institutions have established the corresponding large caliber liquid flow standard facility. To better grasp the domestic existing large water flow standard facility technology development present situation, understand the current water flow metering market demand and the social economic benefits, explore the key technology of the future may form or hot spots of the liquid standard facility, specifically for nationwide some key flow institutions and well-known enterprises have built large flow standard facility has carried on the on-the-spot investigation, and the measuring ability, structural design, main use, key technology innovation, business demand and development, use and maintenance of the device are mainly investigated.

In the process of investigation, typical large-caliber liquid flow standard facilities in China mainly include:

1) National Large Water Flow Metering Station(Kaifeng): static volumetric method, measuring pipe diameter DN500 ~ DN1600, flow range (200 ~ 16000) m^3/h, accuracy level 0.1%.

2) Henan Institute of Metrology: static volumetric method + master meter method, frequency converter + regulator tank steady flow mode, the measured pipe diameter is DN15 ~ DN600, the flow rate/flow velocity range is (0.5 ~ 5) m/s, the maximum local flow velocity is 8m/s, and the flow stability is better than 0.05%.

3) Institute of Metrology of Hebei Province: weighing method and master meter method are complementary, the measurement diameter range is DN15 ~ DN800, flow range is (0.01 ~ 5090) m^3/h, uncertainty range U_r=0.05% (k=2, weighing method), U_r =0.2% (k=2, master meter method).

4) Jiangsu Institute of Metrology: integrating static weighing method + static volumetric method + master meter method, measuring diameter DN6 ~ DN2400, flow range (0.05 ~ 24000) m^3/h, water tower + frequency conversion voltage regulator, accuracy grade is better than 0.2%(up to 0.05%).

5) Zhejiang Institute of Metrology: dynamic volumetric method + master meter method, frequency conversion voltage regulation method. The pipe diameter of dynamic volumetric method facility is DN300 ~ DN600, the flow range is (1 ~ 6000) m^3/h, and the uncertainty is better than 0.05%; Master meter method DN300 ~ DN1200, flow range (1 ~ 12000) m^3/h, uncertainty is better than 0.2%. In addition, the volume of calibrated measuring volumetric tank is $75m^3$, and the overall flow stability is 0.50%.

6) Shandong Institute of Metrology: weighing method + volumetric method, flow range is (1 ~ 5600) m^3/h, measurement pipe diameter can reach DN600 (can be extended to DN1000).

7) Fujian Institute of Metrology: The principle of static weighing method + master meter method is adopted. The weighing method facility measures the pipe diameter DN10 ~ DN300, the volume flow rate (0.14 ~ 1800) m^3/h, and the measurement uncertainty U_{rel}=0.05%(k=2); The master meter method facility measuring pipe diameter DN10 ~ DN600, volume flow (0.14 ~ 7000) m^3/h and measurement uncertainty U_{rel}=0.15%(k=2).

8) Endress+Hauser Flow Meter Technology Co, LTD.(Suzhou): Using the principle of master meter method, with 4 large-diameter pipelines: DN1400, DN1600, DN1800, DN2000 ~ DN2400, the pipe diameter range can be DN2 ~ DN2400, mainly responsible for providing internal real flow calibration or test for large caliber flowmeter produced by enterprises, not to carry out external business.

9) WELLTECH(Shanghai): It has the largest calibrating diameter range, the highest degree of automation and the highest calibration accuracy of similar facilities in China, the calibrating diameter range is DN3 ~ DN3000 (can be extended to DN3800), the maximum straight pipe diameter is 3m, the maximum standard flow is 25000 m^3/h, and the total uncertainty is better than 0.037%. The whole facility is divided into 4 sets of systems, a total of 8 pipelines, among which system 1, 2, 3 (4 pipelines) adopts variable head dynamic volumetric method with flow regulation; system no.4 (4 pipelines) adopts static weighing method with high slot stability.

10) Guangzhou Institute of Energy Testing: Using the principle of static weighing method + static volumetric method + master meter method, the pipe diameter range is DN2 ~ DN1000, the flow rate range is 0.005 ~ 10000 m^3/h, the local maximum flow velocity can reach 10m/s, the extended uncertainty is better than 0.2%(k=2), and

the overall flow stability is better than 0.1%.

Physical figure of large-diameter liquid flow facility of part mechanism is shown in Figure 4:

(a) DN500～DN1600 large water flow standard facility (NWLFMS)

(b) DN800 large water flow standard facility(HBIM)

(c) DN6～DN2400 large water flow standard facility(JSIM)

(d) DN2～DN1000 large water flow standard facility(GZIET)

Figure 4: Physical effect diagram of large water flow standard facility in some domestic institutions

4.2 Comparative analysis of measuring capability of the facility

According to the facility parameter information obtained from the investigation, the comparison of the technical indexes of the typical large-diameter water flow standard facility in China is shown in Figure 5:

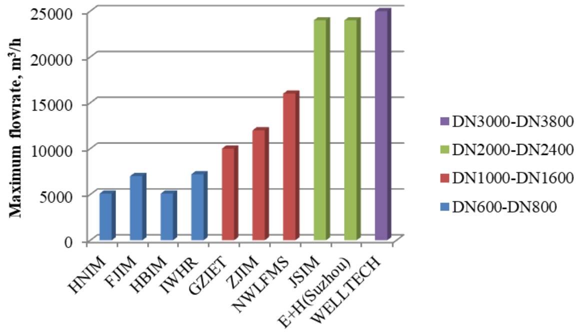
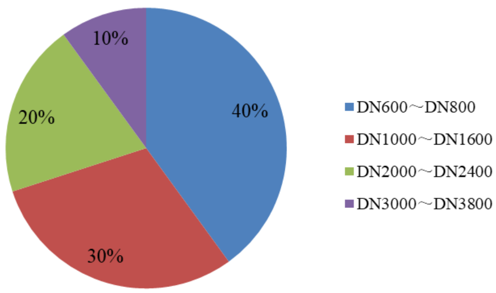
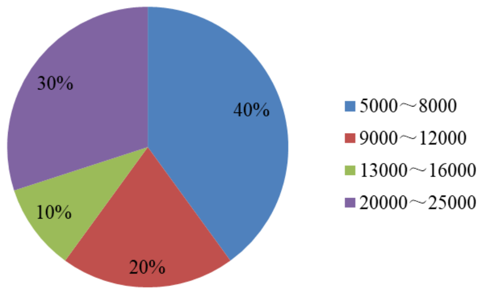


Figure 5: Technical index of large water flow facility of domestic flow verification institutions

The distribution of facility measuring capability and uncertainty level are shown in Figure 6 and Figure 7 respectively:



(a) Maximum verifiable caliber



(b) Maximum flowrate

Figure 6: Schematic diagram of measuring capability distribution of the facility

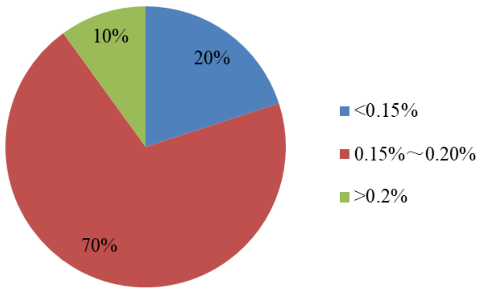


Figure 7: Distribution diagram of the facility uncertainty level

As can be seen from the data in the figure above, among the surveyed large caliber flow facilities, the maximum allowable diameter ranges from DN600 to DN3800 and the flow range covers from 0.005m^3/h to 25000m^3/h. The facilities with the maximum diameter greater than DN1000 and the maximum flow over 8000m^3/h account for 60% and 60% respectively. The extended uncertainty of most facilities is better than 0.2%(k=2). Water flow facilities with accuracy range of 0.15% ~ 0.2% account for 70%, and the maximum uncertainty is 0.037%, corresponding to the variable head dynamic volumetric water facility of WELLTECH (Shanghai) Company. These large-diameter facilities are mainly based on the principle of volumetric method and master meter method, and are distributed in more than a dozen provincial administrative regions in China. Among them, the use number, business scale and technical capacity of large caliber flow facilities in East and South China are the highest. This is closely related to the practical environment of wide distribution of rivers, frequent use of large caliber flow meters and numerous flow production enterprises in east and South China.

In addition, it is also found in the survey that most of the domestic large-caliber water flow facilities are compound facilities, that is, they contain two or more working principles of weighing method, volumetric method and master meter method at the same time, and the flow facilities with uncertainty greater than 0.15% basically cover the master meter method. This is because the master meter method has a unique technical advantage in the field of large water flow measurement, which makes it widely used in the design of flow facilities in recent years.

The pressure stabilizing mode of the facility plays an important role in whether the facility can provide stable flow in the flow meter testing, and also directly reflects the technical level of the facility. The pressure regulating modes used in the facility include: overflow water tower, pressure regulating tank, variable head water tower and frequency conversion pump direct feed. Among them, overflow water tower has the best pressure stabilizing effect, and is also the most traditional and classic way. However, due to the large construction investment and high operation cost, the newly built large flow facility has been seldom adopted in recent years. Judging from the technical characteristics and development trend of large water flow metering, frequency conversion and frequency + container voltage regulation will become the preferred methods of pressure and flow stabilization in the construction of large water flow facilities in the future.

In general, the current situation of domestic large diameter water flow standard facilities can be summarized as follows:

1) The overall number is large and the growth is fast: some facilities have certain characteristics, and some technical indicators (such as measuring pipe diameter, maximum flow rate, maximum flow velocity, etc.) are the highest in the world.

2) The technical level of the facility is reasonably distributed: a small part of the facility has a high level, has reached or close to the world advanced level; Most of the facility design pays more attention to practicality, such as standard table method is widely used, on the one hand, pay attention to the work efficiency of the facility; on the other hand, also consider the control of the facility's own energy consumption.

3) The quality management level is gradually improved: in order to ensure the reliability of the quantity value of the flow facility, the competent government departments have organized several flow facility comparisons in a planned way. In recent years, CNAS will also be included in the measurement audit laboratory certification assessment of essential items, and these activities also prompted the facility owners to actively improve their quality management system.

4) Increasing exchanges with the international community: with the process of global economic integration, technical exchanges and cooperation with the international community have entered various fields of social economy, and the field of large water flow measurement is no exception. On the one hand, in order to eliminate trade barriers, the global mutual recognition agreement of metrology is gradually carried out, and international comparison projects of large diameter flow facilities are more frequent. On the other hand, with many international transnational flow meter manufacturing enterprises have set up factories in China and established large flow facility, also

introduced some advanced facility design technology into China, some domestic measurement technology institutions also actively from abroad to introduce a whole set of high-level water flow measurement facility and technology.

5. Conclusion

In view of the huge and urgent verification demand of the current economic society for the measurement of large water flow, a special investigation has been carried out on the technical development status of the typical large-caliber water flow standard facility in China, focusing on the classification principle, structural characteristics, technical indicators and application scope of the existing large water flow standard facility. The measuring ability and regional distribution of different flow facilities are compared and analyzed. After the study, the main conclusions are as follows:

1) In China, weighing method, volumetric method and master meter method are the main methods for large caliber flow facilities, and most of them are compound facilities. With the increase of test pipe diameter and maximum flow rate, dynamic volumetric method and master meter method gradually become the mainstream. Although the master meter method started late, it has been widely used due to its technical advantages.

2) In the existing large flow standard facilities, most of the maximum experimental flow rate is higher than 6000m^3/h, and the accuracy level is concentrated in 0.1% ~ 0.2%. Among them, the maximum allowable diameter range is DN600 ~ DN3800, and the flow range covers 0.005m^3/h ~ 25000m^3/h. The number of facilities with the maximum diameter greater than DN1000 and the maximum flow over 8000m^3/h account for 60% and 60% respectively. The extended uncertainty of the vast majority of facilities is better than 0.2%, and the water flow facilities in the range of 0.15% ~ 0.2% uncertainty level account for 70%, and the maximum uncertainty is 0.037%.

3) At present, the large caliber flow facilities in East China and South China are the strongest in terms of the number of use, business scale and technical capacity, which is mainly due to the wide distribution of rivers, frequent use of large caliber flow meters and numerous flow production enterprises in east China and South China.

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