



Application of Ultrasonic Meter Box for Open Channel in Western Area in China

Ms. Yan Song

Beijing Huashui Metering Company

September 11th 2023, Beijing P.R.China

Content

- **Background**
- **Description**
 - working principle
 - Features & benefits
 - Tests in factory & field
- **Application**

Background:

- In the past decades, with vigorous development of China's economy, National Water Resource Strategy has been put on unprecedented level
- Agricultural water reservation (农业节水)、improvement of the efficiency and productivity of agricultural water(提高水资源利用效率)、improvement of the management efficiency of water resource (提高水资源调配能力) , accurate measurement of water volume is the precondition前提是对水量的准确计量
- In the vast Western area of China, affected by geological factors, the variation in flow directions is complex, sediment concentration is heavy, types of channels are varied, to have accurate volume measurement is difficult. To eliminate the affection on measurement accuracy in the field, box-shaped ultrasonic flow meter is designed

A box-shaped flow meter for open channel provides measurement accuracy on site even in turbulent and channel sediment condition.



Working Principle 工作原理:

- The working principle of **discharge**流量 is velocity-area method流速面积法:
Instantaneous flow = mean velocity * cross sectional area
- The working principle of **velocity**流速 is ultrasonic transit time method超声波时差法
It employs ultrasonic time-difference technology to determine velocity by measuring the transmit time taken for the pulses travelling between transducers.
- **Wetted cross-sectional area**过流面积 in the box
Interior width of the box * water depth (not water level) inside the box

Features & Benefits 特点及优势:

➤ **Box-shaped cube provides a stable section area 稳定断面 for measurement**

Meter box is made in aluminum or stainless steel with or without entry flame depends on mounting options. It provides a relatively stable space for ultrasonic transit-time system to compute velocity and the meter to determine the distribution area.

➤ **Accurate flow measurement with multiple cross-path 交叉多声道 velocity**

8 – 24 pairs of transducers (according to the size of the box) in a interleaved cross way 交叉错层 to map the vertical velocity profile of distribution area, enables the product to be resistant to swirl, or other unstable flow condition.

➤ **Automatic sediment height identification 淤积高度自动识别**

The interleaved cross transducers with no more than 5cm spacing for each path not only provide good sampling of vertical velocity profile, but also helps to determine the sediment height in the box. This function secures the measurement accuracy in the field where sedimentation in the channel is heavy.



Features & Benefits 特点及优势:

➤ Triple water level survey 三水位测量

Meter box employs electric water gauge (on one side panel), ultrasonic water level sensor (on the top panel) and transducers (on both side panels) to determine water level in the box. The water depth is computed according to optimized water level data. This feature provides the true section area no matter the meter box is submerged or partially full.

➤ Integrated design makes it easy to install and almost maintenance-free 一体化设计

Meter box takes all-in-one design concept, the mainboard is integrated inside the top of the box. It is also possible to have battery powered meter box version with lithium cell and RTU integrated in the box. No incompatibilities' problems.

No moving parts within the box, very low head lost, can be square or rectangle basing on the needs on field.

Meter box can be mounted to existing head wall, control gate, or slide into provided grooves in channel. It makes the installation at very low cost.





National verification of measurement accuracy in the laboratory

Group Standard T/CIDA 0007-2021 Box-shaped Ultrasonic Flow Meter for Open Channels, which was published on June 2021, and came into force on July 2021 in China.

Flow measurement accuracy of Beijing Huashui Metering's UPM-X400 received the official test report from National Test Center for Equipment of Irrigation and Drainage on January 2022.



Testing methodology and equipment 测试方法及设备

The test was conducted by reference meter method. The water goes through reference meters, water tanks, and tested meter box in a closed loop. Press “start” on the interface of host computer software, the computer starts to read the flow rate data from tested meter box and reference meter. Press “finish” to terminate the test, the software shows the accumulated volume data of tested meter box and reference meter, and the measurement uncertainty.

The test equipment is consist of host computer control desk, surge tank, water storage tanks, pumping station, frequency inverters, reference meters, flow regulating valves, pressure regulating valves, standard steel open channel etc.

The tested box meter is fixed on the frame in the steel open channel, which is 1.5m wide, 1.5m high, and 12m long.



Field testing under canal sediment condition 渠道淤积工况下的现场比测

The field test methodology is to use a rotating current meter to determine the cross-section velocity, and multiplies the distribution area to get the flow rate as reference data. The distribution area is determined by water gauge and the known width of the canal. The accuracy is to be assessed by the cumulative flow rate of meter box through the testing period, to the reference flow rate.

The rotating current meter method is well designed under hydraulic principle and widely applied through China. This field testing is conducted under 《Specifications for water measurement of irrigation canal system》 GB/T 21303-2017 and 《Code for measurement of fluid flow in open Channels》 GB50179-2015.



Equipment [↵]	Code [↵]	Description [↵]
Huashui meter box [↵]	UPM-X1000 [↵]	1000 (width) mm*1000(height)mm, 20 pairs of transducers arranged in cross-split level [↵]
Rotating current meter [↵]	LS25-3A [↵]	verification certificate within validity period, applicable water depth > 16cm, velocity \geq 0.05m/s [↵]
Remote terminal unit & meter box display [↵]	TL12 [↵]	4G communication, solar power supply [↵]

Testing items & results 测试项目及比测结果

Table 6.3.1.1 Testing data record of meter box under free flow condition				
Date: 25 th March, 2021		Weather: Clear 17°C		
Site: Tuanjie village, Lailou town, Shaya county, Xinjing Uygur Autonomous Region				
Recorder: Hu huitao		Record date: 25 th March, 2021		
Hand measured sedimentation height: 190mm		Meter measured sedimentation height: 221mm		
No.	Instantaneous flow rate (m ³ /h)	Water level (mm)	Cumulative flow rate (m ³)	Collect time
1	417.29	652	658	12:21
2	417.22	645	665	12:22
3	415.93	641	672	12:23
4	412.65	641	679	12:24
5	410.05	641	686	12:25
6	405.20	641	693	12:26
7	383.91	640	699	12:27
8	363.12	638	705	12:28
9	357.90	634	711	12:29
10	340.40	629	717	12:30
11	323.44	626	723	12:31
12	309.28	623	728	12:32
13	291.46	618	733	12:33
Average flow rate (m ³ /s)	0.104	Average flow rate=SUM (instantaneous flow rate1: instantaneous flow rate13)/13/3600		



Table 6.3.1.2 Error% comparing under free flow condition		
Flow rate calculated by rotating current meter method (m ³ /s)	Average flow rate measured by meter box (m ³ /s)	error%
0.102	0.104	1.9%
Error = (meter box avg flow – rotating current meter flow)/ rotating current flow*100%		

Testing items & results 测试项目及比测结果

Table 6.3.2.1 Testing data record of meter box under downstream damming condition				
Date: 25 th March, 2021			Weather: Clear 17°C	
Site: Tuanjie village, Lailou town, Shaya county, Xinjing Uygur Autonomous Region				
Recorder: Hu huitao			Record date: 25 th March, 2021	
Hand measured sedimentation height: 190mm			Meter measured sedimentation height: 221mm	
No.	Instantaneous flow rate (m ³ /h)	Water level (mm)	Cumulative flow rate (m ³)	Collect time
1	285.72	711	1408	15:39
2	286.57	713	1413	15:40
3	287.36	717	1417	15:41
4	283.92	720	1422	15:42
5	288.02	721	1427	15:43
6	289.89	721	1432	15:44
7	287.54	723	1436	15:45
8	283.41	725	1441	15:46
9	288.25	726	1446	15:47
10	286.91	728	1451	15:48
11	289.61	730	1455	15:49
Average flow rate (m ³ /s)	0.079	Average flow rate=SUM (instantaneous flow rate1: instantaneous flow rate11)/11/3600		

Table 6.3.2.2 Error% comparing under downstream damming condition		
Flow rate calculated by rotating current meter method (m ³ /s)	Average flow rate measured by meter box (m ³ /s)	error%
0.077	0.079	2.5%
Error = (meter box avg flow – rotating current meter flow)/ rotating current flow*100%		



Application in western areas in China

As a newly developed device of flow rate measurement for open channel, meter box has been widely and successfully applied to irrigation districts in China. It has been approved that automatic sediment height identification function and triple water level survey helped to secure the accuracy in real world.

The accuracy of meter box field testing



Thank you for your attention!

Ms. Yan Song
651059915@qq.com +86 1391 158 9970