Order to Talk

1. Water Measurement Techniques
2. Irrigation Water Price & Fee Collection

1 Water Measurement Techniques

The purpose of water measurement is:

- to make water supplier be able to supply water to users according to their demand and,
- to supply water to agricultural field with planned program and proportionally, and
- to serve volumetric water tariff collection
The purpose of this part is:

- to understand water measurement facilities in order to provide a base of selecting water measurement techniques for irrigation systems
- to increase the level of irrigation monitoring and water management in an irrigation district.

In the canal irrigation district:
The water measurement is carried out at:

<table>
<thead>
<tr>
<th>Measurement location</th>
<th>Purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>at the main canal</td>
<td>to control the water supply</td>
</tr>
<tr>
<td>at the inlet of the branch canal</td>
<td>to distribute the inflow</td>
</tr>
<tr>
<td>at the inlet of the tertiary canal</td>
<td>to estimate the total amount of water, to get water fee</td>
</tr>
</tbody>
</table>

Present Condition of Irrigation Water Measurement in China

➢ better in big reservoir irrigation systems than in small-medium sized irrigation systems
➢ better in canal irrigation systems than in well irrigation systems

Water measurement on open canals

① Current-meter/flow meter
② Water measurement with canal structures
③ Special water measurement equipment
④ Float measurement
Current-meter/flow meter

Electro-magnetic recorder
Wave current meter
Ultrasonic current meter
Propeller current meter

Measurement point with flow meter

<table>
<thead>
<tr>
<th>Measurement points</th>
<th>Relative depth of the measurement points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td>2</td>
<td>0.2, 0.8</td>
</tr>
<tr>
<td>3</td>
<td>0.2, 0.6, 0.8</td>
</tr>
<tr>
<td>5</td>
<td>0.0, 0.2, 0.6, 0.8, 1.0</td>
</tr>
</tbody>
</table>

The relative depth is the ratio of device depth to the total water depth of water of the vertical line.

Method used with flow meter for different water depth

<table>
<thead>
<tr>
<th>Main canals</th>
<th>Water depth/ m</th>
<th>&gt;3.0</th>
<th>1.0-3.0</th>
<th>0.8-1.0</th>
<th>&lt;0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>method</td>
<td></td>
<td>5-point</td>
<td>3-point</td>
<td>2-point</td>
<td>1-point</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Branch, lateral and field canals</th>
<th>Water depth/ m</th>
<th>&gt;1.5</th>
<th>0.5-1.5</th>
<th>0.3-0.5</th>
<th>&lt;0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>method</td>
<td></td>
<td>5-point</td>
<td>3-point</td>
<td>2-point</td>
<td>1-point</td>
</tr>
</tbody>
</table>

Mean velocity of the measurement line

\[
P_v = \frac{P_{n1} + P_{n2} + P_{n3} + P_{n4}}{4}
\]

\[
P_v = \frac{P_{o1} + P_{o2} + P_{o3} + P_{o4}}{4}
\]

\[
P_v = \frac{P_{a1} + P_{a2} + P_{a3} + P_{a4}}{4}
\]

\[
P_v = \frac{P_{b1} + P_{b2} + P_{b3} + P_{b4}}{10}
\]
Water measurement with canal structures

Canal structures used for water measurement must meet the following conditions:

1. The structures have no damage, no deformation, no delaminating and no seepage.
2. Adjusting and lifting equipment should be in a well and complete condition, the gate is not skew and distortion, the edge and the sliding channel of the gate can be closely matched.
3. There is no sediment and silting within, in front of and behind the gate, there is no other matters stopping water.
4. Requirements for hydraulic calculation should be met, head loss is not less than 3 cm, the submergence degree is not bigger than 0.9 in submerged flow.

Types of canal structures for water measurement:

- Standard canal cross-section
- Water gate and culvert
- Water measurement with aqueduct
- Water measurement with invert siphon
- Water measurement with drop chute (steep flume)

◆ Standard canal cross-section
- Lined straight canal section
- Calibrated by flow meter for Q-H curve
- Under free flow conditions

◆ water gate and culvert

Q: can be calculated with different formula and calibrated by current meter
◆ Water gate and culvert

![Diagram of water gate and culvert]

Fig. 8. Water measurement and distribution gate of Venturi short tube

◆ Water measurement with aqueduct

![Images of water measurement with aqueduct]

Q: can be calculated by uniform flow or calibrated

\[ Q = \frac{\pi}{4} H^2 \]

◆ Water measurement with adverse siphon

![Diagram of water measurement with adverse siphon]

Q: can be calculated by formula as above and calibrated by current meter

\[ Q = \frac{C^2}{2g} \]

◆ Water measurement with drop chute (steep flume)

![Diagram of water measurement with drop chute (steep flume)]

Q: can be calculated by formula as above and calibrated by current meter

\[ Q = \frac{m^2}{4g} \left( H_1 - H_2 \right)^{m+1} \]

\[ Q = \frac{C^2}{2g} \]
Special canal water measurement equipment

- Thin-plate weirs / sharp crest weirs
- Parshall flume
- No throated flumes
- Long-throated flume
- Water measurement sill
- Parabolic flume for U-shape canals
- Flow-divided discharge meter (simply called divider)
- Water distributor

Thin-plate weirs / sharp crest weirs

Discharge formula of long-throated flume with different throated cross-sectional shapes

<table>
<thead>
<tr>
<th>Throat cross-sectional shape</th>
<th>Yc/Q-h relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectangular</td>
<td>✓</td>
</tr>
<tr>
<td>Triangular</td>
<td>✓</td>
</tr>
<tr>
<td>Trapezoidal</td>
<td>✓</td>
</tr>
<tr>
<td>Parabolic</td>
<td>✓</td>
</tr>
<tr>
<td>Compound</td>
<td>✓</td>
</tr>
</tbody>
</table>

The ratio of the plate thickness to the water head above the weir is less than 0.67

Parshall flume

Fig. 1. The structure of Parshall flume
Parshall flume, discharging 62 ft³/s under free-flow conditions.

Parshall flume

No throated flumes

Free flow:
\[ Q = \frac{b}{8} \left( y - c \right)^{1.5} \]

Submerged flow:
\[ Q = c \left( y - c \right)^{1.5} \left( 1 - \log \frac{y}{c} \right) \]

Fig. 2. Structural diagram of no-throated flume
No throated flumes

Fig. 3. The structure of long-throated flume

Control section
Variable spread length

Long-throated flume

L = 1.0 - 1.5 Hmax

水位测量堰

Compare with long-throated flume: No Lateral contraction

水位测量堰

ultrasonic

Data log
(a) Long-throated flume (broad-crested weir) under construction

(b) The long-throated flume (broad-crested weir) in use

**Flow-divided discharge meter (simply called divider)**

**Water measurement in well irrigation districts**

**Mainly those used for pipelines**

1. Directly measuring water quantity
2. Recording time method
3. Recording electricity method
4. The combination methods of (1) and (3), or (2) and (3)
5. Short pipe method
6. Venturi meter.
venturi meter

Trajectory Methods

(1) Vertical pipe method       (2) horizontal pipe method

Water measurement instrument and device

- Water level device
- Water meter
- Pressure-difference flow meter
- Electro-magnetic flow meter
- Ultrasonic flow meter
- By-pass flow meter
- Propeller flow meter

Water table meter (sensor and recorder)
Ultrasonic flow meter

Water meter

Electro-magnetic flow meter

Ultrasonic flow meter
Means to get the data

To get the data

Accuracy of water measurement

- Water measurement error requirement:
  - ✓ 5% for water meters
  - ✓ 8% for special structures (weirs)
  - ✓ 10% for canal structures (gates, culvert etc.)

Suggestions of Choosing Water Measurement

1. The design of the water measurement devices should be included in the planning of the irrigation system. The installation of these devices should be determined according to the local conditions as well as be convenient for calculated water fee from the amount of water. Normally the lowest level of the device should be installed at the inlet of the quaternary canal. It is better to measure the inflow rates for each farmstead/village/group.
Suggestions of Choosing Water Measurement

2. The functions of the chosen devices should be checked if the hydrology and hydraulics requirements of the canal or pipe are satisfied when the water measurement devices are determined. These functions include the range of the measuring, the limitation of non-submersion, sensitivity, precise, the abilities of transportation sand, the abilities of passing float, requirements of water table and water head loss.

3. When the devices are satisfied for the conditions mentioned above, it should be also installed easily, low cost, able to anti-different disturbs and with easily manage and maintenance.

4. The choosing of the devices should be determined according to the different objectives of the measurements, the differences of the canal sections and/or differences between the pipe sections and capacity of the water flowing in the pipe.

5. It is first choice to use the exist structures in the canal for the water measurement if the measuring precise can be satisfied. In order to ensure the measuring precise and other hydrology and hydraulics requirements, it might be necessary to repair in some parts of the construction or reform it. And the water table recorders are also necessary. However, the comparison for economic indicators that it is reasonable because the investment for building new water measurement devices is saved and there is no extra water head loss.

References

National standard of China

“Standard of Water Measurement for Irrigation Canals”, GB/T 21303-2016
Irrigation water price and water fee collection

PAY or NO PAY?

ATP or WTP?

Irrigation Water Price----Not only an economic issue, but a social, political, ...issue!

Concepts of “irrigation water price” used in China

✓ “Full cost recovery” price
✓ “Operation cost recovery” price
✓ “Adopted price” in practice

➢ Full cost recovery: including depreciation of the I&D structures, operation cost, staff salary, daily R&M.
➢ Operation cost recovery: as the full cost recovery but not including depreciation.
➢ Irrigation water price adopted in practice is different at different locations and systems in China, considering the farmers’ ability to pay (ATP) and WTP.
➢ Water fees are collected by the WUAs or by the villages, which are handed over to the management agency and keep part of it for O&M of farm canals.
Target: Gradually to achieve that irrigation water price should be determined based on the “operation cost recovery”. Currently, one comprehensive program on agricultural water price reform is going on, to achieve this target within a period of 10 years from 2016.

Before the target achieved, financial subsidies is required to keep good O&M conditions of I&D.

Overview in China

On average, the irrigation water price is only cover 30%-50% of the supplying cost;

For about 25% large scale irrigation systems and 65% medium scale systems, the “operation cost recovery” price is not calculated and authorized;

The rate of water fee collection is about 70%;

40% of the management agencies/bureaus of irrigation systems can not have sufficient budget to cover their O&M cost.

Overview on World Irrigation Water Price

1. Policies of incentive and subsidy is popular
   - Agricultural irrigation is key to food security and base of country’s development.
   - Volumetric water price and area-based price, or combined.
   - E.g. In Spain, combined method was used, i.e.. Charge some amount based on area and extra fee charged by volume.
   - In Israel, it is charged at “supply cost” price and ladder water price is used.
   - Different water price used by different suppliers / systems.

2. Irrigation water price
   - In Japan, Agriculture is the biggest user, charging water tariff basically by area.
   - In US, charging at a water price based on the water supply / production cost, and making different prices based on volume used to encourage water saving.
   - In Spain, again, volumetric, area-based and combined all are used.
➢ In Mexico, water prices are different for different crops and in different regions. Water price is low for grain crops and high for cash crops, e.g., at 0.45 $/m³ for strawberry that is 15 times of that for grain crops, reflecting the supportive policy to food security.
➢ In Japan, water price is only 0.01 $/m³ in east coast area and at highest of 0.035 $/m³ north inland areas.
➢ In Romania, water prices are 0-20.34 $/m³, depending on the water supply cost.

➢ In China, area-based and volumetric, and combined tariff used
➢ Irrigation water price is from 0-0.1 $/m³.

World Irrigation Water Price

➢ What is the irrigation water price in your country?
➢ How to collect water fees in your country?

THANK YOU