On-line detection technology of flow meter in water supply network based on the principle of district metering area and mass balance

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Objectives

The objectives of this paper are to propose and validate an online detection technology for flow meters in urban water supply networks based on the DMA concept. The study aims to address measurement inaccuracies caused by component wear and environmental factors. The technology utilizes the area mass balance principle and divides the network into independent measurement areas. An online detection system is developed using advanced information technologies to collect real-time data and solve measurement errors. Tests on a simulated pipe network confirm the feasibility and effectiveness of the proposed technology based on the principle of district metering area and mass balance.

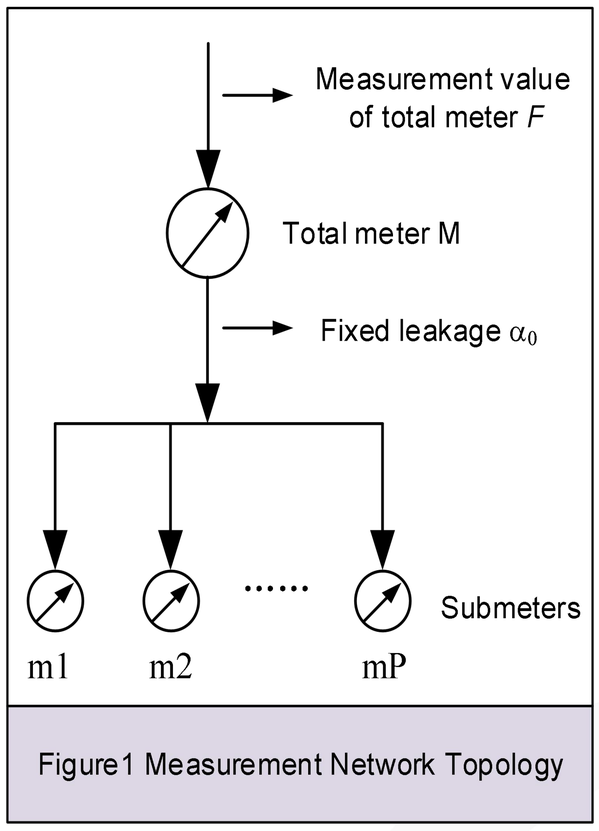

Figure1 Measurement Network Topology

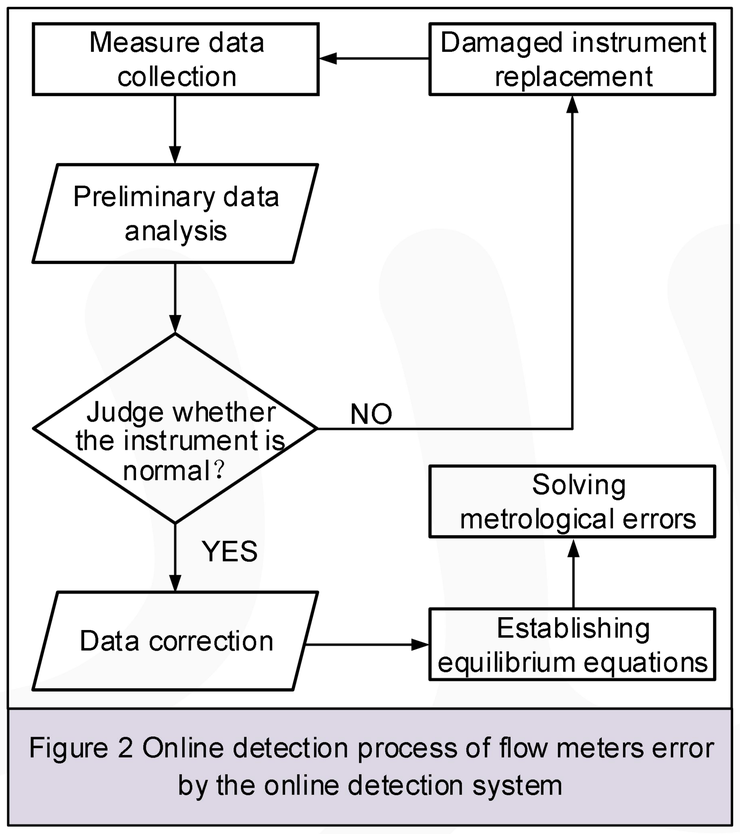

Figure 2 Online detection process of flow meters error by the online detection system

Methods

According to mass balance principle, "total meter water supply"="sum of all sub meter water consumption"+"pipe section leakage", we can get:

$$F'(i)=\sum_{k=1}^{P}F_{mk}(i)(1-\delta_{mk}(i))+\alpha_0(i)$$

After accumulating data for n periods, the equation system composed of n equations can be obtained:

$$\begin{cases} F_{m1}(1)(1-\delta_{m1})+F_{m2}(1)(1-\delta_{m2})+\cdots+F_{m\mathrm{P}}(1)(1-\delta_{m\mathrm{P}})+\alpha_0=F'(1) \\ F_{m1}(2)(1-\delta_{m1})+F_{m2}(2)(1-\delta_{m2})+\cdots+F_{m\mathrm{P}}(2)(1-\delta_{m\mathrm{P}})+\alpha_0=F'(2) \\ \vdots \\ F_{m1}(\mathrm{n})(1-\delta_{m1})+F_{m2}(\mathrm{n})(1-\delta_{m2})+\cdots+F_{m\mathrm{P}}(\mathrm{n})(1-\delta_{m\mathrm{P}})+\alpha_0=F'(\mathrm{n}) \end{cases}$$

Tests were conducted on a simulated pipe network, analyzing the measurement accuracy and out-of-tolerance of flow meters.

Results

The proposed online detection technology for flow meters in urban water supply networks based on the DMA concept was validated through three groups of different test schemes conducted on a simulated pipe network. The results confirm the feasibility and effectiveness of the online detection technology, demonstrating its ability to accurately detect measurement errors and ensure the reliability of flow meter measurements in urban water supply networks.

Conclusions

This research paper proposes a new on-line detection technology for flow meters in water supply networks based on the principle of district metering area and mass balance. The mathematical models developed for this technology were successfully validated through different tests, confirming the correctness of the theoretical analysis and the feasibility of the proposed technology. The advantage of this technology lies in its ability to achieve online remote verification of water meters without the need for standard devices, accurately diagnose water meters that are out of tolerance, and provide more accurate data support for water metering in the water supply system.

Table 1 Experimental results on a simulated pipe network

Serial NO.	Meter NO.	Maximum permissible error(%)	On-line detection error(%)	Error range	Meter status evaluation
1	S2-1	2	0.22	≤2%	SA
2	S2-19	2	0.40	≤2%	SA
3	S2-13	2	1.18	≤2%	SA
4	S2-14(1)	2	3.48	＞2%, ≤5%	SB
5	S2-8	2	1.06	≤2%	SA
6	S2-7	2	0.71	≤2%	SA
7	S2-15	2	0.67	≤2%	SA
8	S2-14(2)	2	5.20	＞5%, ≤10%	SC
9	S2-20	2	0.11	≤2%	SA