Water loss Control in DMA Monitoring System Used Wireless Technology

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Abstract : This article is about using information technology to apply with water loss inspection system in District Metering Area (DMA). Inspector can check Flow rate and Minimum Night Flow; NMF via Smart Phone or PDA include sending SMS Alert in case the Pressure, Flow rate and NMF is over the range of controlling. This will be used as equipment to implement water loss in international proactive and can keep on water loss reduction more efficiency. The system consists of Data Logger which collects data of Flow rate from DMA Master Meter. PC is Wap Server which dial via modem in order to get data through FTP Protocal that will convert text file to Microsoft Access Database. Wappage will use xhtml language to show database on Wapbrowser and can show the result on Smart Phone or PDA by graph and table for system analysis.

Keywords : DMA , NMF , Leakage

1. Introduction

Nowadays, conservation of nature resources and environment is a factor for everyone interests particularly water resources for consumption. Moreover, water is an important foundation in services and production industries. Therefore, water loss reduction is very important especially water distribution system, which caused water loss from the underground leakage pipe that water does not flow up to the surfaces. There are many factors and reasons that cannot survey in short time.

At present, MWA distribute water from distribution plants located in surround service area. Water is distributed to pipe network system similar to spider webs network. Water distribute areas can be divided into 13 areas (100,000 – 200,000 customers per a water distribute area). The large water distribution area will affect to management of water loss reduction in large scale. Furthermore, it cannot indicate exactly where the leakage area is high. Therefore, MWA has to solve this problem all distribution areas to survey leakage pipes or replace old pipes which has to spend unnecessary high budget for implement.

DMA (District Metering Area) is a new system of distribution management by cutting off the large distribution areas to small areas (1,500-3,000 customers per a water distribute area). Pipe network system is a closed system and independent each other. DMA will have one spot to distribute water to service area which install main meter and have a pressure recorder to collect data of water pressure and quantity at a different time of period.

Due to reduction the area and closed system, it makes the water loss management more easily. It can conduct step test in order to analyze the system problem deeply to villages or allays. Moreover, it can be arranged the important of problems accurately and efficiency.

However, DMA is just equipment to manage water leakage in order to increase the efficiency in performance, it is necessary to conduct information technology instead of sending officers to check flow rate and pressure in the field directly which make the delay. By using information technology to apply with measurement, the officers can monitor pressure and flow rate via mobile phone / PDA or alert incoming message if the system is unusual.

2. Principle

DMA is a water distribution area, which is limited by DMA boundary. The water distribution is controlled by the main water meter in order to monitor and continually record water flow rate.

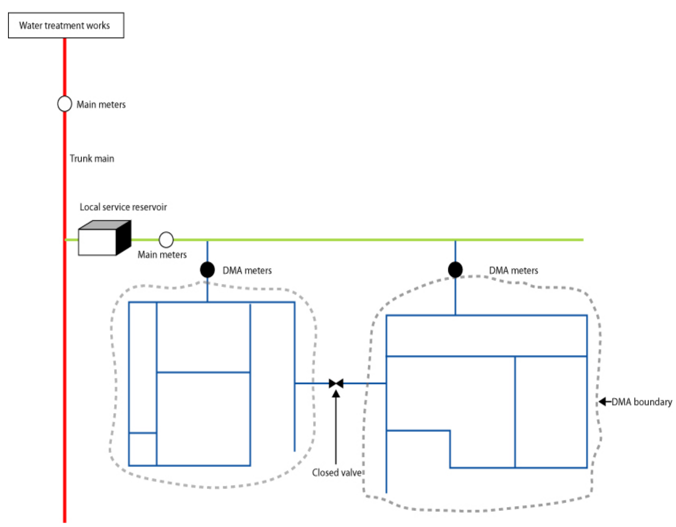


Fig. 1. Division of Distribution into DMAs

Night Flow Data from the water meter is used for water leakage calculation in DMA, which is the basic information in considering the method of reducing the water leakage in DMA. It can also be used in comparing with other DMAs to prioritize the leakage solution.

2.1. Pressure and Leakage Relationship

The rate of water leakage and water loss in DMA are significantly related with the operating pressure in the distribution system. The higher operating pressure, the more increasing leakage and loss in the system as the leakage formula shown below.

$$L_1 = L_0 (P_1 / P_0)^{N_1} \tag{1}$$

Where

L_0 = initial leakage loss in m^3/h
L_1 = new leakage loss in m^3/h
P_0 = initial pressure (m)
L_1 = new pressure (m)
N_1 = pressure exponent (non-dimensional) , may be anywhere between 0.5 and 2.5 for individual small zones, for large systems with mixed pipe materials, it is reasonable to assume a linear relationship, that is, $N_1 = 1$.

In order to determining and analyzing water leakage and loss, Average Night Pressure (AZP) and Average Zone Night Pressure (AZNP) as major data are included in this research.

Average Zone Pressure (AZP) - the pressure in a Pressure Managed Area (PMA), which is calculated or measured at a surrogate point, and deemed to be the average of all the pressures in the DMA

Average Zone Night Pressure (AZNP); like AZP, but for the minimum night flow period.

$$\text{ANZP} = [\, P_{Hight} \times S \,] + (1-S) \times P_{Low} \tag{2}$$

$$P_{av} = (P_{Hight} + P_{low})/2 \tag{3}$$

Where

P_{Hight} is the highest pressure in Zone,
P_{Low} is the lowest pressure in Zone,
P_{av} is the average pressure in Zone, and
S is the ratio of number of measuring point having higher Pressure than P_{av}

2.2. Leakage

The most important thing in DMA management is to manage the water leakage within DMA. Following the figure 2: Typical 24 Hour DMA Flow Profile, it can be seen that the Minimum Night Flow consists of the Customer night use and Leakage, which can be separated into two types of Background leakage and Burst leakage according to the theory.

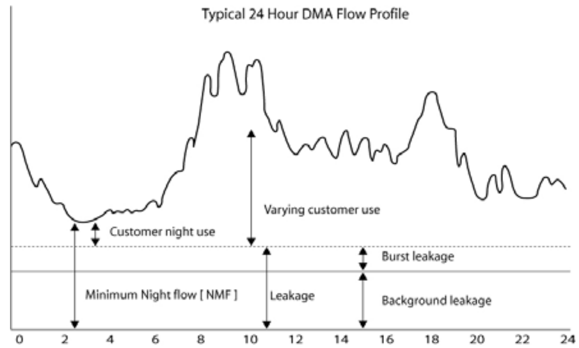


Fig. 2. Typical 24-Hour DMA Flow Profile

2.2.1 Background Leakage (LB)

Background Leakage (LB) is the very little amount of water leakage from joints within the water pipe system, which is difficult to inspect. The leakage depends on the lifetime of the pipe.

The background loss estimate at 50 meters used in the Managing Leakage series was:

$$\text{LB (50m) (l/hr)} = (4 \times \text{No. of properties}) + (0.04 \times \text{meters of main}) \tag{4}$$

A more flexible approach has been the following equation:

$$\text{LB (50m)} = \text{ICF } (4 \times \text{No. of properties}) + (0.04 \times \text{meters of main}) \tag{5}$$

ICF is the Infrastructure Condition Factor. Its value normally lies between 0.5 and 2.0, depending on the condition of the mains - 0.5 if the mains are considered to be in good condition, or 2.0 if they are considered to be in poor condition from a water tightness point of view.

$$\text{ICF} = \frac{\text{Presently Lowest Possible Losses of DMA}}{\text{Lowest Possible Losses for DMA with Standard Good Condition}} \tag{6}$$

The background estimates also require a pressure correction using the average zone night pressure. There are several pressure correction factors (PCFs) in use. Two of the commonly used ones are given in Table 1. The Report 26 value was derived as a relationship between the pressure and night-flow losses. The 1.5 power law value was derived specifically for background losses.

Table 1. Pressure correction factors for background losses

AZNP (m)	PCF (report 26)	PCF (1.5 power law)
20	0.33	0.25
25	0.43	0.35
30	0.53	0.46
35	0.64	0.59
40	0.75	0.72
45	0.87	0.85
50	1.00	1.00
55	1.13	1.15
60	1.27	1.31
65	1.41	1.48
70	1.56	1.66
75	1.72	1.84
80	1.88	2.02
85	2.05	2.22
90	2.22	2.41

So, overall the background losses in a DMA could be given by:

$$LB = ICF \times PCF \times (4 \times \text{No. of properties}) + (0.04 \times \text{meters of main}) \quad (7)$$

2.2.2 Burst Leakage

Burst Leakage is the most kind of leakage in the water pipe system. Leaked water sometimes can be seen on the ground surface, which the current technical tools can be easily used for investigating this kind of leakage. The level of Burst leakage can be calculated by multiply the Burst Flow rate by the duration since the pipe is leaked to the repaired (ALR).

$$\text{Leak Volume} = (A+L+R) \text{ x Flow Rate} \quad (8)$$

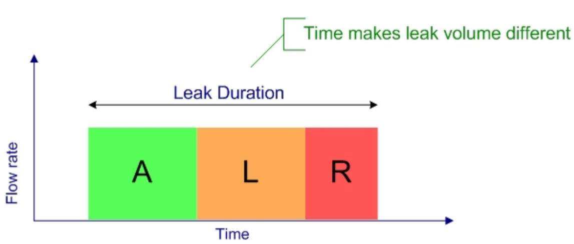


Fig. 3. ALR Time

$$ALR = \text{Awareness Time} + \text{Location Time} + \text{Repair Time} \quad (9)$$

Awareness time is length of time taken from a leak first occurring to the time when the water services organization aware a leak exists, location time is time to locate the leak (depends on intensity of activity to locate it) and repair time is time to repair the leak (generally a short period)

Furthermore, Burst Flow rate is depended on the size and type of water pipe, including the water pressure.

Typical value at 40 m ANZP

- 25 m^3/d for an underground service pipe burst
- 75 m^3/d for typical distribution main burst
- 150 m^3/d for typical trunk mains burst

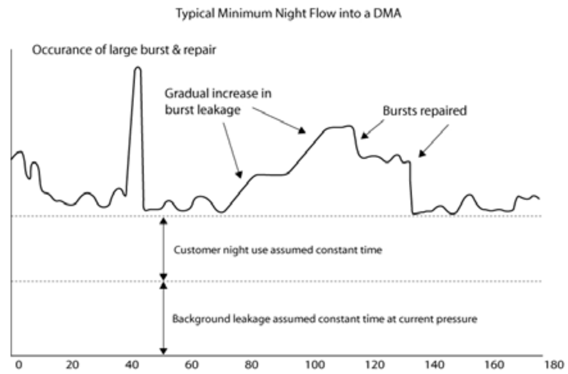


Fig. 4. Flow rate affected by Burst leakage

In the normal operations, Location Time will not be taken more than 1 week and within 1 day for Repair Time. Therefore, Awareness Time is the factor that much affect to water loss. As the faster we receive the leakage information, the more we can reduce the water loss (See figure 4).

3. How the system works

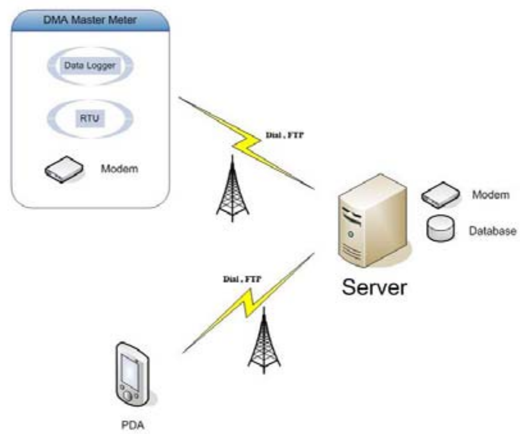


Fig. 5. DMA Monitoring System

This system comprises of the followings. Firstly, "DMA Master Meter" monitor and measure the flow rate, then send the data measured to store in "Data Logger". PC that functions as a WAP Server then connect to data logger via dial up modem and retrieve data via FTP Protocol. It converts Text File to Microsoft Access Database. PDA users can also use the WAP-Browser to access/browse the WAP-Page displayed in xhtml language which can be shown in table and graph format.

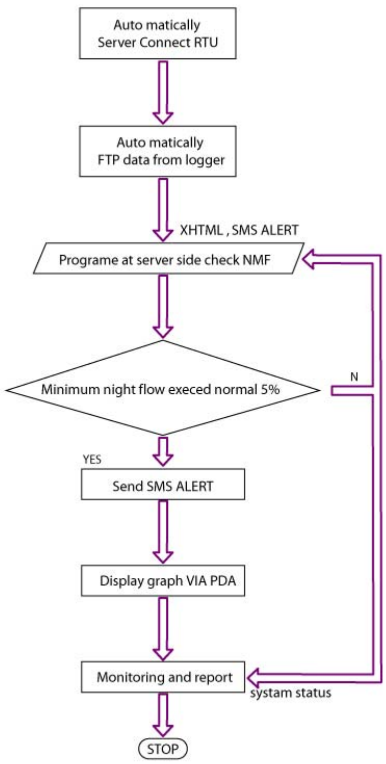
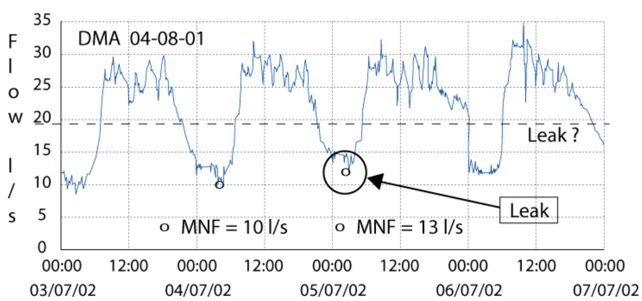


Fig. 6. System Work Flow

4. The results of the experiment

DMA 04-08-01, completely established in the early of the year 2002, is the responsible area of Sukhumvit Branch Office of the MWA. We found that the acceptable Minimum Night Flow is 10l/s after implementing the Water Loss Management by DMA.



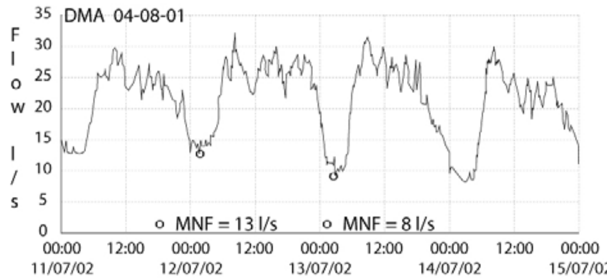


Fig. 7. DMA 04-08-01 Flow rate Profile

Figure 7 represents the flow rate measured from the Master Meter of DMA 04-08-01. As we can see that the value of Minimum night flow on 5 July 2002 increased abnormally, the communication system we settled had sent the alert via short message (SMS) to the administrator. Then the administrator monitored the minimum night flow of the two following days (Awareness Time = 3 days) to make sure if the leakage actually occurred. When the leakage is guaranteed, the inspection team is sent to investigate the leak pipe (Location Time = 4 days) and then repair (Repair Time = 1 day).

After finishing the implementation, we can reduce the UFW in the system up to 432 cu.m/d while the value of ALR is just 8 days.

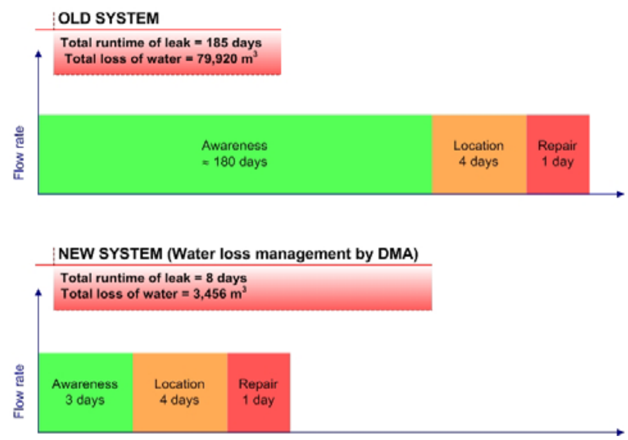


Fig. 8. Compare about Awareness Time

According to Figure 8, in the former water loss monitoring system, awareness time of leakage recovery may be extended to 6 months or 180 days since the leakage was started in the system.

In the old system, there are two sources of leakage information; Call center gathering information from people in service area and Water Leakage Detective team. The leakage alert from people means that the leakage must be visible and quite severe. Whereas the lead time in surveying the service area of Water Leakage Detective team may be 6 months per time (2 times per year according to MWA's water leakage surveying lead time). Therefore, the leakage information the leakage data components such as possible leakage area, Minimum night flow and operating pressure are too late to be acquired.

In order to reduce lead time of water leakage and awareness time in water loss control, DMA , mater meter and wireless technology are integrated to be the new monitoring system. By utilizing the faster gathering information, instant NFM alert and online monitoring via smart phone /PDA, the awareness time will be decreased from 180 days to 3 days. Certainly, this will result to decrease significant declination of water loss (From 79,920 m3 to 3,456 m3).

5. Conclusion

DMA is the effective tool for managing with the losing water and it will be more effective to use with the Information Technology System. Watching the Minimum Night Flow (NMF) is essential as it can indicate the level of burst leakage in the system. The sooner the in-charge administrator gets the information about the change of NMF, the lesser the Awareness Time of Burst Leakage may take. Therefore, DMA can greatly help reducing the losing water causing by burst leakage.

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