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INTERMITTENT WATER SUPPLY – CRITICAL ISSUES

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Abstract: *Intermittent water supply is the type of service that delivers water to users for less than 24 hours in 1 day. It is hardly found in developed countries, but very common in developing countries, like India. But, due to lack of design standards for intermittent water supply system, designers continue to follow the methods proposed for continuous water supply system. As a result of this improper design, the intermittent water supply system snags with several issues. The major concerns are contamination of water due to the suction of non-potable water by negative pressures induced in the pipes, inconvenient timings of supply, and inadequate pressure-head. Another major problem is consumers would like to store the water as much as possible for drinking and other uses during non-supply hours. Most of the consumers discard the stored water when the water supply is resumed next day and it leads to wastage of water. This paper first highlights key issues associated with the intermittent water supply system and put forward the preventive measures that would minimize the negative consequences.*

Keywords: *water supply, intermittent, water distribution system*

INTRODUCTION

Rapid population growth and the increase in per capita consumption resulted from improved living standards exerts excessive stress on water supply systems, especially in developing countries. During this water starved circumstance, an intermittent water supply is the widely adopted method to enable provision of limited water quantities to as many people as possible, although achieving a 24-hour supply remain a desirable future goal (IWWA, 2000). In intermittent supply system the duration of water supply is variable; it may be 1-2 hours per day or 3-4 hours per day and this supply system is mainly practiced for controlling water demand, usually by necessity rather than by design. Majority of water supply systems in developing countries are under water starved condition and operate intermittently. However, the need to develop design procedure has not yet received significant attention. Specific problems due to intermittent supply systems include (Halcrow Water Services and Bristol Water Services, 2003):

- serious risk to public health, resulting from ingress of contaminated groundwater into the water distribution system;
- inability to practice effective supply management;
- inability to practice effective demand management;
- operational inadequacies, which unduly weaken the physical infrastructure;
- customer inconvenience.

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WATER SUPPLY STATUS

The fundamental objective of any water supply system is to supply adequate and portable water to all the consumers at an affordable cost. In most of the developing countries like India, water service providers failed to meet this basic target due to an intermittent water supply, which is a supply system that delivers water to its users for less than 24 hours in a day. 24x7 continuous, pressurised water supply overcomes shortcomings of intermittent supply and ensures customer convenience.

Worldwide investments in water supply services brought only partial improvement, mainly due to accelerated population growth, especially in Africa and Asia. Further, urban populations in a region have better access to water than rural areas; 93% of urban areas in South East Asian countries have access to an improved water supply (WHO/UNICEF Joint Monitoring Programme, 2010). But, it is of interest to note that 91% of systems in South East Asia are intermittent as reported by a WHO survey, (Pickford, 1987); practically all Indian cities are reported to operate intermittent systems, (Kumar and Abhyankar, 1988; World Bank, 2005). Conditions are similar in most African countries. In Mombassa, Kenya, average service hours are 2.9 per day (Hardoy et al., 2001). The long list of examples also includes many countries in The Middle-East, where this problem penetrates deeply into overall political environment.

CAUSES FOR INTERMITTENT WATER SUPPLY

The most common concept on the cause of intermittent water supply is that, the amount of water is scarce (not sufficient) for supplying continuously. Water scarcity arises due to three reasons: poor management; increased demand; and finally absolute water scarcity. Water scarcity due to poor management may be (i) at supply level, (ii) high leakage and wastage due to improper maintenance, (iii) improper operation methods, and (iv) inefficient management strategies. This type of problems is led by the fact that water distribution systems originally planned, designed, and executed for a continuous supply are operated as intermittent supply system. This type of problems could be either eliminated, or completely alleviated if appropriate design procedures and equipment suitable for an intermittent supply could be provided, even if the supply itself remains intermittent.

The problem of water scarcity due to increased demand exists at the initial stages of urban development. At this stage the water cannot be supplied continuously to all consumers as the numbers of hydraulic connections exceed the designed hydraulic capacity of the water distribution system. At the latter stages of the urban development, the desired demand of consumers exceeds not only the capacity of water distribution systems but also it exceeds the existing water source available for abstraction (such as wells, river intake, reservoirs etc.) This condition leads to absolute scarcity of water at the supply source itself. This is found to be the most complicated problem to solve, as the alternative sources may be located at far of distances. In such case, stringent measures of water conservation need to be applied to mitigate the problem.

ISSUES RELATED TO INTERMITTENT SUPPLY

Intermittent water supply is usually associated with problems relating to both water quantity and quality as water is conveyed through pipes at relatively low pressures than the designed level. The overall shortage in water availability necessitates supply at a low per capita supply rate for a limited time period. These two conditions force consumers to collect water in storage vessels for

using water during non-supply hours. Under this situation, the water demand at the nodes in the network is not based on actual demand of the consumers, but on the maximum quantity of water that can be collected by the consumers during supply hours. Consumers will draw and store as much water as possible resulting from the fear of shortage and irregular supply timings. Unfortunately, they may not use all of it (stored water) and this water will be replaced by the fresh supply when the supply resumes on the next day. This is refilling of freshwater leading to wastage of water. Also, in intermittent water supply system, the supply hours is not always convenient for the users. Thus, they tend to go to public taps located quite far-away even during midnight to collect water, taking lots of productive time from them. The most typical problems of intermittent water supply are listed below.

Inequitable distribution within a network

Intermittent supply generates inequitable water distribution due to pressure dependent flow conditions. Obviously, consumers located far away from the supply points or at higher altitudes in the area receive less or no water. In distribution systems designed based on the same concepts as that of continuous supply systems, the consumers exposed to intermittent conditions are likely to keep their taps open to obtain as much water as possible whenever the service resumes (IWWA, 2000). As the amount of water flowing out from taps depends on the pressure head, once the supply is restored the larger peak flows than expected will occur in the pipelines, increasing the pressure losses in the network. Consequently, those consumers furthest away from the supply points will always collect less water than those nearer to the source.

Contamination of water

Intermittent water supply system is more prone to high risk of contamination, which creates substantial health hazards. During non-supply hours the water distribution network is empty, and it creates a back siphoning effect. This back siphoning will enhance the sucking contaminants from sewerage system's pipelines and other foul water bodies existing in the nearby areas. Interruption of supply can create low pressures or even a vacuum condition in pipelines that last for a significant period of time. First, ingress of contamination may occur through broken pipes or joints. Consequently, the contamination readily enters through leak points on pipelines due to the negative pressure prevails in the water distribution system. Furthermore, the contamination at household storage tanks is another type of risk. This household contamination is resulting due to the fact that the storage facility is rarely constructed according to specified standards with prescribed preclusive measures of contamination.

Coping costs of consumers

Households with intermittent water supply must pay extra costs, so called coping costs, for additional facilities, such as storage tanks, pumps, alternative water supplies and household treatment facilities. The consumers who cannot afford such facilities spend high cost to fetch water from public taps or vendors.

Coping costs of water providers

Intermittent water supply involves more frequent valve operation, and therefore requires more manpower than in case of continuous supply. More frequent operation would also result in more frequent maintenance and replacement of valves (McIntosh, 2003). Also, intermittent flow generates repetitive pressure fluctuations that potentially accelerate deterioration of pipes and joints; the consequence being high maintenance costs. An intermittent supply, with higher

possibility of contamination would also incur additional cost for pipe cleaning and chlorination.

Meter Malfunctioning

Measurement of any water supply is always preferred, be it intermittent or 24x7. Intermittency in water supply causes inaccuracy in water meter reading. In case of an intermittent supply when the supply is stopped, generally the pipe remains filled with water. It is hard to conceive any air entering the pipe and allowing the meter to rotate. Moreover most of the meters used these days are magnetic flow meter or differential pressure meter (orifice or venturi type). It is impossible for air to create any effect to register a reading even if it can flow through the pipe. Further meters might reverse during vacuum conditions, and the air in a pipe might drive meters at excessive speed during the charging stage after the service has been resumed.

PREVENTIVE MEASURES

Presently, many cities in developing countries are confronted with demand increase due to rapid population growth and the increase of per capita consumption. Under these circumstances, an intermittent water supply inevitably has to be applied in order to provide the limited water to as many people as possible. Therefore, in the areas with water scarcity, a realistic concept to be applied in order to minimize negative impacts of intermittency over consumers would be:

- Improving governance to maximize efficient use of limited water in order to minimize the magnitude of absolute water scarcity (scarcity at supply level)
- Modifying water distribution network design procedures with the consideration of negative impacts associated with the intermittent water supply.
- Ensuring 100% reliable supply (at specified time, for stated duration, with adequate pressure-head in every day) could minimize the wastage of water, as the consumers won't store too much excess quantity than their daily demand.
- Conducting awareness program to convey the limitation of water at the supply level and to stress the importance of efficient use of available water.
- Proper maintenance of metering system and forcing high tariff. This high tariff could substantially reduce the wastage of drinking water.
- Appropriate valve selection and leak detection methods suitable for flow characteristics in intermittent flow condition should also be provided (IWWA, 2000).
- Providing measures to minimize negative consequences associated with intermittent supply, such as contamination hazard for drinking water quality.

ISSUES TO BE ADDRESSED

Conventionally the design of water distribution systems has been based on the assumption of 24x7 water supply. In most of the developing countries water supply is not continuous but intermittent, and this should be considered at the design stage. While operating a water supply system which is originally designed for a continuous one in to an intermittent mode, severe pressure-head deficit problem arises. This pressure deficiency at demand nodes resulting from extraction of more water than the actual demand and it leads to inequities in supply of water even within a system.

In addition to inequities, low pressures arise because systems are designed based on estimated per capita allocation. It is usual assumption that the demand is spread over a 24 hours. In order to account the uncertainties design flow rate is at about 2.5 times the average flow rate. In reality,

water is drawn in a shorter duration, and the actual peak demand is several times greater the design peak demand. This implies that the system suddenly becomes undersized because flows in pipes are much greater than anticipated.

In intermittent water networks the quantity of water collected by consumers will be dependent on the driving pressure-heads at the outlets rather than the designed pressure-head. Thus, the relationship between the pressure-head and the demands are important, and it cannot be presumed that the demand will be met under all conditions (irrespective of the pressure-head). Therefore, the application of head driven methods of network analysis to intermittent flow conditions is inappropriate. The demand driven methods should be used to analyze the network behavior while designing intermittent water distribution systems.
An optimal design of intermittent water distribution system is the one that can supply sufficient quantities of water to the consumers at adequate pressures and at an affordable cost. In the conventional method, the objective of water distribution network design is finding the combination of pipe diameters that provides pressure above a specified minimum at least cost. However, in water starved systems, the objective might be that the limited quantity of water be distributed as fairly and equally as possible to achieve better supply for people.

CONCLUSIONS

Due to increasing population, rapid urbanization, improved living standards, and water scarcity, it is prudent to shift from the traditional 'supply based management' to a 'demand management' paradigm. Demand management focuses on measures that make more efficient use of precious water resource that is available with scarcity. This paper primarily focuses on the critical issues associated and the issued to be addressed in an intermittent water supply system. Intermittent water supplies are supposed to be adopted due to water scarcity and if not planned and operated properly, results in wastage of water and it leads to low pressure-head. The low pressure-head values at the demand node resulting in inequities in water supply to the consumers. Also, the intermittent water supply is vulnerable to health hazards due to accelerated contamination intrusion. It is therefore important to recognize and account these realities while designing and operating an intermittent water supply system.

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