Domestic pumping and plumbing

(Vast scope for conserving both water and energy)

S. L. Abhyankar

Demand and supply:

Water is a basic necessity for life. Every essential commodity needs to be studied on two aspects of demand and supply.

Demand:

In domestic usage, people need water for the following purposes:

- Drinking and cooking
- Bathing
- Flushing of toilets and at wash basins
- Cleaning floors
- Washing clothes, utensils
- Watering plants
- Fire-fighting
- Amenities, e.g. desert cooler, swimming pool
- Therapeutical
- Drinking and bathing for pets and domestic animals.

Sources:

Supply of water is explored from any of the following resources:

- Surface waters – rivers, lakes, dug wells
- Ground water
- Rain water harvesting
- Recycling
- Some people have also announced having developed a technology to convert humidity in air into water ! Each unit is said to have a capacity to make 12 litres of water per day, if humidity is of the order of 85%.

Traditionally, in villages, the consumer gets water directly from the source. With evolution of community life, especially with urbanisation, water supply to residents has become the responsibility of Gram Panchayats, Municipal Corporations, etc. These bodies explore water resources and manage piped supply to the residents.

With growing scarcity of resources to meet the needs to growing population, most localities also explore ground water within their compounds. Rainwater harvesting is also being made mandatory in many places.

A case study of 200 people in urban locale:

As per IS: 2065, water supply in urban locales is specified to be 200 litres per capita per day. By this the annual demand works out as 14,000 m^3.

If there is ground water explored by having a bore well, say 100 m deep and with a yield of 30 lpm by 24-hr pumping, water supply as much as 15,768 m^3 will be available. Unfortunately, the water is often not suitable for drinking. Also, the pumping head is very high, causing high energy consumption.

If rainwater harvesting is thought to be implemented, at an annual average rainfall 2.5 m, as suming that 200 residents live in a building with a roof area of 300 m^2, the total harvestable rain would be 750 m^3, which becomes a meagre 5.1% of the annual demand of 14,600 m^3. One wonders weather it is logical for rainwater harvesting to be made mandatory for such meagre resource.

Actually, much of water usage gets converted into wastewater. Out of 200 litres per capita per day, main consumption for drinking and cooking would be barely 5 litres. So, more than 97% water becomes wastewater. If much of this wastewater can be recycled, there will be no worry of water scarcity ! And the huge activity of water supply by municipalities will become vastly reduced, especially if compact and affordable recycling units can be available for installation in every building.

Vast scope for conservation of both water and energy in multistorey buildings in urban locales:

Multistorey buildings in metropolises receive municipal water supply in a ground-level reservoir (GLR). This then is raised to an overhead reservoir (OHR).

The rating of the pump is influenced by capacities of both the GLR and OHR. Often the pump is selected and installed by the builder. The natural tendency of the builder is to economise on the investment. A review of the pumping system would reveal great scope for conserving both water and energy.

Most simply, larger size of piping can save substantial energy. Actually, there is an IS Standard on the subject, IS: 2065 'Code of Practice for Water Supply in Buildings'. But one wonders how many people are really aware of this Code IS : 2065 being there! Basically, the municipal authorities approving the building plans should be aware of it and also the builders. Even if some people may be aware of it, one wonders, how many use it.

It seems IS: 2065 was first formulated some time in 1962. It was reviewed for second revision in 1983. Multistorey buildings were not so much in vogue in those days. So, may be, the Standard merits another revision.

Typically, if a multistorey building has 50 households with an average occupancy of 4 persons per household so, total population of 200 persons, at water demand of 200 litres per capita per day, the building would be consuming 40 cubic metres of water per day.

If the capacity of GLR is only 20 cubic metres and total 40 cubic metres are received from municipal supply into GLR in 4 hours, say from 2 a.m. to 6 a.m., at least 20 cubic metres have to be raised to the OHR during these 4 hours. This is how the capacity of the GLR determines the rate of pumping, in this case, at least 5 cubic metres per day.

From my personal experience, multistorey buildings are often tall enough, 50 households over 25 floors! The curious point is that water needed by residents of the first and second floors, i.e., much lower floors, is also raised all the way up to the OHR on the 26^{th} floor!.

An intelligent energy-saving option would be 'Series Pumping' with intermediate storages. If one can think of 2 intermediate storages, totally 3 storages, each storage will cater to one-third of the total water demand. Energy required for pumping is primarily influenced by the product of Q*H*T, Q being the rate of flow, H the total head and T the time duration of running the pump. Residents up to the first intermediate storage will be served by pumping Q/3 * H/3. For residents to be served by the second intermediate storage, another pump can pump another Q/3 * H/3 from the first intermediate storage to the second intermediate storage and for those served by the topmost storage, the third pump will pump another Q/3 * H/3 from second storage to the topmost storage. The time duration of running of the three pumps will be different. The first and second pumps will have to run until the third pump has done its pumping. The third pump will run for the shortest duration. The second pump twice of that and the first pump the longest. To illustrate by example, for pumping 40 cubic metres for a population of 200 persons and with municipal supply flowing in 4 hours, i.e., at 10 m^3/h, supposing the pumps are rated for 8 m^3/h, first pump will run for 5 hours, to pump to first intermediate storage. The second pump will pump some 26 m^3 in 3.25 hours to second intermediate storage. The third pump will pump 14 m^3 to the topmost storage in 1.625 hours. Suppose the head between two successive storage is 30 m. By this, the total pumping becomes 5 + 3.25 + 1.625 = 9.875 hours at 8 m^3/h against head of 30 m. The resultant summation of pumping becomes (8 m^3/h)* (9.875 hours)* (30m.) = 2370 m^4 with 3 storages. Instead, by having single storage the pumping becomes (8 m^3/h)* (5 hours)* (90m) = 3600m^4. This suggests directly 34.16% energy-saving potential !!!

One can do this by three much smaller pumps each of rating Q/3*H/3, instead of one large pump of rating Q*H. Also only one standby of rating Q/3*H/3 should suffice for all three pumps together, making 33% standby instead of 100% standby of rating Q*H.

One can realise from the above that many permutations are possible for values of Q, H and T, the time duration of pumping.

One is promoted to ask. "Does not one-time 'economical' investment by the builder become lifetime liability of residents ?"

At energy-conservation potential of the order of 34.16% may be., the residents can do an investment analysis on their own and often, a fresh investment to replace the system installed by the builder may attractively pay back fast enough. One can of course take a neat overview of the complete system, including the sizes of piping, their layout, bends, valves, etc. The end-result of energy conservation ought to prove very lucrative.

Hydro-pneumatic or pressure-booster systems:

One does not have to think too much to see the energy-guzzling and hence objectionable aspects of these pressure-booster or hydro-pneumatic pumping systems. These are so obvious:

(1) First of all, a typical water supply plumbing in buildings is Part (a) to raise the water from ground-level reservoir (GLR) and then Part (b) to distribute to households.
The prssure-booster systems tend to do Part (B) also by pumping, which is conventionally done by gravity from the overhead reservoir (OHR). And in pressure-booster systems, the pumping is done through small-size, high-friction pipes.

(2) The systems are designed to give a preconceived unform terminal pressure even at the highest and farthest point in the building. And the preconceived terminal pressure is of the order of, say, 1.5 bar. May be some may be thinking of even 2.5 bar. Even at 1.5 bar, it is in effect providing an extra pumping head of 15 m (!) just by preconception.

(3) Depending upon the setting of pressure switch, the pump motor may have to start much too often. At a discussion forum on pumping troubles, I had umpteen number of queries being asked by users of such systems about frequent upsetting of the pressure switch setting, causing haunting of the pump to a level of nuisance.

(4) These systems are often offered with automation. But the automation ought to include sensor for level of water in GLR. Or else, the problem will with foot valve and the pump will not pump and the residents will suffer water shortage in spite of a fanciful uniform pressure system.

(5) One manufacturer mentioned to me that he redesigned his motors for this application to withstand as many as 50 starts per hour. Even if one were to discount the number of starts to, say, 20 starts per hour, it still is a special motor. And in the event of a failure of the motor, if one were to go for a replacement motor and replace with a a 2-hp, 2-pole motor from the market, it will not be specially designed motor. The new motor will fail more frequently than the original motor. And these problems will be faced by the rsidents and not by the builder. If a builder has some background in engineering, the residents will often have no engineering background.

(6) Even discounted number of starts per hour, say 20, still means that the motor will draw starting current as many times in an hour. And starting current of the motor is 6 to 7 times the full-load current. How can such a pumping system be energy efficient?

(7) The argument that the pressure booster systems help to reduce the structural load is flimsy. Average height of an OHR is 2.5 m, which means the load strees of merely 250 gms per cm^2. Buildings have been having OHRs since ages, even in high-rise buildings. The design of a structure is and can never be so critical as not to be able to bear the strees of $0.25 kg/cm^2$

(8) The basic question to be asked is the reason for apreconceived terminal pressure. The reason seems to be that the affording people wish to have water-jet massaging, sauna bath and such fanciful lifestyles. If those affording people wish to have that in their households, let them use their own captive pumping for that. Why should the water supply to the whole building be made energy guzzling for the fancy of a few? Another argument on the same line is of hotels, especially those catering to tourism by the foreigners. Even in such cases, the hotels can have such health and hygiene facilities in a centralised location. Again, there should be no need for the water supply in the entire building to be by pressure boosting.

Ministry of Power would do a national service by bringing in a ban on pressure-boosting pumping in any building to be installed for entire water supply in a building. The pressure boosting may be allowed only for health facilities but not for entire building.

Summary of observations and suggestions:

(1) Vast scope for augmenting water supply by recycling; an economical treatment system is needed.
(2) Great potential for energy conservation by thinking differently, e.g., series pumping.
(3) Need for re-looking into IS: 2065 and need for spreading awareness of this code of practice.
(4) Need to curb luxuries in usage of water; e.g., sauna baths in elite homes.
(5) Need to spread piped supply to curb stealing by use of inappropriate and indifferent minimonoblocs.
(6) Need to curb spread of energy-guzzling systems like hydro-pneumatic systems.

Reference Book:

Indian Pumps
Newsletter of the Indian Pump Manufacturers Association,
June 2005