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A NOVEL STRATEGY TO SAVE ENERGY CONSUMED IN ELECTRIC WATER LIFTING FOR MULTI STORIED BUILDINGS

Mrityunjaya Kappali
Research Scholar, Dept. of E&E Engg.
NITK, Surathkal -575 025, Karnataka, India
[Asst. Professor, E&E, SDMCET, Dharwad, India]
E-mail: mrkappali@rediffmail.com

Dr. Uday Kumar R. Y
Asst. Professor, Dept. of E&E Engg,
NITK, Surathkal -575 025, Karnataka, India
E-mail: udaykumarry@yahoo.com

ABSTRACT
Electric water pumps have become almost an essential commodity for urban households. Existing practice of water lifting in multi-storied buildings employs Top Floor Storage Method (TFSM). Here considerable amount of water is pumped to unnecessary heights, resulting in energy wastage. This paper presents a novel scheme "Individual Floor Storage Method" (IFSM). Here water is pumped to the required optimum heights thus saving energy. Proposed method is analyzed for two different cases: (i) A two-storied house and (ii) A three-storied student hostel. The energy saving is to the extent of 10% for the first case and 20% with the payback period of 3.5 years for the second case. As a concept, IFSM is very simple and economic. It yields greater benefits i.e. higher energy saving if implemented for multistoried buildings with large water consumption like hospitals, hostels, flat complexes etc. In the present day scenario of mushrooming multi storied buildings and escalating energy costs, IFSM is more appropriate compared to the existing TFSM.

KEY WORDS
Energy Conservation–Water Lifting – TFSM– IFSM

1. Introduction

Majority of the electric energy used in the world today is obtained from non-renewable fossil fuels like oil, natural gas and coal. These are fast depleting. Economic and reliable alternate sources are not yet available. Hence energy conservation is the need of the hour. This benefits the individual users by decreasing their electricity bill and the electric supply boards by reducing demand on their already overloaded supply networks.

Electric water pumps have become almost an essential commodity for urban dwellings. There are millions of them being used. Hence even though individually each pump power rating is less (fractional kW to multiples of kWs), the net power of all the pumps put together is quite considerable. As a result, energy conservation attempts in this area will yield appreciable benefits as the total quantum of energy saving becomes large.

With the above as the background, present paper deals with water lifting aspects in multistoried buildings. Section 2 explains the present practice of water lifting in multistoried buildings. Section 3 proposes a novel strategy for water lifting. Then two different cases, a two storied house and a three storied student hostel, are considered to study the application of this method. Section 4 discusses the new strategy for a two storied house. The energy saving is found to be to the extent of 10%. Section 5 deals with the second case i.e. three storied student hostel. Here the energy saving is found to be more, being of the order of 20%. Section 6 presents the additional benefit and challenges encountered in introducing the proposed strategy. Section 7 gives concluding remarks.

2. Water Lifting in Multistoried Buildings: Present Practice

Presently, in multistoried buildings, a single overhead tank is placed above the topmost floor. All the water is lifted up to that height and then brought down to lower floors (Fig.1). This method can be called as "Top Floor Storage Method (TFSM)" [1]. Here, even the water required at lower heights is unnecessarily lifted to higher levels. For example, for a two-storied building (ground + first floor) overhead tank is placed on the top of the first floor (I-F) at a height of approximately 8.2m. This position of the tank is alright for the I-F water requirement. But, for the ground floor (G-F), though water is required at just 4.8m height, it is lifted up to 8.2m.and then brought down. Such a lifting of water to unnecessary large heights means more energy consumption, which is wastage. This opens up an opportunity for energy conservation.

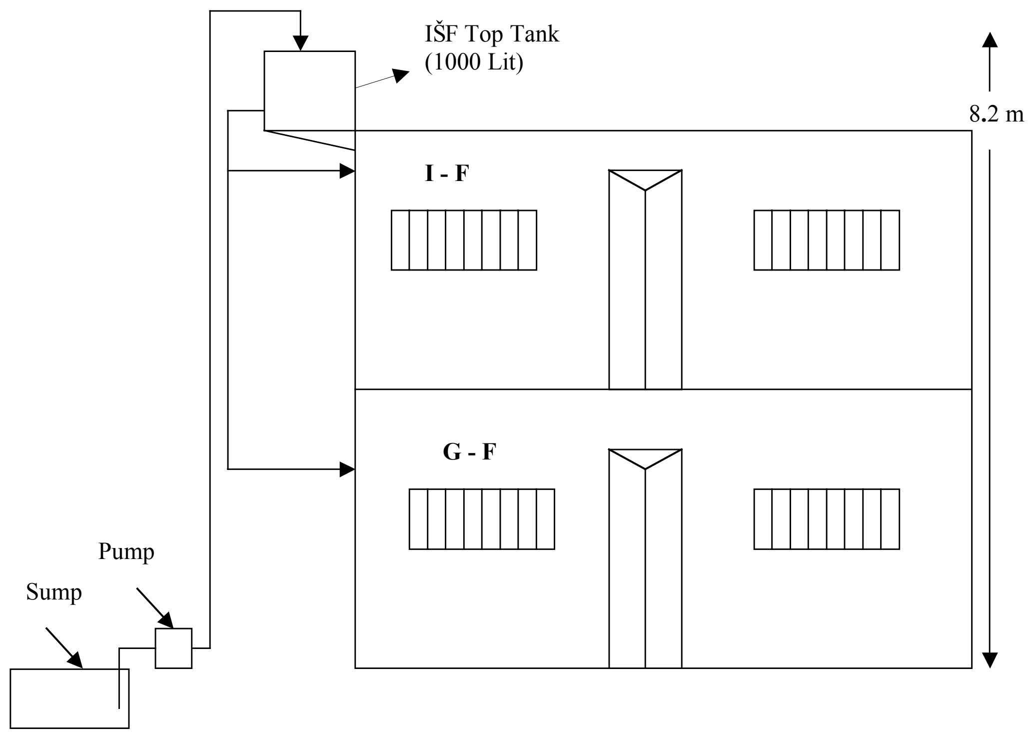

Fig. 1 Existing Scheme (TFSM) for 2 storied building

3. IFSM: The New Strategy

The new strategy is simple and cost effective. It proposes that instead of one single large overhead tank on topmost floor, small tanks at each floor height are to be employed supplying water to corresponding floor (Fig. 2). Independent pipe line is laid from pump to each floor tank through a multi output valve. Water is pumped to each floor tank independently using the valve. This strategy is termed as "Individual Floor Storage Method (IFSM)" [1].

IFSM results in considerable saving of energy as is shown in the next sections of this paper. The energy saving is more for multistoried flat complexes, hostels, hospitals, etc. with large water consumption. It is to be noted that due to aspects like inexhorbitant hike in cost of land and popularity of flat system for security reasons, there is a trend towards more number of multistoried buildings in urban areas. Added to this, the energy cost is escalating. In such a scenario, owing to its higher energy efficiency, IFSM is more appropriate compared to the existing TFSM.

4. Case I: IFSM for a Two Storied House

4.1 Proposal and Test Details

Here a two-storied house with daily water need of 800 liters (400 liters for G-F & 400 liters for I-F) is considered. Water from municipal supply is stored in a sump with a depth of 1.2m. Using a pump, water is lifted from this sump to the overhead tank. The pump used has the following specifications: 1-phase ac, 0.75 KW, 230V, 50Hz, mono-block. The energy consumed by this pump for lifting water as a function of delivery head (Hd) at a fixed suction head Hs=1.2m was evaluated [3]. The findings are given in Fig 3. It can be observed that the energy consumed increases as the head increases.

4.1.1 TFSM (Fig.1)

Meeting the total water requirement by the presentpractice, TFSM, means having one overhead tank of 1000 liters capacity kept on the I-F roof top (tank inlet point being 8.2m above ground level). Then water is drawn from a sump (1.2 m depth) and lifted up to 8.2m For pumping the required 800 liters/day, the electric energy required/day is calculated using values from Fig. 3 corresponding to Hd = 8.5m. This is obtained as = 0.3 KWHr.

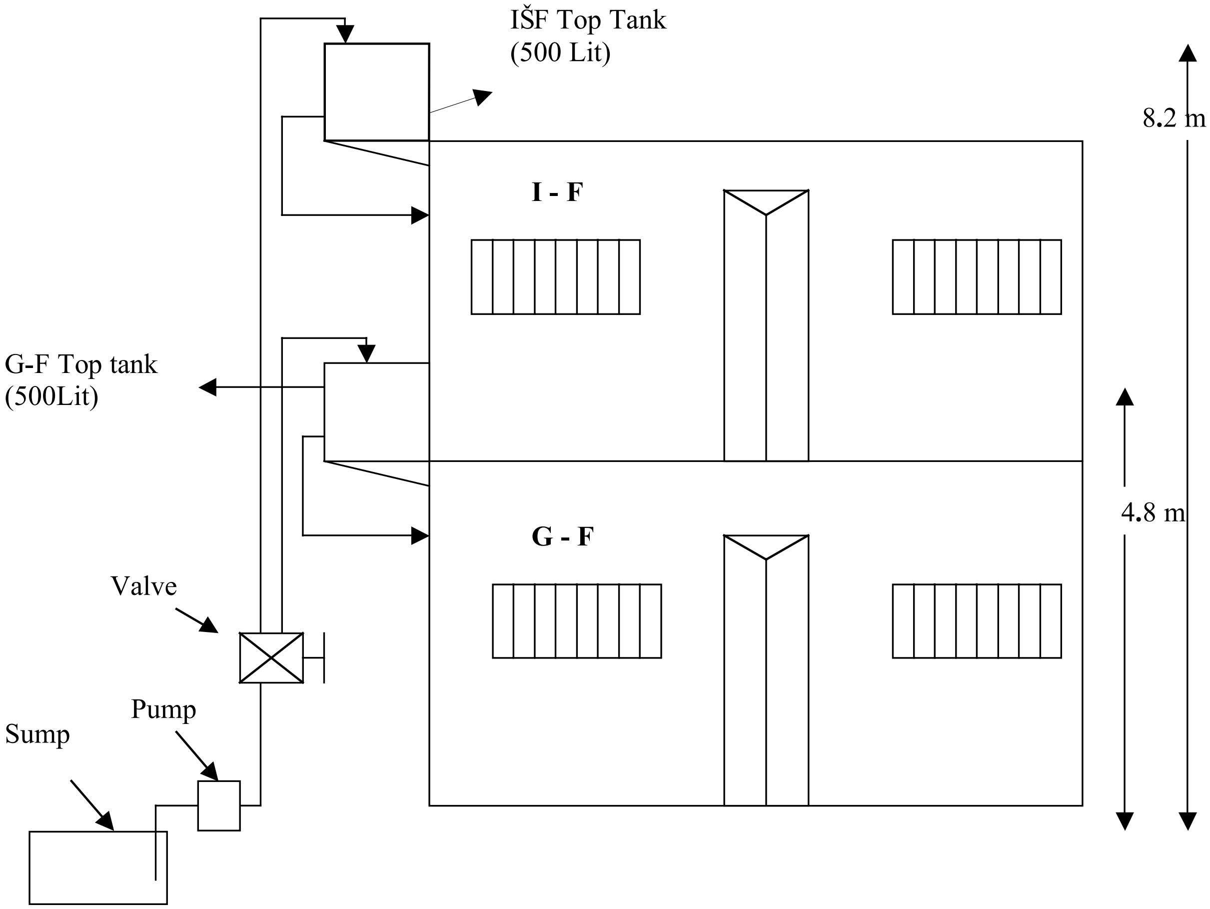

Fig.2 Proposed Scheme (IFSM) for 2 storied building

4.1.2 IFSM (Fig.2)

Meeting the total water requirement by the new strategy, IFSM, means providing two 500 liters tanks: one on G-F roof top (tank inlet point 4.8m above ground) supplying water to G-F and the other on I-F roof top (tank inlet point 8.2m above ground) supplying water to I-F. The water is drawn from the sump (1.2m depth) and lifted up to 8.2m while filling I Floor tank whereas lifting is only up to 4.8m while filling G-F tank. Two-way valve helps in selecting the tank to be filled. For pumping the required 400 liters/day to each tank, the total electric energy required/day is calculated using values from Fig.3 corresponding to Hd=4.8m and Hd=8.2m. With this scheme, the electric energy required/day =0.27 KWHr. This is less than that required with TFSM. Thus there will be a saving of 0.03 KWHr/day which amounts to a saving of 10% energy.

4.2 Additional Expenditure

Cost of one 1000 liters PVC tank and that of two 500 liters PVC tanks is almost the same. The additional expenditure will be only on extra plumbing work & valve, which is approximately Rs. 250 ($ 5.7 @ Rs.44/dollar) for a two storied building. This is well within the reach of the pump users.

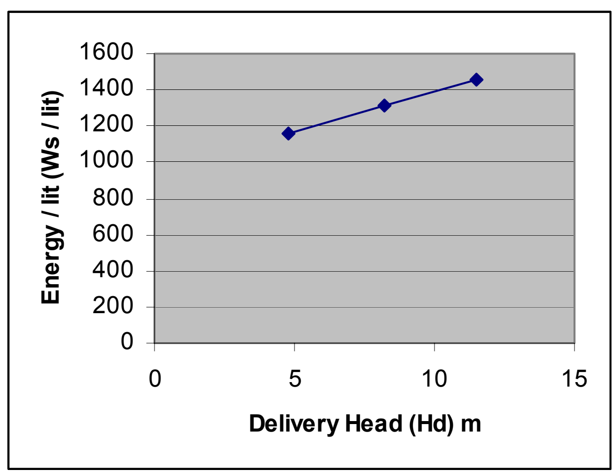

Fig. 3 Energy Consumed by Pump in 2 storied building at Hs = 1.2 m

5. Case II: IFSM for a Three-Storied Student Hostel

5.1 Building Details

Student hostel at the campus of SDM College of Engineering & Technology, Dharwad, India is considered. This has 3 floors: G-F, I-F and second floor (II-F).

5.2 Present Practice

Presently, in this hostel, TFSM is employed for water lifting. Entire water is lifted from the bore-well to the II-F top tank and stored there. Then this water is brought down and supplied to different floors. Table 1 gives details of water required at different floors [2]. Even the water required at G-F and I-F heights is lifted to II-F height. Hence there is wastage of energy in lifting the large quantity of water unnecessarily to higher level. Interesting observation is that most of the water is required just at ground floor as the mess/canteen is situated there. The test results of the discharge rate and energy consumed/day by pump with TFSM are shown in Table 2.

Table1: Floor-wise water requirement at hostel (lit).

Floor	For Students	For Mess	Total
G-F	10000	26500	**36500**
I-F	10000	--	10000
II-F	10000	--	10000
Total	30000	26500	**56500**

Table 2: Discharge rate and Energy consumption with existing method (TFSM) in hostel

Discharge rate at II-F top tank	2.0 lit/sec
Energy consumption/day for lifting 56500 lit water	**40.82 KWHr**

5.3 Proposal and Test Details

A keen observation of the hostel construction reveals the availability of extended GF roof (mess terrace) which can be exploited to position the GF top tank. Hence, to avoid new civil constructions, the proposal is [4]:

- Go for IFSM with two-level storage.
- Two overhead tanks are to be employed: (i) provide new PVC tank (10000 lit capacity) on the mess terrace i.e. at G-F terrace level. This is to be used to cater water to the G-F. (ii) already existing II-F top tank is to be used to supply water to I-F aswellas II-F.
- Additional pipeline is to be laid from the hostel base to the G-F top tank with a 2-way valve so that water can be directed either to G-F top tank or II-F top tank.

Tests were conducted with the existing pump to obtain the flow rates at different discharge levels. With these values the energy consumption for lifting the required water is calculated (Table 3). Total energy consumption/day with IFSM (32.76 KWH) is less than that required with TFSM (40.82 KWH). Energy saving and payback period calculations are made using values from Table 2 and Table 3. The results are presented in Table 4. The energy saving is to the extent of 20%.

Table 3: Test results with proposed method (IFSM) in hostel

	G-F top Tank	II-F top Tank	Total
Discharge rate(lit/sec)	2.8	2.0	
Water Lifted/day (lit)	36500	20000	56500
Energy Consumption per day (KWH)	18.72	14.04	**32.76**

Table 4: Payback period calculations with IFSM in hostel

Energy saved/day	40.82 - 32.76 = **8.06 KWHr**
Energy saved (%)	8.06/40.82 = 19.7 ≈ **20%**
Money saved/year @ Rs.3/KWHr	**Rs. 8825.7** ($200.6)
Additional expenditure for additional tank and plumbing work (i)PVC tank cost @ Rs.2.7/lit (ii)Material and labour charges for plumbing work = Rs.3000	Rs. 2.7x10000+3000 = **Rs. 30000** ($681.8)
Payback period	30000/8825.7 = **3.5 years**

6. Critical Observations

IFSM leads to uniform distribution of dead weight as water storage is distributed on different floors.

IFSM demands small structural modifications in existing buildings to position water tanks at different floors. However this provision can easily be made in design stage itself for new buildings.

IFSM necessitates devising proper control mechanism of directing water from pump to different floor tanks. Accomplishing this manually using a multi output valve is easy in situations where dedicated human operator is available. However an automatic setup, properly designed and incorporated, will be more reliable.

One concern generally raised by many is that the expenses for construction of new building with IFSM will be very high compared to that with TFSM. The perception seems to be that in TFSM the tank is placed on the topmost terrace which is naturally available whereas for IFSM additional special construction is necessary. In reality it's not so. Even in TFSM, the structural design has to account for the extra load due to tank being placed.

7. Conclusion

Existing practice of water lifting in multi-storied buildings employs TFSM. Here considerable amount of water is pumped to unnecessary heights, resulting in energy wastage. Hence this paper proposes a novel strategy "Individual Floor Storage Method (IFSM)" for saving energy. Here water is pumped to required optimum heights and hence saves energy. Proposed method is analyzed for two different cases: (i) A two-storied house and (ii) A three-storied student hostel. From the tests, the energy saving is found to be 10% for the first case and 20% with the payback period of 3.5 years for the second case. As a concept, IFSM is very simple and economic. It yields greater benefits i.e. higher energy saving if implemented for multistoried buildings with large water consumption like hospitals, hostels, flat complexes etc. In the present day scenario of mushrooming multi storied buildings and escalating energy costs, proposed IFSM is more appropriate compared to the existing TFSM.

It is also to be noted that there are some challenges with IFSM which we need to tackle like automating the process of directing water to different floors and constructional provisions to position tank at each floor. If the engineering fraternity and the municipal authorities take interest in implementing the proposed new strategy, IFSM, it will be a commendable step towards energy conservation in the field of water lifting applications.

Acknowledgement

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References

[1] M. Kappali, A Novel Method of Saving Energy Consumed by Domestic Water Pump, *Proceedings of the 13th National Power System Conference (NPSC),* Chennai, India, pp: 839-842, Vol: II, Dec.2004.
[2] M. Kappali, *Energy Conservation in Electric Water Lifting In SDMCET Campus: A Report* (SDMCET, 2004)
[3] Akshata et al, *Performance Evaluation of Single Phase Domestic Water Pump* (Visvesvaraya Technology University Graduate Dissertation, SDMCET, 2004).
[4] M. Kappali and Dr. Udaykumar R.Y., Energy Saving in Water Lifting, *Int. Con. on Energy,* Andhra Pradesh, India, Feb.2006.