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Greywater: Characterization & Utilization in Green Buildings

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Abstract—*For healthy growth of human beings, safe and sufficient quantity of water is necessary. Greywater is defined as wastewater from kitchen, bath, and laundry excluding wastewater from toilets. The total greywater accounts for around two-third of total domestic wastewater produced. The qualities of greywater depends on the sources and installations from where the wastewater is drawn. The objective of this study is to characterize grey water and its utilization in green buildings. As per Indian Green Building Council (IGBC) grey water utilization is essential part of water efficiency. Credit points are awarded based on the percentage of total greywater reused in the green building which subsequently affects its rating. Different types of greywater have different characteristics and hence can be classified into four different categories; bathroom, laundry, kitchen and greywater of mixed origin. Greywater collected from different sources displayed similar biodegradable contents as demonstrated by BOD5 concentrations. It is obvious that an extensive biological treatment of the greywater is indispensable in order to avoid technical problems and health risks as well as to promote the public acceptance for greywater recycling. Following an extensive biological treatment, independent of the system employed, it is not necessary to add chemical disinfectants to the treated water and can be used as a non-potable water source. The greywater treatment systems can be "Coagulation and flocculation", "Constructed wetland treatment", "Filtration", "Rotating biological contactor", "Membrane bioreactor", "Sequencing batch reactor" and "Up-flow anaerobic sludge blanket reactor". To utilize greywater, a dual plumbing system must be installed to separate it from blackwater, which is the wastewater generated from toilet-flushing. Dual plumbing is not difficult to install, but is most-cost effective if done during initial construction. Thus, greywater use can be a milestone in water deficit areas.*

1. INTRODUCTION

A burning topic that has caught the attention of the masses across the globe is the well-being of Mother Earth. Now-a-days we all know that because of the excessive pollution caused by mankind, our Earth has been at the receiving end. Globally, buildings are responsible for at least 40% of energy use. An estimated 42% consumption and 50% of the global consumption of raw materials is consumed by buildings when taking into account the manufacture, construction, and operational period of buildings. In addition, building activities contribute an estimated 50% of the world's air pollution, 42% of its greenhouse gases, 50% of all water pollution, 48% of all solid wastes and 50% of all chlorofluorocarbons (CFCs) to the environment [1]. New technologies and protocols are introduced to save our Mother earth. Green building is one of them.

India too faces the environmental challenges of the construction sector. The gross built-up area added to commercial and residential spaces was about 40.8 million square meters in 2004-05, which is about 1% of annual average constructed floor area around the world and the trends show a sustained growth of 10% over the coming years. With a near consistent 8% rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen an increase, from a low 14% in the 1970s to nearly 33% in 2004-05[2]. Energy consumption would continue to rise unless suitable actions to improve energy efficiency are taken up immediately. Green building is one such initiative which can help address national issues like handling of consumer waste, water efficiency, reduction in fossil fuel use in commuting energy efficiency and conserving natural resources.Green homes can have tremendous benefits, both tangible and intangible. The most tangible benefits are the reduction in water and energy consumption right from day one of occupancy. The energy savings could range from 20 – 30 % and water savings around 30 – 50%. Intangible benefits of Green homes include enhanced air quality, excellent daylighting, health & wellbeing of the occupants, safety benefits and conservation of scarce national resources. The prime principle of a Green building is the utilization of biodegradable materials or waste materials that can be reused after its proper treatment especially Greywater, hence reducing the total water requirement in the construction, which ultimately decreases the total construction cost. Wastewater generated from indoor uses such as laundries, showers, and sinks is termed as Greywater. It can be reused in toilet-flushing or irrigation and helps in minimizing the loading on any type of wastewater treatment system hence reducing

overall water consumption. To separate greywater from Blackwater, a dual plumbing system must be installed.Proper greywater management, comprising collection, treatment and reuse has a great potential in the construction Green Buildings. Water shortage is prevented due to the reuse. Since Greywater often contains valuable nutrients for gardening and irrigation as a result there is no need to buy expensive mineral fertilizer. Also, people feel more responsible of their treatment system when it is decentralized and may pay more attention to the issue of greywatermanagement.

2. CHARACTERISTICS OF GREYWATER

Domestic waste water contains harmful chemicals and microorganisms which can also produce bad odors. It can be segregated at the source into two separate flows; Blackwater having gross faecal contamination and greywater or sullage having remaining household wastewater which is not faecally contaminated. Separation of Blackwater from greywater at the source, can decrease the number of pathogens and the corresponding danger arising due to them. Greywater storage should be prevented, as it enhances offensive odors and microbial growth, but direct use can eliminate these effects and can also reduce health risk.

The main objectives of domestic greywater reuse guidelines can be:

a) Protect people from waterborne diseases.
b) Greywater installations don't harm the environment, the site and maintains a specific standard.
c) Cost effectiveness should be analyzed. [3]

The qualities & characteristics of greywater depends on the sources & installations from where the wastewater is drawn (i.e. kitchen, bathroom or laundry). It also depends on distribution network & activities carried out. Depending on the source, greywater can have different characteristics. Generally source of greywater can be classified into four types; bathroom, laundry, kitchen & greywater of mixed origin. Segregation at the sources will help in evaluating the potential for reuse. [4]

Characteristics of greywater are highly influenced by lifestyle, social and cultural behavior of the residents, availability of water and its consumption. The total greywater accounts for around two-third of total domestic wastewater produced and out of which nearly 50% is light greywater. So recycle and reuse of greywater can be beneficial. [5]

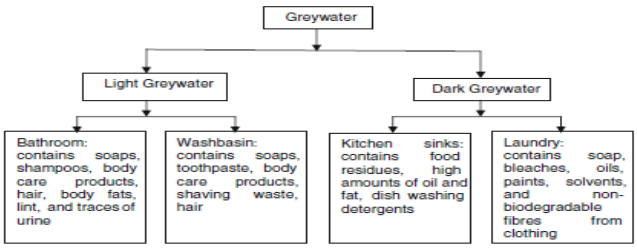

Fig. 1: (Greywater Sources and their constituents)[5]

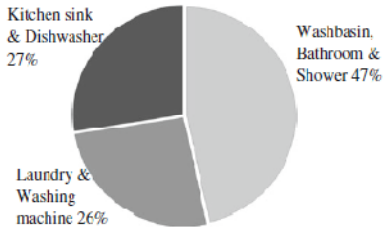

Fig. 2: (Distribution of greywater at different sources)[5]

3. UTILIZATION OF GREYWATER IN GREEN BUILDING

Recycled Greywater can be used for toilet- flushing, hence avoiding unnecessary use of high-quality water. irrigation of areas is another major use of graywater. With the installation of dual plumbing system, percentage of water used in toilets has reduced.[5]

This concept of using greywater in the construction of green buildings is economical especially in the areas that suffer from the severe problems related to the availability of good quality water. As greywater is two-thirds of total waste water produced and fifty percent of that is light greywater, utilization would not be so difficult and systems can be made according to the necessary conditions.

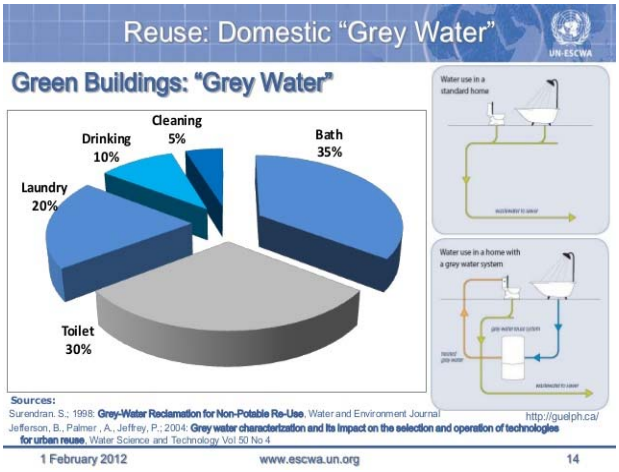

Fig. 3: (Domestic Greywater) [5]

4. TREATMENT OF GREYWATER

To destroy as well as to remove the microorganisms present in the greywater, treatment is required. So far as human contact is concerned, it should be prevented as it will be an expensive affair to achieve the quality required for human use and maintenance of such system will be difficult. The safest way of greywater reuse is not to bring it in contact with human beings. If we can reuse all the greywater produced, then around 30 to 50% of fresh water can be saved per house. [1]

Technical feasibility, public health, social acceptability and sustainability are the aspects that should be looked after while reusing or treating greywater. Disinfection added with coarse filtration is the most common technology used for domestic reuse. Biological treatment is required for systems of large distribution network which will remove biodegradable materials generally. Immediate processing and reuse is necessary for effective greywater treatment. [6]

Biological treatment of the greywater can't be ignored, so that technical problems and health risks are avoided and it is also necessary for public acceptance and hygiene. [4] The greywater treatment systems can be "Coagulation and flocculation", "Constructed wetland treatment", "Filtration", "Rotating biological contactor", "Membrane bioreactor", "Sequencing batch reactor" and "Up-flow anaerobic sludge blanket reactor".[5]

5. ECONOMIC ASPECTS OF GREYWATER

India's condition of water requirement has been increasing and the sources are reducing, which may lead to a serious water scarcity by 2025. The reuse of grey water is the best method in water scarce areas. Greywater recycling can be a best method for urban water management.An innovative cross connected system that collects Grey Water from residential buildings and recycles it for toilet/urinal flushing in both residential and office buildings have been proposed bySara Moslemi [7]. In individual GW recycling systems, the water saving potential for homes is limited by demand and not supply. [7]

6. DISCUSSION

Hand washbasins, baths and showers generate less polluted greywater. Definition of greywater excludes the wastewater discharged through kitchen sinks, washing machines and WCs.Reuse of greywater after separating from Blackwater can reduce burden on the treatment system. This approach can help in both treatment and conveyance economically. Total availability of water supply can be increased by reusing greywater. Conservation of Drinking water which is a high-quality water supply, can be done through the substitution of reused water wherever appropriate.

Safety of greywater needs attention with respect to the presence of pathogens. Improper treatment of greywater can hamper the quality and characteristics of soils. Improper maintenance and storage of greywater may lead to various problems.

7. CONCLUSION

Greywater characterization and its utilization in Green buildings have been studied in this paper. As we know that Greywater is generated from toilets, flushing, laundry etc. from a household, and can be recycled through different methods so that it can be reused again. We studied that recycling of greywater is a significant source that could potentially aid problems caused by lack of fresh water. . Moreover, in individual households, it has been established that greywater could support the amount of water needed for toilet flushing and outdoor uses such as car washing and garden watering. Following are the conclusions withdrawn from this paper:-

a) Different characteristics of Greywater which includes its source, qualities and its types. Characteristics of greywater are highly influenced by lifestyle, social and cultural behavior of the residents, availability of water and its consumption.
b) Recycled Greywater can be used for non-potable water uses such as toilet- flushing, thereby avoiding unnecessary use of high-quality potable water.
c) Technical feasibility, public health, social acceptability and sustainability are the aspects that should be looked after while reusing or treating greywater.
d) The best alternative and cost effective process in rural areas is the reuse of grey water.

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