DESIGN AND DEVELOPMENT OF A TECHNOLOGICAL SYSTEM FOR GREY WATER REUSE

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ABSTRACT

This work has as purpose "contribute to the decrease of the consumption of water drinking to purposes that not so require". Its objectives are to design, develop and transfer a system not conventional for such purpose; to improve the health and conditions of habitability of sanitary spaces with sustainability. To such end, it proposes are: an strategy of "Participatory action research" as "a social practice of knowledge production that seeks social change seen as a totality, occurs in the very action and contributes to it"; a system that allows to replace the traditional toilet tank and reuse and store water used in toilets to be downloaded in nuclei sanitary toilets. With regard to the results achieved, the work has 2 stages that includes: 1. Developing the theoretical framework; the study of history and analysis of geographical areas of application; the generation of possible solutions for responding to the system; the selection of surpassing proposal; 2. adjustment of the surpassing proposal; preparation of technical documentation; design of your building process; adjustment of its operation, use and maintenance; its materialization; experimentation and evaluation. The conclusions was that this system is "Adaptive" and "affordable" that presents facility construction and installation work; features that make it an "adoptable product" in different types of architectural objects and a "sustainable product" because that makes it possible to the care of the environment.

Keywords: Use rational of the water; appropriate technologies; Sustainability of the Habitat.

1 PURPOSE

This work seeks to promote "clean" technologies, within a social framework, so that they help to understand the need for change that must be addressed to improve the quality of life of the populations and maintain our ecosystem for future generations.

2 GENERAL OBJECTIVES

- Generate a product whose investment justifies the implementation in social buildings, at a cost of application according to the economic capacity and the social situation of their users-builders.
- Apply this system in spaces health of buildings of interest social.
- Demonstrate and disseminate its proper functioning and implementation of the system.

3 SPECIFIC OBJECTIVES

- Objective environmental.
- Promote and generate alternative sustainable through the system technology posed, to strengthen and emphasize their acceptance, understanding to these as the value added of the product.
- Disseminate and demonstrate the suitability of grey water reuse.
- Productive objectives.
- Generate a product innovative, trusted users are willing to implement.

- Generate a national product able to compete in the local market against industrialized alternatives of foreign origin.
- To build a low cost system using local resources. To get a simple product capable of being developed with simple manufacturing processes.
- To get a product capable of being used on social architecture.

• Social objectives

- Approaching the population of low-income useful tools to improve their conditions of hygiene and occupational safety and their well-being and comfort, trying to save their natural and cultural contexts and that they comply with their conditions, economic, technological, etc.
- Adopt and implement prototypes, technology for the recycling and reuse of grey water, integrators of requirements and conditions, environmental, technological, cultural, productive, health, etc. of the sites into account.
- Encourage the work cooperative to scale community and family.
- To promote integration and social inclusion.
- Implement and comply with the tenets of the "green and decent" work.

4 PROBLEMS RAISED

• Rational use of the water. The shortage of water is a problematic current in the world and in the country, in general, and in the province, in particular, while the sector industrial and the agricultural are which more water used, is the context House which represents them habits of consumption real of the population as individuals particular. “Wastewater reuse in agriculture, is a way of recycling water and purifying nutrient. Also, this reuse allows to reduce the environmental impact...” [1] See Figure 1.

• Grey water reuse. The waters grey, are waters effluents led by them drains of bathtubs, washbasins, pools of the kitchen, dishwasher or washing machines; at first glance, they seem to have no value, but we understand that with a simple treatment it can be reused, thus extending their life cycle and adding value to use. On the other hand, population growth and the indiscriminate use of drinking water make it necessary to "reuse" as far as possible. Is raises decrease the use of water drinking in artifacts primary of the system sewage recycling the water of artifacts side, producers of waters grey through the design and development of a product that allows reuse them waters grey produced in this case by the basin of nuclei health: the system stores the water of the same to subsequently serve of download in them toilets of mentioned core. The use of this device would allow an approximate cool down of 15 liters daily per person; generated, for example, in a housing with 4 inhabitants an estimated monthly savings of 1800 liters. This decrease in consumption takes greater importance in areas where, the distribution of the water fails to meet the required minimum levels.

Average daily water use per person	
Shower	80 lts.
Sink	18 lts.
Toilette	60 lts.
Bidet	2 lts.
Clothes washing	15 lts.
Dish Washing	20 lts.
House Cleanning	15 lts.
Irrigation	30 lts.
Daily average	240 lts.

Figure 1. Water use per person.

- Advantages of the use of waters grey

The benefits of grey water reuse include, a minor use of drinking water, therefore the decrease of the flow derived septic, to the urban network or treatment plants, a highly effective purification, a solution for places where cannot use another type of treatment, lower use of energy by pumping and treatment the possibility of planting where there is no other type of water, or the recovery of nutrients that are lost, among other aspects.

Some of the disadvantages of water reuse systems, if not the largest, is that they must meet certain requirements that make it difficult to use in different situations, since their spaces and dimensions of installation and use to be used must allow developing the water treatment process and collect the appropriate climatic conditions. "One of the most common disposal practices of domestic wastewater has benn the direct disposal without treatment…this, can generate some health problems in population. For example infectious diseases whose pathogens are efficiently dispersed in the environment…" [2]

There are that have in has that although them waters grey normally not acquire the character of extremely dangerous for the health or the environment (understood the concept of waters black as effluent that generate decomposition, bad smell and acquiring that character), is must submit to a treatment effective prior to your download or reuse, avoiding of this way some effects not desired.

5 ALTERNATIVES FOR THE REUSE OF GREY WATER TECHNOLOGY IN TOILETTES

"There are grey water collect systems that send used water directly to the use points without pretreatment. These systems don´t perform any treatment to groos grey water". [3] There are on the market products that enable the reuse of grey water. These play the role without any problem, but require alternative energy for its operation, pumping elements that more expensive product, purifying chemical costs, the loss of space for the placement of the product, among other problems.

The proposal developed aims to change the way we think, create, produce and use these devices, optimizing the use of water, generating minimal spaces and providing a satisfactory solution to the user.

5.1 Design, development and experimentation of alternative systems for the reuse of grey water.

This task force proposes the development, experimentation and implementation of strategies and actions to achieve a system of recycling of grey water from the basin of a health nucleus (bath), for use of an essential element for life as it is water due to population growth and the indiscriminate use of the same make it necessary to "recycling" as far as possible. He case from here is poses is concerns its reuse for your employment in the cleaning of the toilet.

It is important to consider will be the most suitable treatment system which is designed for specific environmental conditions, i.e. that it takes into account the specific conditions of our medium, both natural conditions and cultures involved.

Installation of treatment systems must not only consider the effectiveness of the purification but also that this should be discussed the relationship of the surrounding elements, special needs, cost, maintenance and refuse, among other aspects.

Within them materials analyzed for the generation of this device, is sought that met with some features technical that facilitate their manufacturing and are capable of resist to the step of the time in health with a high level of humidity; In addition, provide us with the possibility of generating a waterproof vessel capable of accommodating the reuse water.

The selected materials needed to be low cost and humidity resistance properties.

By such reason is proposed further forward with 3 proposed proposals:

5.1.1Fiberglass prototype.

Fiberglass has good characteristics of malleability and ductility to generate parts of different characteristics, dimensions and custom designs.

Methods of use of fiberglass are easy and allow a serial production of the element construct. To build an array of the element from which successive copies are being made and as many as necessary.

Other advantages are: this material allows a custom layout object (gives the designer freedom to its design and the user's choice) and a finish; the weight of the device is reduced considerably comparing it with elements traditional as the ceramic or the sheet. Above all, it covers all the technical characteristics necessary for the operation of the device and the training of the labor force is very simple and with tools readily available on the market at lower costs.

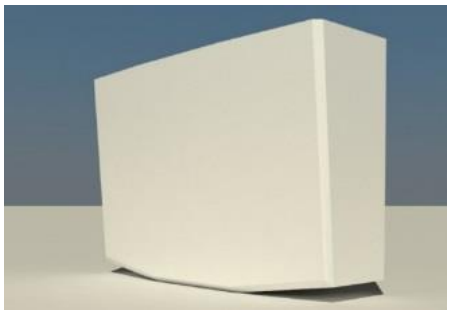

Figure 2. Design of fiberglass backpack. Picture belong to the authors

5.1.2 Prototype 2-steel stainless.

Like the previous alternative (alternative 2), stainless steel provided us feature in terms of its resistance to corrosion and oxidation, its resistance to impacts, to its optimum factor hygiene-cleaning, aesthetics, excellent weldability, ease to mold in relation to other metallic materials and material capacity cleared any doubt about their problem-solving capacity. It is noteworthy that greater sensitivity towards environmental problems has contributed to causing an increase in the use of stainless steel.

Figure 3. Stainless Steel Backpack. Image belong to the authors.

One should mention that a prototype in this material with the dimensional, geometric and morphological characteristics of the alternative 2 has been implemented.

5.2 Design, development and experimentation of alternatives technologys for accumulation, filtering and grey water.

Is a device that takes them waters grey from of the sink, then try (process of elimination of bacteria and others that could produce smells or pollution of the environment health), the deposit for then be evacuated to the delete them effluents of the toilet.

It has sought to develop a device integrated into the already existing avoiding to add more items, in general, they are small-sized sanitary spaces. Also, it takes into account the ideology of the user where many times to include new elements within the health are somewhat reluctant.

The search for an alternative that would have such features, surpassing proposal sought only one element that houses all the functions and parts necessary for its functioning; compact and in a container of dimensions reduced. This allows, in a health center, a change from the conventional tank to the device proposed with few modifications.

It is a product with low impact for users because all the elements of the grey water system itself are inside.

5.3 Integration of the system in the core health

Figure 4. System integration 3d image. It belongs to the authors.

Is a simple construction, easy installation system that provides the ability to adapt to any health core conventional, being applicable to existing centers such as those in construction. See Figure 4. Another important element that emerged later in the study was the achieve clarification and purification of water. It is a reservoir located inside the ATRAG that achieves the clarification of water at the same time that the biological improvement of the deposited grey water. Due to their scarce time of permanence of the water grey inside the device, not is required another type of treatment.

6 OPERATIONAL AND FUNCTIONAL DETAILS OF THE PRODUCT AND IT EXPERIMENTATION

For correct implementation, design and experimentation of the system, he worked in the workshop with a backpack of PVC acquired commercially. On it, were the different tests which served to polish the design and the technical part of the system. Conventional backpacks are equipped with: a ½ water inlet "at the bottom; a download that is resolved with a bellows that is curved and it unites to the toilet that is by where will run the water of download; a pump system of double volume, which allows the download of 9 or 12 liters of water as appropriate use; a top access cover to connect for maintenance of the backpack, it has a button, which according to the manufacturer is cylindrical or prismatic. Own grey water recovery system accessories are a rear entry of 40 with a flange connection to avoid leaks. The main comes directly from the basin and enter in the deposit of water that is deposited in a spout of PVC of 40 with perforations. Cano said that is wrapped in a filter of fats that is can get in any trade of the area. The water before entering the backpack goes by saying filter leaving all the sediments (SOAP, toothpaste, etc.). The filter according to manufacturer there are to renew it every 3 months. This task would be done by lifting the top of the backpack, removing the PVC pipe and replacing the filter. You should clarify that PVC pipe is put by pressure to the pipe coming from the basin. See Figure 5 and 6.

Another element which adds, as already mentioned is the access of water purification tablets. From the front of the backpack, is placed a flange of polypropylene double-layer 1 "(sufficiently so that they enter the pills), then an elbow at 90 ° and a perforated polypropylene pipe bilayer that you descend until you reach the minimum level of water that will take the backpack. The 1system is so that when the water goes up your level in the backpack, within the pipe of polypropylene pads

come into contact with water, purifying it. The pads must be replaced approximately every 2 months.

Figure 5 and 6. Operational and functional experimentation.

7 CONSTRUCTION OF THE PROTOTYPE

7.1 Glass fiber backpack

From the backpack stainless steel mold is the realization in the workshop of a backpack of fiberglass. The fiber of glass is a luck of multilayer between filaments of glass of very little thick with layer on layer of a glue special. First, in the backpack of stainless steel, is placed a resin to form removal, successive layers of adhesive and fiber that can dry up a rigid structure of "fiberglass" are placed on it. Between the layers 2 steel sheeting of subject, for the mounted to wall, left planned also to grant more rigidity to the backpack system. The "demolding" must do is with special care because could fail is the backpack in fiber. All the holes are made a time demolded and well dried it backpack. See Figure 7.

7.2 Backpack in stainless steel.

While "a priori" determines that the most suitable to use on the backpack will be made in fiberglass, in meetings with specialists in the topic emerges that there is the need to first build a backpack in stainless steel, as mold, which also serve to make a real analysis of this important part of the system serves as a mold for the subsequent realization of backpacks in fiberglass. This backpack is made starting from a plate of steel stainless. In it, is the layout of the parts of the backpack, taking into account the subsequent welding. Cuts are made with great precision, as each party has to fit perfectly with the other. Then, is performed them welds by the side internal of the backpack to not side-stepping to the view. The same is done with a welder of steel stainless.

Then holes planned for all the connections necessary is performed as last step before make some polished of the surface.

Once the prototype in stainless steel finish, began to notice some of its disadvantages: excessive weight (even without being charged with water) and the high price per unit of finished backpack that emerged from an analysis of costs.

Figure 7. Packaging Design. Picture belong to the authors.

8 DESIGN AND IMPLEMENTATION OF THE GASKET, CAP AND LOGO

8.1 The packaging

The materialization of the packaging led to a major investigation and that opened some doors to future interventions and work with the material paper carton that is a product that is widely accepted for recycling at the time.

It was to identify the Centers for the collection and recycling of the same but in which the cardboard paper is sent to other cities where it is recycled. Called the attention that in Tucumán not is has could give with a center where is working directly with cardboard recycled.

Figure 8. Packaging Design. Picture belong to the authors.

The packaging is worked with a factory that made paper recycled cardboard boxes.

The decision of the box in form of portfolio was tested with all then products in and after an evaluation is observed that is very practice to be transported. A design friendly and of simple identification, were well received in samples carried out in the Faculty of architecture and urbanism of the National University of Tucumán.

8.2 The access cover and logo.

When comes the problem of the name / logo, at the same time, is raises the problem of have an access from the front of the backpack. Both problems were dealt with together giving a unique solution. The lid and the logo would be a same object and it should hide a flange behind the same.

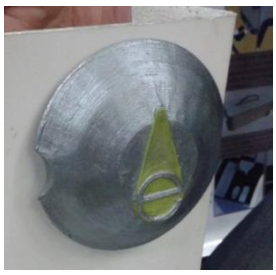

Figure 9. Cover. Picture belong to the authors.

9 EXPERIMENTATION AND EVALUATION OF THE FULL SYSTEM.

Prototype in real scale. In workshop is proceeded to the construction of a model demonstration that includes a sink, a toilet and the system of collection of waters grey included. The prototype was assembled on a metal structure where the floor and wall are simulated with bolted plates of superboard. On the plates sanitary items with all their fixations are arranged in the same way as if they were placed in a health center. Facilities that are not built are the basic health care but that you opt for a container that fulfills its function. As regards the main of water cold, is performs the connection of the same of equal way that to a basin, of mode such that the system is it more identical possible to the reality. The idea of this prototype with all the elements in operation is to evaluate the system in a controlled environment to make the adjustments that are necessary for the following stages. In the system after use the basin for sanitizing is them hands, the water circulates by gravity within them pipes behind the plate of wall to get to the point of access of the water behind the backpack. In this point, is saw the difficulty of that the water with the first filter that is had decided use tended to stall is, as said filter not had the speed appropriate for filter and allow the entry of the water. The scale model allowed us to then evaluate the chosen filter to improve this issue.

Starting from the income to the backpack, the water is exposed to the pill water treatment that you removed the color, also, of prevent the possible production of germs and bacteria.

After the evacuation of the water through the toilet, we see that the system works although it presents some points to keep in mind when it is installed in health centres. Always place the washbasin and toilet closest possible because it could stall as the circulation through the pipes is simple gravity to have long stretches of mains water, including return is appropriate to achieve an efficiency in the proposed system. Also, as mentioned, the water filtration system must be fast enough to prevent the return of water into the pipe, with the possibility that the water is in basin flooding it. He is proposed to then study a type of filter similar or lower density but same filtering capability. So is placed a cloth dripping used in drains of kitchens, which allow grey

water filtering, decanting the solid remains the same. Are sets that the dripping pan should be response each a period of 2 months.

Figure 10. Real size model exhibited at the Tucumán Expo Fair 2015.

CONCLUSIONS

- Designed, built and experienced and evaluated system has been well received and has been adopted.
- Is determined that the methods and tools used served to get to a product that may have an impact real starting from its use and production in series.
- Is found that there is a need in the medium by opt by systems environmentally friendly and that improve the quality of life of the users. Is noted the need of: to delve into the reporting on the need for environmental sustainability, in general, and on the rational use of water, in general; (b) the promotion of spaces for transfer in this regard.

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