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The new technologies of rainwater utilization

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Abstract: Although rainwater utilization is a very new building technology, by using minimum technical standards that are now proved, it belongs increasingly to modern housing equipment. Both specialist companies and people who build their own houses are now installing systems that vary quite a lot, both according to the quality of design and the materials used. As with other building techniques too (e.g. heating, that is similar to the domestic water supply from the point of view of technical requirements), rainwater utilization is in a permanent state of further development. But the necessary minimum technical standards, that have evolved from practice over the last few years, can nevertheless be realised even today.

Keywords: roof surface, filtering, storage, pumps water

1. INTRODUCTION

Both in new buildings as well as with installations made later, the following principles should be taken into account:

· no connections from other paved areas such as balconies, terraces or yard surfaces, because of massive pollution

· designing the rainwater system accoding to building standards (guaranteeing the drainage of the building, even with disruptions in the system, no restrictions in the sectional area, ventilation of the drainage system). Preventing deposits of dirt and water.

· fine filtering of the water before entering the storage tank

· securing the storage tanks against the entry of foreign matter and exit of water (household insurances often refuse coverage for water damages, especially with storage inside buildings)

· pipework should be as straight as possible and short

· use of non-corrosive materials and highquality, durable components

· strict separation of potable and domestic water systems (according to local regulations); complete identification of all components in the system as „not for drinking purposes“ („non-potable“) and maintaining this [2].

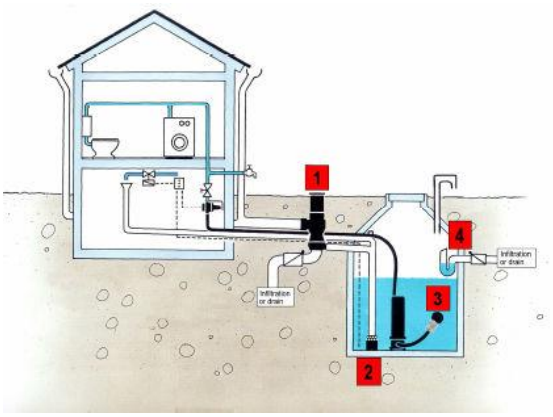

Fig 1 Rainwater harvesting system
Graphic courtesy of Wisy Ag.

2. ROOF SURFACE

All roofing materials are suitable for the collection of rainwater, with a few exceptions. Notsuitable, or only suitable with reservations are:

· roofs covered with grass or sedum plants (discharged water is coloured, only usefull for watering the garden)

· weathered asbestos-cement roofs (even without the use of rainwater they represent a type of negligent physical injury because of the high fibre abrasion, and should be replaced)

· roofs with a fresh bitumen coating or permanently flexible bitumen felt roof covering (washing machine connection only when there is no emission of colour pigments into the rainwater)

· metal roofs, except stainless-steel, roofs with large metal parts (unsuitable for garden watering, enrichment of metal ions in the soil).

Pollution and puddle formation in the gutters of the other parts of the rainwater system can lead to unwanted soiling and formation of fungus. Varying percentages of the rainwater will be evaporated or

retained according to the pitch of the roof and the roof covering (e.g. formation of puddels on flat roofs).

Basically all suitable roof areas should be connected to the system. Overflow water should go to soakaways or seep away where possible [3].

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3. FILTERING

The rainwater from the roof should generally be filtered with a fine filter before entering the storage tank (for orientation: mesh size < 0,3 mm). There should be no further fine filters after the storage, either on the suction or the pressure side, because these are unnecessery, often heavily reduce the life of the pump through flow resistance, and can develop into a source of germs through the growth of bacteria on the filter insert [2].

Requirements for the filtering system:

· reliable removal of large and small particles from the rainwater coming from the roof

· permanently good filter effect with small loss of water

· drying out after rainfalls

· no clogging, no germs, no fungus, no algae

· ensure the drainage of rainwater from the roof according to building standards, even if the filter is clogged or the storage tanks are closed

· good accessibility, simple cleaning without consequential costs, little maintenance

Fig. 2 Downspout (Hans Otto-Wack)

Stainless steel is considered the best filter fabric because it can withstand all weather conditions, even ice formation and frost, is self cleaning and self drying, maintains shape, and does not rust, thus reducing contamination likelihood. The vortex filters in Fig. 3 include a removable stainless steel filter insert and the downspout filter in Fig. 3 is constructed solely of stainless steel [4].

Fig. 3 Vortex and downspout filters (Wisy AG)

Modern filters do not require replacing and require little maintenance, unlike the old roofwasher design. Figure 4 shows the difference between the old design and the modern filter design. The roofwasher on the left requires periodic cleaning and
filters need replacing yearly, while the filter on the right never needs replacing.

However, the self-cleaning filter does require monitoring as buildup may occur, depending on the local environmental conditions. If the stainless steel filter insert needs cleaning, it can be washed in the dishwasher.

Fig. 4 Old and modern filter designs
(Rainwater Management Solutions and Wisy AG)

4. STORAGE

Rainwater storage tanks serve both for the storage and the cleaning of the rainwater. The amount of cleaning is thereby directly dependent upon the flow of the water in the storage vessel (inlet, overflow, suction).

Requirements for rainwater storage:

· mesurement of volume according to roof area (not too large, approx. 1m³ per 25 – 40 m² of roof area)

· fulfilling the requirements of the building standards (ensuring the drainage of the building)

· stability of shape, secured against settlement cracks and buoyancy, durability

· neutralised against acid rain, good oxygendistribution in the water

· automatic removal of all materials that are lighter than water and float (storage not too large, correctly constructed overflow)

· providing a sufficiently large overflow against other water or backpressure, sewer gases and animals;

· sealing covers and walls against foreign particles, other water, sewer gases and animals

· good accessibility, simple cleaning without extra costs, little maintenance

This requirements will be best fulfilled in practice by a one-piece concrete cistern. Other types of storage tanks usually require more expense to achieve this standard. Old cesspools can also often be renovated to serve as rainwater storage cisterns. Cisterns in the earth are basically preferable to cellar tanks. To protect against backpressure from the sewer it is reasonable to provide a soakaway in the ground for the overflowing amount of rainwater; no sewer connection is required in this case [1].

Tanks are the most expensive component in the rainwater harvesting system. However, tanks are the

most important part of the system as water supply is dependent on a fully functioning tank. The many tank materials vary based on local availability and climate (fig. 5).

Fig. 5 Below ground tank
(Image courtesy Rainwater Management Solutions)

5. PUMPS WATER SYSTEMS

Requirements for a pump water system:

· pipework designed to requirements (see pump characteristic curves in connection with the requirements of each construction project), small power consumtion

· high degree of effectiveness (small space between pump housing and rotor disk)

· consistent use of high-quality, non corrosive materials throughout

· durability (non-abrasive mechanical parts, highquality bearings, easy to repair, possibility of use with different pressure and system controls; operation without diaphragm pressure vessels in the branch current

· quiet-running, low-noise (especially suitable: multiple-stage pumps) and muffled installation with flexible connections to the pipework

· proper installation of the pump; secured against running dry

· no large spaces filled with water and a lack of oxygen, e.g. pressure diaphragm vessels in the branch current connected to the pump

· low suction height for suction pumps and a short, airtight, suction feed pipe

· floating suction system for submersible pumps

6. FILLING UP WITH POTABLE WATER

If the rainwater storage is insufficient in long dry or frostly periods, potable water must be fed into the system in order to ensure further operation. This can only be carried out according to building regulations in an open feeding system, with the provision that there is a strict separation of potable and household water. The use of a drinking water feed module, or a pipe separator is also possible. The open feed should fundamentally be above the level of backpressure, but never in the storage tank itself. It is recommended to automatically control the filling by a detector and a magnetic valve (with a catch pan for dirt) and to limit the volume of filling to ½ of the daily requirement [3].

7. MAINTENANCE

Every installation must fundamentally be maintained at certain intervals to guarantee the permanent

operational safety. In a good system, the parts in mechanical use, such as the pump or the magnetic valve, should be overhauled 2 to 4 times per year, whilst the parts that are not used so much, such as the filter collector or storage tanks, may be overhauled twice a year [1].

In practice it has been found that the components needing most maintenance (e.g. gravel/sand filters, fine fabric filters, diaphragm pressure vessels in the branch current on the pumps, cheap pumps, corrosive components), and design and installation faults (too much storage, backfall on the rainwater gutter, magnetic valves or dirt collectors etc.), significantly increase the frequency of maintenance and the consequential costs. If many high maintenance parts are installed, the installation will, in extreme cases, become an occupational therapy and a grave for subsequent costs, but not a sensible building technology.

8. DESIGN AND CONSTRUCTION

Rainwater utilization installations can be fundamentally installed in any building. The only exceptions are for buildings where there is no suitable place for the storage, or which have no suitable roof surfaces, or cannot be secured against sewer

backpressure.

In any case an individual design is needed for a rainwater installation; even with a detached singledwelling house preliminary planning can possibly save enormous subsequent costs and annoyances. The basis of the planning and design is the above described minimum technical standards and the amount of water that can be collected. These can be calculated with the following formula:

Roof area in m² x 0,75 (flow-off rate for pitched tiled roofs) x m of rain per year = rainwater collected in m³ per year. About 85% - 90% of the rainwater calculatet in this way can be used; the rest is not available für the supply because of internal use for the installation (e.g. rinsing of the filter). But if there is a poorly maintained pot filter in front of the storage tanks, there may only be a water supply of 20% to be expected [2].

The size of the water storage, oriented on the available roof area can be calculated from:

Rainwater supply per year in m³ x correction value (0,05) = storage size in m³.

A rough formula is that there is about 1 m³ of cistern volume for every 25 – 40 m² of roof area. A warning should be given about having too much storage; as this will overflow too seldom, the floating layer will not be swept away and the water will then become putrid and will have to be discarded. Practice has rather shown that a surprisingly high economic use can be achieved, even with a storage system that is tighly calculated [2].

Care in the award of orders to specialist companies is required. As rainwater utilization is still a new building technology, many tradesman have little experience of installing rainwater systems. Before placing an order the tradesman should be required to either show approbiate qualifications (such as a successfully completed training course) or installations that have already been properly installed [1].

9. SAFETY EQUIPMENT

The following safetty equipment must be installed according to the type of installation and building:

- continuous identification of all parts of the installation, especially the points of use, as „not for drinking purposes“ („non-potable“)
- approbiate label on the main valve of the drinking water supply, indicating the rainwater installation
- insulation of the pipework against freezing and condensation when in ducts
- drain valve at the lowest point of the pressure system
- safety equipment for taps, against unauthorised use
- accoustic alarm for faults

CONCLUSIONS

Investigations of rainwater so far known, have shown that the quality of the rainwater in the area of use has very little to do with the possibly soiled rainwater from the roof.

Quite the opposite: a water supply to a washing maschine can, for example, permanently conform with the European limits for bath water, with an appropriate professionally installed system.

The water is then clear, odourless and colourless, and free of solid matters; using washing machines with rainwater is to be recommended.

The conditions for this are that a certain minimum technical standard must be ensured; if mistakes are made in the design, choice of components, or execution of the work, on the other hand, there may be drastic losses in the quality that will quickly be shown in the development of odours.

The use of rainwater systems instead of water from the mains can only be considered for the following areas: flushing toilets, for washing machines, household work and cleaning, garden and other watering purposes.

A complete rainwater system should not be installed just for garden watering because of economic grounds; a few rainwater barrels for the summer month will be quite sufficient for this.

REFERENCES

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