

Rainwater utilization in housing

Preliminary remarks

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. As an ecologically sensible and necessary technology it therefore has a growing economical importance and creates employment. 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. The following paper should therefore be of help for the design, the purchase and the installation.

Quality of rainwater and areas of use

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 machine 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. As with other building techniques too (e.g. heating) a sound technique is the prerequisite for a trouble-free and low maintenance (and therefore cheaper) operation of the system.

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.

Technology of rainwater utilization

The system as a whole

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

- use of rainwater only from suitable roof surfaces
- no connections from other paved areas such as balconies, terraces or yard surfaces, because of massive pollution
- designing the rainwater system according 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
- ensuring the 2nd and 3rd cleaning stages in the storage tanks will always function.
- 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 high-quality, durable components
- exclusion of light and warmth of more than 18° C
- 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.

Roof surfaces

Extremely soiled roofs should not be used (pigeon or dove-cotes, regular heavy dust emission nearby, e.g. cement factory). All roofing materials are suitable for the collection of rainwater, with a few exceptions. Not suitable, or only suitable with reservations are:

- roofs covered with grass or sedum plants (discharged water is coloured, only useful 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 puddles 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.

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 unnecessary, 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.

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

Many filter systems on the market for rainwater installations do not fulfil these criteria because they hold the dirt that is filtered out, which then builds up a layer preventing the water from passing through and forms a growth (e.g. sand/gravel filter, filter mats, fabric filters etc). In order to avoid large losses of water they require intensive maintenance. On the other hand, filter systems that are largely self-cleaning (filter collectors, vortex filters) are ideal.

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). This applies both to storage vessels inside as well as outside.

Requirements for rainwater storage:

- measurement 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)
- permanently water-tight and must have protection against light, storage temperature permanently below 18° C, frost protection
- stability of shape, secured against settlement cracks and buoyancy, durability
- neutralised against acid rain, good oxygen distribution in the water
- calm inlet of rainwater and potable water. Calm suction (for permanent sedimentation of all materials heavier than 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

These 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.

Pumps/household water systems, Pressure-raising systems

There are different types of pumps according to the system used. In most cases the best types are multiple submersible pumps (advantage: no suction problems), or self-priming, multiple-stage, rotary pumps, both with automatic pressure regulator. The pump and the pipework system are handled with care by the choice of a starting and final pressure that is adapted to the requirements. In any case only high-quality products should be used; a warning is expressly given against cheap offers.

Requirements for a pump/household water system:

- pipework designed to requirements (see pump characteristic curves in connection with the requirements of each construction project), small power consumption
- 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, high-quality 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

Filling up with potable water

If the rainwater storage is insufficient in long dry or frosty 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 end of the pipe from the potable water system must, in this case, be at least 20 mm above the edge of the filling funnel to the rainwater system, whereby attention must be given that there is no back-

pressure in the pipework of the part not under pressure. 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.

System controls

The installation of an automatic system control is recommended under the provision that the rainwater system should be operationally safe and easy to use. It should always control the protection of the pump from running dry or air entering, and the filling of potable water when rainwater is in short supply. An optical filling gauge is also recommended.

Requirements for a system control:

- high degree of switch durability, permanent and low maintenance functions

- short switching paths
- optimum use of the storage volume, low but sufficient sedimentation volume when running-dry protection is used
- minimum potable water feed when required (1/2 of daily requirements)
- use of non-corrosive, environmentally friendly materials (also for the fixing elements)

Safety equipment

The following safety 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“)
- appropriate 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
- acoustic alarm for faults

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.

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.

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 single-dwelling 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 calculated in this way can be used; the rest is not available for 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.

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 tightly calculated.

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 appropriate qualifications (such as a successfully completed training course) or installations that have already been properly installed.

The author

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