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The reuse of rainwater drains by using «green roofs».

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ABSTRACT

The article is devoted to the possibilities of purification of rainwater drains by using "green roofs" and their further using for domestic needs: watering the garden and the roof itself; toilets washing; laundry. To collect rainwater it is proposed to use the storage tank. The basis of the calculations are taken by the German method Wilo, adapted to the conditions of Ukraine. A significant contribution to this methodology is taking into account the uneven distribution and precipitation throughout the whole year and the lack of costs for watering the garden and roof in the winter period. Purified rainwater from "green roofs" can be assembled into tanks and used for technical needs. For collecting rain water from an intensive flat roof with an area of 200 m2 for the family of 4 people a tank of 5 m3 is required. In this case, the total needs for the house and watering the garden are 111 m3 / year, and daily needs - 0,341 m3 / day.

1. Introduction.

The advantage of "green roofs" in urbocenoses is not only in reducing the load on storm sewage and sewage filtration. Purified rainwater from "green roofs" can be assembled into tanks and used for technical needs (toilets washing, the using of washing machines, gardening etc.) [1,2]. Due to rising water tariffs,

rainwater using is becoming more and more justifiable. The Germans consider that soon rainwater will be as commonplace as the separation of wastes, 60% of drinking water can be saved by using rainwater. These funds can be used for other purposes. But more important is the preservation of water, the most valuable resource. The environmental technologies of the German company Wilo [3] have the best reputation in the world for using of rainwater. This company has developed a handbook for using of rainwater. This manual provides examples of calculations of rainwater inflow, water demand determination, calculation of tank volume for rainwater storage and choice of water supply system. In addition, it is interesting and valuable to introduce a runoff coefficient (c) for different types of roofing surfaces, including for intensive and extensive green roofs. There is no such method in Ukrainian DBN B.2.6-14-97 [4] and DBN B.2.6-220: 2017 [5].

In areas where is a big part of the precipitation falls in the winter months, "green roofs" may not be as effective because there is less water retention in the winter. Consequently, efficiency increases in those regions where a significant amount of precipitation falls in the warm period.

The technology of "green roofs" is used for quantitative and qualitative regulation of rainwater drains. Qualitative regulation of rain drains involves their filtration and reuse of wastewater, which saves valuable natural resources - water.

2. The main part.

The calculation of the tank for storing rainwater from the intensive roof with steppe type of landscaping, made by us in the south-east of Ukraine (Fig. 6.1) is executed. Calculation of the tank volume for the advanced author's methodology based on Wilo's methodology [3].

According to DSTU N B V.1.1-27: 2010 annual precipitation for this region is 522 mm/year [6]. The maximum average monthly precipitation [7] falls on June (30 days) and can be 66 mm / month.

1. Calculation of the amount of precipitation:

The amount of precipitation per month per unit area: $q = 66$ dm^3/m^2;

The collection area: $S = 200$ m^2;

Runoff coefficient $c = 0,5$ [3] (flow coefficient data varies depending on roof design, climatic conditions (affecting evaporation) and phytocoenosis [8];

Days per month zm = 30 days.

The maximum monthly outgoings of rainwater is determined by (1).

By the formula (1) $Q_p = 66 \cdot 200 \cdot 0,5 = 6600$ dm^3/month.

$Q_p = q\ S\ c$, dm^3/month. (1)

Average daily flow of rainwater in the month of maximum precipitation (June):

$Q = Q_p / z_m$, dm^3/day (2)

By formula (2) Q = 6600/30 = 220 dm^3/day.

2. Calculation of needs in rainwater:

per person:

drain tank of a toilet without economical button: 14 m^3/year [3];

Washing machine: 6 m^3/year [3];

crane for washing(cleaning): 1 m^3/year [3];

total q_l = 14 + 6 + 1 = 21 m^3/year.

for all residents of the house (n = 4 people)

$Q_{p,needs,l} = n\ q_л$ = 4 · 21 = 84 m^3/year;

for irrigation of the garden with an area S_c = 250 m^2 with the requirement q_c = 0,06 m^3/(m^2·year) [3]

$Q_{p,\ need,c} = S_c\ q_c$ = 250 · 0,06 = 15 m^3/year;

for watering the "green roof" with area S_p = 200 m^2 with the same need

$Q_{p,need,n} = S_n\ q_c$ = 200 · 0,06 = 12 m^3/year;

Total water requirements:

$Q_{p,needs,pl} = Q_{p,needs,c} + Q_{p,needs,n}$ = 15 + 12 = 27 m^3/year;

Total house needs and irrigation:

$Q_{p,needs} = Q_{p,needs,l} + Q_{p,needs,\ pl}$ = 84 + 27 = 111 m^3/year;

Daily needs during the irrigation season of the gardens are approximately z_s = 243

$Q_{needs} = (Q_{r,needs\ ,l}/365) + (Q_{r,needs,\ pl}/z_c)$, m^3/day. (3)

By the formula (6.3) Q_{needs} = (84/365) + (27/243) = 0,3412, m^3/day

3.Tank calculation

Experience shows that the volume of the tank for storing 2-3 weeks of water is optimal. Larger volume leads to a deterioration in the quality of water, and less - to using of drinking water in larger amount. We accept the time of accumulation of water 3 weeks or z = 21 days;

Required tank volume with available rainwater

$$W_{needs,ò} = Q\,z\,/\,1000,\ m^3. \quad (4)$$

By the formula (6.4) $W_{needs} = 220 \cdot 21/1000 = 4.62\ m^3$

The consumption time of the received water volume will be

$$Z = W_{needs} / Q_{needs},\ days. \quad (5)$$

By formula (5) $Z = 4.62 / 0.3412 = 13.5$

4. Because of the water consumption time corresponds to the recommended (2 weeks) we accept to install a tank with a volume of 5 m^3. In case of exceeding the consumption time (3 weeks) the volume of the received tank is reduced *(in the case of rapid consumption of water we leave the received volume of the tank or, in the presence of the customer's funds, increase it in the hope of a possible excess of the norm of precipitation).*

Conclusions

Thus, the important ecological and economic benefits of "green roofs" in modern urbocenosis are: reducing the amount of sewage due to evaporation and moisture absorption of plants; improvement of the quality of sewage due to natural filtration; reducing the load on storm sewage by reducing the rate of water flow.

Purified rainwater from "green roofs" can be collected in tanks and used for technical needs. For collecting of rainwater from an intensive flat roof with an area of 200 m^2 for a family of 4 people a tank of 5 m^3 is required. In this case, the total needs for the house and irrigation of the garden are 111 m^3 / year, and daily needs - 0,341 m^3 / day.

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