D-Rainclean®

Treatment and Drainage of Polluted Rain Water Runoff

Including DIBt-Approval
D-Rainclean® –
The Filter Channel

The Product

Current analyses entrusted by the Federal Environment Office* show that the load of heavy metals in waters and soil will have to be considerably reduced by appropriate treatment. Approximately 930 t/a, 80 t/a lead and 2078 t/a zinc in waters and soil originate from car traffic, only.

With the development of D-Rainclean®, a combination consisting of a filter channel made from PP and a Filter-Media, Funke offers a professional solution for the treatment of polluted surface water. D-Rainclean® absorbs the partly heavily polluted rain water of streets, parking areas, court- and roof areas and releases it in harmless condition. Thus D-Rainclean® meets the requirements according to the revised DWA worksheet A 138 regulating the treatment of polluted rainwater prior to its percolation in Germany.

D-Rainclean consists of plastic elements 50 x 40 x 37 cm filled with a Filter-Media which is part of the system. This Filter-Media cleans the rainwater by filtration, adsorption and inclusion, ion exchange, precipitation and biodegradation as required by the high legal demands of the soil and water protection. There are 2 different versions of D-Rainclean® Channel; the open version also allowing for planting and a closed version with a cast-iron cover class D/400 kN. Appropriate end pieces are available for the system. Depending on the degree of load the D-Rainclean® Filter-Media has a life cycle of between 15 and 20 years.

*Report UBA-FB „Entries of Copper, Zinc and Lead into Waters and Soils – Analysis of Emission, Pathways and possible Emission Reduction Measures” 11.2004
Requirements Entirely Met

The DWA (German Association of Water-Management and Waste) has edited the worksheet DWA-A138 “Planning, Construction and Operation of Installations for the Percolation of Rain Water”. It describes the different possibilities to percolate rain water. Contrary to the previous edition, which was related to non-harmful polluted rainwater, the new edition also contains regulations for the treatment of heavily polluted rain water prior to percolation. As a consequence, architects, planners and owners will have to deal with the civil engineering and law aspects of this issue. D-Rainclean® offers the solution. Near highly trafficked streets and parking areas, even in a distance of up to 15 m from the driveway, critical pollution loads and regularly exceeding threshold values are to be found. D-Rainclean® absorbs these contaminants and cleans them prior to reaching the ground water. Thus, soil pollution or pollution of the ground water is avoided.
Along with Channel and Filter-Media, further components of the D-Rainclean®-System offer ideal solutions for different installation situations. There is a Cast-Iron Cover and Frame available which allows the Channel to be used for load class D/400 kN. After heavy rainfalls, an emergency overflow unit ensures that surplus rainwater may be diverted in a controlled way. Using the end pieces, a professional completion can be
System Components

End Piece
for the left or the right side, respectively
Dimensions: 250 x 400 x 366

Emergency Overflow Unit
with connection DN/OD 110, left or right
Dimensions: 500 x 400 x 366

Installation Wrench

D-Raintank®-Unit
without connection built and the D-Raintank® unit creates the pre-condition for the D-Rainclean® System to be installed in areas with low water permeability. Further accessories as nails and installation wrenches facilitate the installation and maintenance on site.
**The Filter-Media**

**Heavy Metal Sorption/ Desorption and Precipitation**
Heavy metals are subject to different processes in D-Rainclean\textsuperscript{®}: Whereas nickel is mainly retained by sorption, lead, cadmium, copper and zinc remain within the Filter-Media by sorption and precipitation. Cadmium, together with zinc and nickel are classified heavy metals being mobile and shifted relatively easy. As for cadmium, a constantly high pH-value within the D-Rainclean\textsuperscript{®} Filter-Media is very important. Just like copper, the bonding of lead is achieved by specific adsorption processes. Mercury, however, which is known to be very immobile, is bonded to the organic substances contained in the D-Rainclean\textsuperscript{®}. Chromium with higher pH-values is bonded to very hardly soluble Cr(OH)\textsubscript{3} and Cr\textsubscript{2}O\textsubscript{3} is mainly bonded to iron ions.

**Water Holding Capacity**
The soil-microbiology produces a very important degradation performance, especially during the warm seasons. Sufficient moisture of the D-Rainclean\textsuperscript{®} Filter-Media is an indispensable condition for this process. The retentive power is attained by a big pore space, an appropriate rate of organic substances and a high ratio of water absorbers in the D-Rainclean\textsuperscript{®} Filter-Media. Additionally, the D-Rainclean\textsuperscript{®} Channel provides for a water reservoir of 3.0 l per metre on the bottom of the channel.

**Sorption of Noxious Substances**
Going from a $k_f$-value of $5 \times 10^{-4}$ m/s (water permeability), the detention period of the water flow in the D-Rainclean\textsuperscript{®}-Channel is approx. 10 min. After the water has passed the Filter-Media, the testing values with regard to the evaluation of the pathway soil – ground water according to § 8 chapter 1, sentence 1 of the German Federal Soil Conservation Law (Bundes-Bodenschutzgesetz) go below values determined in the law (see table 1). The sorption isotherms of the appropriate heavy metals lead and zinc have been recorded for soil and D-Rainclean\textsuperscript{®}.

| Table 1: Testing Values Soil – Ground Water according to German Federal Soil Conservation Law (Bundesbodenschutzgesetz) |
|-------------------------------|-------------------|
| Arsenic (As)                  | 10 µg/l           |
| Lead (Pb)                     | 25 µg/l           |
| Cadmium (Cd)                  | 5 µg/l            |
| Chromium (Cr)                 | 50 µg/l           |
| Copper (Cu)                   | 50 µg/l           |
| Nickel (Ni)                   | 50 µg/l           |
| Mercury (Hg)                  | 1 µg/l            |
| Zinc (Zn)                     | 500 µg/l          |

**Laboratory Testing**
Compared with “good soil” the D-Rainclean\textsuperscript{®} Filter-Media shows considerably better adsorption results. On average, 90 % of the zinc is adsorbed. The proportion of lead being adsorbed is at approx. 99 % and thus considerably higher. As soon as the threshold concentration is attained, the uptake of the D-Rainclean\textsuperscript{®} Filter-Media is exhausted. This arises after approx. 15 – 20 years depending on the volume of traffic (see graph page 8). Thereafter it is advisable to exchange the Filter-Media.
**Coefficient of Water Permeability**

The D-Rainclean® Filter-Media possesses a coefficient of water permeability of $5 \times 10^{-4} \text{ m/s}$ and thus has a sufficient infiltrative capacity. At the same time an appropriate detention period of the polluted water within the D-Rainclean® system provides for a sufficient adsorption of harmful material.

**Organic Harmful Materials**

The D-Rainclean® Filter-Media has an organic matrix, supporting the bonding and the degradation of organic harmful material. Mineral oil hydrocarbons and lightly volatile halogenated hydrocarbons in a concentration and a physical condition (residual spreading) occurring on trafficked areas normally, are well degradable. As the micro-organisms in the D-Rainclean®-Channel settle on moistened surfaces, the size of the total surface is a vital criterion for the biodegradation of organic substances. D-Rainclean® has an extremely large total surface.

**Oil Infiltration in D-Rainclean®**

Increasing infiltration (cm) over a period of 60 minutes after the addition of 10 l oil

The oil looses its fluidity and covers the surface of the pore space like a thin film. This way the oil provides a good target for the micro-organisms. With a minimum of 60% of pore space, D-Rainclean® Filter-Media offers ideal premises in this respect.

**De-Icing Salt**

The question came up if by the use of de-icing salt (normally NaCl) adsorption places will be blocked by sodium and if already bonded hazardous material will be washed out again. This is why the short- and long-term effect of de-icing salt to the capacity and the life of D-Rainclean® Filter-Media were tested. The results reveal that the adsorption capacity of heavy metals in the D-Rainclean® Filter-Media is influenced to a very little extent only by sodium chloride. Even shock loads with sodium chloride in step with actual practice do not cause a rinse flush of already bonded heavy metals into the ground. Heavy metals remain bonded in the Filter-Media permanently, even if sodium chloride is used. The life of D-Rainclean® is depending on the quantity and the frequency of de-icing procedures. Tests show, however, that the predicted life of about 15 years can be attained.

**Planting of the D-Rainclean®-Channel**

It is not generally necessary to plant the D-Rainclean®-Channel. It is, however, possible if desired. Even though the Filter-Media is extremely oligotropic, there is enough nutrient content for selected plants. The open channel may for example be planted with 2 pachysandra or 2 mahonia and 2 vinca minor or 1 cotoneaster.
pH-Value
The carbonate buffer range of the D-Rainclean® Filter-Media is above pH 7.2.

The Cation Exchange Capacity
The cation exchange capacity (KAK$_{pot}$) defines the maximum quantity of cations absorbable, like heavy metals for example. Concerning exchange processes characterized by the type of ions, a KAK$_{pot}$ of min. 20 cmol/kg is aimed at. This value is mainly achieved by adding adsorptive components and zeolites.

The property of the D-Rainclean® Filter-Media to function as an ion exchanger ensures the bonding of heavy metal ions. An active contribution to ground water protection!

Disposal
Clean D-Rainclean® Filter-Media fulfills the requirements of the classification soil “ZO” according to information no. 20 of the Länderarbeitsgemeinschaft Abfall – LAGA, (National Waste Consortium). Saturated Filter-Media always meets the classification value Z2, with the exception of effluents originating from pure metal roofs. Depending on the input of contaminants and after the respective testing it is even possible to attain a classification value of Z1.

The classification of used D-Rainclean® Filter-Media to certain dump categories – classifications between DK 0 and DK 5 are possible – arise from the load case of the Filter-Media. The latter depends on the life cycle and the intensity of the input of contaminants. Normally charged Filter-Media can be discharged on dumping grounds class II or if moderately charged disposed even on dumping grounds class I (Decisive for the choice of the dumping ground class is not the total contamination value but the eluate value).

Useful Life
Light Impact – approx. 20 years
Water from roof areas, yard areas, bicycle and pathways, car park areas, streets with max. 300 DTV
(Category 1 – 5 ATV A 138)

Average Impact – approx. 18 years
Water of roof areas in industrial areas with significant air pollution, streets with a max. of 300 to 5,000 DTV,
(Category 6 – 8 ATV A 138)

Heavy Impact – approx. 15 years
Areas in industrial estates, trafficked parking lots, streets with 5,000 to 15,000 DTV per day (Category 9 – 11 ATV A 138)

Duration of the D-Rainclean® Filter Media with different loads

<table>
<thead>
<tr>
<th>Duration / Years</th>
<th>Light Impact</th>
<th>Average Impact</th>
<th>Heavy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>ALG 005 - 006</td>
<td>ALG 005 - 006</td>
<td>ALG 005 - 006</td>
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DTV = average daily traffic volume
In 2006 the DIBT (German Institute of Structural Engineering) have issued a general technical approval for D-Rainclean® to Funke Kunststoffe GmbH. DIBt-Approvals are accorded either to construction products and design within the scope of the State Building Regulations, considerably differing from generally accepted rules of engineering or for which no DIN standard is existing. They prove the applicability of construction products and design with respect to structural engineering requirements of buildings. A decisive point of view, as a general technical approval stands for an additional surplus of security for the client and the user alike. With D-Rainclean®, they obtain a defined and approved system for the professional treatment of polluted rain water. Funke Kunststoffe GmbH is proud of being the first company to receive this approval for a system used for the treatment of polluted rain water.
D-Rainclean® — The Applications

1) Sectional View

2) Sectional View

3) Sectional View

4) Sectional View

5) Sectional View

Technical data subject to change.
Example for the drainage of a parking area

**Drawing 1/2: D-Rainclean® Filter Channel with/without cover**

**Drawing 3: D-Rainclean® Filter Channel with raised curb**
The separation from D-Rainclean® by a Raised Curb is an option for example between rows of car parks.

**Drawing 4: D-Rainclean® Filter Channel with HS-Infiltration Pipe**
The combination with a HS®-Infiltration Pipe allows for the D-Rainclean® System to be installed in soils characterized by low water permeability.

**Drawing 5: D-Rainclean® Filter Channel with Cover**
The D-Rainclean® Filter Channel with cast iron cover (500 mm × 360 mm) is particularly suitable for the use in connection with trafficked areas. The filter channel is equipped with a cast iron frame and adapted for class D/400 kN.

**Calculation of Area**

Going from a parking area of 900 m² ($A_{red} = 620$ m²) – which is sufficient of approx. 38 parking spaces – and assumed raindata of $n = 1.0$ a⁻¹, 72 m D-Rainclean® Filter Channel is necessary. This is divided into 27 m closed version with a cast iron cover class D/400 kN and 45 m open filter channel. The material costs for this layout amounts to about 13,000 Euro. Unlike the drainage via the local sewerage system an economical solution!

Further advantage of a D-Rainclean® Solution:

– Load reduction of the sewer system and the sewage treatment plant
– Modest maintenance costs
– The rain water is percolated on site – leading to an improved ground water recharge

Considering the different components as oil separator, silt trap, control chamber, drainage pipes etc. costs will add up to about 16,000 Euro (plus VAT and rainwater fees where applicable).
DB Deutsche Bahn AG

Even the Deutsche Bahn AG (German Railway) is using the D-Rainclean® System successfully already. In the scope of the extension of the rail road between Munich and Augsburg or during the side works in Germswang Bavaria. In both cases, on behalf of the DB Netz AG, contaminated excavation material is temporarily stored on a sealed area. The rainwater in this area is collected in a sedimentation tank and diverted into a distribution chamber via a pump shaft or a pressure pipe line. From there the rainwater enters into the D-Rainclean® System. The Filter-Media cleans the rainwater loaded with various harmful materials by filtration, adsorption and inclusion, ion exchange, precipitation and biodegradation as required by the high legal demands of the soil and water protection regulations.

D-Rainclean® – Special Solutions

Eco-Soil-Filter

The Eco-Soil-Filter, a combination of a concrete container and D-Rainclean® Filter-Media, produced by B. Müller GmbH, a concrete plant in Achern, offers a professional solution for the dealing with rain water on developed areas. The system that has been developed together with Funke Kunststoffe GmbH consists of a round concrete corpus, size between DN 1500 and DN 2500 equipped with an inlet and an outlet with baffle, a geo-textile and D-Rainclean® Filter-Media. In combination with a cistern or D-Raintanks®, the Eco-Soil-Filter is suitable for both, the water management and -percolation as well as for rainwater treatment. It is not only these characteristics that turn the new system into an interesting alternative for architects and builders. Looking at the system from a creative aspect, it is very easy to integrate and contrary to a traditional trench, the Eco-Soil-Filter does not need much space. An important point of view as to the size of building sites and continuously rising land prices!

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Note
You will find further information on D-Rainclean® in our “Technical Information” which is available on request.

Technical data subject to change.