

DynaSand™ Continuous Filters



The original DynaSand Filter

- well proven technology combined with the latest innovations

Contents

From Inventor to You	3
Continuous Improvement	3
DynaSand Filter models - freestanding units or for installation in a concrete basin	4
Construction	4
Free standing filters.....	4
Concrete basin installation.....	4
Proven Process	5
Wash water and energy reduction.....	5
DynaSand™ filter – process design and applications	6
Process applications	6
Examples of Industrial Applications	7
Typical results in different applications	7
Advantages	7
Lab and Pilot Services	7
Product Solutions	8
DynaSand Sand filter	8
Mechanical filtration	8
Contact filtration	8
Desalination plants.....	8
DynaSand Oxy.....	9
Nitrification.....	9
Taste and odour control in Drinking Water	9
DynaSand Deni	10
Denitrification.....	10
DynaSand Carbon	11
Drinking or Raw water applications	11
Waste water applications.....	11
Industrial applications	11
DynaAir - low pressure air supply system for DynaSand.....	12

DynaSand by Nordic Water is the world's leading continuous sand filter, initially designed by the Johnson Institute in Sweden in the late 1970-ies, which allows you to get the most out of your water treatment. Combined with DynaAir, Lamella Separator and/or DynaDisc by Nordic Water, your water quality can be greatly improved with significantly reduced operating costs over the entire life time of your investment. With tens of thousands filters installed around the world for municipal and industrial applications, Nordic Water has all the experience and equipment needed to exceed your expectations.

From Inventor to You

In 1974 Dr. Hans Larsson led a group at Axel Johnson Institute to develop the continuous backwash sand filter. This group was awarded a US patent for the filter in 1978 and for Continuous Contact Filtration in 1981. Axel Johnson Institute became Axel Johnson Engineering in 1981 and Nordic Water Products in 1992. Over the course of Nordic Water Products' long history and extensive experience the filter has been modified and improved for use in multiple applications, including denitrification, nitrification, and enhanced phosphorous removal.

The uninterrupted mode of operation offers the user a number of advantages compared to conventional backwash sand filters. In conventional sand filters solids are accumulated in the sand bed progressively increasing the head loss until, finally, the sand must be cleaned by backwashing before treatment can resume. The time between backwashings can indeed be very short, reducing the effective operating time. It is only with the development of the DynaSand by Nordic Water continuous sand filtration technique, that the users could benefit from an optimal solution to their needs for a continuous processing of water and waste

water which also provides a constant filtrate quality even at high surface loads.

Tens of thousands DynaSand filters have been installed by Nordic Water throughout the world, providing excellent reliability and performance to their users in a wide variety of applications.



Dr Hans Larsson with the first DynaSand prototype.

Continuous Improvement

The DynaSand family of filters includes the latest in sand filter advancements such as materials that are highly wear resistant to the constant abrasion from sand movement in normal operation. These advanced materials result in less maintenance and extend the life of your equipment. Additionally, two adjustable weirs with a uniquely designed wash box will allow operators to optimize the sand washing rate (sand to water ratio), thus minimizing the backwash wasting rate.

DynaSand Filter models - freestanding units or for installation in a concrete basin

All DynaSand filters are available as freestanding units or as modules for installation in a concrete basin.

Construction

All DynaSand versions (DynaSand Sand Filter, DynaSand Oxy, DynaSand Deni and DynaSand Carbon) are available as free standing units in Stainless Steel or FRP (other options are available for special applications) or as units to be built into concrete tanks. Both are available with various filter areas and filter depths.

The DynaSand filter is a compact filter with no moving parts. No rinsing water supply tanks, rinsing pumps or automatic backwashing system is needed.

Free standing filters

The free standing DynaSand filter consists of a cylindrical tank with a conical bottom and filter internals. The tank has flanged connections for feed, filtrate and wash water. A filter plant may consist of a single filter or a number of filters working in parallel to match the capacity required. The filter units are connected by an array of pipes which distribute the inflowing water and drain the filtrate and the wash water.

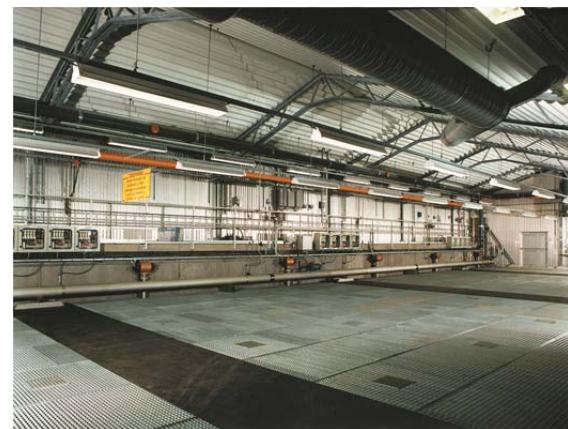


Free standing unit in stainless steel

The DynaSand free standing filter is supplied with a platform for easy access during inspection and servicing.

Concrete basin installation.

Large capacity plants are generally built with filter modules in concrete basins. The filter cells (each consisting of multiple filter modules) consist of a stainless steel or FRP bottom cone and filter internals, and share a common sand bed. A plant can be designed for a virtually unlimited filter area, enabling the DynaSand to be applied to small and large treatment plants with widely varying capacities.



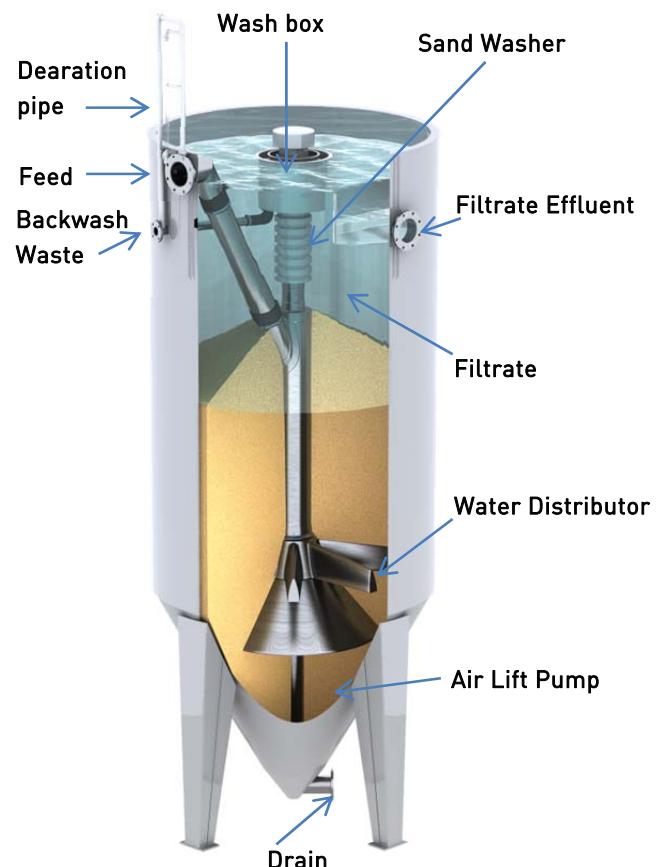
Filter Basin

Proven Process

The DynaSand is an up-flow, moving bed filter that is constructed with various media depths for different applications and configurations. Raw water enters near the top and is led to the bottom of the tank by means of a water distributor. Suspended solids are filtered out as the raw water flows up through the media bed. As the water reaches the top of the filter, it passes over the effluent weir as filtrate and is discharged. A portion of the filtrate is diverted through the sand washer and used for cleaning and transferring the waste solids.

The DynaSand filter employs a backwash rinse that is performed continually while the tank is processing water. An air lift pump, located at the center of the module draws the media from the bottom of the filter up into the wash box. As the media is released into the wash box, it falls into the sand washer where the filtered solids are separated from the sand. From there, the filtrate carries the solids out as waste (backwash). The washed sand falls down onto the media bed for continued use.

Each air lift pump is adjusted and regulated by the pneumatic cabinet supplied with the installation.



Wash water and energy reduction

The amount of wash water used can be significantly reduced by running the sand pump intermittently. This is achieved by the use of an optional wash water valve, and a solenoid in the pneumatic cabinet. This is especially valuable in ground water treatment, but has proven equally effective also in other applications such as in waste water applications, e.g. tertiary treatment. When running the sand pump in cycles the energy

cost is also reduced due to the decrease of the air consumption, and letting the sand bed rest intermittently can result in a higher quality filtrate.



Air Supply Control Cabinet

DynaSand™ filter – process design and applications

DynaSand is used to solve purification problems in drinking water treatment, industrial water supply, recovery and reuse of water and treatment of wastewater before discharge. Customers are public utilities, pulp and paper industry, iron and steel industry, chemical process industry, pharmaceutical industry, mining and mineral industry, food industry, power plants, incineration plants, metal finishing and electroplating industry and others who use and process water.

Continuous Contact Filtration is used to produce process water and drinking water from river or lake water and for certain wastewater applications. The flocculation chemicals are mixed into the feed stream of the DynaSand filter(s). The first part of the filter bed provides excellent conditions for fast floc formation and serves as flocculation reactor. No flocculation tanks are required. Presettling can be eliminated because of DynaSand's ability to handle high concentration of solids.

Process Water Recycling reduces water consumption and permits full control of the water quality. After screening or primary settling, spent process water is pumped to the DynaSand filters. The filtered water is recycled. Wash water is flocculated and

Process applications

The requirements for water treatment are being increasingly regulated by new laws and regulations. This means that more powerful and efficient equipment is needed. The DynaSand filters by Nordic Water provide an economic and energy saving method.

The DynaSand continuous contact filter can be applied in both municipal wastewater and industrial water treatment processes. Whether

thickened. The overflow from the thickener goes back to the filters.

Tertiary Filtration is used for final treatment of wastewater before discharge. Contact filtration with aluminium or iron salts as flocculation agents may be employed, as required, to precipitate phosphorous and enhance suspended solids removal. The end product meets the highest environmental standards applicable to municipal wastewaters and industrial effluents. The final filtration process can be combined with biological Denitrification. Nitrates are converted to nitrogen gas by a thin film of active bacteria on the filter granules.

Treatment of Metal-Bearing Industrial Effluents includes precipitation of the metallic ions, followed by flocculation, sedimentation, and final filtration in a DynaSand filter. The process produces low residual metal contents and meets strict environmental standards.

In most applications the filter media is natural, graded quartz sand. Normally the sand in the filter does not need replacing, but a small amount of refill may be needed on a yearly basis (abt. 0.3% of the volume). Particular material is used in bio activated filters. DynaSand Carbon is a special version with activated carbon as media.

you need reuse of quality water, nutrient removal, industrial water treatment, or raw water treatment, DynaSand by Nordic Water opens up for new process solutions and delivers unparalleled effluent quality, meeting the highest of environmental standards:

- Suspended solids reduction
- Two stage Continuous Contact Filtration

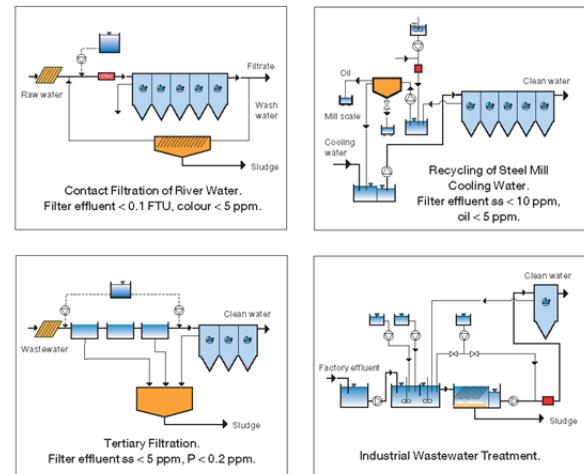
- Nitrogen removal (denitrification and nitrification)
- Phosphorous removal
- BOD/COD removal
- Activated Carbon treatment
- Treatment of metal-bearing effluents
- Pretreatment to other processes

Examples of Industrial Applications

- Metal finishing
- Backwash water recovery
- Process water
- Cooling tower blowdown/side stream filtration
- Steel mill scale
- Chemical processing
- Ideal for pretreatment in lieu of gravity filters

Typical results in different applications

DynaSand is flexible and can be adapted to different requirements.



Advantages

DynaSand improves the process

- no first filtrate – always clean effluent of a high quality
- no shockloads on the wash water treatment system
- high suspended solids without need for pre-treatment
- low headloss
- low energy consumption
- low supervision and maintenance costs
- no interruption of the operation for backwashing
- small footprint

DynaSand simplifies the system

- no need for backwash pumps
- no wash water storage tanks
- no wash water collecting tanks
- no need for backwash automation
- no air scour blower
- no clogging filter bottom nozzles
- single media filter bed
- the system is easy to construct and easy to maintain
- Easy retrofitting for biological treatment

Lab and Pilot Services

Nordic Water operates an in-house laboratory and utilizes an extensive line of pilot units to help in selection and sizing. We offer lab testing to further recommend the correct

process or piloting to determine proper sizing and operation of your system. Nordic Water is committed to providing the best equipment for consistent delivery of quality effluent.

Product Solutions

DynaSand Sand filter

Mechanical filtration

Mechanical filters retain suspended filterable matter without precipitants and are used as:

- Filter steps after the final sedimentation.
- Filter steps after industrial waste water treatment (e.g. neutralisation) for retaining metal hydroxide flocks
- Side Stream filtration in cooling water circuits
- Filter steps in steel and rolling mills for fine mill scale in water circuits.

Thanks to the continuous operation of DynaSand filters, the filter can cope with fluids with high ratio of solids.

Contact filtration

Contact filtration (flocculation filtration) is characterised by the addition of precipitants (e.g. Al-,Fe- solutions) to the feed. The goal is to flocculate the matter in the filter bed, which retains primarily colloidal, organic and

inorganic compounds and coarse particles. Real dissolved water contaminants (e.g. orthophosphate) are also precipitated and retained.

Contact filtration is primarily used when treating surface water to create drinking and industrial water or to eliminate phosphorus in municipal sewage treatment plants; phosphorus concentrations $< 0.1 \text{ mg/l}$ are reached in the outlet of the DynaSand filter.

Desalination plants

For desalination plants two stage filtration is especially suitable for saltwater filtration as a pre-treatment for desalination plants. Two stage filtration can be designed for gravity flow without pumping. By using two stage filtration with different sand grain sizes to achieve a low content of solids the life time is increased and maintenance of the ensuing RO-process is reduced.

DynaSand Oxy

The DynaSand Oxy filter is designed for aerobic applications and is therefore equipped with an aerator. Just like in a conventional DynaSand filter the DynaSand Oxy filter uses a continuous upstream filtration process where the filter media is washed continually. Cleaning of the filter media is operated by an air lift pump which pumps the filter media to the sand washer.

DynaSand Oxy is therefore excellent for use in biological aerobic treatment such as nitrification, BOD reduction and other applications where filtration and aeration in the same filter is desired. The process air is supplied by a blower or compressor and is admitted to the process via non-clogging aeration hoods in the filter.

The filter can be equipped provided with a cover, which prevents the treated water from absorbing oxygen from the atmosphere. This is important for any subsequent denitrification stage.

As the nitrification process can be greatly improved by using a deeper filter bed the DynaSand Oxy is available with various filter bed depths ranging from 2-6 m. The optimal height is calculated based on conditions for each project.

Nitrification

The water to be nitrified enters the DynaSand through the inlet distributor. As the water flows upwards through the filter bed ammonia (NH_4^+) is converted into nitrate (NO_3^-) by bacteria – nitrosomonas and nitrobacter – which form a layer on the surface of the filter grains.

Using DynaSand Oxy for nitrification is a space saving technology with high oxygen efficiency.

Taste and odour control in Drinking Water

The aerated filter media bed works like a biologically active filter to improve the drinking water quality. DynaSand Oxy can be used for biological treatment of surface water for taste and odour control and for treatment of ground water for biological iron and manganese removal.

DynaSand Deni

Denitrification is generally performed in tanks or basins. However, in many cases it is practical to partially denitrify the fluid in a DynaSand filter, a so-called DynaSand Deni. The denitrifying bacteria reduce nitrates in the absence of oxygen. External carbon sources are normally added for denitrification, e.g. methanol or ethanol, as the filter is normally installed at the end of the treatment chain.

DynaSand Deni filters are quite similar to ordinary DynaSand filters, with only minor modifications to the filter design. The filter could be operated in the same way, but there are normally some differences in the settings.

As the denitrification process can be highly improved by using a deeper filter bed its essential to choose an optimal filter bed depth when designing the nitrification process with DynaSand Deni. Standard filter bed depths are ranging from 2-6 m.

Denitrification

Just like in a conventional DynaSand filter, the water to be denitrified enters the filter through the inlet distributor. As the water flows through the filter bed, nitrite (NO_2^-) and nitrate (NO_3^-) are converted into nitrogen gas (N_2) by a layer of micro-organisms formed on the surfaces of the filter grains. The nitrogen is discharged to the atmosphere.

The entire filter bed participates in the denitrification process. The bed is in a state of continuous movement so that, every grain and

bacteria move between the zones of different nitrate content. As a result, the bacteria count is high and uniform in the entire filter, and the DynaSand Deni has high tolerance to load surges.

DynaSand Deni filters can be installed after DynaSand Oxy filters.

DynaSand Carbon

In some applications when water contains soluble pollutants that are not possible to remove by contact filtration or bio filtration activated carbon is ideal for removal by adsorption. Activated carbon is one of the world's most powerful adsorbents and can be used to remove a wide range of contaminants from industrial and municipal waste waters or surface and ground water for drinking water production.

DynaSand Carbon filters are quite similar to ordinary DynaSand filters, with only minor modifications to the filter design. The filter could be operated in the same way, but there are normally some differences in the settings.

Different types of activated carbon could be selected, even though coconut shell is most common due to the material hardness and wear resistance.

The inlet concentration of suspended solids or turbidity to Carbon filters are often low which means that the cleaning cycle could be intermittent. This operation gives a significant saving in wash water and energy.

The retention time is essential when designing carbon filters. Different bed depth alternatives could be chosen. Maximum surface loading rate are also considered as fluidization will occur at a lower velocity than for sand due to the low density of activated carbon.

DynaSand Carbon filters are often installed directly after ordinary DynaSand filters with contact filtration. The water could then flow by gravity from the DynaSand to the DynaSand carbon filters.

Drinking or Raw water applications

The DynaSand carbon filters could be used for drinking water or raw water applications mainly to remove COD-Mn, and to improve taste and smell of the water.

Waste water applications

In recent days more requests have risen to use the DynaSand Carbon filters for removal of endocrine substances at waste water treatment plants. The activated carbon should remove medical substances and pollutants from the outlet water which could affect the hormonal balance in wildlife.

Industrial applications

There is a wide range of industrial applications for DynaSand Carbon. A typical example is removal of hydrocarbons in the waste water in the petrochemical industry. DynaSand filters followed by DynaSand Carbon filters treat storm water from an industrial area which is mixed with process water from a refinery. The purpose is to reduce extractable hydrocarbons to below 3 mg/l and suspended solids (SS).

DynaAir - low pressure air supply system for DynaSand

By choosing the DynaAir low pressure compressor system instead of standard compressors, substantial energy savings can be achieved. The DynaAir system feeds the air lift pumps in the DynaSand filters with compressed air at a pressure which is lower (<2 bar), than the pressure normally generated by conventional compressor systems. Normal operating pressure with screw compressors is 5-7,5 bar. The lower working pressure and the frequency controlled motor speed when using DynaAir can decrease the energy costs about 60% for DynaSand filters.

Compression in DynaAir is contact free which means that the compressed air is free of oil and hence there is no need for oil filter or oil separator. The air is cooled before exiting the DynaAir unit and the condensate can be discharged to a floor drain without further treatment. The DynaAir system is mounted in a sound proof cabinet with a local control system easy to install and connect. A pneumatic cabinet designed for low pressure is used together with the DynaAir to regulate and control the air flow to the filters. Each DynaAir unit contains two low pressure frequency controlled compressors for alternation and redundancy.

