The NFP Range of Denitrification Reactors.

Suitable for installation in a cabinet for systems with or without a sump.
Designed for use in freshwater or saltwater aquariums and ponds.

MODEL	MINIMUM / MAXIMUM SUITABLE TANK SIZE			MAXIMUM FLOW RATE / HOUR			MEDIA	DAILY FOOD
	LITRES	GALLONS	US GALLONS	LITRES	GALLONS	US GALLONS	VOLUME	VOLUME
NFP 509	200 / 1000	45/220	50/250	1.5	0.22	0.26	2lt	8ml (1 bag)
NFP 512	800 / 2000	175/440	200/500	3.0	0.44	0.5	4lt	16ml (2 bag)
NFP 616	1500 / 5000	350/1100	400/1300	7.5	1.1	1.3	10lt	40ml
NFP 1020	5000 / 15000	1100/3300	1300/4000	22.5	3.3	3.8	25lt	100ml

Note that the flow rates shown above maximum rates and are only achievable when the reactor has been fully matured for over 3 months and is operated in full automatic mode with a water temperature of 20-30 C.

OPERATING INSTRUCTIONS

Great time and effort was taken when creating this new family of nitrate filters to overcome the problems that are commonly found with similar products on the market and to make the units as simple and effective as possible – however be aware that these filters work on natural biological processes which involve the growth of a stable colony of denitrifying bacteria and therefore a certain amount of patience and understanding is required.

Features of the new reactor are:

- Ease of cleaning via fully removable lid.
- Large bore exit pipes that will not block.
- Special media that will not choke up with dead bacteria.
- Pressurised operation possible for flexibility of reactor positioning.
- Recirculation system to ensure an even distribution of nitrate and food to the bacteria.
- Can be operated in manual, semi-automatic and fully automatic mode.

What is denitrification and how does it work?

Within the aquarium, fish and uneaten food produce waste which breaks down to form AMMONIA (NH4). Aerobic bacteria within the filtration system of the tank then oxidise the ammonia first to NITRITE (NO2) and then further to NITRATE (NO3). This series of processes is continuous and ultimately leads to a build up of nitrate in the aquarium which can only be reduced without a nitrate filter by either large regular water changes, heavy aquatic planting or by a reductive process whereby the oxygen from the nitrate molecules is utilised by anaerobic bacteria to convert it to NITROGEN GAS (N2).

The natural reduction of nitrate to nitrogen gas will only occur if there is an area within your system with a very low oxygen level that will allow anaerobic bacteria to exist in sufficient quantities to handle the waste that is being produced by your tank's inhabitants, such as within live rock or in a deep sand bed. Where this does not exist it is necessary to create such an environment and this is where the NFP denitrification reactors come in to play.

The Deltec NFP Reactors offer a large surface area on which millions of anaerobic bacteria can colonise, a system of recirculation of the water to ensure that the nitrate is easily available to all of the bacteria and a way of introducing a carbon based food, (alcohol) to feed the bacteria which allows them to multiply and to remove the nitrate from the water column.

Daily feeding of the anaerobic bacteria.

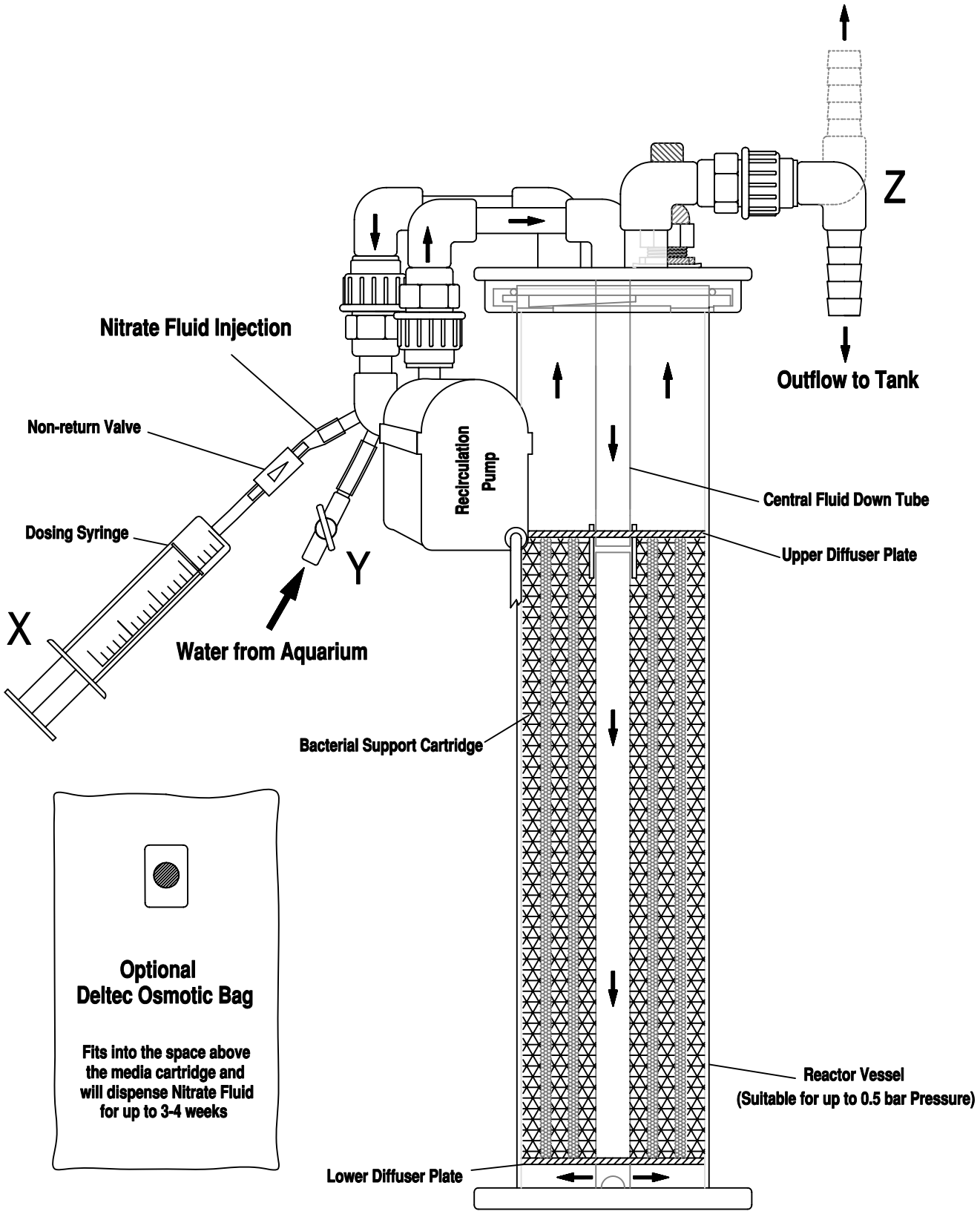
During the operation of the filter it is necessary <u>every day</u> to provide a carbon based food for the anaerobic bacteria which is usually supplied in the form of alcohol. We recommended that you use Deltec Nitrate Fluid, which is a special blend of alcohols and other solutions and is supplied with the smaller units or available as a consumable product from your retailer.

For the larger models the rate of consumption of the Nitrate Fluid may become cost prohibitive and for these units it may be more economically viable to use a mixture of Vodka and RO water as a substitute. The Vodka should be mixed with RO water in a ratio of 1 part of Vodka to 3 parts of RO water.

Deltec NFP Denitration Reactors

AppliesTo Models - NFP 509, NFP 512, NFP 616, NFP 1020

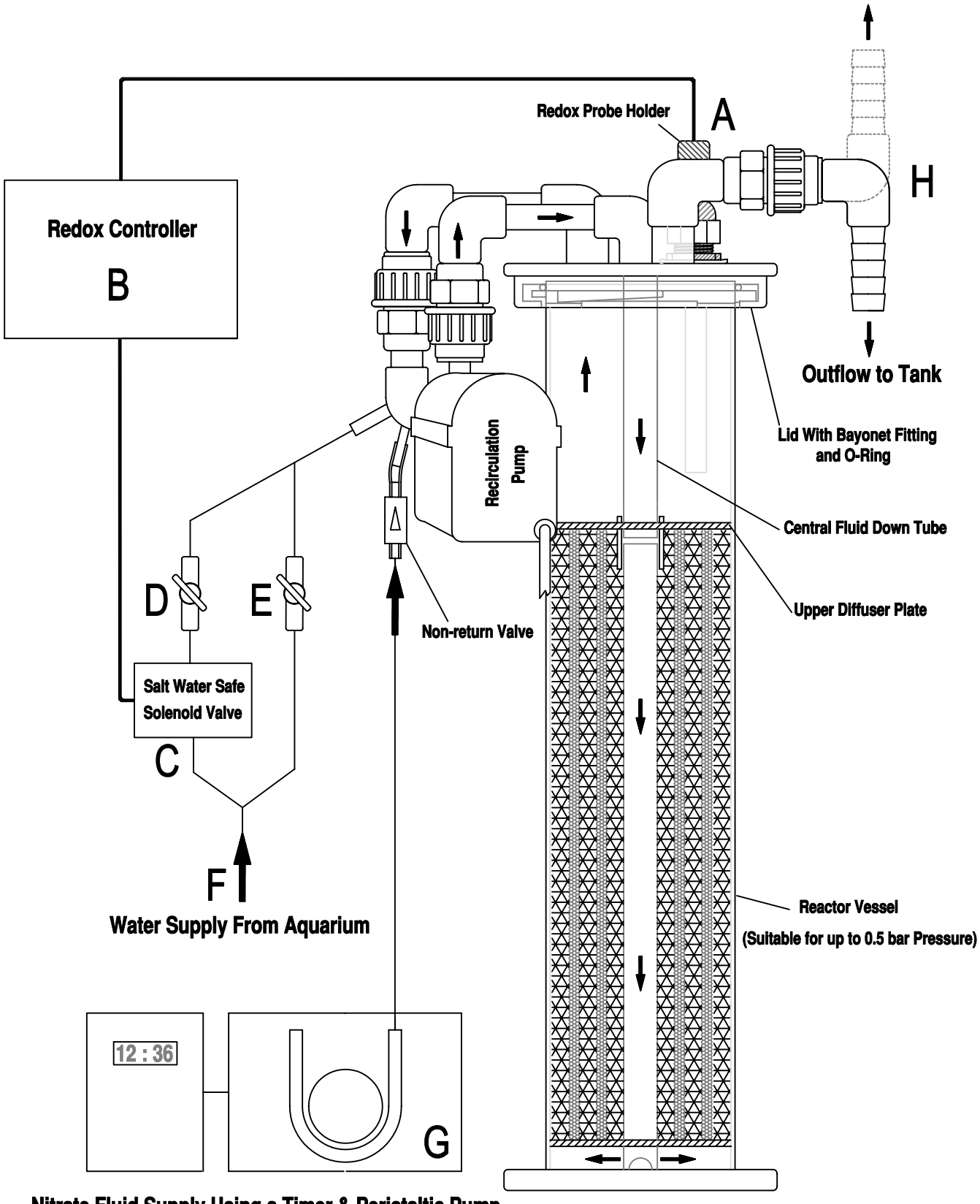
Diagram For Manual Control



Deltec NFP Denitration Reactors

Applies To Models - NFP 509, NFP 512, NFP 616, NFP 1020

Diagram For Fully Automatic Control



Nitrate Fluid Supply Using a Timer & Peristaltic Pump

MANUAL METHOD OF OPERATION

The NFP reactors can either be operated manually, semi automatically or fully automatically

This will depend on the application and level of sophistication that you want to go to. The first part of these instructions describes the operation of the unit without the need for any supplementary equipment other than a reliable high sensitivity nitrate test kit which is not supplied with the unit.

We would generally recommend that you only follow the MANUAL OPERATION method for the smaller reactors; however the principles are valid for all models.

1 – Assemble and connect the unit as shown on the diagram for manual operation and position it in a cabinet or in an area where there is easy access. Note that the lid for the reactor unscrews in an anti-clockwise direction. Be careful not to over tighten the lid when reassembling. The outlet pipe can be directed downwards or upwards depending on where the unit is situated in relation to the tank or sump.

2 – Establish a method of feeding the reactor with water from the aquarium such as:

Pressure feed: Use a suitable pump or power head to take water directly from the aquarium or sump and return water directly back to the aquarium / sump. This allows remote positioning of the unit at any height or in the cabinet below the aquarium. Ensure that connections and hoses from the power head to the unit are suitable for the pressure developed.

Gravity feed: The unit can be operated on a siphon from the tank and into a sump thus negating the requirement for a separate power head or pump.

Sumpless operation: Note that as the reactor is capable of withstanding pressures of up to 0.5 bars that it is possible to install the unit below the tank in a cabinet and to pump the water down, through and back up to the aquarium.

IMPORTANT POINT: always ensure that if you feed from the aquarium down to a sump that you fit the system with a siphon break to prevent the continued siphoning of the contents of the tank in the case of a power failure.

IMPORTANT POINT: when using the reactor under pressure or below the aquarium never remove the redox probe holder or remove the reactor lid without draining part of the water off first and switching off the pump.

3 – Fill the reactor with water from the aquarium. To speed up the initial seeding of the filter we suggest at this stage for you to add a commercial bacterial culture such as Rowa*Bac* or simply to squeeze the water from a filter sponge or similar taken from an established biological filter into the reactor chamber.

4 - Close the lid of the reactor and turn on the water feed supply using tap ‘Y’ to ensure that the chamber is completely full of water and that the system of feed and return is operational and has no leaks.

Ensure that if the reactor is mounted below the water level that the feed and return pipes are securely fastened to prevent one coming loose and allowing the tank to siphon out.

5 – Turn on the recirculation pump to circulate water around the reactor and once again check for any leaks.

You are now ready to start maturing the bacterial filter media.

5 – Shut off the water supply to the reactor using tap ‘Y’ and leave it like this for 3 days to allow the oxygen in the water to be used up and to allow growth of the anaerobic bacteria.

Feeding the system: The bacteria within the reactor must be supplied with a carbon based food, (Deltec Nitrate Fluid), on a daily basis throughout the duration of the reactor’s use. To make this possible when using the manual method, Deltec supply you with a plastic syringe ‘X’ which should be first filled with Deltec Nitrate Fluid and then fitted to the end of the non return valve at the inlet to the recirculation pump.

The amount of Nitrate Fluid to add to the reactor will depend on a number of factors such as the flow rate and the level of nitrate in the water. When first starting the system we recommend that 4ml of Nitrate Fluid should be added for each litre of biological media within the reaction chamber over a period of 24 hours, (detailed in table).

For the purpose of these instructions we will use the NFP509 which has a reactor media volume of approximately 2lt.

On days 1 – 3 whilst the water flow rate is switched off it is necessary to add 8ml of Nitrate each day. This should be added in 2 doses of 4 ml, one in the morning and one in the evening.

7 – On day 4 open up the tap ‘Y’ very carefully until you achieve 1 drip every 3 seconds and wait for a further day before testing the outlet water. Continue to feed the unit morning and evening with the same volume of Nitrate Fluid as was used for the first 3 days.

8 – Day 5 – check the water coming out of the reactor at ‘Z’ for nitrate level using a reliable nitrate test kit. If the reading from the water is zero then increase the flow rate by no more than 1/3 of its current rate to one drip every 2 seconds and wait for 2-3 days for the level to drop back to zero. Continue to feed everyday with the starting volume of Nitrate Fluid.

If the reading still shows that there is nitrate coming from the reactor then wait another day and another day until you achieve a zero reading before increasing the flow rate. Continue to feed the unit morning and evening as on the first 3 days and wait until the reading drops to zero.

Initially, whilst there is still oxygen present at sufficient levels within the reactor, aerobic bacteria may grow within the media converting any ammonia in the water to nitrite or nitrate. This may show as a slightly elevated nitrate or nitrite level coming out of the reactor compared with that of the water going in.

Note: Large incremental jumps in flow rate especially at this stage can crash the growing bacterial culture within the reactor by the introduction of too much oxygen which will raise the redox and will slow down the maturation period.

9 – Gradually, in stages which will take 2-6 days between changes, it should be possible to slowly increase the drip rate from the reactor by 20-30% at each step, then to wait for the reading to come down to zero before increasing the flow again. The ultimate goal is to turn the volume of water in the tank through the reactor once every 14 days as a maximum and once every 28 days as a minimum. At this flow rate it will be possible to keep the nitrate levels fully under control.

Increasing the amount of food: As you increase the water flow rate through the reactor it will also be necessary to gradually increase the amount of food that is dosed every day. This is the tricky part and it will require a little trial and error by the user to learn how much extra to add as you increase the flow rate.

By the time the reactor is running at maximum capacity it will be necessary to be adding about 25% more food than was being added during the initial stages which for the example for the NFP509 means up to 11ml per day. If due to the size or your tank relative to the reactor you do not need to achieve maximum capacity then it is possible to just continue at the initial feed rate.

Be careful not to overdo the additions of the food as this will tend to reduce the redox to below 200 and can often be seen as cloudiness in the tank.

If not enough food is added you will find that it will not be possible to increase the flow rate further as there will be insufficient food to support a large enough bacterial colony to achieve a zero nitrate reading for the set flow.

10 - Once the system is running in a stable manner at a flow rate which gives you sufficient volume from the reactor to turn the volume of the tank over every 14-28 days then continue to feed morning and night at that set volume to maintain the nitrate level in the system.

See the paragraph at the end of the section on fully automatic operation on what to do when the level of nitrate in your system gets down to zero.

SEMI-AUTOMATIC METHOD OF OPERATION

For those people who do not want to inject the unit on a daily basis

If you want to have a semi automatic method of operating the filter without going to full automation then there are two possible methods.

1 – Use of Deltec Osmotic Nitrate Bags.

2 – Use of a peristaltic pump to supply the Nitrate fluid.

DELTEC NITRATE BAGS

These special bags operate using the principle of osmosis through a semi permeable membrane. The bags are refillable and hold 250ml of Nitrate Fluid which they release slowly over 4 -5 weeks through the bag walls which are made of a semi permeable membrane material. This gradual release supplies the bacteria with food continuously without any further requirements for daily injections.

The Nitrate bags fit into the reactor body in the space above the bacterial media. The number of bags that are required will depend on the size of the reactor and the size of the system on which it is being used.

A single bag will release about 50ml of Nitrate Fluid per week or 7ml per day which makes it ideal for the NFP509. Two bags will release 14ml per day; 3 bags – 21ml and so on.

Use of the Nitrate Bags

Each membrane bag is fitted with a bung which is removable for filling with the Nitrate Fluid. Fill the bag with 250ml of fluid, replace the bung and place the bag within the reactor body in the space above the bacterial media. Refit the lid of the reactor.

If you are using more than 1 bag then remember to mark each bag so that you know when each needs to be refilled.

Follow steps 1-10 as shown in the manual instructions.

From step 6 onwards it is obviously not necessary to use the injection system any longer as the semi-permeable bags will carry out the function of feeding the Nitrate Fluid to the bacteria.

There is normally sufficient Nitrate Fluid in the system to last for 5 weeks however we recommend that you empty and refill the bags after 4 weeks to ensure that the bacteria do not run out of food.

Obviously with this method the reactor is supplied with food at a constant rate which can not be varied other than by adding an additional bag. As the feeding rate will determine the amount of bacteria in the system and therefore the final water flow through the reactor then this method will not allow the reactor to reach its maximum possible capacity.

Note that at the end of the 4 weeks that the bag will still be full of water as only the alcohol is allowed to pass through the membrane and into the reactor. Empty this water away and refill the bag with fresh solution.

To refill the bag, first switch off the recirculation pump and nip the water supply by folding over the feed pipe or switching off the feed pump. Remove the Nitrate Bag, empty and replace its contents then return it full to the reactor. Take this opportunity to clean the build up of bacteria from the outlet pipe and lid.

When you are changing over the bag it is important to ensure that you do not waste too much reactor water during the change over as this will need to be replaced with fresh tank water which will have a higher redox. After refitting the lid, allowing it to refill and then switching on the recirculation pump we would recommend that you turn feed water supply back off for a couple of hours to allow the redox to fall again allowing for the replaced water.

USE OF A PERISTALTIC PUMP TO SUPPLY THE NITRATE FLUID

As with the Nitrate Bags, this method automates the feeding process but does not control the redox or water flow rate and is an intermediate step towards full automation of the system.

For this method you will require a dosing pump with a flow rate that is suitable for the amount of food that you are required to add on a daily basis. You will also require a digital plug timer that it is possible to control down to second intervals.

Connect the peristaltic pump to the non return valve as shown on the fully-automatic diagram. Note that some cheaper pumps do not automatically seal when the pump switches off and therefore if the pump is mounted above the reactor it can allow siphoning of the food into the reactor even if it is switched off. Always use the non return valve or the water can back siphon. Always read the operating instructions for the pump that you chose for the task.

If your reactor requires 8ml of food per day then we would recommend that you feed it as 2 doses of 4ml or ideally 4 doses of 2ml per day; the ability to do this will depend on the volume capacity of your peristaltic pump. As the feeding requirement increases then simply increase the duration each day that the pump is set to dose the reactor with Nitrate Fluid.

Follow steps 1-10 as shown in the manual instructions.

From step 6 onwards it is obviously not necessary to use the injection system any longer as the peristaltic pump will replace this function and will carry out the feeding of the Nitrate Fluid to the bacteria.

FULLY-AUTOMATIC METHOD OF OPERATION

This method is suitable for all sizes of reactor and is covered by a separate diagram which is attached.

For this method you will require the following items of equipment;

1 – The NFP Nitrate Reactor.
2 – A redox controller, probe and calibration solutions.
3 – A solenoid valve which is suitable for salt water (can be ordered with your Deltec reactor).
4 – A peristaltic pump and timer, (timer capable of controlling down to second intervals), to supply the Nitrate Fluid.

Operation of the NFP reactor follows the same principles as has already been explained in the first two sections. These should be read and understood before moving on.

Supply of Nitrate Fluid to the Nitrate Reactor.

Either of the two methods described under ‘Semi-Automatic Method of Operation’ for feeding the reactor with nitrate fluid can be used however for optimum output or with the larger reactors it will be necessary to use the peristaltic pump option.

The same ratio of daily Nitrate Fluid addition to media area applies as in the manual section and an indicative starting level for each reactor is given in the table at the top of the introduction page.

Supply of water to the Nitrate Reactor

This is where the fully automatic operation of the Nitrate Reactors varies from the other two methods described.

With this method we use a controller ‘B’ and probe ‘A’ to ensure that the redox within the unit is maintained at the correct level of oxygenation, or deoxygenation, for the denitrification process to operate at its optimum level.

As we can see from the diagram there are two feeds to the reactor, both with control taps ’D’ & ’E’. The supply for these two feeds can come from a common pump which can be split with a T or Y connector at ‘F’.

One of the water feeds is fitted with a solenoid ‘C’ which will be actuated by the redox controller to switch the flow off and on. This solenoid must be salt water safe if used on a saltwater tank and not one of the general units used for CO2 or fresh water. The special solenoid can be ordered at the time of ordering the Nitrate Reactor.

The redox controller and probe must be calibrated prior to use and will require regular recalibration as they tend to drift with time towards a more positive value. Note that it can take several days for a new probe to settle down and to start reading the correct value when first installed and calibrated.

Operating the Fully-Automatic System

1 - Fill and check the reactor as described earlier, fit the redox probe and controller, switch on the recirculation pump and then close off both water feeds for 3 days.

2 – From day 1; set the timer on the peristaltic pump ‘G’ to supply the correct dose of Nitrate Fluid as shown in the table for the particular model of reactor. Add this volume split into 2 or 4 doses over the period of the day controlled by the digital timer.

3 – After 3 days open tap ‘E’ gradually until you achieve 1 drip every 3 seconds and then follow the instructions for testing and adjusting the water flow over a period of days and weeks as described in the manual operation section.

At this initial stage the only tap that will be adjusted will be tap ‘E’. We will start to use the second water feed through the solenoid and tap ‘D’ once the reactor starts to mature by a couple of weeks.

The redox in the unit will start off at a positive value and will slowly move to zero and then to a negative reading as the oxygen in the system is used up by the bacterial culture. Remember that we want to control the redox at about minus 170mv.

4 - Now that the reactor has been running for a few weeks and the redox has fallen we can start to use the redox controller to add more water to the system to increase the flow through the reactor when required which will maintain the redox at the optimal level for denitrification.

When the redox level reaches minus 170mv the controller should be set to activate the solenoid. This will allow additional water into the reactor which will subsequently reduce the redox and will switch the solenoid off again.

To ensure that the volume of water that we add via this secondary water supply is not too high, thus bringing the redox down too far, we set tap ‘D’ so that there is only a low flow rate going into the reactor. The rate of flow will depend on the size of the reactor, in the order of drips for the small reactors and a slow dribble for the larger ones. It is better to control in regular small stages than to add the water in one large amount and to drop the redox down too far below its optimal level.

Note that the redox will fall every time you add food to the system therefore small regular doses will give a more stable reactor.

Balancing and optimising the Reactor

Once the reactor has been running for several weeks we will find that the flow rate through the reactor has increased many fold and the nitrate level with in the aquarium or system is starting to fall.

At this point we have 3 controls to adjust to optimise the performance of the reactor.

1 - The Nitrate Fluid (food) volume.
2 - The main water flow.
3 - The secondary redox controlled water flow.

All 3 are in equilibrium and if we adjust one then we must adjust the others to bring it back into balance.

- If we increase the volume of Nitrate Fluid then the amount of bacteria within the reactor will be allowed to increase and the redox level will fall, (become more minus). At this point the redox controller will open up the solenoid valve to allow more water through tap ‘D’ to bring the redox back to below 170mv. If we find that the redox still stays high or that the solenoid is open all the time then we should increase the flow rate through tap ‘E’ to bring the system back into balance.

- If we increase the flow rate through the main water supply tap ‘E’ by too much then we will see that the redox will start to rise, (less negative), and the solenoid will not open at all. At this point we must increase the amount of Nitrate Fluid supplied to bring the system back into balance or reduce the flow rate through tap ‘E’ back to a level that the existing food and bacterial level will support.

Once the nitrate has been reduced to zero

This section is relevant to all methods of operation

Once the nitrate level within your system is under control you will not require the same amount of denitrification however each day there will be nitrate added to your aquarium from your fishes and food. At this stage you should run the filter at a tick over level, (unless it is being used on a system with a heavy load that requires the unit to continue to run at its optimum flow).

It will be necessary to reduce the amount of water passing through the reactor and at the same time the amount of food.

For the manual injection system, reduce the volume of Nitrate Fluid that is injected by 10% each time in a series of steps and reduce the flow rate by the same amount. Nitrate bags can be partially filled and operated for the same 4 week period and the peristaltic pump can simply operate for a shorter period of time each day.

Monitor the nitrate from the reactor to ensure that it is still maintaining a zero reading from the outlet and if not then and slowly reduce the flow rate until it is in balance with the volume of nitrate food that is being added. Keep on reducing the feed rate and flow until you start to see nitrate appearing in the tank. This is just below your equilibrium level for your system.

Rebalance the reactor at this point and try to maintain your nitrate level at 1-2 mg/lt and certainly less then 10 mg/lt. If the nitrate remains at zero then it may be necessary to reduce the feeding and flow further until a low level appears found in your system. If this level starts to rise then you need to increase the flow and feeding accordingly.

It is possible to just switch off the reactor however you will need to go through the maturation period again once the nitrate level rises with time. Another benefit of maintaining the operation of the nitrate filter is that the bacteria release trace elements back into the water which can be beneficial especially to corals.

SIMPLE TROUBLESHOOTING GUIDE

Q. - MY TANK HAS STARTED TO GO CLOUDY .

A. - You are introducing too much Nitrate Fluid into the system without sufficient bacteria in the reactor. Cut back on the feeding and it will clear.

Q. - THERE IS MORE NITRATE COMING OUT THAN IS GOING IN.

A. - The filter still contains oxygen and is acting as an aerobic filter. Wait for a few more days and retest.

Q. - THERE IS A SMELL OF ROTTEN EGGS COMING FROM THE UNIT.

A. - The redox on the unit is too low. Reduce the amount of feeding or increase the flow rate.

Q. - THE pH IS LOW COMING OUT OF THE UNIT.

A. - This is normal. Aerate the water coming out of the reactor or run it through some coral gravel.

Q. – THE FLOW RATE OUT OF THE REACTOR IS REDUCING.

A. – Check that the outlet from the reactor is clean and has not started to block up with dead bacteria.

Q. – MY INITIAL REDOX READING SHOWS A STRANGE LEVEL

A. – It can take 5-6 days for a new redox probe to settle down and to give the correct reading.

Q. - IN FULLY AUTOMATIC MODE IT IS BECOMING DIFICULT TO MAINTAIN ZERO NITRATE AT THE OUTLET.

A. – Recalibrate your redox probe as it has probably drifted more positive and is opening the solenoid too early.

MAINTENANCE

Your reactor will require regular cleaning maintenance due to the build up of dead bacteria and the closer you run the unit towards its maximum capacity the more regularly it will require cleaning.

1 - If the lid and pipes become blocked then remove the lid and thoroughly clean all the surfaces, pipes and the pump.

When you reassemble the unit remember to try to waste as little water from the reactor as possible as this will have to be made up with tank water which will be at a higher redox and will take a while to rebalance. After cleaning switch the water feed to the reactor off for a few hours to assist this process.

2. – Eventually even the media within the reactor will become so chocked up with dead bacteria that it will be necessary to clean this out too.

Empty the water from the reactor into a bucket and remove the cartridge from the chamber. Scrape off as much dead bacteria as possible and if necessary wash it in the water that you have just removed.

NEVER WASH THE FILTER IN FRESH WATER FROM THE TAP

Re-roll up the media and return it to the canister before carefully decanting the saved water from the bucket back in. Reassemble the rest of the unit and place it back into service.

After a major clean like this we would recommend that you reduce shut off the flow for a day then build it back up over a week or so to its original level

For further information or assistance please email info@theaquariumsolution.com or visit our web site at www.theaquariumsolution.com