nyex™
An Arvia Solution

The hidden environmental costs of Activated Carbon water treatment

To comply with environmental discharge limits, many companies may use an environmentally UNfriendly water treatment. Here's how Arvia can offer an alternative.

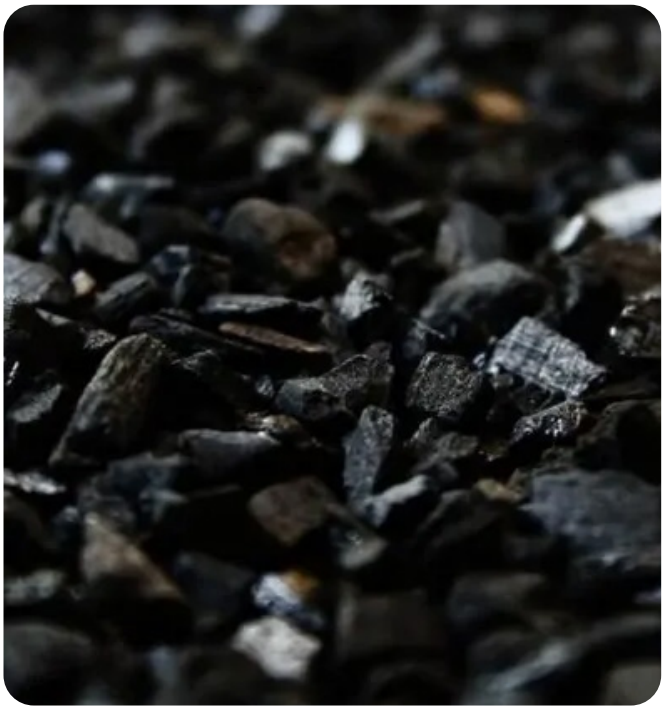
Activated Carbon

Activated carbon has been one of the water treatments of choice for many years. It's often used where water used in the manufacturing process comes into contact with recalcitrant organic compounds; these must be removed or drastically reduced to comply with a permit to discharge.

In chemical plants, activated carbon filtration is normally used in conjunction with and often downstream of other treatment systems, the science being that each process removes certain groups of pollutants, resulting in a wastewater discharge 'within spec'.

An environmentally responsible alternative

However, depending on what the water to be treated contains, our research shows that in quite a few cases a granular activated carbon (GAC) treatment system may not be the best solution for the removal of many volatile organic compounds especially when considering the overall environmental impact a GAC system makes.



In its place or running in parallel, we can often show that an equivalent Arvia water polishing system with its unique Nyex™ media can be cheaper in the long run and is far more environmentally conscious than GAC.

Granular activated carbon manufacturing

To get a good understanding of why this is the case, let's briefly consider how the activated carbon absorption media is produced and subsequently renewed as well as its impact on the environment.

The carbon is created (what is referred to as 'activated') by pyrolysis: slowly heating the raw material like coconut shells, wood, biomass, bones or coal to around 1000˚C without the presence of oxygen. (This is essentially what charcoal burners did in the woods centuries ago but on a far greater scale under highly controlled conditions.) Impurities are subsequently removed by acid washing.

Environmental issues

The main environmental issues here are twofold: First there's the question of raw materials. Although coconut shells, bone and most biomass substances are by-products of recycling, coal and wood are definitely not. It could be argued that most wood used is often a by-product of another process (forestry slash, chippings and sawdust, for example.) However, the type of wood burned has a direct result upon the quality of the final GAC; almost inevitably, slow-growing oak produces a better quality than fast-growing bamboo, for example. So on balance, the raw materials for activated carbon production may utilise precious natural resources – some of which could conceivably be used for food or fuel. And these days, that's not a good look …

Secondly, a large amount of energy is required to turn these materials into activated carbon. In many cases, natural gas is used. Different feedstocks – even different species of plants or trees – will require different levels of energy to convert to activated carbon.

How activated carbon works

The result of the activation process is that the carbon media has an incredibly large surface area of between 1,000 – 2,000 m^2 per gram, so a teaspoonful would easily cover a football field!

How GAC works is that unwanted or harmful organic compounds are absorbed by the carbon naturally, leaving far less in the water as a solution.

How to regenerate activated carbon

The massive surface area is the simplicity of GAC – yet also its drawback; because over time there won't be enough 'clean' carbon left for the unwanted compounds to be absorbed and the carbon media will therefore need replacing.

In some cases, it can be returned to a reprocessing facility where it's regenerated. This involves heating up the used carbon to over 800˚C in a reactivation furnace. It vaporizes the undesirable organics and special precautions are taken to ensure emissions are safely controlled, normally by the use of an afterburner. However, doing this requires a good percentage of the energy that was used to make it in the first place! Add that to the cost of transporting it to and from the reprocessing site and the environmental impact is high.

Alternatives to reprocessing

Sometimes it's uneconomical to re-process the activated carbon media, so it is removed to be used as a fuel to fire cement kilns. This burns it off eventually and goes a small way to make the production of cement less environmentally harmful.

Finally, if spent media is not classed as hazardous and cannot be re-activated or it's not cost-effective to do so, it can be sent to landfill.

All three of the choices above involve the removal and transportation of the media as well as the potential for the disruption of a plant's production process which also need to be borne in mind.

So essentially the creation and re-processing of GAC media scores poorly on any kind of environmental scale. But it doesn't end there.

Activated carbon systems in use

In use, a GAC system must not be overloaded with too much influent, as this can lead to over-permit discharge levels, potentially risking a heavy fine. Whilst it is possible to insure against that eventuality, it's an added complication that many plant managers can do without. Overloading can also shorten the life of GAC media.

There is also a risk that when the absorption sites on the media get saturated, the hazardous compounds stay in solution, which can lead to microbial growth and 'channelling' – essentially the water taking the path of least resistance, again leading to over-permit discharges. Most large GAC operations have to be regularly maintained and tested to minimise risks of this.

Finally, all GAC media will need to be changed at regular intervals depending on influent volume and concentration of organics. Depending on the configuration of the system, this may involve taking all or parts of a process off-line whilst replenishment takes place. This is potentially disruptive unless co-ordinated with other maintenance.

Environmental impacts

Overall, GAC systems are reasonably predictable and may be cost-effective in some smaller systems where influent organic loading is low and media only needs changing two or three times a year. However, carry out any kind of environmental audit on a GAC-based water treatment system and it wouldn't score very well long-term, due to the initial energy and resource use and replenishment/disposal as well as the transportation elements involved.

Essentially a GAC-based system is an example of linear consumption with little or no recycling possibilities and a lot of energy use – the major factor in its large carbon footprint.

On the other hand, Arvia's Nyex™ systems have little environmental impact once built and installed and are a typical example of circular economy. They carry out mainly the same tasks and score far better against activated carbon on an environmental audit basis. This is an important factor to bear in mind when considering the future; eventually, the total environmental impact (or carbon footprint) will become a major factor in any plant's design and potentially even its permitted discharge levels.

Activated carbon alternatives

Depending on the removal process and the particular installation, Nyex™ reactors can be scaled to any required size and configured according to the specific removal treatment. They can also be placed in various points of a wastewater treatment process, protecting existing RO (reverse osmosis) or biological systems as well as acting as a tertiary water polishing stage. It all depends upon what's in the water and the level to which it needs to be removed.

However, the main advantage is that the Nyex™ media used in our Nyex Rosalox™ systems requires minimal replenishment – it can be as low as a couple of kilos per annum.

The unique patented process absorbs many recalcitrant compounds and as electricity passes through, chemically alters these organics, leaving very little residue. At the same time, the unique Nyex™ media actually regenerates itself. Depending on configuration, these systems can remove many unwanted compounds down to below measurable levels and are becoming accepted as an environmentally-responsible alternative to GAC in many industries including life sciences, specialty chemical, agrochemical, petrochemical and semiconductors.

Nyex™ systems – adaptable and flexible

Essentially the Nyex™ system is next-generation chemical science (with many patents to its name) and in many installations will also be more cost effective than GAC. In other plants, Nyex™ systems can be installed to complement GAC, the two technologies working in concert to offer a robust and effective water treatment regime.

It's also possible to retro-fit Nyex™ systems into existing facilities; our space-efficient reactors can be placed strategically to treat specific flows, working together with other technologies to result in the best possible outflow quality with the lowest 'life cycle' environmental impact.

At Arvia we have identified many specific manufacturing situations where our Nyex™ based systems can offer greater efficiency as well as considerable OpEx savings against GAC and other competing water treatment technologies.

We believe it's one of the ways where manufacturers can make a real difference to their overall environmental impact – something that will become increasingly important to every company in the years to come.

For more information or to talk to an experienced water treatment engineer who will understand your organisation's unique issues with wastewater, contact us today on +44 1928 378 983.

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