



Activated Carbon for the Chemical Industry

Purification of liquids, waste air and water

Chemical production and activated carbons

The chemistry is present in all the areas of our day-to day lives, whether we are using our car, playing sports, practising hobbies or working on computer – chemicals are found everywhere.

Due to growing awareness of sustainable responsibility, the impact of the production of chemical products should be kept so little as possible. Thus the requirements for recycling production streams, air and water emissions are becoming stricter.

In many of such processes, activated carbon can be used to achieve recovery of valuable materials, to clean waste water and air, helping to minimize the impact on the environment.

Activated Carbon Characteristics

The manufacturing and activation process and the used basic raw materials have a determining influence on the adsorptive capacity of activated carbon products.

In the **Gas Activation Process**, previously carbonised material is subjected to the oxidising action of gas, such as steam, carbon dioxide, air or a mixture of these. Activation temperatures typically range from 700 to 1.000 °C.

In the **Chemical Activation Process** non-incinerated carbonaceous material like sawdust are initially mixed with dehydrating or oxidising chemicals like zinc chloride or phosphoric acid and heated up to temperatures between 400 and 800°C under exclusion of oxygen.

The selection of the most suitable type of activated carbon for a specific application depends on the physical and chemical properties of the substances to be adsorbed. Aside from this material data, other process-related factors also play a role in the adsorption process.

In the liquid phase: decolourization and purification of liquid solutions

Adsorption technology is widely used for the treatment of liquids. Apart from decolourization, activated carbon shall remove organic compounds seen as impurities. These applications are proceeding predominantly with activated carbons in powder form, our series "Carbopal" used by stirring or suspension. With powdered activated carbons, a multi-stage process is possible. When using granular activated carbons by percolation process, the solution to be treated is filtered through an activated carbon layer charged in columns. The "Epibon" products are characterized by open porous structure suitable for such treatments.

The filtration behavior of powdered activated carbons depends partly on the fineness, and also from the grain shape of the product. In the production of powdered activated carbon, the fineness is adjusted for optimum filtering characteristics. Here, a filter element is precoated with powdered activated carbon - if required in combination with a filter aid – to produce a filter layer through which the solution to be treated is passed. The combination with filter aid has no impact on the adsorption capacity of the powdered activated carbon. Separation of the powdered activated carbon is achieved by filtration in appropriate filter systems (press-filter, centrifuges and cartridge filters)

When using granular activated carbons, depending on the type and concentration of the substances to be adsorbed reactivation of spent activated carbon is possible.





Applications and selection of activated carbon

The various grades of activated carbons available by Donau carbons offer a wide variety of adsorption properties for all the different applications like liquid, waste air or water treatment.

Selection of the suitable grade is done through extensive know-how based on almost 100 years' experience in the production, processing and characterization of activated carbons dealing with customers' specific requirements.

Selection activated carbon form – Overview of advantages

Powered activated carbon	Granular activated carbon
Low invest cost	Possibility of environmental friendly & cost-saving reactivation
Temporary usage	Compensation of concentration fluctuations
No preloading	Security Level
Low space needed	few analytic needed
Multiple use	Easy Handling

Usage of activated carbon in the chemical production

Requirements for the use of activated carbon in the chemical industry are tough. The products must not only be performing and reliable but have to comply with the purity of the end-product. The products of Donau Carbon offer the best quality according to the task or to eliminate substances.

Donau Carbon offers each customer the full service of suitable quality activated carbon, position of mobile filters, transported in the appropriate silo trucks and take-back and disposal or according to the possibility the reactivation of spent activated carbon.

Activated carbon used for chemical treatment:

Application/ to be treated media	Task / substance to be removed	Recommended activated carbon
Phosphoric acid	Removal of humic acids	Epibon Y 12 x 40 spezial / Epibon X 12 x 40 spezial Carbopal Gn-P
Hydrochloric acid	Removal of chlorobenzene	Hydraffin CC 12 x 40 spezial
Adipic acid	Removal of cyclopentanone	Epibon Y 12 x 40 spezial
Natural resins, e.g. shellac	Decolourization by removal of erythromycin	Epibon Y 12 x 40 Carbopal Gn-A II
Amino acid, e.g. methionine & cysteine	decolourization	Epibon MC 14 x 35 Epibon Y 12 x 40 LC Carbopal PA 4N
Glycerine	decolourization and deodourization	Epibon Y 12 x 40 Hydraffin CC 12 x 40
Paraben	decolourization	Epibon Y 12 x 40 spezial
Pentaerythritol	decolourization	Hydraffin P 800 C
Amine purification	Removal of organic compounds	Hydraffin 30 N
Diammonium hydrogen phosphate	Removal of BTEX	Epibon Y 8 x 30 spezial Epibon Y 12 x 40 spezial
Bates, caustic solutions and galvanic baths	Reduction of COD-concentration	Hydraffin 30 N Hydraffin MB 4 or P 800

Activated carbon for the off-gas at chemical production sites

Gaseous emissions are problematic in most of the productions, as they may cause undesirable odours or being health relevant. To control air pollution, activated carbon can be used against a vast variety of substances in unimpregnated or impregnated form. Donau Carbon can draw on its own carbon impregnating facilities.

In air and gas cleaning applications, the substances to be removed are frequently present in very low concentrations or they tend to polymerize so that their recovery is either not possible or not economically warranted. Common equipment and technologies employed for treating such gas streams are fixed-bed adsorbers and moving bed adsorber systems, or combinations thereof, consisting of several adsorbers units. While these processes predominantly use „once-through“ carbons, thermal reactivation of the spent carbon may be economically attractive for large adsorbers systems.

Typical contact times required for the **adsorption of organic vapours and odorants** in fixed-bed adsorbers range between 0.1 and 0.2 seconds. Longer contact times may be selected when the gas stream to be treated has a high relative humidity or stringent emission standards have to be met. Normally, fine-pore activated carbons with a high adsorptive capacity are used for this task and discarded once they are exhausted.

The suitability of an activated carbon for a given application can be determined by the adsorption isotherm for benzene from air at 20° C, for example. Another relatively simple method is the determination of the tetrachlorocarbon or n-butane activity according to ASTM. The relevant Parameters and values are written in the technical data sheet of all Desorex and Supersorbon qualities.

Activated carbon for ground air treatment:

Products	Diameter / Grain size	BET-Surface [m ² /g]	CTC [wt. %]	Type of AC
Alcarbon UC 50/4x8	4x8 mesh	1100	50	Granular, virgin, coconut shell based
Desorex K 43	4mm	1000	60	Extruded, virgin, coal based
Desorex K 47	4mm	900	50	Extruded, virgin, coal based
Desorex K 47 F	4mm	800	40	Extruded, virgin, coal based
Desorex LR	4mm	800	40	Extruded, reactivated coal based

In many exhaust air cleaning applications, the air to be treated not only contains low-molecular-weight substances - usually inorganic substances which are difficult to adsorb - but also organic vapours (e.g. traces of hydrogen sulphide, gasoline vapours) to be removed by adsorption. In such cases, combinations of impregnated activated carbon and unimpregnated carbon serving a sole adsorptive function have proved to be successful.

Highly volatile pollutants such as chlorine, ammonia, sulphur dioxide, mercury and hydrogen sulphide are poorly adsorbed on activated carbon at atmospheric pressure, so that a pure physical adsorption process is not applicable.

Impregnated activated carbon for the removal of different substances:

Desorex	Granulation [mm]	Impregnation	Substance
K 23 J K 43 J	2 4	potassium iodide	H ₂ S up to a gas humidity 70%
G 50	3 4	potassium hydroxide	H ₂ S regardless of the gas humidity
K 33 a K 47 a	3 4	potassium carbonate	SO ₂ , HCl, NO _x , H ₂ S, acid gases
K 33 P 10 K 47 P 10	3 4	phosphoric acid	NH ₃ alkaline gases
HGD 2S HGD 4S	2 4	sulphur	Hg

Such substances can, however, be removed by chemisorption, i.e. chemical conversion followed by physical adsorption on activated carbon impregnated with metal salts, iodine and sulphur as well as acids and alkalis. In the process, the impregnants act either as a chemical reaction partner or as a catalyst. Compared to physical adsorption, chemisorption requires a contact time that is approximately 1 second longer.

The **solvent** processing industry, e.g. the printing industry, dry cleaning shops and paint shops, depend on solvents which are vaporized in the course of the production process. Recovery of these solvents from the process exhaust air is desirable both from economic and ecological aspects. The principle underlying the Donau Carbon (formerly Lurgi) **Supersorbon® solvent recovery process** is the adsorption of solvents on activated carbon and their subsequent desorption by means of superheated steam or hot inert gas. The resulting condensate is further treated to recover the solvent for reuse in the production process.

The solvent recovery process relies on high-quality activated carbon grades with a well-balanced pore structure. While the micro-pores are crucial to solvent retention and hence, compliance with the prescribed VOC emission limits, the access pores in the macro- and meso-pore range facilitate desorption of the solvents from the activated carbon. The activated carbon is charged in fixed-bed adsorbers and should offer as low a flow resistance as possible. This is the reason why 4 mm extruded carbon pellets are the adsorbents of choice for this application. Depending on the type of solvent to be removed, activated carbon grades of different raw material origins or low-ash carbon grades are employed to give the best treatment result.

Activated carbon for removal of different solvents:

Supersorbon	Solvent
C IV spezial BC IV spezial	low boiling solvent
K 42	low and higher boiling solvent
K 40	low and higher boiling solvent
K 43	higher boiling solvent

Activated carbon for the waste water at chemical production sites

When dealing with prevention of pollution of aquatic environment, activated carbons can be used in several ways.

The maximum allowable pollutant concentrations for the industry are settled in most of the countries by local laws. A frequent parameter to report pollutant concentration is the **COD** (chemical oxygen demand). To meet the commitments in term of COD, industries like refineries or steel industries are using granular activated carbons in columns, from coal based material, which will guarantee the best adsorption efficiency as well as long service life of the filters. As a second advantage for this system, reactivation of the activated carbon can be considered.

Example: Wastewater treatment plant with capacity of 150 m³ / h water and the following treatment steps:

1. Tanks (surface water + 30 m³ / day of process water)
2. Flocculation
3. Sand filters
4. Biological treatment
5. Tertiary treatment with two AC filters each 60 m³ in series

Life of the coal bed: 2-3 years

One other task of waste water treatment plant is the elimination of **traces of pollutants** classified as WHC water hazardous compounds. Their concentrations are often very low, sometimes in µg/l but even though they have to be treated.

Donau Carbon recommends the use of powdered carbons particularly when it deals with temporary pollutions or low flow rates. A dosage of 10-20 g of activated carbon per m³ of waste water is a typical level that can be tried out.

If recurring, waste water, the use of granular activated carbon is an economically plausible solution.

Reduction of color in waste water is an important issue, not only for the textile industry but for all kind of effluents. In large scale trials tests, the use of an open porous activated carbons proved the optimal results. By dosing the powdered carbon together with the polymers, during the coagulation/flocculation step, the reaction will occur in the existing contact reactors.

Powdered Activated Carbon for Waste Water Treatment		
Activated Carbon	raw material	application
Carbopal AP	Lignite	pharmaceutical pollutants & very high COD removal
Hydraffin MB4	Wood	Decolourization and COD removal
Hydraffin P800	bituminous coal	High quality product for COD removal
Hydraffin PR	bituminous coal	Price attractive alternative

General Information

Laboratory / Application Department Support

Evaluation and control of new and used activated carbon will be done in our own laboratories in compliance as well with own methods as also with national and international standard test processes. Our application engineers have decades of experience in the field of water treatment and is pleased to support our customer. Donau Carbon is offering a comprehensive service:

- analyses of adsorbents (mechanical, chemical and physical properties)
- determination of isotherms
- separation experiments
- support for selecting an optimal activated carbon for waste water applications
- Mobile filters used as pilot plants for on-site tests are also provided upon request.

Thermal reactivation of activated carbon

In many cases, loaded or exhausted granular activated carbons can be reactivated by means of a thermal process which is similar to the original activation process. Donau Carbon provides a thermal reactivation service for granular activated carbon as a costsaving and environment-friendly alternative to disposal at two locations (Frankfurt/Main, Germany, and Pischelsdorf, Austria). Using the latest technologies, the reactivation plants (rotary kiln) guarantee an optimum quality of the reactivated product. Quality control and analyses in the company's own ISO 9001-certified laboratory ensure the quality of the reactivated carbon and its suitability for reuse. The plants are equipped with state-of-the art offgas cleaning systems meeting stringent European emission standards.

Service and Mobile Compact Systems

In addition to its activated carbon sale and reactivation activities, Donau Carbon offers mobile and stationary adsorption units for ground water rehabilitation and soil vapour treatment. These compact, con-tainerized units are available for sale or for hire and come with a complete service package from delivery, collection, replacement, refill through to the disposal of the spent carbon, as requested by the customer.



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