The Biological Activated Carbon (B.A.C.) Process

Granular activated carbons are utilised, in conjunction with ozone, in an advanced water treatment process known as the "Biological Activated Carbon" (BAC) process. The basis of this process is the breakdown, by oxidation with ozone, of a wide range of organic species into compounds which are degraded biologically on bacterial biomass which has developed on the surface of the activated carbon, and the adsorption of the non-biodegraded organic species, by conventional adsorption processes. The biomass that is fixed onto the carbon occurs naturally in water; its growth is promoted by the biodegradable matter in the water that results from ozonation, and it is controlled by periodic backwashing. As well as enhanced dissolved organics removal, benefits of the BAC process include significant reductions in required disinfectant doses, significant reductions in disinfection by-product (DBP) potential, reduced regrowth potential, reduced pipe slimes and significantly extended activated carbon service life.

While conventional filter media (i.e. sand, filter coal) have the ability to support biological growth, activated carbons, because of their porosity, surface texture, surface chemistry and adsorption capacity, are the preferred media for the BAC process. Two types of GAC are utilised in the process:

- Microporous GAC, e.g. coal based, generally used for both physical adsorption and biological stabilisation.

- Macroporous GAC, e.g. wood based, generally used for biological stabilisation only.

The adsorption capacity performs three functions in the BAC process:

- Adsorption of substrates, nutrients and oxygen, and their concentration and retention on the carbon surfaces, to allow extended contact time between the contaminant and the biomass. This promotes biodegradation even when the concentrations of substrate and nutrient in the influent water are too low to support bacterial growth on their own.

- Adsorption of toxic compounds, protecting the biomass from the undesirable effects of their presence.

- Chemical reduction of oxidants/disinfectants (e.g. ozone, chlorine) by GAC at the inlet to protect the biomass from the effects of these compounds.

Also, chemical groups on the carbon surfaces enhance microbial attachment.

Both macroporous and microporous GAC's perform similarly in the BAC process for some functions, and differently for others, because of their different pore structures:

- Removal efficiencies of biodegradable organics, e.g. assimilable organic compounds (AOC's) and biodegradable organic compounds (BDOC's) are similar for both types, under steady state conditions.

- Removal efficiencies of disinfection by-product (DBP) precursors are marginally but measurably greater for the microporous GAC than for the macroporous GAC, under steady state conditions.

- At water temperature above around 10°C , the ammonia removal efficiencies, under steady state conditions, will be similar for both types of GAC's; at temperatures below 5°C, macroporous GAC outperforms micorporous GAC for ammonia removal, while BDOC removal efficiencies remain similar.

- Acclimation times (i.e time required for the biomass to develop) are similar for both macroporous and microporous

GAC's.

- Microporous GAC's have a significantly greater adsorption capacity (around 5 times greater) than macroporous GAC's for DOC and DBP precursor removal.

It will be noted that, while microporous GAC's will function in both adsorption and biodegradation modes, macroporous GAC's operate essentially only in biodegradation mode. If all the contaminants are biodegradable, either type would be suitable. If large reductions in DBP precursors are required, or if non-biodegradable TOC's are to be removed, microporous GAC's are the products of choice.

Testwork, and operating experience in newly commissioned Water Treatment Plants, have indicated that C&S Brand Granular Activated Carbons are extremely effective, both as a substrate for the biological growth and as an absorbent for the non-biodegradable organic species, while possessing the hardness and abrasion resistance required to cope with the required frequent backwashing, and the surface characteristics required to retain and protect the required biomass.