AFM (Active Filter Media) sand biofouling & filter design implications

Content of this paper is applicable to the drinking water industry, or any application where health and safety and biofouling interactions are of importance, from boiler feed water to the tertiary treatment of sewage effluent.

The function of any pressure sand filter is the removal of solids from the water. The solids may be of organic or inorganic in nature, or in simpler terms, solids that can be digested by bacteria and solids that can not be digested by bacteria.

In a sand filter the non biodegradable solids do not present a problem, since they will generally be removed during the next back flush. The problem occurs from the solids that will break down in the filter as a consequence of bacterial activity. Dissolved organics, fats and Urea etc, can not be removed by a sand filter, however they also act as a food source for the bacteria.

Any surface in a pool or spa in contact with the water will have a film of bacteria, this film develops very rapidly over a period of hours or days. This can not be avoided, the vast majority of the bacteria will be harmless, however the greater the concentration of bacteria, the more likelihood there will be that some of the bacteria could be potentially dangerous. Hygiene is therefore paramount, and all surfaces should be regularly cleaned or scrubbed to remove the surface film. However there are areas that can not be cleaned, such as the inside of pipes (especially the joints) and balance tanks. Bacteria can also develop in the pool, especially if there is a slow, or poor water circulation.

When bacteria are in suspension, they will be easily killed by the chlorine or ozone present in the water. However as soon as the bacteria become fixed to a surface, they excrete a protective coat, and the levels of chlorine conventionally used in pool water will have little effect. The key point is therefore the surface area available for bacterial colonisation in the swimming pool system. By way of example, a 50m pool will have a surface area of around 3000 square meters (including all of the pipework). One cubic metre of 16 x 30 filter sand will also have a surface area of around 3000 square meters, and there may be around 50 tonnes of sand in the filters.

The sand in the sand filter represents the largest surface area by many orders of magnitude and the principal source of a stable bacterial biomass in the pool system. Although this is a rather simplistic comparison and doesn't take into account the bacterial loading from the bathers, as explained above, the bacteria load from the bathers will be in suspensions, and is therefore sensitive to the chlorine. The bacteria in the sand filters are not sensitive to chlorine, and they will continue to grow and develop given the opportunity.

The bacterial load present in a sand filter as the sand ages, will become considerable. Indeed the primary reason for sand filters failing (excluding mechanical failure) is the growth and development of the bacteria. The bacteria will eventually develop to such an extent that the bed may coagulate and result in complete bed blockage or streaming. When the sand is emptied it has the appearance of mud, this mud is almost pure bacterial cell biomass. In addition to blocking the sand, the bacteria excrete waste products from the mineralisation of organic solids and dissolved organics. These by-products react with the chlorine to increase the chlorine demand and level of combined chlorine. Bacterial fouling of the sand in pool sand filters is therefore of major importance on many levels relating to filter performance, water quality, chemical demands, operating costs and health and safety.

Sand filter design with regards to flow distribution through the bed, and back-flushing efficiency are absolutely essential. For example, if there is not plug flow through the filter bed, the filter will fail, if back-flush efficiency is not 100% then the filter will fail. While it is possible to achieve plug-flow, it is not possible to achieve 100% removal of retained solids and fats that have coated the sand grains. Every sand filter will therefore have a degree of fouling relating to the design of the filter, the length of time the filter has been in service, and the loadings placed on the filtration system.

At Dryden Aqua we have used fluidised beds of sand as biological filters to incubate bacteria for effluent treatment. This would be like filtering water using a sand filter that was on continuous back flush. The sand lasts for a period of at least 1 year under these conditions. Failure of sand due to attrition in pool filters is therefore not and issue, the only reason for changing the sand is filter failure or serious biofouling.

Filter design and operation is very important, but it is not the complete solution. Fundamentally sand is not the best material to use in sand filters, other types of media that have an even higher surface area such as zeolites or activated carbon, can be even better at incubating bacteria. In order to resolved these problems Dryden Aqua developed AFM (Active Filter Media). The filter media will remove smaller particles from the water than sand, it will even adsorb and crack a portion of the dissolved organics and thereby lower the level of THM`s. AFM is self sterilising, and will tend to prevent bacteria development in the filter bed. By way of example we have operated a simple sand filter for the tertiary treatment of sewage effluent. The filter has operated continuously over the last 5 years. If sand had been used in the filter, it would have failed after a period of few weeks.

AFM is in use in over 40 pools and spas in the UK, to-date none of the filters have failed or needed to have the sand changed. In public spa systems the sand normally needs to be changed ever few months. We know that AFM under similar conditions will last for several years, or may never need to be changed.

AFM has been tried and tested in real systems over a period of 5 years, and is now commercially available to the UK swimming pool industry. A new production facility to manufacture 100 tonnes per day is presently under construction by Dryden Aqua. The factory and process will be completed by the end of the summer 2003, after which we should be able to meet any demand for the product.

The design of swimming pool water treatment systems have been historically considered from an engineering and chemical viewpoint. However biological issues are the real problem and the chemistry of the water is a secondary factor related to trying to control the bacterial levels. Good engineering and equipment are essential, but the biological aspects have been largely ignored. It has perhaps been assumed that bacteria and higher organisms can not survive in a chlorinated system, this assumption does not apply to sand beds. AFM filter media, on the other hand goes a long way to provide the ultimate solution to swimming pool water quality, by dramatically reducing the bacterial loading present in the filtration system.

Dr.Howard T Dryden
Dryden Aqua Ltd
Butlerfield
Bonnyrigg
Edinburgh EH19 3JQ
Tel 018758 22222
Fax 018758 22229
www.AFMfilter.com