Failure of plastic media biofilters due to ponding caused by the fungus *Subbaromyces splendens* Hesseltine.

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Fungi are a common component in fixed film reactors (trickling filters) and are generally associated with strong organic or industrial wastewaters. All these fungi are naturally found in polluted rivers and streams except for one species that forms thick greyish growths at all depths within filters. *Subbaromyces splendens* was originally recorded in 1952 from a percolating filter treating the wastewater from a pharmaceutical factory producing antibiotics.[1] The genus was named after the Indian scientist Subba Row who discovered aureomycin and synthesized folic acid. The fungus is somewhat of a curiosity as its natural habitat still remains unknown and has only subsequently been recorded from fixed film reactors treating both domestic and industrial wastewaters.

Very little is known about this fungus except its growth is linked with sewage strength.[2] Although the maximum growth rates, germination and conidia production occur during the warmest months within filters, the actual standing crop of fungus is less at high temperatures due to lysis of the fungus when nutrients become limiting. The fungus is extremely slow growing and so is unable to compete directly with other fungi or bacteria within the filter.[3] Therefore it reaches maximum abundance in filters during autumn and early winter, falling to a minimum in spring and early summer. The grazing fauna do not appear to have a function in the control of this coarse fungus, its abundance apparently controlled by competition, temperature and physical sloughing. The fungus is normally overgrown and excluded by the more rapidly growing bacterial component of the film.[4]

While the fungus is not very successful in mineral media filters it flourishes on plastic media, especially random packed plastics, and appears to be almost ubiquitous in such systems throughout the US and Europe (Figs. 1 and 2). Fungal films are structurally stronger than bacterial ones and the extensive mycelium of *Subbaromyces splendens* makes it less readily sloughed off. The high surface area of plastic media results in less competition from bacteria and the smooth nature of the medium compared to mineral media, gives the fungus a competitive advantage. *Subbaromyces splendens* has been recorded as growing on all types of plastic media including the new plastic-strip media. However, it is only in random and modular media that the fungus can pose a problem to the operator.

Figure 1. *Subbaromyces splendens* can form surface growth when media is continuously loaded with wastewater, although growths are normally restricted to lower depths.

Plastic media is widely used for the pre-treatment of high-strength industrial wastewaters and are housed in prefabricated or modified structures that could not be used with conventional mineral media, which have much higher bulk densities. For example random plastic media have bulk densities around 100 kg m^3 compared to 900 kg m^3 for mineral media. This means that biotowers used with plastic media can be very large structures, up to 12 m in height and 30 m in diameter. The ability to construct towers of this size using prefabrication techniques is critical to their cost effectiveness as a treatment process. Bacteria films are constantly sloughed from the smooth plastic media ensuring the bulk density of the wetted media is minimal. In contrast, due to the strength and extensive nature of the mycelium of *Subbaromyces splendens*, the biofilms it forms are not readily dislodged increasing the weight of biofilm retained. Grazing fauna, far less abundant on plastic media than on mineral media, also have little effect on the stability of the fungal biofilm resulting in a gradual accumulation of biomass. *Subbaromyces splendens* can grow throughout the filter leading to significant areas of the filter becoming choked by the biofilm resulting in excessive retention of wastewater (ponding) within the filter. At best this leads to a gradual decline in treatment capability, as less media surface area is available for treatment, resulting in poorer quality effluents. At worse, the ponding caused by the fungus can increase the bulk density of areas within the filter potentially putting the whole structure at risk of collapse, especially where ponding only occurs towards the outer wall. The resultant loss in treatment capability, the cost of media removal and cleaning, cost of structural repairs, and the potential danger to operators if the structure does collapse, are all evident. The problem of excessive development of *Subbaromyces splendens* is particularly associated with pharmaceutical wastewaters, although it is also associated with a wide variety of influent types. While both modular and random plastic media can be affected, structural problems are normally restricted only to randomly packed media. The size of the media is also largely irrelevant with most standard sizes employed at industrial plants being affected. It is often a surprise to operators how even the largest interstices can become blocked by this robust fungus.

Figure 2. All plastic media types are affected by the fungus, including both random and modular forms.

Where structures have been thought to be at risk operators have replaced random plastic media with plastic-strip medium. This new medium is comprised of thousands of long strands of flexible heavy duty plastic that hang vertically within the reactor space only supported at the top, just below the nozzle distribution system for the influent. The fungus grows well on this medium forming thick biofilms, but due to open, flexible, nature of the media it is unable to cause ponding. The medium also ensures that excessive fungal growths easily slough away. Some success has been achieved in trying to control the growth of *Subbaromyces splendens* by reducing the frequency that wastewater is applied to the filter by controlling the speed of the rotating distribution system. However, due to the long retention times within filters this may have the effect of simply restricting fungal growth to deeper within the filter. The safest option, but the most expensive, is to ensure that the structure housing the medium is able to withstand the maximum possible bulk density (i.e. total saturation of the medium with water). This would be equivalent to, if comparing a 50 mm slag media with a similar sized random plastic medium, an increase in bulk density by a factor of 1.58 and 10.27 for each medium type respectively (e.g. 1401 and 1005 kg m^3 respectively on average). However, as one of the major advantages of using such media is the saving on capital cost of engineering work, stronger housings or even the use of smaller structures may make the selection of this type of media economically less attractive in many cases. Replacement of existing random packed or modular media with plastic-strip media is extremely expensive, but for many it may be the only option.

Random and modular plastic filter media retain a major role in conventional and high rate treatment, however, care must be taken when used for the treatment of strong complex wastewaters that may favour fungal rather than bacterial film development. In these cases an alternative media should be considered. Research is still required to identify what components of wastewaters stimulate the development of *Subbaromyces splendens* and to find effective control measures.

References

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