UPFLOW SLUDGE BLANKET FILTRATION (USBF)

PHOSPHORUS REDUCTION MEMORANDUM

One of the beneficial features of the USBF technology is increased efficiency of phosphorus removal. This is due to the fact that a significant amount of the influent phosphorus is reduced by biological phosphorus uptake.

The mechanics of biological phosphorus uptake, known as "luxury uptake", is due to exposure of activated sludge to alternating oxide and anoxic conditions. Under the conditions, the cells store more energy in the form of phosphorus than needed for their survival. If strictly oxide conditions are maintained during subsequent clarification, phosphorus will be retained by the cells and it will eventually be removed with excess sludge. Unlike most other methods of clarification, the upflow sludge blanket filtration process maintains oxide conditions in the filter, and phosphorus reduction by biological uptake to as low as 1 mg/l has been achieved as demonstrated in the table below.[1]

The following results were recorded during the 2007 Annual Report filing test period at Kicking Horse Ski Resort, Golden, BC:

	March 15	March 22	March 29	April 2	April 9	Average
Total Phosphorus [mg/l]	1.11	0.78	0.69	0.95	2.2	1.15

Notes: 1. Total Phosphorus reduction was entirely by the biological phosphorus uptake. NO CHEMICALS WERE USED.
2. 24 hour composite samples were analyzed.
3. Official lab analysis available

For further phosphorus reduction phosphorus precipitant chemicals such as aluminum sulfate, ferrous sulfate or other salts are used. In most domestic wastewater phosphorus is present in three forms, orthophosphate, polyphosphate and organic phosphorus. Polyphosphate and organic phosphorus cannot be readily precipitated but both are converted to orthophosphate during biological treatment, which can. Since the bulk of phosphorus reduction is accomplished by biological uptake, the small polish dosages of metal salt precipitant do not significantly increase sludge production.

In simultaneous chemical precipitation metal salts are dosed into the anoxic compartment of the USBF bioreactor. Continuous sludge internal circulation and mixing ensure efficient precipitation, coagulation and flocculation within the bioreactor with an added benefit of increased efficiency of the USBF clarifier.

The following effluent Total Phosphorus parameters were recorded at a 1 MGD (4,000 m^3/d) USBF facility during seven months period from June to December 2002. The facility was provided with aluminum sulfate (alum) dosing system. During the period dual 24-hour composite samples were taken and analyzed and only the higher results were recorded. The following are monthly averages of the daily composite sample analysis.

2002	June	July	August	Sept.	Oct.	Nov.	Dec.	Average
Total Phosphorus	0.4	0.5	0.2	0.3	0.4	0.5	0.3	0.4

Notes: 1. TP design parameter was 1.0 mg/l
2. The facility has not been provided with any post-biology (read post USBF) filtration
3. Since the bulk of the total phosphorus reduction was by biological uptake, the alum consumption and the ballast sludge production were light
4. Two 24-hour composite samples were analyzed. Only the higher results were recorded.
5. Official lab analysis available
6. With added post-biology (post USBF) microscreen filtration, reduction of Total Phosphorus to 0.1- 0.25 mg/l range is believed to be eminently possible

[1] Sludge decant return from storage or dewatering to bioreactors if such is the case must be chemically treated as anoxic conditions during quiescent periods will cause phosphorus release.

At another facility, Islander Resort in Florida, the following results were recorded in 2006:

2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Average
Total Phosphorus	0.1	0.13	0.3	0.4	0.5	0.1	0.2	0.25

Notes:
1. TP design parameter was 1.0 mg/l
2. Islander Resort facility is at 12,000 GPD (45 m^3/d) a relatively small system with highly fluctuating flow and very rudimentary control system only
3. The facility is provided with post-biology (post USBF) microscreen filtration
4. In the original configuration ferric sulfate was used for chemical precipitation, but it was replaced with aluminum sulfate in the last few years
5. Grab samples as mandated by Florida Department of Environmental Protection were analyzed and recorded monthly
6. Official lab analysis available