Policy for Biological Treatment Processes for Iron and Manganese Removal

The Minnesota Department of Health (MDH) requires that pilot studies be performed for all alternative treatment technologies, including biological treatment processes. The following is the MDH policy for the approval of biological treatment processes for the reduction/removal of iron and manganese from drinking water sources.

Biological filters/contactors can be used for the removal of iron and manganese if a pilot study on the raw water source is conducted and can show iron and/or manganese removal/reduction to levels below the secondary maximum contaminant limit (MCL) of 0.3 mg/L for iron, and 0.05 mg/L for manganese. The design parameters that are determined during the pilot study will be required for the full-scale design. If a significant amount of ammonia is present, the policy for biological ammonia removal must be followed, in addition to monitoring for iron and manganese.

The first step in the approval process is to submit a pilot study proposal for the proposed treatment technology. Proposals for pilot studies must first be reviewed and approved by MDH. A final pilot study report must be submitted to and approved by MDH before proceeding to final full scale design. The design of biological filters/contactors shall comply with the Great Lakes Upper Mississippi River Board
Standards Recommended Standards for Waterworks (Ten States Standards) and this policy.

The pilot study must:

1. Accurately represent the final proposed treatment process, which may include but is not limited to:
    a. Type of filtration
    b. Depth of filter media
    c. Type of filter media
    d. Size and gradation of filter media
    e. Filtration rates, backwash system design (air and water is required)
    f. Backwash rate
    g. Type of backwash water (raw, treated and unchlorinated, or de-chlorinated, etc.)
    h. Empty bed contact time
    i. Dissolved oxygen concentration
    j. Number and types of filters piloted
    k. Method of oxygen addition
    l. Chemical addition
    m. Maximum allowable filter/contactor headloss before backwash
2. Establish water quality goals, including range (in mg/L) allowed of iron and manganese in the raw water, anticipated iron and manganese removal through treatment.

3. Operate through the entire anticipated temperature range of the raw water after the required amount of bacteriological growth is established.
4. Discharge all treated/filtered water to waste, unless otherwise allowed by the administrative authority.
5. Monitor and record raw water measurements (at least every two weeks) of:
    a. Iron
    b. Manganese
    c. Ammonia
    d. Dissolved oxygen concentration [1]
    e. Alkalinity
    f. pH
    g. Temperature
    h. Total organic carbon (TOC) [2]
6. Monitor and record filter effluent measurements (at least twice a week) of:
    a. Iron
    b. Manganese
    c. Ammonia (if present)
    d. Dissolved oxygen concentration [1]
    e. pH
    f. Temperature
    g. Total organic carbon (TOC) [2]
    h. Total coliform [3]
        - It is recommended that dissolved oxygen be monitored continuously.
        - TOC monitoring can be reduced to monthly.
        - Sample prior to disinfection; can be reduced to monthly.
7. Monitor and record filter headloss, water flow rates, air/oxygen flow rates, and filter run times.
8. Specify the disinfectant type (monochloramine, free chlorine) to be used. If monochloramine disinfectant type is used, it is recommended that free ammonia in the finished water be between 0.0 and 0.05 mg/L.
9. Provide the results of bacteriological tests of the finished water with the disinfectant applied at the desired concentration (in the treatment plant) to see if the proposed disinfection process can attain a heterotrophic plate count (HPC) of 0.0 cfu/ml. The tests shall be conducted once per week. Additional tests may be required by the administrative authority.
10. Include a Disinfection By-Product (DBP) Formation Potential Test (14 day test) if the raw water TOC is greater than or equal to 2.0 mg/L. Systems with a raw water TOC less than
11. 2.0 mg/L should consider conducting a DBP Formation Potential Test.
12. Determine appropriate water and air backwash rates and time for the proper removal of loose clusters of bacteria that may break through the filter. The use of air with water backwash is required. Since biofouling may occur, backwashing with chemical addition should be evaluated.

13. Determine and simulate the maximum expected shutdown time for the biological filter/contactor while maintaining water quality goals upon start-up.
14. Establish a protocol for start-up after a period of shutdown and after backwashing events. Consideration should be given to backwashing the filter/contactor after a period of shut down. (This backwash requirement must be taken into account for the maximum shut down time in Step No. 12.) It should also be determined if a minimum volume of water is required to be filtered to waste upon filter startup after a backwash and/or shutdown in the full-scale operation.
15. Indicate if backwash reclaim is to be used in the final water treatment plant design.
16. Target iron and manganese removal to below the secondary maximum contaminant levels (0.3 mg/L for iron and 0.05 mg/L for manganese).
17. Only use chemicals that are ANSI/NSF Standard 60 listed.
18. Consider the use of a polishing filter.

Once the pilot study is completed, a copy of the final report must be submitted to the MDH for approval. After the final report has been approved, a complete set of plans and specifications for the full-scale treatment plant design shall be submitted to MDH for review and approval.

The final design shall include the following items:

1. Smooth-nosed sample taps shall be provided on the raw water influent, on the effluent line from each biological filter, and on the finished water effluent downstream of the final chemical feed point.
2. Continuous disinfection must be provided. A minimum residual of 0.2 mg/L of free chlorine or 1.0 mg/L of total chlorine must be maintained at all points of the distribution system. The total chlorine level shall not exceed 4.0 mg/L.
3. All chemical, oxygen injection, and pH adjustment points shall be clearly labeled on the plans.
4. The type, size, gradation, and depth of the filter media shall match the parameters established in the pilot study.
5. A means for measuring headloss must be provided. The project specifications shall indicate the maximum headloss allowed before backwashing of the filters/contactors is required.
6. Backwashing the filter/contactor with air and water shall be provided. The backwashing rates for both air and water shall be provided.
7. The filtration rate and empty bed contact time for each filter shall be stated in the project specifications.
8. It is strongly recommended that filter to waste piping be provided.
9. The project design specifications should include the run time of the filter to waste step after backwashing the filter/contactor (if necessary). This shall be determined in Step No. 13 of the pilot study requirements (above).
10. The provisions for backwashing the filter/contactor shall be described in detail.

11. Consideration should be given to the building size and layout to allow for additional chemical feed equipment for the biofiltration process if future chemical addition is needed to enhance performance.
12. Split stream (blending) of treated and untreated water will be allowed. The treatment shall take into consideration multiple sources with potentially different levels of iron and manganese.
13. A means for cleaning and maintaining the clearwell, while still maintaining plant operation, shall be provided. It is recommended that the clearwell/wet well be separated into at least two separate basins to allow for cleaning and maintenance of the clearwell while still allowing operation of the treatment plant.
14. If filter backwash reclaim is provided, the reclaim rate shall not exceed 10 percent of the total influent flow. Results from the pilot shall be provided.
15. The water operator must be certified at the proper level. A recalculation of the certification level will be conducted. Additional training may be required by the administrative authority.
16. The full-scale design must include the continuous monitoring of dissolved oxygen in the filter/contactor effluent.

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