Sludge Age (Days) = \[
\frac{\text{MLSS in Aeration Tank (Lbs.)}}{\text{TSS Entering Aeration Tank (Lbs./Day)}}
\]

The conversion of ammonia nitrogen (\(\text{NH}_3/\text{NH}_4^+\)) to nitrate nitrogen (\(\text{NO}_3^-\)) which occurs during an activated sludge process is directly dependent on sludge age. A longer sludge age will result in conversion of ammonia (\(\text{NH}_3\)) to nitrate (\(\text{NO}_3^-\)). Sludge ages typically vary from a low of about 3 days to a high of about 30 days, depending on the individual process.

Another parameter which can be used to evaluate the balance of solids in an activated sludge process is the mean cell residence time (MCRT). The MCRT is expressed in units of “days” and can be computed as follows by dividing the amount (Lbs.) of MLSS in both the aeration tank(s) and final clarifier by the amount (Lbs.) of suspended solids wasted per day and discharged in the effluent per day:

\[
\text{MCRT (Days)} = \frac{\text{MLSS(Lbs) in Aeration} + \text{MLSS(Lbs) in Clarifier}}{\text{SS Wasted (Lbs/Day)} + \text{Effluent SS (Lbs/Day)}}
\]

The MCRT represents the average time that a microorganism will stay in an activated sludge system. Typical values of MCRT will usually be in the range of 5 to 15 days. As with sludge age, a longer MCRT will result in more conversion of ammonia nitrogen (\(\text{NH}_3/\text{NH}_4^+\)) to nitrate (\(\text{NO}_3^-\)).

7. **Return Sludge** - A portion of the sludge which settles in a secondary clarifier should be returned to the aeration tank to maintain the mixed liquor suspended solids (MLSS) concentration necessary to keep the F/M ratio within the desired range. Sludge is normally returned on a continuous basis at some selected rate. Sludge return rates can be computed in various ways, depending on which particular control parameter is utilized. The following are three (3) common methods which are frequently used:

a. **MLSS Method** - This method is probably the most common and is based on the suspended solids concentrations of the mixed liquor (MLSS) and the sludge being returned. The amount of return sludge at a particular concentration needed to maintain a certain MLSS concentration in the aeration tank(s) is often expressed as a percent of the incoming flow (average daily flow) to the aeration tank(s) as follows:

\[
\% \text{ Return Sludge} = \frac{\text{MLSS (mg/l)} \times 100}{\text{Return Sludge SS (mg/l)} - \text{MLSS (mg/l)}}
\]

The actual “return sludge rate” in units such as “gallons/day” (GPD) or “million gallons/day” (MGD) can then be computed by multiplying the “% Return Sludge” by the average daily flow:

\[
\text{Return Sludge Rate} = \% \text{ Return Sludge} \times \text{Average Daily Flow}
\]

b. **Settleability Method** - This method is based on results of the 30-minute settleability test. The % Return Sludge, expressed as a percent of the incoming flow (average daily flow), can be computed as follows:

\[
\% \text{ Return Sludge} = \frac{\text{Settled Sludge @ 30 Minutes (ml/l)} \times 100}{1000 - \text{Settled Sludge @ 30 Minutes (ml/l)}}
\]

The actual “return sludge rate” can then be determined as in the MLSS method by multiplying the “% Return Sludge” by the “Average Daily Flow”. The settleability method is not always as accurate as the MLSS method because it assumes that the settling which takes place in the 1,000 ml graduated cylinder in the 30-minute settleability test is the same as that which takes place in the clarifier.

c. **SVI Method** - This method utilizes the Sludge Volume Index (SVI). The calculations are virtually the same as the MLSS method except that the SVI is used to estimate the suspended solids concentration of the return sludge. The “% Return Sludge”, expressed as a percent of the incoming flow (average daily flow), can be computed as follows: