Example 6.4

In a certain settler, solid-liquid separation is satisfactory when operated under the following conditions: $X_t = 5\ g{\cdot}l^{-1}$, superficial loading rate $T_s = 0.5\ m{\cdot}h^{-1}$ and recycle factor s = 1. When the superficial loading rate is increased to $0.55\ m{\cdot}h^{-1}$ the settler fails, independent of the value of the applied recycle factor. The values of the Vesilind constants have been determined as $k = 0.4\ l{\cdot}g^{-1}$ and $v_0 = 7\ m{\cdot}h^{-1}$. Estimate the safety factor of the settler.

Solution:

For the data given $k{\cdot}X_t = 0.4{\cdot}5 = 2$. The largest ratio of T_s/v_0 that can be applied for $T_s = 0.5\ m{\cdot}h^{-1}$ and $v_0 = 7\ m{\cdot}h^{-1}$ = $T_s/v_0 = 0.5/7 = 0.07$.

Using Fig. 6.8, point A is identified as the intersection of the curve for s=1 with $k{\cdot}X_t = 2$. The value of the ratio T_{sm}/v_0 for an ideal settler ($s_f = 1$) would be 0.135. T_{sm} is $7{\cdot}0.135 = 0.94\ m{\cdot}h^{-1}$. As the applied T_{sm} in reality is $0.5\ m{\cdot}h^{-1}$ the value of the safety factor can be calculated as $s_f = T_{sm}/T_s = 0.94/0.5 = 1.88 \approx 2$.

Example 6.5:

In the above example, when the concentration $X_t = 5\ g{\cdot}l^{-1}$ is maintained and the superficial loading rate T_s is lowered to $0.25\ m{\cdot}h^{-1}$, what will be the minimum value of the sludge recycle rate s ? If a superficial loading rate T_s of $0.25\ m{\cdot}h^{-1}$ is applied, what will be the maximum possible concentration X_t and what will be the required minimum value of sludge recycle factor s?

Solution:

$k{\cdot}X_t$ remains 2 and the value of $T_s/v_0 = 0.25/7 = 0.036$. Again using Fig. 6.8 and applying the safety factor of 2, then point B is identified. It can be seen that the corresponding s curve (going through B) is marginally higher than that for s = 0.5.

As for the second part of the question: when clarification is limiting, for $s_f = 2$ and $T_s/v_0 = 0.25/7 = 0.035$ in Fig. 6.8 the corresponding value of $k{\cdot}X_t$ can be determined as 2.67 or $X_t = 2.67/0.4 = 6.7\ g{\cdot}l^{-1}$ (point C). The required recycle rate is determined as s = 2. For lower values of the sludge recycle factor s, clarification ceases to be the limiting process. For thickening the required area will be larger.