Assumption 2. *Steady-state operation with nucleation and growth.*

Continuous crystallizers are most often operated in steady-state mode. Assuming stable operation, in steady-state all state variables are constant in time $(n(L,t) \rightarrow n(L))$. With negligible agglomeration and breakage, no crystals in the feeding stream, and assuming size independent growth, eqn (2.31) reduces to the classical characteristic MSMPR equation:

$$G\frac{\mathrm{d}n(L)}{\mathrm{d}L} = -\frac{n(L)}{\tau} \tag{2.32}$$

The nucleation is taken into account as an additional, traditional boundary condition of eqn (2.32):

$$\lim_{L\to 0}\frac{\mathrm{d}n(L)}{\mathrm{d}t} = \mathrm{B} \Rightarrow \lim_{L\to 0}\left[\frac{\mathrm{d}n(L)}{\mathrm{d}L}\frac{\mathrm{d}L}{\mathrm{d}t}\right] = Gn(0) \tag{2.33}$$

where $n(0)$ denotes the number of zero sized particles (nuclei). Then, the variables of eqn (2.32) can be separated and an analytical solution for the differential equation can be obtained:

$$n(L) = -n(0)\exp\left(-\frac{L}{G\tau}\right) \tag{2.34}$$

Therefore, the semi logarithmic CSD plot can be used to simultaneously determine the nucleation and growth rates, as Figure 2.7 presents.

A linear population density function is obtained in the MSMPR if and only if the modeling assumption holds for the investigated crystallization system (size independent growth, negligible breakage and agglomeration *etc.*). Practically, the CSD often deviates from the ideal linear form, but this deviation enables the underlying crystallization mechanisms to be inferred.[18] An example is presented in Figure 2.8.

We would like to remind the reader that the model equations were derived for a cooling crystallizer but they are not restricted to systems with that particular method of producing supersaturation.

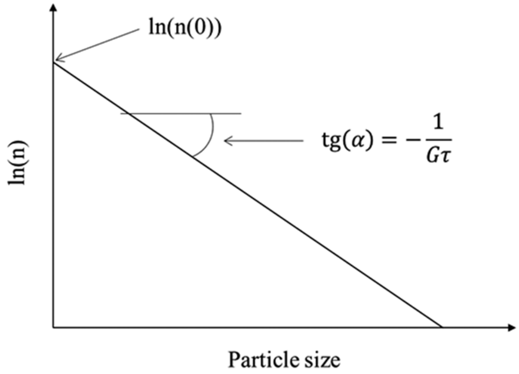

Figure 2.7 Nucleation and growth kinetics determination from the steady-state population density function of MSMPR crystallizers.