Multiplying eqn (1.16) with v^i and integrating over the interval of 0 to ∞ results in the generalized rate equation of the moments:

$$\frac{\mathrm{d}M_j}{\mathrm{d}t} = -\frac{M_j}{\tau} + \dot{N}v_{\mathrm{c}}^j + jk_{\mathrm{a}}\left(\frac{1}{k_{\mathrm{v}}}\right)^{\frac{2}{3}} k_g\sigma^g M_{j-\frac{1}{3}} \tag{1.17}$$

The dynamics of the crystallization process can be obtained by numerical solution of the set of ordinary differential equations:

$$\frac{\mathrm{d}v}{\mathrm{d}t} = k_{g1}\mathrm{e}^{\frac{-k_{g2}}{RT}}\sigma^g k_{\mathrm{a}}\left(\frac{v}{k_{\mathrm{v}}}\right)^{\frac{2}{3}}$$

$$\frac{\mathrm{d}C}{\mathrm{d}t} = \frac{(C_{\mathrm{i}} - C)}{\tau} - \frac{\dot{N}n_{\mathrm{c}}}{Ar_{\mathrm{v}}} - \frac{k_{\mathrm{a}}\left(\frac{1}{k_{\mathrm{v}}}\right)^{\frac{2}{3}} k_g\sigma^g M_{\frac{2}{3}}}{V_{\mathrm{m}}}$$

$$\frac{\mathrm{d}M_0}{\mathrm{d}t} = -\frac{M_0}{\tau} + \dot{N}$$

$$\frac{\mathrm{d}M_1}{\mathrm{d}t} = -\frac{M_1}{\tau} + k_{\mathrm{a}}\left(\frac{1}{k_{\mathrm{v}}}\right)^{\frac{2}{3}} k_g\sigma^g M_{\frac{2}{3}} + \dot{N}v_{\mathrm{c}}$$

$$\frac{\mathrm{d}M_{2/3}}{\mathrm{d}t} = -\frac{M_{2/3}}{\tau} + \frac{2}{3}k_{\mathrm{a}}\left(\frac{1}{k_{\mathrm{v}}}\right)^{\frac{2}{3}} k_g\sigma^g M_{\frac{1}{3}} + \dot{N}v_{\mathrm{c}}^{2/3}$$

$$\frac{\mathrm{d}M_{1/3}}{\mathrm{d}t} = -\frac{M_{1/3}}{\tau} + \frac{1}{3}k_{\mathrm{a}}\left(\frac{1}{k_{\mathrm{v}}}\right)^{\frac{2}{3}} k_g\sigma^g M_0 + \dot{N}v_{\mathrm{c}}^{1/3}$$

$$\dot{N} = k_{b1}\mathrm{e}^{\frac{-k_{b2}}{RT}}\sigma^b Ar$$

The shape factor of solute can be obtained from the literature or by image analysis techniques and microscope images. Seeded batch growth studies help in obtaining the growth rate parameters explicitly. Batch data of heterogeneous nucleation and growth experiments can be used to finally fit the nucleation rate parameters, which is a safe assumption for the continuous crystallization.

The previous method was for direct nucleation and crystallization on the surface of the excipient crystalline particles. Yazdanpanah *et al.* proposed a new technique for direct crystallization on the surface of an amorphous polymeric film (continuous medium) in an end-to-end continuous fashion.[90] A schematic of the process is shown in Figure. 1.8. The process consists of three sections: (1) excipient film preparation by melt or solution deposition on the polymer on a back-layer surface, (2) a crystallization pool for direct nucleation and