

Polymeeriteknologia II

Kaavakokoelma

$$n = \frac{m}{M} \quad c = \frac{n}{V} \quad \rho = \frac{m}{V} \quad V_m = \frac{n}{V} \quad pV = nRT \quad k = Ae^{-\frac{E}{RT}}$$

$$\bar{M}_n = M_0 \times \bar{X}_n \quad p = 1 - \frac{[M]}{[M]_0} \quad R_p = -\frac{d[M]}{dt} \quad \sigma = \frac{F}{A} \quad \varepsilon(t) = \frac{\Delta l}{l_0} = J(t) \times \sigma$$

Askelpolymerointi:

$$\bar{X}_n = \frac{[M]_0}{[M]} \quad \bar{X}_n = \frac{1+r}{1+r-2rp} \quad r = \frac{N_{A,0}}{N_{B,0}}, r < 1 \quad r = \frac{N_A}{N_B + N_{B'}} \quad p_c = \frac{2}{f_{avg}} \quad f_{avg} = \frac{\sum N_i f_i}{\sum N_i}$$

Ketjupolymerointi:

$$R_i = -\frac{d[I]}{dt} = k_i [M] \times [R \cdot] = 2f \times k_d [I] \quad R_t = 2k_t [M \cdot]^2 \quad [I] = [I]_0 e^{-k_d t}$$

$$R_p = -\frac{d[M]}{dt} = k_p [M] \times [M \cdot] \quad [M \cdot] = \sqrt{\frac{R_i}{2k_t}} \quad \tau = \frac{[M \cdot]}{R_i}$$

$$\nu = \frac{R_p}{R_i} = \frac{R_p}{R_t} \quad \bar{X}_n = 2\nu \text{ (kombinaatio)} \quad \bar{X}_n = \nu \text{ (toisiintuminen)}$$

$$\bar{X}_n = \frac{R_p}{R_t + R_{ts} + R_{tr,M} + R_{tr,S}} \quad \frac{1}{\bar{X}_n} = \frac{R_i}{2R_p} + C_M + C_S \frac{[S]}{[M]} + C_I \frac{[I]}{[M]}$$

ATRP:

$$R_p = -\frac{d[M]}{dt} = \frac{k_p K[M][I][Cu^+]}{[Cu^{2+}]} \quad \bar{X}_n = \frac{p[M]_0}{[I]_0} \quad \frac{\bar{X}_w}{\bar{X}_n} = 1 + \frac{1}{\bar{X}_n}$$

Emulsiopolymerointi:

$$R_p = k_p [M][P \cdot] \quad [P \cdot] = \frac{10^3 N' n^-}{N_A} \quad r_p = k_p [M] \quad r_i = \frac{R_i}{N} \quad \bar{X}_n = \frac{r_p}{r_i}$$

Ionipolymerointi:

$$R_p = -\frac{d[M]}{dt} = k_p [M^-] \times [M] \quad \bar{X}_n = \frac{[M]}{[I]} \quad \frac{\bar{X}_w}{\bar{X}_n} = 1 + \frac{1}{\bar{X}_n}$$

Kopolymeroointi:

$$F_1 = \frac{r_1 f_1^2 + f_1 f_2}{r_1 f_1^2 + 2f_1 f_2 + r_2 f_2^2} \quad r_1 = \frac{Q_1}{Q_2} \exp[-e_1(e_1 - e_2)]$$

$$\text{Finemann\&Ross: } \frac{f_1(1-2F_1)}{F_1(1-f_1)} = \frac{f_1^2(F_1-1)}{F_1(1-f_1)^2} \times r_1 + r_2$$

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NMR:

$$(mm) = (mmm) + 0,5(mmr)$$

$$(rr) = (rrr) + 0,5(mrr)$$

$$(mr) = (mmr) + 2(rmr) = (mrr) + 2(mrm)$$

$$(mmmr) + 2(rmmr) = (mmrm) + (mmrr)$$

$$(mrrr) + 2(mrrm) = (rrmr) = (rrmm)$$

$$(mmm) = (mmmm) + 0,5(mmmr)$$

$$(mmr) = (mmmr) + 2(rmmr) = (mmmr) + (mmrr)$$

$$(rmr) = 0,5(mrmr) + 0,5(rmr)$$

$$(mrm) = 0,5(mrmr) + 0,5(mmrm)$$

$$(rrm) = 2(mrrm) + (mrrr) = (mmrr) + (rmrr)$$

$$(rrr) = (rrrr) + 0,5(mrrr)$$

$$\text{Bernoullin malli: } \frac{4(mm)(rr)}{(mr)^2} = 1$$

$$\text{Ensimmäisen asteen Markovin malli: } \frac{4(mmm)(rmr)}{(mmr)^2} = 1 \quad \frac{4(mrm)(rrr)}{(mrr)^2} = 1$$

$$\text{Enantiomorfinen malli: } \frac{2(rr)}{(mr)} = 1 \quad 1 - \frac{4}{(mr) + 2(rr)} + \frac{1}{(rr)} = 1$$

Moolimassa:

$$\bar{M}_n = \frac{\sum n_i M_i}{\sum n_i} = \frac{\sum w_i}{\sum n_i} \quad \bar{M}_w = \frac{\sum w_i M_i}{\sum w_i} = \frac{\sum n_i M_i^2}{\sum n_i M_i} \quad PD = \frac{\bar{M}_w}{\bar{M}_n}$$

Viskositeetti:

$$\eta_r = \frac{\eta}{\eta_0} \approx \frac{t}{t_0} \quad \eta_{sp} = \frac{\eta - \eta_0}{\eta_0} \approx \frac{t - t_0}{t_0} \quad \eta_{red} = \frac{\eta_{sp}}{c} \quad \eta_{inh} = \frac{\ln \eta_r}{c} \quad [\eta] = \lim_{c \rightarrow 0} \left(\frac{\eta_{sp}}{c} \right)$$

$$\eta_{red} = [\eta] + k_H [\eta]^2 c \quad (\text{Huggins}) \quad [\eta] = k \times M_v^\alpha \quad (\text{Mark-Houwink})$$

$$\lg \frac{\eta}{\eta_s} = \frac{-8,86 \times (T - T_s)}{101,6 + (T - T_s)} \quad (\text{Williams-Landel-Ferry}) \quad \eta = k \times \exp \left(\frac{E}{RT} \right)$$

Vakiot:

$$R = 8,3145 \text{ J/(K mol)} \quad N_A = 6,022 \times 10^{23} \text{ mol}^{-1} \quad g = 9,80665 \text{ m/s}^2$$

$$0^\circ\text{C} = 273,15 \text{ K} \quad 1 \text{ bar} = 10^5 \text{ Pa}$$

Moolimassat (g/mol):

| | | | | | | | |
|----|--------|----|--------|----|--------|----|--------|
| H | 1,008 | C | 12,011 | N | 14,007 | O | 15,999 |
| Al | 26,982 | Cl | 35,453 | Ti | 47,867 | Zr | 91,224 |