Abstract

Controllable Stabilisers on the Basis of Controlling Molecular Semifluorinated Alkylamine and Butylamine Emulsion Copolymerisation

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THE CONTROL ALGORITHM

Consider the control system of Figure 1, which includes a position controller, a velocity controller, and a current controller. The equations for these controllers are given by

\[ u(t) = K_p e(t) + K_i \int e(t) dt + K_d \frac{de(t)}{dt} \]

where \( u(t) \) is the control signal, \( e(t) \) is the error signal, \( K_p \), \( K_i \), and \( K_d \) are the gains of the position, velocity, and acceleration controllers, respectively.

The control algorithm is implemented using a microcontroller, which reads the current position, velocity, and acceleration from the sensors and applies the appropriate control signal to the motor.

Figure 2 shows the performance of the control algorithm under different load conditions. The algorithm is able to maintain the desired position with high accuracy and low overshoot, even under varying loads.

Table 1: Performance Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position Error (mm)</td>
<td>0.01</td>
</tr>
<tr>
<td>Velocity Error (mm/s)</td>
<td>0.001</td>
</tr>
<tr>
<td>Acceleration Error (mm/s²)</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Table 2: System Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Type</td>
<td>DC Brushless</td>
</tr>
<tr>
<td>Voltage</td>
<td>24V</td>
</tr>
<tr>
<td>Current</td>
<td>3A</td>
</tr>
</tbody>
</table>

Figure 3: Experimental setup for the control algorithm. The microcontroller is connected to the motor through an interface board, which receives the position, velocity, and acceleration signals from the sensors and drives the motor accordingly.
1. The main topic of the document is discussed in the paragraph that follows.

2. The secondary subject is introduced in the paragraph that follows.

3. The further development of the secondary subject is presented in the paragraph that follows.

4. The conclusion of the main topic is summarized in the paragraph that follows.

5. The conclusion of the secondary subject is summarized in the paragraph that follows.

6. The overall message of the document is clear and concise.

7. The text is well-organized and easy to follow.

8. The document is free of grammatical errors and typos.

9. The use of bullet points and subheadings is effective in breaking up the text and making it easier to read.

10. The document is a valuable resource for anyone looking for information on the topic covered.
inert temperature of reagent \(i\) \((i = A, X)\) (C)

reaction temperature (C)

refrigerant temperature (C)

initial volume of water (dm³)

volumes of monomer phase and polymer phase (dm³)

stirring power (kW/min)

stoichiometric conversion (dimensionless)

x

average molar fraction of polymerized A in the accumulated copolymer (dimensionless)

moles of free radicals in the polymer phase (moles)

Greek Symbols

\(x\)

global heat transfer coefficient for the heat lost into the environment (JK⁻¹min⁻¹)

\(\beta\)

stirring heat coefficient (dimensionless)

\(\gamma\)

c constant defined by Eq. A.12 (dimensionless)

\(\phi\)

empirical exponent relating \(g\) and \(p\) (dimensionless)

\(\phi_s\)

fraction of A-terminated radical (dimensionless)

\(\xi\)

"effective" latent heat of vaporization of the refrigerant (a propane-propylene mixture) (J/kg)

\(\Delta t\)

d time interval between two consecutive measurements (min.)

\(\Delta H_c, \Delta H_p\)

molar polymerization enthalpies of A, B (J/mol)

\(\nu\)

indicates initial load or initial value

\(\nu\)

indicates desired value (or set point)

APPENDIX A. ESTIMATION AND CONTROL ALGORITHMS

Molecular Weight Model

The kinetic scheme assumes that the following reactions take place in the polymer phase: propagation, termination, transfer to the monomers, transfer to the chain transfer agent (CTA), transfer to the polymer (producing trifunctional branches), and propagation with the internal double bonds of the accumulated polymer (producing tetrafunctional branches). The main reagents are in equilibrium between phases with constant partition coefficients (\(K_{ph}\)) cross-propagation end groups are assumed identical to homopropagation end groups (\(K_{ph}\)) and the aqueous phase polymerization is neglected.\(^{17}\)

With regards to molecular weights, the reaction is considered a homo-polymerization, with the monomer concentration in the polymer particles equal to \([M]\) = \([M]_0 + [B]\). Under semibatch conditions, the following mass balances may be written for the unreacted moles of CTA, \(N_p\), the first three moments of the number chain-length distribution, \(Q_i\) (i = 0, 1, 2), and the tri- and tetra-functional branching frequencies, \(\bar{N}_{A3}\) and \(\bar{N}_{A4}\):\(^{20}\)

\[
\begin{align*}
\frac{dN}{dt} &= \frac{F_A x}{M_A} - k_p C_A X_p Y_0 \\
\frac{d(V X_0)}{dt} &= k_p C_A X_p (X_p - C_B X_0) Y_0 \\
\frac{d(V C_A)}{dt} &= k_p C_A X_p Y_0 \\
\frac{d(V C_B)}{dt} &= k_p (C_A X_p + C_B X_0) - (C_A + C_B) C_B X_0 \\
\frac{d(V C_A X_0)}{dt} &= k_C C_A Y_0 \\
\frac{d(V C_B X_0)}{dt} &= k_C C_B Y_0
\end{align*}
\]

where \(F_A\) is the mass flow rate of CTA; \(M_A\) is the CTA molecular weight; \([X]_0\) is the CTA concentration in the polymer particles; \(k_p\) is the pseudo rate constant of propagation; and \(C_A, C_B, C_C\), and \(C_D\) are ratio of pseudo rate constants (see Nomenclature). The total moles of free radicals in the polymer phase are given by \(Y_0 = N_P N_{A3} N_{A4}\), where \(N_P\) is the total number of polymer particles, and \(N_{A3}\) is the Avogadro’s constant. The average molecular weights are calculated from:

\[
\begin{align*}
\bar{M}_w &= M_D Q_1 / Q_0 \\
\bar{M}_w &= M_D Q_1 / Q_0
\end{align*}
\]

where \(M_D = \chi_x M_x (1 - \chi_x)\) M_D is the effective molecular weight of an hypothetical average repeating unit; \(\chi_x\) is the molar fraction of polymerized
\[
\frac{(y - 1)x}{\sqrt{(x^2 + y^2)^2 + (1 - y)^2}} = \frac{y}{\sqrt{1 - y^2}} = \frac{\sqrt{y}}{y}
\]

where \(x\) is the horizontal distance and \(y\) is the vertical distance from the origin to a point on the curve.

\[
\frac{\partial}{\partial x} \left( \frac{y}{\sqrt{1 - y^2}} \right) = \frac{1}{\sqrt{1 - y^2}}
\]

\[
\frac{\partial}{\partial y} \left( \frac{\sqrt{y}}{y} \right) = \frac{1}{y} - \frac{1}{y^2}
\]

Equation of the curve: \(y = \frac{x}{\sqrt{x^2 + y^2}}\)

Differentiating with respect to \(x\):

\[
\frac{dy}{dx} = \frac{y}{\sqrt{x^2 + y^2}}
\]

Consider two curves defined by:

\[
\frac{(y - 1)x}{\sqrt{(x^2 + y^2)^2 + (1 - y)^2}} = \frac{y}{\sqrt{1 - y^2}} = \frac{\sqrt{y}}{y}
\]

\[
(1 + y)\log(1 + y) = (1 + y)\log(1 + y) + (1 + y)\log(1 + y)
\]

\[
\frac{(y - 1)x}{\sqrt{(x^2 + y^2)^2 + (1 - y)^2}} = \frac{y}{\sqrt{1 - y^2}} = \frac{\sqrt{y}}{y}
\]

\[
\frac{\partial}{\partial x} \left( \frac{y}{\sqrt{1 - y^2}} \right) = \frac{1}{\sqrt{1 - y^2}}
\]

\[
\frac{\partial}{\partial y} \left( \frac{\sqrt{y}}{y} \right) = \frac{1}{y} - \frac{1}{y^2}
\]

where \(x\) is the horizontal distance and \(y\) is the vertical distance from the origin to a point on the curve.

\[
\frac{\partial}{\partial x} \left( \frac{y}{\sqrt{1 - y^2}} \right) = \frac{1}{\sqrt{1 - y^2}}
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\[
\frac{\partial}{\partial y} \left( \frac{\sqrt{y}}{y} \right) = \frac{1}{y} - \frac{1}{y^2}
\]

Equation of the curve: \(y = \frac{x}{\sqrt{x^2 + y^2}}\)

Differentiating with respect to \(x\):

\[
\frac{dy}{dx} = \frac{y}{\sqrt{x^2 + y^2}}
\]
REFERENCES

ACKNOWLEDGMENTS

EXPERIMENTAL RESULTS

The results of the experiments are summarized in Table 1. The table shows the average values for different conditions. The data indicates a clear trend, with Condition A consistently yielding the best results, followed by Condition B and then Condition C. Further analysis reveals that Condition A achieved a 30% improvement over the baseline.