EXPERIMENTAL METHODS IN CHEMICAL ENGINEERING

STATISTICS, EXPERIMENTAL DESIGN, AND MODELING

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Revised November 2000

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List of Symbols

A	heat transfer area used in Example 4.1 [m^2]
$[A]$	concentration of chemical species A used in Example 4.2 [$kmol/m^3$]
b_i	i-th model parameter
$\mathbf{b}$	parameter vector $(p \times 1)$
$\mathbf{C}$	C-matrix or $\left(\mathbf{X}^t\mathbf{X}\right)^{-1}$ $(p \times p)$
C_p	heat capacity [kJ/kg-K]
$\mathbf{e}$	dimensional error vector $((n-p)\times 1)$
E(y)	expected value of the statistic y
F_{cal}	calculated F-ratio, ms_i/s^2
F_{tab}	tabulated F-ratio dependent on α, ν_1, and ν_2
$\mathbf{F}^*$	matrix defined by Eq. (2.9)
k_1, k_{-1}, k_2	reaction rate constants used in Example 4.2
K	flow consistency used in Eq. (1.2) [$Pa \cdot s^{n+1}$]
m	mass of liquid used in Example 4.1 [kg]
ms_i	mean square, S_i/ν_i
n	flow index used in Eq. (1.2)
n	total number of observations
n_i	number of observations at the i-th level
p	number of model parameters
p^{sat}	vapor pressure [kPa]
Q_s	power supplied used in Example 4.1 [kJ/s]
r	residual degrees of freedom, n-p
r_B	rate of formation of chemical species B
R	response used in Chapter 3
R	residual, $y - \hat{y}$

s	sample standard deviation
s^2	sample variance defined by Eq. (3.14)
s_i	sample standard deviation at the i-th level defined by Eq. (3.15)
s_p^2	pooled sample variance defined by Eq. (3.16)
$s(y)$	standard error of statistic y, such as parameters or prediction
S	total sum of squares
S_A	model sum of squares due to the average of all responses
S_M	model sum of squares
$S_{M'}$	model sum of squares without the average included, $S_M - S_A$
S_R	residual sum of squares, $S - S_M$
S_E	sum of squares, pure error
S_L	sum of squares, terms-left-out, $S_R - S_E$
t	time[s]
t	t-statistic defined by Eq. (5.22)
T	temperature [K]
U	overall heat transfer coefficient used in Example 4.1 [kJ/m^2·s·K]
$V(R)$	variance of a response
$V(x_i)$	variance of an individual measurement
x	factor or independent variable
x_i	i-th factor
X_i	coded i-th factor defined in Appendix 2.A
$\mathbf{X}$	X-matrix $(n \times p)$
y	response or dependent variable
y_{ij}	j-th response at the i-th level
$\bar{y}$	sample average defined in Eq. (3.13)
$\mathbf{y}$	data vector $(n \times 1)$
$\hat{\mathbf{y}}$	model vector $(p \times 1)$
z	normal deviate defined by Eq. (5.23)

Greek Symbols

α	risk of making wrong decision
a_i	scalar value defined by Eq. (3.A.2)
b_j	j-th parameter in nonlinear model defined by Eq. (2.7)
ß	parameter vector
ß*	initial guess to parameter vector
dR	instantaneous deviation of the response
$d\mathrm{x}_i$	instantaneous deviation of the measurement x_i
$\dot{g}$	shear rate [s^{-1}]
e	experimental error
η	apparent viscosity [Pa-s]
η	true mean of population
η_0	zero shear viscosity [Pa-s]
q_i	coded temperature defined by Eq. (2.2)
Θ	temperature rise defined by $T - T_\infty$ [K] in Chapter 4
ν_i	number of replicates at i-th level equal to n_i-1
ν_E	pure error degrees of freedom or total number of replicates
ν_L	degrees of freedom, terms-left-out
ν_M	number of parameters in model, which equals p
ν_R	residual degrees of freedom, which equals n-p
x_i	i-th factor in nonlinear model used in Eq. (2.7)
X	nonlinear design matrix
r	polymer density [kg/m^3]
σ	standard deviation of population
σ^2	population variance
f_j	partial derivative defined by Eq. (2.10)