



)

De ig, f m l i- ha e a, d ca al ic chemical eac :  
a im la i , l f ll i , e e, i ,

A Ab, rehe i ebche ica, reac, rba a i b  
 ••• ab a bre i red b • re e ab • jec b • bde e • ba b  
 ad a bedb -ri eb • ce • i iza • ba a i b i b e b • r b  
 • r • b re e • .bThebad a bedb • ce ba a i b i b -b  
 e li egra e b • gra b(reac, r, • -ri eb i iza • hb  
 i chba a i ,ba db • ce b • -bhee i g)b ba a i zeta db  
 • d i bche ica, b • ce eb • r b a eb i i iza • .bTheb  
 reac, rba a i b • gra li b • beb edb • be ar a eta db  
 a a i ze r i- ha eta d i ca a i icreac, r b b ggeb b bheb  
 ra ba db • ce be gi eer bhe be breac, r b i eba db  
 • era ibg b • di • .bAb r i- ha bca a i icreac, r bde-b  
 ig ba d i a a i i b • r, ReaCa ,ha bee bde e • ed. ReaCa b  
 i • r • ra e b • der b bde ig b heb • i b(reac, r b i e :b  
 r gb • ,bCSTR, ba ch, bca a i icb ed-bed, bca a i icb i-b  
 dized-bed, bga ri idb i redba ,bric re-bed, bhree- ha eb  
 ed b b re-bed, b b reb, r i b • r ,bCSTRb r i ,ba db  
 hree- ha eb idized-bed. bThi b a er, gi e bab a i b fb  
 heb r i- ha bba d i ca a i icreac, r : bca i ca • ,b  
 h • i ba d bde ig b • der, b erica, b e b d ,ba d b • r -b  
 • ba, g ri h .bAbde b ri • b • fbhebreac, rba a i i b ••• r b  
 i cr di gb • ari • b ca e b i hbe eri e a bda ali b  
 re e ed. b

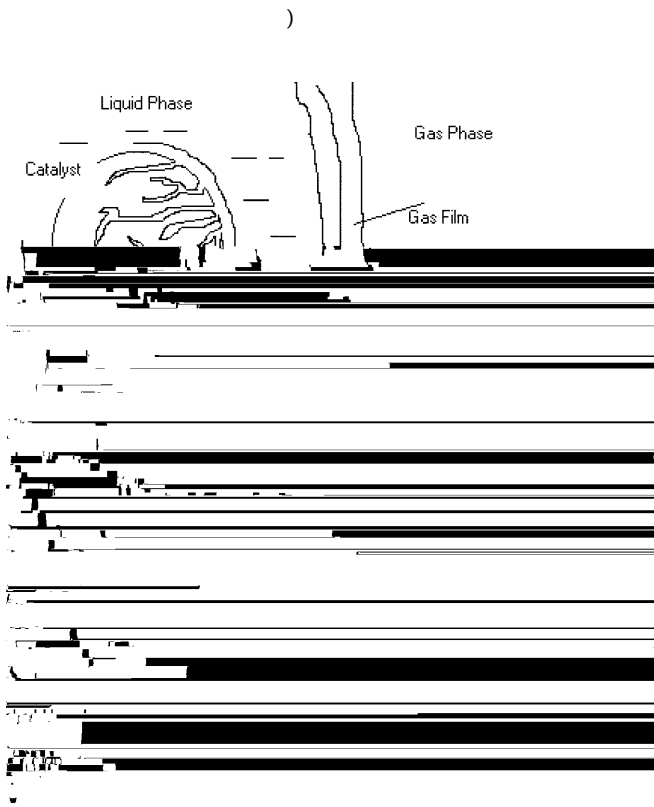
A Hea b ra f e rba: reab( b)b  
 C<sub>G</sub>, Ga b r b • ce bra • b fb • • ebb ( • r r)b  
 C<sub>G</sub><sup>ib</sup>, I re b r bga b • be ra • b • fb • • ebb  
 ( • r r)b  
 C<sub>G</sub><sup>b</sup>, O re b r bga b • ce bra • b fb • • b b  
 ( • r r)b  
 C<sub>L</sub>,

...  
A ia.b • b • b ( )b  
 $\rho_{Lb}$

---

---

---



F . 1.

de e<sup>o</sup> edli b herbha bheba ed,lab ar i gb e lageb A<sup>o</sup> herb er<sup>o</sup> b fbReaCa b a b ir b ba<sup>o</sup> bi reb<sup>o</sup> -b  
 izr bebbi a<sup>o</sup> edba bhebe db fbhebcaxc ra<sup>o</sup> .bEach<sup>o</sup> fbheeb hee ib gba abi<sup>o</sup> ,b chta b<sup>o</sup> ec ibgbreac<sup>o</sup> i bi berie b  
 a he a icab<sup>o</sup> der tha bee be edb er<sup>o</sup> b herb b-b<sup>o</sup> rb arazre, bge ericb i i gba db i i gb fb rea ,ba db  
 i hedbe eri eb a<sup>o</sup> rbi ra<sup>o</sup> b<sup>o</sup> r .bTabrebllri b ge ericthea b ra ferbe i e b (Figb6).  
 • et<sup>o</sup> ari<sup>o</sup> be a re ;b rb<sup>o</sup> rebe a re bhebreaderb  
 a<sup>o</sup> breferb<sup>o</sup> bSarehb(1994).b

Ab er-frie d<sup>o</sup> li b<sup>o</sup> gra tha bee bde e<sup>o</sup> edb  
 • b<sup>o</sup> r eba dba a<sup>o</sup> zebhebdiffere breac<sup>o</sup> r b<sup>o</sup> e .bFig re b2,b  
 3,ba db b<sup>o</sup> balfe b fti b cree .bAb<sup>o</sup> re eb erb  
 a a<sup>o</sup> b a<sup>o</sup> bebre e edfb<sup>o</sup> bheba b<sup>o</sup> r bRe r b a<sup>o</sup>  
 beb ie edli bgra hica<sup>o</sup> r bab ra<sup>o</sup> r a .bTheb er bca b  
 ie b<sup>o</sup> er<sup>o</sup> ,b<sup>o</sup> ce bra<sup>o</sup> ,be era re,ba db reb b  
 re,b hichb a<sup>o</sup> bebbi a<sup>o</sup> edba half c<sup>o</sup> b fbreac<sup>o</sup> rb  
 re g h,b<sup>o</sup> r e,bca a<sup>o</sup> b eigh ,b r breac<sup>o</sup> bi eb (Figb5).b

Theb d c<sup>o</sup> b<sup>o</sup> fb f ricbacid b<sup>o</sup> bhebe ac b<sup>o</sup> ce li lab  
 hree- be b<sup>o</sup> ce bha b<sup>o</sup> d ce b f ricbacidba db ea b  
 f<sup>o</sup> air,b<sup>o</sup> r e b f r,ba db a er .bTheb<sup>o</sup> ce b<sup>o</sup> i b fb  
 hreebec<sup>o</sup> b :b(1)bhelfeedb re ara<sup>o</sup> bec<sup>o</sup> b b(2)bheb  
 reac<sup>o</sup> rb ec<sup>o</sup> ;b(3)bhebab<sup>o</sup> r berbec<sup>o</sup> b b<sup>o</sup> helfeedb  
 re ara<sup>o</sup> bec<sup>o</sup> b b<sup>o</sup> r e b f r feedli b<sup>o</sup> b bedb i hb  
 d<sup>o</sup> bai r bi bheb f r i b r e r b<sup>o</sup> b<sup>o</sup> d ce b SO<sub>2</sub> .bThebe<sup>o</sup> bdb  
 ec<sup>o</sup> bi bhebreac<sup>o</sup> r b r e r bec<sup>o</sup> b bGal<sup>o</sup> bf<sup>o</sup> bheb  
 feedb ec<sup>o</sup> ,b f r b<sup>o</sup> ideba db air,be e r ta b(787<sup>o</sup> F)b  
 419.4<sup>o</sup> Cba db(19.4<sup>o</sup> P ia) b 33,759.12 b Pa .b f r b<sup>o</sup> ideba db

3. Three- ha ebga i idbca a<sup>o</sup> icbreac<sup>o</sup> r bde ig b<sup>o</sup> der b (CSTR b r i<sup>o</sup> )b

$$\begin{aligned}
 \text{N} - \text{ra i reb} & \bullet \text{ ebb} & L\left(C_{L,}^{ib}, C_{L,}^b\right) & R_b K_c c_b \left(C_{L,}^b, C_{S,}\right) & 0.0 & (1) \\
 \text{i id- ha eb a bara ceb} & & & & & \\
 \text{N} - \text{ra i reb} & \bullet \text{ ebb} & L\left(C_{L,}^{ib}, C_{L,}^b\right) & R\left(K_L g\right) \left(\frac{C_{G,}}{H} C_{L,}^b\right) & R K_c c_b \left(C_{L,}^b, C_{S,}\right) & 0.0 & (2) \\
 \text{i id- ha eb a bara ceb} & & & & & \\
 \text{Ga - ha eb a bara ceb} & & G\left(C_{G,}^{ib}, C_{G,}^b\right) & R\left(K_L g\right) \left(\frac{C_{G,}}{H} C_{L,}^b\right) & 0.0 & (3) \\
 \text{G} & \bullet \text{ b b a bara ceb} & & & & \\
 \text{a} & \bullet \text{ b b heba a<sup>o</sup> b} & R K_c c_b \left(C_{L,}^b, C_{S,}\right) & R & & (4)
 \end{aligned}$$

M<sup>o</sup> de rta b<sup>o</sup> b  
 1. bGa ba dbri idb ha e bareb e r tagi a edb

)

• Ҷеб ф• баиреаc б и ҳеаc• ҳе:б• б • d ceбSO<sub>3b</sub>a db reac б и ҳб а е:б• б• r б f ricbaid.Ҳ ҳебa a•b •-b  
 hea би ceбhi ли ба бе• ҳе: icreac • .bSO<sub>3b</sub>f• бheb ce б a ,b• rб• бe: e: бa:eb eдb•• б ai б a и б  
 reac• rб ec • ли б a eдb• бheb• rбe: b ec • б hereли б • иb•e• e: • б и hи бe: eдia eбe • a• fthea ба db

5. Ca аҶ иcри idb idized-bedreac• r ,bde ig б • de:б

Li id- ha eb• • б ба:а ceб  
 Pr gb• б

$$\frac{dC_{Lb}}{d} K_L C_{Lb} C_S \quad (1)$$

Di e:б• б

$$D_{Lb} \frac{d^2 C_L}{d^2} \frac{dC_{Lb}}{d} K_L C_{Lb} C_S \quad (2)б$$

Ca аҶ бb(e r• )b ha eb

$$K_L C_{Lb} C_S \quad Ca аҶ Pha eb \quad (3)$$

E e:ғ• ба:а ceб

$$\rho_L C_{Lb} \frac{d}{d} \sum^N \Delta H \quad (4)$$

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- -

-

-

-

\_\_\_\_\_

• rga ic),bga b( ge ),ba db• idb (ca a b).bThe• bjec-b  
i el• fb hib a a i bi b• b• areb hebe ha ••• er-b  
• b • re b• r b hebdiffere b e • fb heb hree- ha eb  
reac• i .b

A b i ca rca a b edli b hi breac • li bPd A<sub>2</sub>O<sub>3</sub>ba b  
30b°C.bThebreac • bha bee bl• b• beb i • rderb i hb  
re ec b• b ge b a dbze• b rderb i hbre ec b• be ha • z.b  
Thebreac • b• ich• e i bi bre rebe edba :b

A<sub>gb</sub> B<sub>b</sub> • d c b

hereb

AbO ge b

BbE ha •••

gbGab ha eb

•Li idb ha eb

Thebra eb• a bb ,bb 0.0177tc <sup>3</sup>/gb .bTabrebl2bi b

---

---

---



)

### REACTION

<input type="checkbox"/> Gas Homogeneous
<input checked="" type="checkbox"/> Liquid Homogeneous
<input type="checkbox"/> Catalytic Gas
<input type="checkbox"/> Catalytic Liquid
<input type="checkbox"/> Gas-Liquid
<input type="checkbox"/> Catalytic Gas-Liquid

F . 2. Reac b ha eb e b

e ded-bed .bTheca a icbeffec i e b bfac rli b -b  
e ded-bed b ab db beb chhigherbha bha b r  
ed-bed b(0.799b aredb i h0.13i b ed-bed )d eb b

### REACTOR TYPE

<input checked="" type="checkbox"/> Plug Flow
<input type="checkbox"/> CSTR
<input type="checkbox"/> Batch

F . 3. Reac r b eb e b

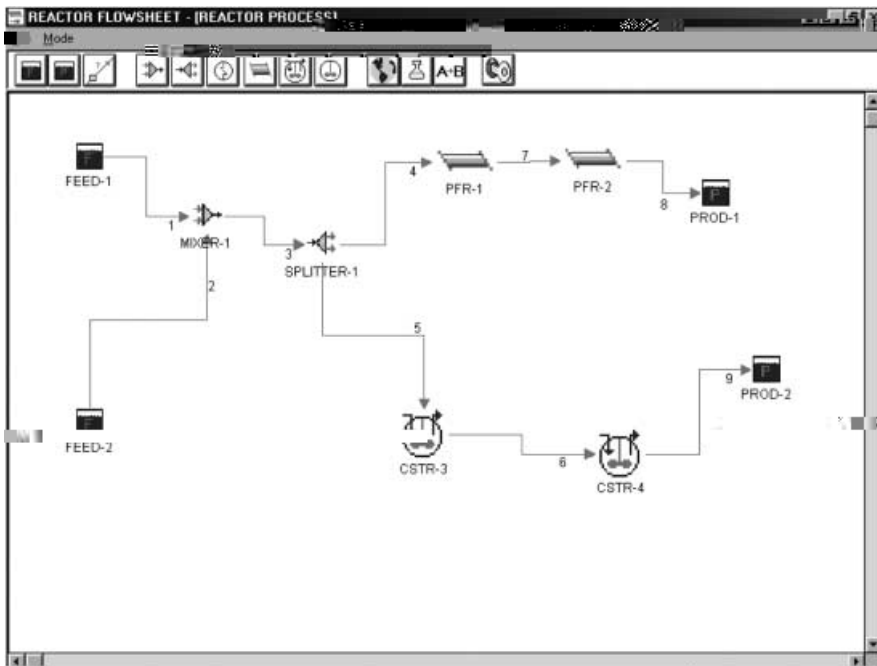
12. Para e er ba db era b di b rbheb ida b fte ha b

Para e er b r b era i gb di b

Ca a <sup>3</sup> lb ar icreb dia e er b(c <sup>3</sup> )b	Fi ed-bed b(ric re-bedba d b b reb ed-bed)=0.5b
Ca a <sup>3</sup> lb adb(g/c <sup>3</sup> )b	S e Hed-bed b(r r <sup>3</sup> ba db idized-bed )=0.05b
Reac r b dia e er b(c <sup>3</sup> )b	Fi ed-bed =1.04b
Ga b b bra eb(c <sup>3</sup> / )b	S e Hed-bed =0.1b
Li idb b bra eb(c <sup>3</sup> / )b	20b
E ha b ce ra b li bri id- ha bba li reb( b/c <sup>3</sup> )b	3140.0b
O <sup>3</sup> geb b ce ra b a ba ra b( b/c <sup>3</sup> )b	62.8b
M rec rarbdiff i f <sup>3</sup> b(c <sup>3</sup> )b	4x10 <sup>4</sup>
Effec i ebdiff i f <sup>3</sup> b(c <sup>3</sup> )b	4.2x10 <sup>6</sup>
Ca a <sup>3</sup> lbde f <sup>3</sup> b(g/c <sup>3</sup> )b	4.7x10 <sup>5</sup>
	4.16x10 <sup>5</sup>
	1.2b

13. Ma b ra fer b ef cie ba dbca a<sup>3</sup> icb effec i e e b fac b

Reac r b	Ca a <sup>3</sup> icb effec i e b fac b	G Lb a b ra fer b ef cie lb(l/ )b	Li idb ha e b di er b ef cie b(c <sup>3</sup> )b	L Sb a b ra fer b ef cie lb(l/ )b
Tric re-bedb	0.13b	0.02b	0.3266b	0.0276b
B b reb ed-bedb	0.13b	0.144b	0.9977b	0.0408b
CSTRb r <sup>3</sup> b	0.799b	1.05 1.45b	b	1.14b
B b reb r <sup>3</sup> b	0.799b	0.02677b	43.4b	0.0952b
Three- ha eb idized-bedb	0.799b	0.252b	47.9b	0.1b



F . 6. Reac r b - hee i gb

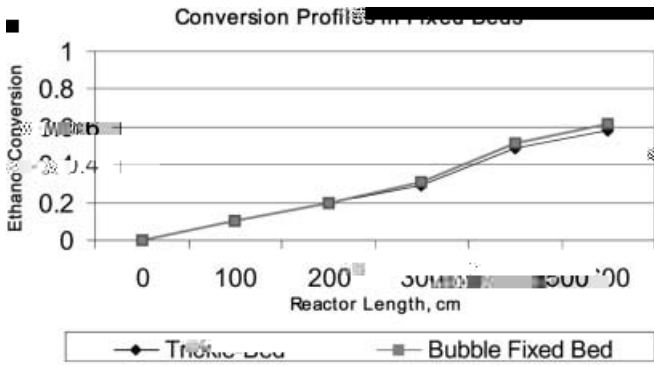
This is a process flow diagram showing two feed streams, FEED-1 and FEED-2, entering a MIXER-1. The output of the mixer goes to a SPLITTER-1. One path from the splitter goes through two Plug Flow Reactors (PFR-1 and PFR-2) to a product stream PROD-1. The other path from the splitter goes to a Continuous Stirred-Tank Reactor (CSTR-3), which then feeds into another CSTR-4, leading to a second product stream PROD-2. Stream numbers 1 through 9 are indicated at various points in the process.

ed-bed, bca a<sup>3</sup> icb idized-bed, bga i idb irredba ,b ric re-bed, b hree- ha eb ed b b re-bed, b b reb r<sup>3</sup> b b r<sup>3</sup> , bCSTRb r<sup>3</sup> b, b hree- ha eb idized-bed. b er-b ra breac b bra e b rbhebLa g ir Hi her b db b der b areti cr ded. b li be i edb i hb rera b be i a eb hebe er a b a b ra ferb effec b ga i idba dbri id b b id)ba dbdi er b b ef cie . bE i a b b fbhebca a-b r<sup>3</sup> icb effec i e e b fac b bac b b rbhebi ra- ar icreb

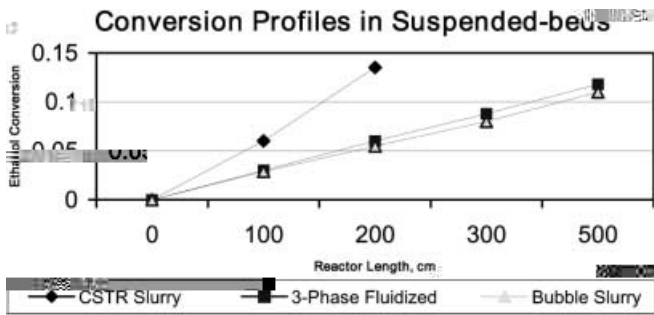
Ab r i- ha bca a<sup>3</sup> icb reac r b i ra rtha bee bde er- b ed. bThebi ra b ac agetha b b der b bde ig bheb b b i gb reac r b<sup>3</sup> e : b r gb , bCSTR, ba ch, bca a<sup>3</sup> icb

re i a ceti bar b li cr ded. b her a ba db b -i- her- b a/ b -adiaba icb di b bi hb r i- reac b<sup>3</sup> e b i hb b b0 reac b ba db6b b b tareb er i edb

)



F . 7. Conversion profiles in fixed-bed reactors.



F . 8. Conversion profiles in suspended-bed reactors.

Reactor design and operation parameters.

G., (1977) bBac i i gba dbri idli rd li bga b  
ñ idb c rre b b b ac edb r .H dbE gbChe bP ce b  
De bDe bl6:37 43b

(1979) bCa ã icbreac r bde ig .bMcGra -Hiz, bNe b r b

(1996) bAd a cedb ce ba ã i b e .bMSEBThe i ,b  
Che ica bE gi eeri gbDe ar e ,bi i ia abS a ebU i er f b

A, H, (1987) bCra i ca b fb  
hree- ha ebreac r .bSadha abl0:247 259b

, H (1967) bP r edic b fb re reb b rb -b  
ha e, b - e b c rre b li b ac ed bed .bA b b  
Che bE gb b l3:1196 1202b

D (1970) bVerg i g rege r b r bga ber a er .b  
Ph.D. bThe i , bT e ebU i er f , bNe he r a d b

D , C (1948) bRa eb fdi r b fb idb  
b a ce .bPar b .b f ica .bdi r .bRec .bTra bChi bP -Ba b  
67:512b

(1999) bSi ra b fb - ha ebca ã icb idized bedb  
reac r b rb r r b re e .bMSEBThe i , bLa ar bU i er f , b  
Bea , bTe a b

F, A H (1975) bGa b rd li b b reb r .b bChe b  
E gb b l8:334b

C , C , C C (1979) bGa b rd ba dbaera edb  
erb b li b echa ica b i rredba .bCa b bChe b  
E gb57:672 677b