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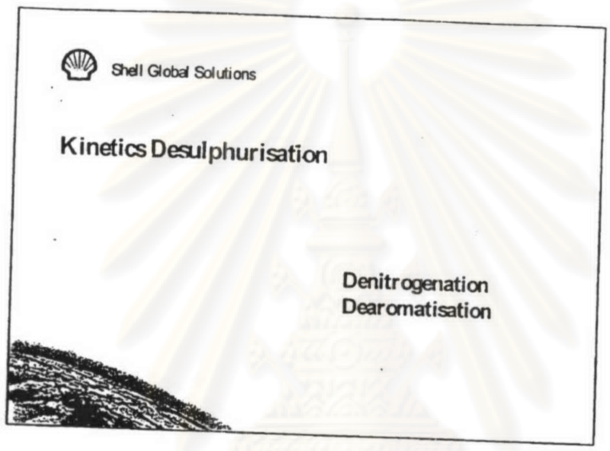
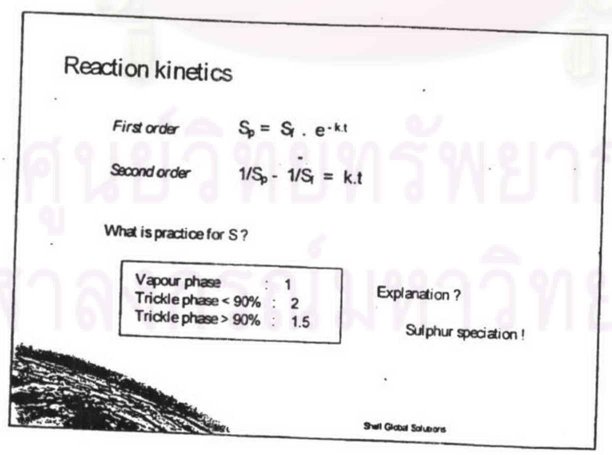
ภาคผนวก

ภาคผนวก ก

ที่มาของสมการจลศาสตร์ในหัวข้อ 2.3 นั้นมาจากเอกสารดังต่อไปนี้

1) จากหนังสือ M-142 Hydrotreater and Hydrodesulfurization Course โดย Shell Global Solution (Confidential)





Effect of processing rate

For continuous flow reactor

$$\text{Reaction time} \sim \frac{1}{\text{Space Velocity}}$$

$$\text{Space Velocity} = \frac{\text{Feed flow rate } (t/h)}{\text{Catalyst } (m^3)}$$

$$\text{Reaction time} \sim \frac{1}{\text{WHSV } (t/m^3.h)}$$

Shell Global Solutions

Kinetics deep HDS

$$\frac{d(S)}{dt} = \frac{k.\, ppH_2^{\,m} .\, C.\, F.\, S^n}{(1 + A_{H_2S} .\, ppH_2S)}$$

in which:

- S : component to be converted
- k : reaction rate constant *)
- m : reaction order pH2
- n : reaction order Sulphur components
- C : catalyst characterisation factor
- A : correction term effect ppH2S *)
- F : feed characterisation factor: MABP, Density, T95, type

* term is dependent on Temperature

Shell Global Solutions

Vapour phase reaction

first order reaction

$$\mathrm{Ln}\left[\frac{S_f}{S_p}\right] = \frac{P}{WHSV}\, k_0 \,.\, \exp(-Ea/RT)$$

Ea = 30,000 (kcal/kmole)
R = 1.987 (kcal/kmol/K)

- <u>severity</u>

T = Average bed temperature (K)

WHSV = Weight Hourly Space Velocity ($t/m^3.h$)

P = $\sqrt{pH_2}$

Shell Global Solutions

Trickle flow reaction

For conversion levels <u>below 90%</u>

pseudo second order

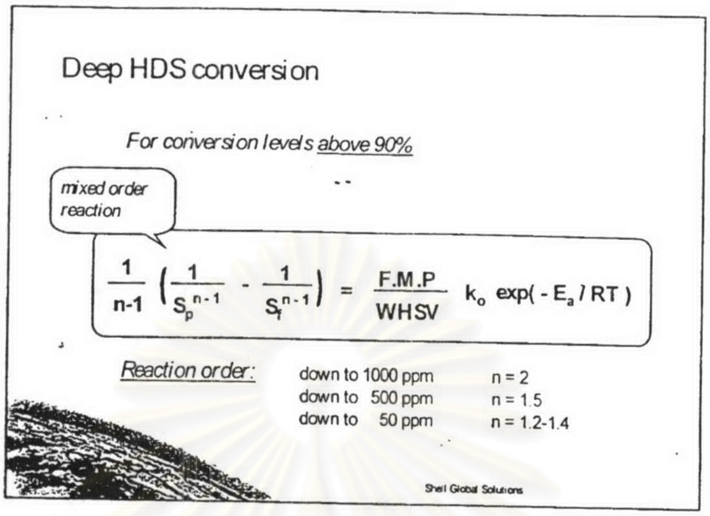
$$\left(\frac{1}{S_p} - \frac{1}{S_f}\right) = \frac{F.M.P}{WHSV}\, k_0 \,.\, \exp(-Ea/RT)$$

Ea = 27,000 (kcal/kmol)

<u>Correction factors</u>

F = feedstock factor
M = boiling range factor

Shell Global Solutions


Deep HDS conversion
For conversion levels above 90%
mixed order reaction
$\frac{1}{n-1}\left(\frac{1}{S_p^{\,n-1}} - \frac{1}{S_f^{\,n-1}}\right) = \frac{F.M.P}{WHSV}\ k_o\ \exp(-E_a/RT)$
Reaction order:
down to 1000 ppm n = 2
down to 500 ppm n = 1.5
down to 50 ppm n = 1.2-1.4
Shell Global Solutions

2) จากหนังสือ Hydrotreater and Hydrodesulfurization Process Guide โดย Shell Global Solution (Confidential)

3.2 MAIN OPERATING VARIABLES - VAPOUR PHASE HYDROTREATING

All kinetic correlation's in this paragraph are based on irreversible pseudo first order reactions. At very low levels of sulphur, nitrogen and olefins the accuracy of data is low due to analytical problems. For desulphurisation and hydrodenitrogenation the prediction has therefore been limited to 0.5 ppmwt in the product. For olefins saturation actual product quality is often limited by thermodynamics rather than kinetics.

Processing of feedstocks containing other contaminants as phenols, ethers etc. has been limiting operations in a few incidents. Insufficient information is currently available to allow a kinetic description.

3.2.1 HDT kinetics and operating conditions

3.2.1.1 Desulphurisation kinetics

For feedstocks, processed in vapour phase, such as naphtha, naphtha minus and kerosene minus fractions, in general the desulphurisation requirements are not the limiting parameter. A WHSV of 4 tons/m^3.hr, as usually designed for, has shown to be ample to meet sulphur specifications, in particular for platformer feedstocks. In actual practice, however, a higher space velocity could be applied by not filling the reactor completely with catalyst.

More recently, however, with increasing coprocessing of cracked feedstocks, this picture is changeing due to increasing sulphur levels in feed as well as a reduced reactivity of the sulphur containing species in feed.

Desulphurisation reactions under vapour phase conditions are described with first order kinetics:

$$\ln \frac{S_f}{S_p} = \frac{k_1 \cdot e^{-E/RT}}{WHSV} \qquad \text{(eq. 3.2.1.1)}$$

where:

S_f, S_p	=	sulphur contents of feed and product (%w)
T	=	average reactor temperature (K)
WHSV	=	space velocity (tons/m3. h)
k_1	=	reaction rate constant (tons/m3. h)
E	=	activation energy (30,000 kcals/k mole)
R	=	gas constant (1.986 kcals/k mole.K).

Thus eq. 3.2.1.1 is used to assess catalyst activity, as based on testrun data, or to predict temperature, cq. space velocity, requirements given the desulphurisation targets defined. With above equation being used, i.e. without correction for actual hydrogen partial pressure and/or feedstock effects the reference value for k_1 should be determined per unit and per type of feedstock processed through fitting on a testrun data or operating summary, preferably at SOR conditions (fresh catalyst).

3.3 KINETICS AND MAIN OPERATING VARIABLES - HYDRODESULPHURISATION UNDER TRICKLE FLOW CONDITIONS

3.3.1 Introduction

Using the theoretical concepts for hydrodesulphurisation and related reactions, as described in Ch. 1, in this chapter the selection/optimisation of the main operating variables are described. To this end a full kinetic description is given of the main reactions as occurring under trickle flow desulphurisation conditions, i.e. Hydrodesulphurisation (HDS) and Hydrodenitrogenation (HDN) at conventional as well as deep-desulphurisation conditions. In addition, to allow an improved estimate of the chemical hydrogen consumption (CCH_2), plots to read off extra hydrogen consumption data due to Aromatics saturation (HDA), will be given for straight run as well as cracked feedstocks and have been extrapolated into deep desulphurisation conditions (PPH_2 up to 50 bar).

As main operating variables will be considered the pressure level, i.e. hydrogen and hydrogen sulphide partial pressure, space velocity and temperature. Catalyst and feedstock effects are included as well. Finally new catalyst deactivation correlations have been developed now valid for conventional as well as deep-HDS conditions.

3.3.2 Kinetic description for HDS, HDN and HDA reactions

3.3.2.1 Hydrodesulphurisation (HDS)

<u>Reaction order and desulphurisation kinetics for conventional desulphurisation</u>
Although intrinsic desulphurisation kinetics always show first order kinetics for single components [2], it is well known that mixtures of components result in an overall pseudo second order kinetics (n=2), as is of application for conventional HDS conditions, i.e. say below 90% HDS. In this description (eq. 3.3.2.1) the constants M, F and C represent the

$$k_0(HDS) = \frac{WHSV}{M * F * C * \sqrt{PPH_2}} * S_f * \left(\frac{1}{S_p} - \frac{1}{S_f}\right) * \exp\left(\frac{E_a}{RT}\right) \quad \text{(eq. 3.3.2.1)}$$

feed boiling range factor, the feed refractiveness factor and the catalyst activity factor, respectively. The space velocity WHSV is defined in tons feed per m3 catvolume per hr (t/m3.hr) while S_f and S_p represent the sulphur in feed and product, respectively, in %w. E_a represents the activation energy in cal/mol and R the gas constant (1.986 cal/mol.°K)

The feed boiling range factor M is derived from the ASTM D86 distillation curve and the average molal boiling point (T_B) as defined in eqs. 3.3.2.2 and 3.3.2.3.

$$\log M = -8.8 \log T_B + 24.38 \quad \text{(eq. 3.3.2.2)}$$

$$T_B = \left(\frac{ASTM10\% + ASTM30\% + ASTM50\% + ASTM70\% + ASTM90\%}{5} - 5.21 * \left(\frac{ASTM90\% - ASTM10\%}{80}\right)^{1.18}\right) \quad \text{(eq. 3.3.2.3)}$$

The catalyst activity factor is defined using the Criterion C424 and C448 activity as reference (C = 1.0) for NiMo and CoMo catalysts, respectively. The ranking of other comparable catalyst systems is discussed in paragraph 3.3.3 (Table 3.3.3.1). The feed refractiveness factor F, discussed in paragraph 3.3.4, is defined with ME and African straight run feedstocks as reference (F = 1.0), see also Table 3.3.4.1.

Reaction order deep-desulphurisation
For deep-HDS it is found that the determining conversion of the refractive tail of sulphur species behaves like a less broad mixture of components and thus fits with an overall kinetics of lower reaction order (Figure 3.3.2.1). Thus in our new kinetics formulation for deep-desulphurisation conditions (> 90% HDS), dependent on catalyst type and feedstock, an effective reaction order in sulphur between n = 1.2 and n = 1.5 is found (Table 3.3.2.1).

Table 3.3.2.1 Kinetic parameters for HDS kinetics (Ref.: eq. 3.3.2.6)

Catalyst: C424 (NiMo)

Feed	Blend Ratio	m	n	E_a	k_0	F	k_{0-eff}
SRGO		1	1.2	30	6.9e9	1	6.9e9
SR/TCGO	< 50% TCGO	1	1.2	30	6.9e9	0.7	4.85e9
	> 50% TCGO	1	1.4	30	9.0e9	0.7	6.3e9
SR/LCO	< 30% LCO	1	1.2	30	6.9e9	0.7	4.85e9
	> 30% LCO	1	1.4	30	9.0e9	0.7	6.3e9

*) discontinuities as a consequence of switching to other range of feedstock composition are within the accuracy of the model

**) for multi component mixtures the feedstock effect is simulated as a two component mixture with the contribution of the most refractive component as determining

Catalyst: C448 (CoMo)

Feed	Blend Ratio	m	n	E_a	k_0	F	k_{0-eff}
SRGO		0.8	1.5	25	5.0e8	1	5.0e8
SR/TCGO	< 50% TCGO	0.8	1.5	30	2.1e10	0.75	1.6e10
	> 50% TCGO	0.8	1.5	30	2.1e10	0.7	1.5e10
SR/LCO	< 50% LCO	0.8	1.5	30	2.1e10	0.75	1.6e10
	> 50% LCO	0.8	1.5	30	2.1e10	0.7	1.5e10

ภาคผนวก ข

แสดงผลลัพธ์ของสมการฝั่งซ้าย ฝั่งขวา และ "อัตราส่วนที่แตกต่าง"กันจากการแทนค่าที่เก็บข้อมูลได้จากกระบวนการผลิต

$$\frac{1}{n-1}\left[\frac{1}{Sp^{n-1}} - \frac{1}{Sf^{n-1}}\right] = \frac{F * M * P}{WHSV} \; k_o .Exp(-Ea/RT)$$

สมการฝั่งซ้าย สมการฝั่งขวา

Calculation value

Data number	left hand side	right hand sid	**Diff (ratio)**
			= left/right
1	8.086	6.317	1.280
2	8.284	6.877	1.205
3	9.059	6.867	1.319
4	9.352	7.411	1.262
5	7.257	7.310	0.993
6	6.249	6.719	0.930
7	6.937	6.717	1.033
8	11.024	7.934	1.389
9	7.896	6.624	1.192
10	6.900	6.120	1.128
11	6.852	6.447	1.063
12	6.686	6.361	1.051
13	6.955	6.067	1.146
14	8.283	7.146	1.159
15	7.034	6.425	1.095
16	6.768	6.167	1.097
17	6.653	6.280	1.059
18	7.374	6.893	1.070
19	7.855	7.207	1.090
20	8.966	8.518	1.053
21	9.305	8.600	1.082
22	8.309	7.709	1.078
23	9.205	8.235	1.118
24	9.411	8.293	1.135
25	7.564	6.891	1.098
26	8.942	8.089	1.105
27	8.561	6.673	1.283
28	8.205	8.954	0.916
29	7.138	7.420	0.962
30	6.551	8.636	0.759
31	10.953	12.196	0.898
32	8.627	9.238	0.934
33	7.307	7.977	0.916

ภาคผนวก ข (ต่อ)

Data number	left hand side	right hand sid	Diff (ratio)
			= left/right
34	9.877	10.704	0.923
35	6.942	7.508	0.925
36	6.718	8.867	0.758
37	6.595	7.449	0.885
38	7.701	8.914	0.864
39	8.451	9.896	0.854
40	6.736	7.577	0.889
41	9.467	10.547	0.898
42	8.597	11.881	0.724
43	8.617	11.899	0.724
44	7.898	10.046	0.786
45	7.995	10.472	0.763
46	10.952	12.312	0.890
47	8.838	11.239	0.786
48	9.715	13.638	0.712
49	6.087	7.718	0.789
50	10.475	11.667	0.898
51	11.134	13.305	0.837
52	8.533	10.548	0.809
53	7.897	10.449	0.756
54	9.282	13.163	0.705
55	7.160	9.142	0.783
56	9.080	13.178	0.689
57	9.999	13.469	0.742
58	8.431	10.846	0.777
59	7.049	8.051	0.876
60	5.326	7.185	0.741
61	6.398	8.860	0.722
62	7.053	10.240	0.689
63	9.282	13.213	0.703
64	9.452	11.071	0.854
65	7.307	10.174	0.718

ภาคผนวก ข (ต่อ)

Data number	left hand side	right hand sid	Diff (ratio)
			= left/right
66	6.770	8.555	0.791
67	7.609	8.863	0.858
68	8.558	10.907	0.785
69	8.477	10.219	0.830
70	6.272	7.896	0.794
71	9.177	12.070	0.760
72	5.755	7.517	0.766
73	9.253	10.870	0.851
74	7.610	9.531	0.798
75	8.950	11.137	0.804
76	7.800	10.259	0.760
77	8.809	12.562	0.701
78	7.267	10.737	0.677
79	9.213	13.006	0.708
80	7.507	11.287	0.665
81	7.993	12.017	0.665
82	8.549	12.946	0.660
83	7.619	11.747	0.649
84	7.862	12.337	0.637
85	10.075	14.417	0.699
86	9.533	14.029	0.680
87	7.179	11.378	0.631
88	10.900	17.659	0.617
89	9.512	15.684	0.606
90	9.127	14.890	0.613
91	6.321	10.389	0.608
92	11.375	20.715	0.549
93	10.142	21.399	0.474
94	10.739	19.521	0.550
95	11.830	21.170	0.559
96	6.799	14.075	0.483
97	11.355	23.146	0.491
98	9.569	21.622	0.443
99	9.048	20.733	0.436
100	7.956	17.470	0.455
101	9.440	20.337	0.464

ภาคผนวก ค

ผลการคำนวณอุณหภูมิของเครื่องปฏิกรณ์และปริมาณกำมะถันในผลิตภัณฑ์เมื่อใช้สมการแบบจำลองคณิตศาสตร์ที่หาได้

Data number				การทำนายอุณหภูมิของเครื่องปฏิกรณ์เมื่อรู้คุณลักษณะของสารป้อน			การทำนายปริมาณกำมะถันในสารผลิตภัณฑ์เมื่อทราบตัวแปรของกระบวนการผลิต		
	Cf	New Right hand side value	Diff left/right	Predicted WABT using CF	Actual WABT	Difference between Predict WABT-Actual WABT	Predict Sp using Cf	Actual Sp	Difference between Predict Sp - Actual Sp
				DegC	DegC	DegC	% wt	% wt	% wt
1	1.123	7.093	1.140	351	347	4.0	0.037	0.031	0.006
2	1.091	7.503	1.104	353	349	3.1	0.034	0.030	0.004
3	1.112	7.635	1.187	355	349	5.3	0.033	0.026	0.007
4	1.095	8.113	1.153	356	352	4.4	0.031	0.025	0.006
5	1.037	7.581	0.957	350	351	-1.3	0.035	0.037	-0.002
6	1.001	6.725	0.929	346	348	-2.2	0.041	0.045	-0.004
7	1.003	6.736	1.030	349	348	0.9	0.041	0.039	0.002
8	1.115	8.844	1.247	360	353	6.9	0.028	0.020	0.008
9	1.030	6.821	1.158	350	345	4.5	0.041	0.033	0.008
10	1.064	6.513	1.059	346	345	1.8	0.043	0.040	0.003
11	1.035	6.674	1.027	347	346	0.8	0.042	0.041	0.001
12	1.024	6.512	1.027	346	345	0.8	0.044	0.042	0.002
13	1.082	6.566	1.059	347	345	1.7	0.043	0.040	0.003
14	1.088	7.777	1.065	352	350	2.0	0.034	0.031	0.003
15	1.083	6.958	1.011	349	349	0.3	0.040	0.039	0.001
16	1.022	6.301	1.074	346	344	2.2	0.046	0.042	0.004
17	1.006	6.317	1.053	346	344	1.6	0.046	0.043	0.003
18	1.050	7.237	1.019	351	351	0.6	0.038	0.037	0.001
19	1.063	7.664	1.025	351	350	0.8	0.035	0.034	0.001
20	1.065	9.070	0.989	356	357	-0.4	0.028	0.028	0.000
21	1.054	9.063	1.027	357	356	0.8	0.028	0.027	0.001
22	1.030	7.939	1.047	353	352	1.4	0.034	0.031	0.002
23	1.077	8.868	1.038	357	356	1.2	0.029	0.027	0.002
24	1.042	8.638	1.090	358	355	2.7	0.030	0.026	0.004
25	1.015	6.992	1.082	352	350	2.4	0.040	0.036	0.004
26	1.038	8.397	1.065	357	355	2.0	0.031	0.028	0.003
27	1.017	6.787	1.261	356	349	7.2	0.042	0.030	0.012
28	0.968	8.665	0.947	356	358	-1.7	0.030	0.033	-0.003
29	0.992	7.363	0.969	350	351	-1.0	0.039	0.041	-0.002
30	0.899	7.760	0.844	350	355	-5.3	0.036	0.046	-0.010
31	0.782	9.532	1.149	367	363	4.5	0.026	0.021	0.005
32	0.993	9.176	0.940	351	353	-1.9	0.028	0.031	-0.003
33	1.003	8.000	0.913	352	354	-2.8	0.034	0.039	-0.005

ภาคผนวก ค (ต่อ)

Data number	Cf	New Right hand side value	Diff left/right	Predicted WABT using CF	Actual WABT	Difference between Predict WABT-Actual WABT	Predict Sp using Cf	Actual Sp	Difference between Predict Sp - Actual Sp
				DegC	DegC	DegC	% wt	% wt	% wt
34	0.981	10.504	0.940	362	364	-2.0	0.023	0.025	-0.002
35	0.981	7.368	0.942	350	352	-1.8	0.039	0.042	-0.003
36	0.877	7.778	0.864	351	356	-4.6	0.036	0.044	-0.008
37	0.978	7.287	0.905	350	353	-3.1	0.040	0.046	-0.006
38	0.948	8.449	0.912	355	358	-2.9	0.032	0.037	-0.005
39	0.937	9.272	0.911	352	355	-2.9	0.028	0.032	-0.004
40	0.968	7.337	0.918	350	352	-2.6	0.039	0.045	-0.005
41	0.962	10.146	0.933	362	364	-2.2	0.024	0.027	-0.003
42	0.814	9.672	0.889	361	365	-3.8	0.026	0.031	-0.005
43	0.794	9.445	0.912	362	365	-3.0	0.027	0.031	-0.004
44	0.865	8.691	0.909	357	360	-3.0	0.031	0.036	-0.005
45	0.808	8.463	0.945	359	361	-1.8	0.032	0.035	-0.003
46	0.827	10.179	1.076	370	367	2.4	0.024	0.022	0.003
47	0.898	10.088	0.876	362	366	-4.3	0.025	0.030	-0.006
48	0.845	11.525	0.843	367	372	-5.6	0.020	0.026	-0.006
49	0.875	6.757	0.901	348	351	-3.2	0.045	0.052	-0.007
50	0.828	9.658	1.085	368	366	2.6	0.026	0.023	0.003
51	0.833	11.089	1.004	370	370	0.1	0.021	0.021	0.000
52	0.918	9.686	0.881	361	365	-4.1	0.026	0.032	-0.006
53	0.899	9.394	0.841	359	365	-5.6	0.027	0.036	-0.008
54	0.836	10.999	0.844	365	371	-5.5	0.021	0.028	-0.007
55	0.925	8.458	0.847	356	362	-5.3	0.032	0.042	-0.009
56	0.855	11.261	0.806	365	372	-7.0	0.021	0.029	-0.008
57	0.878	11.824	0.846	367	373	-5.5	0.019	0.025	-0.006
58	0.854	9.262	0.910	360	363	-3.0	0.028	0.033	-0.004
59	0.884	7.114	0.991	356	356	-0.3	0.042	0.043	-0.001
60	0.899	6.459	0.825	343	349	-5.9	0.049	0.064	-0.015
61	0.841	7.451	0.859	352	356	-4.8	0.040	0.049	-0.010
62	0.847	8.673	0.813	355	362	-6.6	0.031	0.043	-0.011
63	0.830	10.966	0.846	366	371	-5.5	0.022	0.028	-0.007
64	0.838	9.282	1.018	362	361	0.6	0.028	0.028	0.001
65	0.720	7.324	0.998	361	361	-0.1	0.041	0.041	0.000

ภาคผนวก ค (ต่อ)

Data number	Cf	New Right hand side value	Diff left/right	Predicted WABT using CF	Actual WABT	Difference between	Predict Sp using Cf	Actual Sp	Difference between
						Predict WABT-Actual WABT			Predict Sp - Actual Sp
				DegC	DegC	DegC	% wt	% wt	% wt
66	0.806	6.897	0.982	357	358	-0.6	0.045	0.046	-0.001
67	0.799	7.085	1.074	356	354	2.2	0.043	0.039	0.004
68	0.763	8.319	1.029	365	364	0.9	0.034	0.033	0.001
69	0.734	7.506	1.129	365	361	3.9	0.040	0.033	0.007
70	0.847	6.691	0.937	350	352	-2.0	0.047	0.052	-0.005
71	0.724	8.742	1.050	367	365	1.6	0.032	0.029	0.002
72	0.855	6.424	0.896	347	351	-3.4	0.050	0.059	-0.008
73	0.804	8.742	1.059	363	361	1.8	0.032	0.029	0.003
74	0.761	7.252	1.049	357	356	1.5	0.042	0.039	0.003
75	0.689	7.677	1.166	369	364	5.0	0.039	0.031	0.008
76	0.732	7.511	1.038	359	358	1.2	0.040	0.038	0.002
77	0.684	8.593	1.025	369	368	0.8	0.034	0.032	0.001
78	0.659	7.076	1.027	362	361	0.9	0.045	0.044	0.002
79	0.673	8.753	1.053	371	369	1.7	0.033	0.030	0.003
80	0.708	7.993	0.939	362	364	-2.0	0.038	0.042	-0.004
81	0.670	8.053	0.993	365	365	-0.2	0.037	0.038	0.000
82	0.672	8.699	0.983	369	370	-0.6	0.033	0.034	-0.001
83	0.664	7.805	0.976	366	366	-0.8	0.039	0.041	-0.001
84	0.703	8.669	0.907	366	369	-3.2	0.033	0.039	-0.006
85	0.665	9.587	1.051	373	371	1.6	0.028	0.026	0.002
86	0.632	8.870	1.075	374	372	2.4	0.032	0.029	0.004
87	0.632	7.187	0.999	363	363	0.0	0.046	0.046	0.000
88	0.578	10.199	1.069	378	376	2.2	0.026	0.024	0.003
89	0.562	8.818	1.079	375	372	2.5	0.034	0.030	0.004
90	0.651	9.696	0.941	371	373	-2.0	0.029	0.032	-0.003
91	0.622	6.459	0.979	359	360	-0.7	0.055	0.057	-0.002
92	0.466	9.648	1.179	388	382	5.7	0.029	0.022	0.007
93	0.453	9.696	1.046	386	384	1.5	0.029	0.027	0.002
94	0.458	8.949	1.200	388	382	6.3	0.033	0.024	0.009
95	0.474	10.028	1.180	389	384	5.7	0.027	0.021	0.007
96	0.501	7.051	0.964	369	371	-1.2	0.048	0.051	-0.003
97	0.408	9.434	1.204	394	387	6.5	0.031	0.022	0.008
98	0.395	8.547	1.120	390	386	3.9	0.036	0.030	0.006
99	0.395	8.187	1.105	388	385	3.5	0.039	0.033	0.006
100	0.421	7.356	1.082	382	380	2.7	0.046	0.041	0.005
101	0.365	7.418	1.273	392	384	8.4	0.046	0.031	0.015

ภาคผนวก ง

แสดงโปรแกรมการคำนวณหาอุณหภูมิของเครื่องปฏิกรณ์โดยใช้แบบจำลองทางคณิตศาสตร์ที่หาได้

Prediction of Hydro-desulfurization Reactor Temperature and Sulphur in Product

			1) Predict Reactor Temperature	**2) Predict Sulphur in Product**
Part I Input Data	Symbol	Unit		
Date			15-12-03	15-12-03
Sulphur in feed	Sf	% wt.	**0.366**	**0.366**
Sulphur in product (Target)	Sp	% wt.	**0.030**	**0.030**
Feed Boiling Range				
	ASTM 10%	degc	**203.4**	**203.4**
	ASTM 30%	degc	**224.8**	**224.8**
	ASTM 50%	degc	**245.2**	**245.2**
	ASTM 70%	degc	**264.7**	**264.7**
	ASTM 90%	degc	**285.9**	**285.9**
Feed rate		t/d	**8,636**	**8,636**
Reactor Pressure		bar	**52.5**	**52.5**
Reactor Temperature	WABT	degc		**349.5**
Part II Calculation Result				
Predict Reactor Temperature	WABT	degc	**352.5**	
Predict sulphur in product	Sp			**0.034**
Part III Calculation Part				
WHSV	WHSV	ton/m3 hr	3.01	3.01
Reactor Temp	WABT	K		622.50
Over all reaction order	n		1.5	1.5
Molar average boiling point	T_B	K	512	512
Log of boiling ranage factor	log M		0.54	0.54
Boiling rage factor	M		3.430	3.430
Feed factor	F		1	1
Hydrogen partial pressure^(.5)	P	bar	7.25	7.25
Reaction rate constant	Ko	ton/m^3 hr	500000000	500000000
Activation Energy	Ea	kcal/kmol	25000	25000
Gas constant	R	kmol/kcal K	1.987	1.987
Left hand side value			8.284	
Reaction rate	k	ton/m3 hr		0.834
Right hand side value				6.877
Correction Factor	Cf		1.092	1.092
Calculated WABT	WABT	K	625.5	
(1/(Sp^n-1)				5.41
Sp				0.034

Note : formular in this sheet

1/(n-1) (1/(Sp^n-1) - 1/ (Sf^n-1) = F* M* P *Cf / WHSV* ko exp (-Ea/RT)

Cf = -0.9343525* Sf-0.3276005* M-0.0009067*date+ 36.984932

ประวัติผู้เขียนวิทยานิพนธ์

นางสาวนิตยา บุญฤทธิ์ จบการศึกษาปริญญาตรีเมื่อปี พ.ศ.2538 จากภาควิชาเคมีอุตสาหกรรม คณะวิทยาศาสตร์ประยุกต์ สถาบันเทคโนโลยีพระจอมเกล้าพระนครเหนือ

หลังจากจบการศึกษาแล้วได้ทำงานในตำแหน่งวิศวกรกระบวนการผลิตที่บริษัทวนชัยเคมีคอลจำกัด จากนั้นในปี พ.ศ. 2540 ได้เข้าทำงานในตำแหน่งวิศวกรกระบวนการผลิตที่บริษัทโรงกลั่นน้ำมันระยอง จำกัด ซึ่งปัจจุบันได้ทำการกลั่นน้ำมันร่วมกับบริษัทสตาร์รีไฟน์นิ่งจำกัด และเปลี่ยนชื่อเป็นบริษัทอัลลายแอนซ์รีไฟน์นิ่งจำกัด

ตั้งแต่ปี พ.ศ. 2543 ได้เริ่มทำการศึกษาในระดับปริญญาโท ภาควิชาวิศวกรรมเคมี คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย