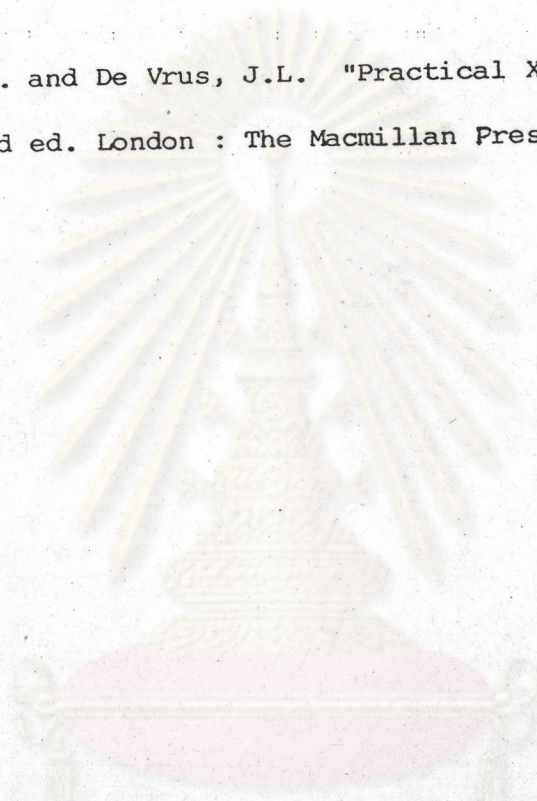


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ศูนย์วิจัยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก

ศูนย์วิทยุทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

IONIC EXCHANGE RESINS
ANION EXCHANGE RESINS

The following table is divided into two parts; the first lists properties of some anionic resins and the second, properties of some cationic resins.

Character S=strong W=weak	Trade name	Manu- facturer*	Active group	Matrix	Effective pH	Selectivity	Order of selectivity	Total exchange capacity; meq/ml	Total exchange capacity; meq/gm	Maximum thermal stability; °C	Physical form; s=sphere b=beads	Standard mesh range	Ionic form as shipped	Shipping density; lb./cu. ft.
S	Dowex 1	1	Trimethyl benzyl ammonium	Polystyrene	0-14	Cl/H approx. 25	I, NO ₃ , Br, Cl, Acetate, OH, F	1.33	3.5	OH ⁻ 50 Cl ⁻ 150	s	20-50 (wet)	Cl ⁻	44
S	Dowex 21 K	1	Trimethyl benzyl ammonium	Polystyrene	0-14	Cl/H approx. 15	I, NO ₃ , Br, Cl, Acetate, OH, F	1.25	4.5	OH ⁻ 50 Cl ⁻ 150	s	20-50 (wet)	Cl ⁻	43
S	Duolite A-101 D	2	Quaternary ammonium	Polystyrene	0-14	—	—	1.4	4.2	OH ⁻ 60 Cl ⁻ 100	b	16-50	Cl ⁻	—
S	Ionac A-540	3	Quaternary ammonium	Polystyrene	0-14	—	—	1.0	3.6	salt 100 OH ⁻ 60	b	16-50	salt	43-66
S	Dowex 2	1	Dimethyl ethanol benzyl ammonium	Polystyrene	0-14	Cl/H approx. 15	I, NO ₃ , Br, Cl, Acetate, OH, F	1.33	3.5	OH ⁻ 30 Cl ⁻ 150	s	20-50 (wet)	Cl ⁻	44
S	Duolite A-102 D	2	Quaternary ammonium	Polystyrene	0-14	—	—	1.4	4.2	OH ⁻ 40 Cl ⁻ 100	b	16-50	Cl ⁻	—
S	Ionac A-550	3	Dimethyl ethanol benzyl ammonium	Polystyrene	0-14	—	—	1.3	3.5	salt 100 OH ⁻ 40	b	16-50	salt	43-46
W	Duolite A-30 B	2	Tertiary amine; Quaternary ammonium	Epoxy polyamines	0-9	—	—	2.6	8.7	80	b	16-50	salt	—

IONIC EXCHANGE RESINS (Continued)

ANION EXCHANGE RESINS (Continued)

Character S = strong W = weak	Trade name	Manu- facturer*	Active group	Matrix	Effective pH	Selectivity	Order of selectivity	Total exchange capacity: meq/ml	Total exchange capacity: meq/gm	Maximum thermal stability: °C	Physical form: s = sphere b = beads	Standard mesh range	Ionic form as shipped	Shipping density: lb./cu. ft.
W	Ionac A-300	3	Tertiary amine; Quaternary ammonium	Epoxy amine	0-12	---	---	1.8	5.5	40	g	16-50	salt	19-21
W	Duolite A-6	2	Tertiary amine	Phenolic	0-5	---	---	2.4	7.6	60	g	16-50	salt	---
W	Duolite A-7	2	Secondary amine	Phenolic	0-4	---	---	2.4	9.1	40	g	16-50	salt	---

- * 1. Dow
- 2. Diamond Shamrock
- 3. Ionac
- 4. Nalco

CATION EXCHANGE RESINS

Character S = strong W = weak	Trade name	Manu- facturer*	Active group	Matrix	Effective pH	Selectivity	Order of selectivity	Total exchange capacity: meq/ml	Total exchange capacity: meq/mg	Maximum thermal stability: °C	Physical form: s = sphere b = beads	Standard mesh range	Ionic form as shipped	Shipping density: lb./cu. ft.
S	Dowex 50	1	Nuclear sulfonic acid	Polystyrene	0-14	Na/H approx. 1.2	Ag, Cs, Rb, K, NH ₄ , Na, H, Li, Ba, Sr, Ca, Mg, Be	Na ⁺ 1.9, H ⁺ 1.7	Na ⁺ 4.8, H ⁺ 5.0	150	s	20-50 (wct)	H ⁺ or Na ⁺	H ⁺ 50, Na ⁺ 53
S	Dowex MPC-1	4	Nuclear sulfonic acid	Polystyrene	0-14	---	---	1.6-1.8 H ⁺ form	4.5-4.9 H ⁺ form	150	b	20-40 (wct)	Na ⁺	50
S	Duolite C-20	2	Nuclear sulfonic acid	Polystyrene	0-14	---	---	2.2	5.1	150	b	16-50	Na ⁺	---
S	Ionac Yarn 1	3	Nuclear sulfonic acid	Polystyrene	0-14	---	---	1.9	4.6	140 (Na ⁺) 130 (H ⁺)	b	16-50	Na ⁺	50-55

IONIC EXCHANGE RESINS (Continued)

CATION EXCHANGE RESINS (Continued)

Character S = strong W = weak	Trade name	Manu- facturer*	Active group	Matrix	Effective pH	Selectivity	Order of selectivity	Total exchange capacity; meq/ml	Total exchange capacity; meq/gm	Maximum thermal stability; °C	Physical form; s = sphere b = beads	Standard mesh range	Ionic form as shipped	Shipping density; lb./cu. ft.
S	Duolite C-3	2	Methylene sulfonic	Phenolic	0-9	—	—	1.1	2.9	60	g	16-50	H ⁺	—
W	Dowex CCR-1	4	Carboxylic	Phenolic	0-9	—	—	—	—	38 ²	g	20-50 (wet)	H ⁺ (dry)	21
W	Duolite ES-63	2	Phosphonic	Polystyrene	4-14	—	—	3.3	6.5	100	b	16-50	H ⁺	—
W	Duolite ES-80	2	Aliphatic	Acrylic	6-14	—	—	3.5	10.2	100	b	16-50	H ⁺	—

- * 1. Dow
2. Diamond Shamrock
3. Ionac
4. Nalco



สารรีเจนเนอแรนต์สำหรับระบบแลกเปลี่ยนไอออน

A. SULFURIC ACID				
% H ₂ SO ₄	Grams H ₂ SO ₄ /Liter	Normality	Specific Gravity	Pounds per U.S. Gallon
1	10.05	0.205	1.0051	0.08388
2	20.24	0.413	1.0118	0.1689
3	30.55	0.623	1.0184	0.2550
4	41.00	0.836	1.0250	0.3422
5	51.59	1.05	1.0317	0.4305
6	62.31	1.27	1.0385	0.5200
8	84.18	1.72	1.0522	0.7025
10	106.6	2.17	1.0661	0.8897
12	129.6	2.64	1.0802	1.082
15	165.3	3.37	1.1020	1.379
20	227.9	4.65	1.1394	1.902
50	697.6	14.2	1.3951	5.821
96	1762.0	35.9	1.8355	14.71
100	1831.0	37.3	1.8305	15.28

B. HYDROCHLORIC ACID				
% HCl	Grams HCl/Liter	Normality	Specific Gravity	Pounds per U.S. Gallon
1	10.03	0.275	1.0032	0.08372
2	20.16	0.553	1.0082	0.1683
4	40.72	1.12	1.0181	0.3399
6	61.67	1.69	1.0279	0.5147
8	83.01	2.28	1.0376	0.6927
10	104.7	2.87	1.0474	0.8741
12	126.9	3.48	1.0574	1.059
16	172.4	4.72	1.0776	1.439
20	219.6	6.02	1.0980	1.833
30	344.8	9.46	1.1492	2.877
40	479.2	13.1	1.1980	3.999

สารรีเจนเนอแรนต์สำหรับระบบแลกเปลี่ยนไอออน (ต่อ)

E. SODIUM CARBONATE

% Na ₂ CO ₃	Grams Na ₂ CO ₃ /Liter	Normality	Specific Gravity	Pounds per U.S. Gallon
1	10.09	0.190	1.0086	0.08417
2	20.38	0.384	1.0190	0.1701
4	41.59	0.786	1.0398	0.3471
6	63.64	1.20	1.0606	0.5311
8	86.53	1.63	1.0816	0.7221
10	110.3	2.08	1.1029	0.9204
12	134.9	2.54	1.1244	1.126
14	160.5	3.03	1.1463	1.339

F. SODIUM CHLORIDE

% NaCl	Grams NaCl/Liter	Specific Gravity	Pounds per U.S. Gallon
1	10.05	1.0053	0.08390
2	20.25	1.0125	0.1690
4	41.07	1.0268	0.3428
6	62.48	1.0413	0.5214
8	84.47	1.0559	0.7050
10	107.1	1.0707	0.8935
12	130.3	1.0857	1.087
16	178.6	1.1162	1.490
20	229.6	1.1478	1.916
26	311.3	1.1972	2.598

Source:
Duolite Ion Exchange Manual, Diamond Shamrock Chemical Company,
Redwood City, CA (1969).

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C. SODIUM HYDROXIDE				
% NaOH	Grams NaOH/Liter	Normality	Specific Gravity	Pounds per U.S. Gallon
1	10.10	0.262	1.0095	0.08425
2	20.41	0.511	1.0207	0.1704
3	30.95	0.774	1.0318	0.2583
4	41.71	1.04	1.0428	0.3481
5	52.69	1.32	1.0538	0.4397
6	63.89	1.60	1.0648	0.5332
8	86.95	2.17	1.0869	0.7256
10	110.9	2.77	1.1089	0.9254
12	135.7	3.39	1.1309	1.333
16	188.0	4.70	1.1751	1.569
20	243.8	6.10	1.2191	2.035
50	762.7	19.1	1.5253	6.365

D. AMMONIA				
% NH ₃	Grams NH ₃ /Liter	Normality	Specific Gravity	Pounds per U.S. Gallon
1	9.939	0.583	0.9939	0.08294
2	19.79	1.16	0.9895	0.1652
4	39.24	2.31	0.9811	0.3275
6	58.38	3.43	0.9730	0.4872
8	77.21	4.53	0.9651	0.6443
10	95.75	5.62	0.9575	0.7991
12	114.0	6.70	0.9501	0.9515
16	149.8	8.79	0.9362	1.250
20	184.6	10.8	0.9229	1.540
30	267.6	17.0	0.8920	2.233

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คุณสมบัติของเรซินยี่ห้อ Amberlite

Amberlite*	Cation Exchange Resin					Anion Exchange Resin						
	IR-120	200	IRC-84	IR-45	IRA-68	IRA-93	IRA-410	IRA-910	IRA-400	IRA-401	IRA-402	IRA-900
Active Groups	strongly acidic - SO ₃ H		weakly acidic COOH	weakly basic	medium basic	medium basic	strongly basic Typ-II-Resin	macro-reticular	very str. basic Typ-I-Resin	porous		macro-reticular
Special Properties		macro-porous			porous	macro-reticular						
Form of Granule	globule			globule								
Actual Size of Granule [mm]	0.45-0.60	0.45-0.60	0.38-0.46	0.35-0.50	0.35-0.45	0.40-0.55	0.38-0.45	0.40-0.50	0.38-0.45	0.40-0.50	0.36-0.42	0.40-0.55
Density [g/l]	850	800	740	670	735	610	705	680	705	700	720	675
Total Capacity [mval/l] swollen Resin	1.9	1.75	4.0	2.0	1.6	1.6	1.4	1.1	1.4	1.0	1.25	1.1
UVC [g CaO/l] Range till	46	36	75	50	45	40	28	18	20	16	24	18
Temperature Resistance	120 °C	120 °C	100 °C	100 °C	80 °C	100 °C	40 °C	40 °C	60 °C	60 °C	60 °C	60 °C
pH-Resistance	without limit	without limit		without limit								
Chemical Resistance	very resistant to usual solvents	espec. resistant to oxidation dito to usual solvents	very resistant to oxidation	resistant to usual solvents	resistant to oxidation	resistant to oxidation	resistant to oxidation	resistant to oxidation	resistant to oxidation	resistant to oxidation	resistant to oxidation	resistant to oxidation

* dependent upon conditions of operation
 * Trade Mark Rohm & Haas Co., Philadelphia

คุณสมบัติของเรซินยี่ห้อ Lewatit

Duolite*	Cation Exchange Resin				Anion Exchange Resin								Absorber			Redox Exchanger	
	C 20	C 21 HI	CC3		A 30 B	A 303	A 305	A 102 D	A 101 D	A 101 D	A 101 HI	A 121	S 37	S 30	A 140	S 10	
Active Groups	str. acidic -SO ₃ H		weak, acidic -COOH		medium basic		str. basic Type II	very basic Type I	str.				weakly basic		str. basic Type I	weakly basic Cu-Amino-Complex	
Particulars		macro-porous			porous	macro-porous	highly porous						Removal of sub-st. in OH-Form	Removal Dye-stuff	Removal Dis-colorants	O ₂ Removal	
Form of Granule	globul			glob.									Granulate		glob.	Granulate	
Size of Granules [mm]	0.3-1.2			0.3-1.2									0.3-1.2	0.3-2.0	0.3-1.2	0.3-2.0	
Density [g/l]	860	850	760	750	740	750	760	740	750	740	740		420-480	300 dry	730	540	
Tot. Capac. [val/l] swollen Resin	2.2	2.0	4.5	2.0	1.5	1.9	1.5	1.4	1.35	1.3	1.3		dep. on cond.		50-90% disc. of sugar syrup	-79 O ₂	
UVC* [g CaO/l] Range till	45	42	87	45	28	50	28	21	21	22							
Resist. to temperature	120 °C	140 °C	110 °C	60 °C	100 °C	60 °C	40 °C	70 °C	70 °C	60 °C			40 °C	60 °C	100 °C	40 °C	
p-H-Resistance	without limit			without limit									4-9	0-8	1-12	8-12	
Resistance to Chemicals	good stable to usual solvents	v. gd.	good	stable to usual solvents	stable to oxidation			stable to oxidation					stable to solvents				

dependent on conditions of operation reg. trade mark of Diamond Shamrock Corp., Redwood City

คุณสมบัติของเรซินยี่ห้อ Duolite

Lewatit®	Cation Exchange Resin				Anion Exchange Resin						and Absorber		
	S 100	S 112	SP 120	CNP	MP 62	MP 64	MK 70	M 600	MP 600	M 504	M 500	MP 500	
Active Groups	strongly acidic -SO ₃ H			weakly acidic -COOH	weakly basic	medium basic	medium basic	strongly Type-II-Resin		very strongly Type-I-Resin basic			
Specialities		higher cross linked	macro-porous	macro-porous	macro-porous	macro-porous			macro-porous			macro-porous	
Form of Granules	globul				globul								
Size of Granules [mm]	0.3-1.2	0.3-1.5	0.3-2.0	0.3-1.5	0.3-1.5	0.3-1.2	0.3-1.2	0.3-1.2	0.3-1.5	0.3-1.2	0.3-1.2	0.3-1.5	
Density [g/l]	800-900	700-800	700-800	700-800	600-700	650-750	ca. 700	670-750	700-780	700-750	700-780	675-750	
Spec. Load [l/h · L]	40	80	40	40	40								
Total Capacity [val/l] swollen Resin	2.2	1.9	1.9	3.8	1.9	1.5	2.2	1.6	1.2	1.3	1.6	1.2	
UVC* [g CaO/l]	50	42	30	70	42	31	45	24	18	21	16	18.5	
UVC* [g CaO/l]	57	42	33	100	50	35	60	30	22	25	19	20	
Resistance to Temperature	120 °C	120 °C	120 °C	100 °C	100 °C	70 °C	40 °C	40 °C	40 °C	70 °C	70 °C	70 °C	
pH-Resistance	without limitation	without limitation			without limitation	without limitation							
Resistance to Chemicals	very stable to oxidation stable to usual solvents	spec. stable to oxidation stable to usual solvents	spec. stable to oxidation stable to usual solvents	very stable to oxidation stable to usual solvents	stable to oxidation stable to usual solvents	stable to oxidation stable to usual solvents	stable to oxidation stable to usual solvents			stable to oxidation			

* dependent on conditions of operation
 ® reg. trade mark Farbentabriken Bayer AG, Leverkusen

ประวัติผู้วิจัย

ชื่อ นางสมหญิง คุณานพรัตน์

การศึกษา วิทยาศาสตร์บัณฑิต (เคมี) จากมหาวิทยาลัยรามคำแหง
ปีการศึกษา 2521

ตำแหน่งและสถานที่ทำงาน นักวิทยาศาสตร์ ประจำฝ่ายตรวจอุตสาหกรรมเคมีและอาหาร
กองตรวจโรงงาน กรมโรงงานอุตสาหกรรม
กระทรวงอุตสาหกรรม



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย