

KARAKTERISASI DAN PENGKONDISIAN RESIN DOWEX X1 CL UNTUK DUKUNG CAC

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ABSTRAK

Karakterisasi dan Pengkondisian Resin Dowex X1 Cl untuk dukung CAC telah dilakukan. Prosedur karakterisasi dipakai dari Rohm and Haas. Larutan standar titrasi HCl, NaOH dikalibrasi memakai campuran asam borat, boraks, dan gliserin. Diperoleh mol HCl 0,177 dan mol NaOH 0,042. Mol H₂SO₄ dikalibrasi memakai titrasi dengan pemanasan diperoleh mol H₂SO₄ 245 mg/l. Kurva standar sulfat dibuat dengan pengukuran spektrometer UV pada panjang gelombang 420nm. Kapasitas Nitrat kolom resin OH 0,178 meq/ml dan kolom resin Cl 0,060 meq/ml. Ekuivalen anion OH untuk resin Dowex X1 OH 16,071 eq/kg, dan ekuivalen anion CO₃ resin Dowex X1 OH 46,714 eq/kg. Untuk resin Dowex X1 Cl, yaitu 1,071 eq/kg dan 1,510 eq/kg. Kapasitas klorid resin Dowex X1 OH 21 eq/kg dan untuk resin Dowex X1 Cl -0,37 eq/kg. Densitas basah dan kering resin Dowex X1 OH 0,9326 gr/ml dan 0,7668 gr/ml. Densitas basah dan kering resin Dowex X1 Cl 0,9090 gr/ml dan 0,9074 gr/ml. Pengkondisian resin sebelum dan sesudah aplikasi proses memakai elusi NaOH 0,5 M.

Kata kunci: resin Dowex X1Cl, karakterisasi, pengkondisian.

ABSTRACT

Conditioning and Characterization of Dowex X1 Cl resin for back up CAC had been done. Characterization procedure applicated from Rohm and Haas. Standard solution of NaOH and HCl titration was callibrated using mix borate acid, borax, and glycerine. The results of that 0,177 mol HCl, and 0,042 mol NaOH. H₂SO₄ molarity callibrated with heating titration, so that resulted 245 mg/l mol H₂SO₄. Sulfate standard curves made by UV Spectrometer measurrements in 420nm. The Nitrate Capacity of bed column resin OH 0,178 meq/ml, and bed column resin Cl 0,060 meq/ml. OH anion equivalent Dowex X1 OH resin 16,071 eq/kg, and CO₃ anion equivalent Dowex X1 OH resin 46,714 eq/kg. For Dowex X1 Cl resin, is 1,071 eq/kg and 1,510 eq/kg. Chlorides capacity of Dowex X1 OH resin 21 eq/kg and for Dowex X1 Cl resin -0,37 eq/kg. Dry and wet density of Dowex X1 OH resin are 0,9326 gr/ml and 0,7668 gr/ml. Dry and wet density of Dowex X1 Cl resin 0,9090 gr/ml and 0,9074 gr/ml. The resin conditioning before and after process applicated in 0,5 M NaOH elution.

Key words: resin Dowex X1Cl, charachterization, conditioning.

PENDAHULUAN

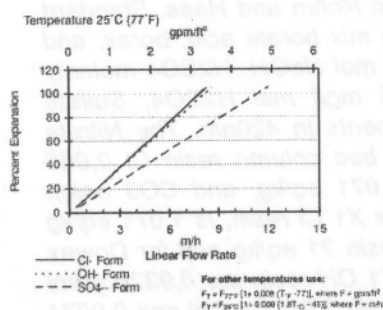
Selektifitas sulfat/nitrat menjadi faktor penting di dalam disain pertukaran ion karena sulfat

diadsorpsi semua penukar ion dalam larutan encer. Selektivitas ion dalam larutan encer berurutan sebagai sulfat⁻ nitrat⁻ klorid bikarbonat. Untuk resin dengan selektip nitrat yang mempunyai respon ke sulfat ($\alpha_{S/N} 1,0$) maka BVs (volume bed) ke nitrat dihitung dengan teori

keseimbangan kromatografi multi komponen yang meningkat sampai resin menjadi tidak selektif terhadap sulfat. Untuk resin yang selektif sulfat ($\alpha_{S/N} 1,0$) panjang lintasan bertambah, pada kondisi ini selektivitas nitrat/klorid menjadi penentu panjang lintasan. Selektivitas sulfat/klorid adalah faktor penting proses desulfasi air laut, yang mempunyai tegangan ionik 0,6M. Sehingga selektivitas ion valensi dua/valensi satu bertukar tempat, dimana klorid digantikan sulfat. Resin grup amina yang menukar sulfat mengikuti sekuen berikut: primer sekunder tertier quaternary. Teoritis sekuen ini menjelaskan basisitas yang ditentukan dengan karakter pelepasan elektron dari grup alkyl ke atom N, maka amina sekunder lebih basis dari amina primer. Sedang amina tertier kurang basis dari sekunder, salah satunya karena kelarutan air rendah dan menghalangi protonasi. Boari,dkk menyimpulkan bahwa matrik resin kelihatan selektif terhadap sulfat tetapi operasionalnya tidak teliti.

Ekspansi bed resin kolom (swelling)

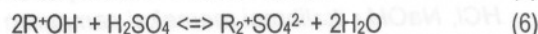
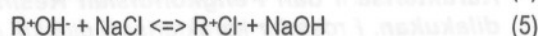
Resin ukuran partikel seragam membutuhkan aliran pencucian untuk mengembangkan tinggi resin dalam kolom sama sebagai resin konvensional polidispersi dari ukuran partikel seragam. Resin Dowex X1 Cl mempunyai ukuran partikel kecil, maka reduksi aliran pencucian diperlukan lebih jauh. Aliran dilakukan dari atas kolom yang akan mengembangkan resin, seperti gambar 1.



Gambar 1. Ekspansi resin mengembalikan klasifikasi semula dengan menghilangkan partikel debu didalam bed kolom.

Aliran pencucian mencegah munculnya saluran tipis diluar bed kolom resin selama siklus operasi. Waktu aliran ekspansi dibutuhkan selama 1jam untuk menghilangkan partikel tidak terdefinisi (bukan materi quaternary amine). Pengkondisian resin Dowex X1 Cl memakai NaOH menyebabkan terjadinya ekspansi resin kolom. Kelebihan NaOH didalam bed kolom digantikan air, selanjutnya bed resin dialiri HCl.

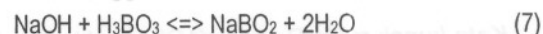
Aliran Cl^- dan air tidak mengembalikan tinggi volume resin pada posisi standar. Untuk itu resin perlu dialiri sodium nitrat pH netral sampai bed kolom resin menyusut kembali (20%-30%). Selanjutnya bed kolom resin distabilkan dengan aliran air suling untuk memposisikan tinggi normal resin didalam kolom. Reaksi pengkondisian resin Dowex X1 Cl



(R adalah resin Dowex X1 quaternary amine)

Penentuan asam borat.

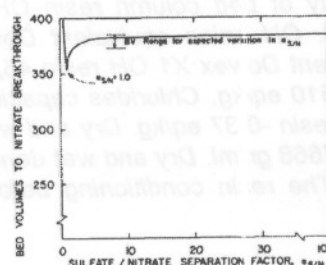
Asam borat berperan sebagai asam monoprotik lemah ($K_a = 6,4 \times 10^{-10}$), yang tidak dapat langsung dititrasi akurat dengan standar alkali. Dengan menambahkan senyawa organik polyhydroxy, misalnya gliserin, maka asam borat beraksi sebagai monobasik kuat dan dapat langsung dititrasi dengan NaOH memakai indikator pp.



Efek dari senyawa polyhydroxy terletak pada basis pembentukan rasio mol kompleks 1:1 dan 1:2 diantara ion borat terhidrasi dan 1,2 atau 1,3 diols.

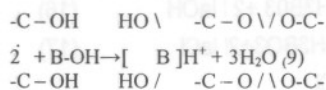
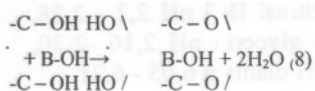
Penentuan boraks

Bila boraks dilarutkan dalam air maka akan terhidrolisis membentuk:

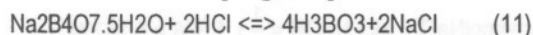


Gambar 2. Titik kritis penukaran ion nitrat yang dipengaruhi karakteristik resin untuk rasio anion sulfat/nitrat selama operasional. Resin adalah Dowex X1Cl quaternary amine $(C_2H_5)_4N^+OH^-$.

Reaksinya sebagai berikut:

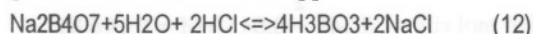


Larutan yang dititrasi HCl memakai indikator mo, reaksi sesungguhnya adalah NaOH, sehingga asam borat tidak berpengaruh pada indikator.

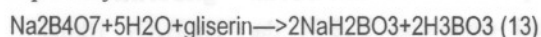


Maka $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ekuivalen dengan 2HCl.

Kemudian residu larutan dititrasi untuk H_3BO_3 yang tersisa dengan NaOH setelah penambahan gliserin memakai indikator pp.



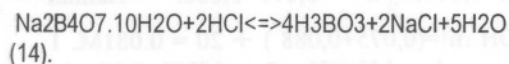
Maka $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ekuivalen dengan 4NaOH. Bila boraks tidak mengandung asam bebas yang dititrasi, maka volume standar alkali yang dipakai menjadi 2x volume standar asam. Titrasi boraks memakai gliserin dan NaOH reaksi dapat dihubungkan sebagai asam borat yang dinetralkan separuhnya.



Maka $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ekuivalen dengan 2NaOH.

Penentuan campuran asam borat dan boraks.

Larutan alkali borat dititrasi dengan standar asam, misalnya HCl, memakai indikator mo. Maka larutan dan indikator akan bereaksi seperti larutan alkali hidroksid (NaOH), sehingga fungsinya menjadi basa dinormal ketika dititrasi dengan asam.



Pembebasan asam borat mengkonsumsi 4mol NaOH pada titrasi alkali, dengan indikator pp dan gliserin.

TATA KERJA

Alat-alat yang digunakan

- Erlenmeyer, Buret, pH meter, Neraca digital, Labu takar, Oven, Pengaduk Magnet, Pemanas, Shaker Haver EML 200 digital, Gelas beker.

Bahan yang digunakan

- ♦ Resin Dowex X1Cl dan OH 100 mesh, serta resin Dowex Marathon MR3 mix 50 mesh.

- ♦ Indikator pp; mo; mm; kalium kromat.
- ♦ Larutan NaOH 0,5N; HCl 0,06N, 0,1N, dan 6N; NaCl 0,01N; KCl; HNO_3 8N; AgNO_3 0,01N; Glycerin 1:1; NaNO_3 0,5N pH netral; larutan sulfat standar 100mg/l; $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$; air suling.

Cara Kerja

Prosedur pengkondisian resin adalah pencucian dua kali aliran asam/basa memakai HCl 2N dan NaOH 1,5N dialiri air suling, selama 1 jam, lalu dialiri nitrat 0,5M. Diambil eluat nitrat 10mL sebanyak 3kali dititrasi HCl sampai titik akhir ganda pada titik pertama PP $\text{pH} \approx 9$, sedang pada titik akhir kedua MO $\text{pH} \approx 4$.

Dilakukan elusi nitrat kolom DowexX1OH dan Cl

Ditimbang 10 gram sisa resin Dowex X1 OH maupun Cl, dimasukkan gelas beker yang berisi air suling 75 mL ditambahkan 8mL HNO_3 diaduk 30 menit dan ditambah 1mL NaCl 0,585 g/l. Diendapkan sebentar, diambil filtratnya 10mL dititrasi dengan AgNO_3 standar indikator K_2CrO_4 1mL.

Analisis Effluent Nitrat

Diambil 5mL sulfat standar 245mg/mL, ditambah 100mL effluent nitrat dari kolom Cl atau OH, ditambah 1 tetes indikator pp. Warna rose larutan dinetralkan dengan 2mL HCl 6M. Larutan ditambah 5mL HCl 0,06M dan 10mL Gliserin 1:1 dan 0,3gr $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$. Larutan diaduk 15 menit, didiamkan 30 menit, diukur memakai UV 420nm.

Pengukuran kapasitas penukaran anion

Diambil 50mL resin Dowex X1 Cl diaduk dalam 50mL NaOH 1M 1jam, dibiarkan 24jam. Resin dicuci air suling 100mL diaduk. Kelebihan OH diuji memakai indikator mo. Kemudian resin direndam air suling 50mL 30menit. Bagian atas beker ditutup untuk mencegah adsorpsi CO_2 . Lalu resin disaring tertutup dan ditiriskan di dalam eksikator. Resin kering ditimbang $\pm 15\text{gr}$, dicatat berat resin sebagai $W_{\text{moist,OH}}$. Resin dalam bentuk *slurry* dipindahkan ke kolom gelas 50mL yang berisi air suling, bagian atas ditutup dan dikocok untuk mengusir intrusi udara. Setelah mengendap distabilkan aliran air suling 5jam, dicatat volume resin sebagai $V_{\text{moist OH}}$. Kedalam kolom dilewatkan 1L larutan NaNO_3 0,5N pH netral dan dikumpulkan effluen nitrat didalam beker. Kolom resin dicuci aliran air suling 1L, lalu resin dipindahkan ke gelas arloji untuk dikeringkan di dalam oven pada suhu 105°C 5jam, ditimbang sebagai $W_{\text{dry NO}_3}$. Dipipet 100ml effluen nitrat

kedalam beker dititrasi HCl 0,1N sampai titik akhir ganda. Titik akhir titrasi pertama memakai pp (pH 9), dan titik akhir titrasi kedua memakai mo (pH 4). Dicatat volume titrasi sebagai V_{HCl} , V_{2HCl} .

Untuk penentuan anion Cl level rendah, ditimbang ± 10 gr resin kering, dan dicatat beratnya sebagai $W_{moist, 2OH}$. Resin dimasukkan ke beker, ditambah 75mL air suling dan 8mL HNO_3 8N. Slurry diaduk 30 menit. Kedalam larutan ditambahkan 1mL NaCl 0,01N. Diambil filtratnya, dititrasi dengan $AgNO_3$ 0,01N. Dicatat volume titrasi sebagai V_{AgNO_3} . Untuk penentuan sulfat level rendah, maka dipipet 100mL effluen nitrat dimasukkan dalam beker. Ditambahkan 5mL standar sulfat 245mg/L, dan 1 tetes pp. Warna merah larutan dijernihkan memakai HCl 6N, lalu ditambahkan 5mL HCl 0,06N. Larutan diaduk ditambah gliserin 1:1 10mL, dan 0,3gr $BaCl_2 \cdot 2H_2O$. Diukur absorbansinya memakai spektrometer UV pada panjang gelombang 420nm.

Pengukuran densitas basah.

Diambil 5gr resin ditambahkan air suling sampai tercelup lalu dibiarkan 24jam. Slurry ini dipindahkan ke piknometer 25ml yang sudah dikalibrasi dengan air suling dan air suling panas. Lalu pikno ditempatkan dalam desikator.

Pengukuran densitas kering.

Seperti prosedur diatas tetapi air suling diganti dengan Toluene. Sebelumnya resin dikeringkan dalam oven pada suhu $115^\circ C$ sampai berat konstan.

Pengukuran % volume kosong (%void volum).
% volume kosong = $(1 - \text{Densitas Kering} / \text{Densitas Basah}) \times 100\%$.

HASIL DAN PEMBAHASAN

Penentuan NaOH dengan asam borat.

Rata rata titrasi 10 mL H_3BO_3 dibutuhkan NaOH 2,03 mL, dengan perubahan warna dari jernih ke ungu muda. Maka molar NaOH = 0,241M.

Reaksi: $NaOH + H_3BO_3 \rightarrow NaBO_2 + 2 H_2O$ ⁽¹⁵⁾

RASIO 1 : 1 $\rightarrow$ mol NaOH = 0,241M, maka rasio 1 : 2 $\rightarrow$ mol NaOH = $\frac{1}{2} \times 0,241 = 0,120$ M. Rasio diols:NaOH=1:1 maka total ekuivalen diols dan NaOH = $\frac{1}{3}$; Rasio diols=NaOH = 1: 2.

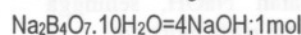
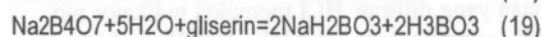
Ekuivalen mol NaOH = $\frac{1}{3} \times 0,241 = 0,08$ M

Penentuan HCl dan NaOH dengan boraks +gliserin

Titrasi 10mL $Na_2B_4O_7$ dengan HCl dibutuhkan 9,9mL, dan memakai NaOH 2,03mL. Pengukuran pH awal 8,45, selama titrasi HCl pH 2,2 - 2,28, ditambah indikator dan glycerin pH 2,16 - 2,20, dan pada titrasi NaOH pH diantara 6,05 - 6,21.

Penentuan NaOH

$0,05 \cdot 10 = M NaOH \cdot 0,36$; $M NaOH = 1,388$ M



borax = 4mol NaOH. Mol NaOH = $\frac{1}{4} \times 1,388 = 0,347$ M.

Penentuan HCl

$0,05 \cdot 10 = M HCl \cdot 5,53$; $M HCl = 0,09$ M; 1mol borax

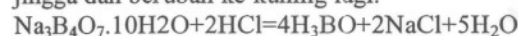
= 2mol HCl. Mol HCl = $\frac{1}{2} \times 0,09 = 0,045$ M

Jumlah mol riil = $\frac{(0,347 + 0,045)}{2} M = 0,196$ M

Titrasi NaOH + HCl: 1mol borax = 4mol NaOH = 2mol HCl; $0,05 \cdot 10 = M NaOH (0,36 + 5,53)$; mol NaOH = $0,05 \div 5,89 = 0,084$ M.

Penentuan NaOH dan HCl dengan campuran borat dan borax + gliserin.

Titrasi campuran H_3BO_3 dan $Na_2B_4O_7$ 10mL dibutuhkan 0,33mL NaOH, dan HCl 5,63mL, perubahan warna dari jernih ke kuning, lalu jingga dan berubah ke kuning lagi.



(20)

Dititrasi NaOH: $0,05 \cdot 20 = M NaOH \cdot 0,33$.

Mol NaOH = $\frac{1}{4} \times 0,303 = 0,075$ M. Dititrasi dengan

HCl: $0,05 \cdot 20 = M HCl \cdot 5,63$; mol

HCl = 0,177; Teori: $\frac{1}{2} \times 0,177 = 0,088$. Jumlah

mol NaOH riil = $(0,075 + 0,088) \div 20 = 0,081$ M. 1 Mol borax = 4 mol NaOH = 2 mol HCl; $0,05 \cdot 10 = M NaOH (0,33 + 5,63)$, maka mol NaOH = 0,084

Total mol ekuivalen reaksi = $\frac{4}{2} = 2$; sehingga mol

NaOH = $0,084 \div 2 = 0,042$ M.

Penentuan H_2SO_4 dengan Na_2CO_3 + indikator metil merah.

Titrasi estafet dari I ke VI sampai diperoleh titik ekuivalen dimana warna larutan tetap merah, meskipun dipanaskan. Volume H_2SO_4 dibutuhkan 4,6; 2,5; 2,7; 3,1; 2,2; 2,9 mL. Perubahan pH larutan 7,18-5,83; 6,68-5,96; 6,92-6,15; 6,05-5,32; 7,4-6,85; dan 7,02-6,2.

Setiap titrasi digunakan 4,4gram Na₂CO₃

$$\text{Rumus : } A = \frac{B}{0,053 \times C} = \frac{4,4}{0,053 \times 17,77} = 0,005 \text{ gr/ml}$$

H₂SO₄ 0,005 N = 245 mg/ml.

Penentuan larutan NaNO₃ dengan HCl memakai indikator pp dan mo.

Titrasi pertama NaNO₃ 10ml dibutuhkan HCl 4,67ml, dan titrasi kedua dipakai HCl 8,67ml. HCl distandarisasi dengan NaOH = 0,096 M. HCl distandarisasi dengan Na₂CO₃ = 0,075 N. Pengukuran pH 9,4 ; setelah penambahan indikator pp pH 9,48, lalu di titrasi pH 7,59, kemudian ditambah mo pH 7,85 dan titrasi kedua pH 4,11. Perubahan warna : jernih → ungu (+ PP) → jernih (titrasi I HCl) → kuning (+ MO) → merah orange (titrasi ke II HCl).

Penentuan OH dan CO₃ resin Dowex X1 OH

Diket : W moist OH (gram) = 13,62 gram ; Volume Nitrat = 10mL ; Volume HCl I = 4,6mL, dan Volume HCl II = 8,9mL

$$\text{EqOH(eq/kg)} = \frac{10 \times (2 \times (4,6) - (8,9) \times 0,075) \text{ (eq/liter)}}{0,014 \text{ kg}}$$

$$= 16,071 \text{ eq/kg}$$

$$\text{EqCO}_3(\text{eq/kg}) = \frac{10 \times 2 \times (8,9 - 4,6) \times 0,075 \text{ (eq/liter)}}{0,014 \text{ kg}}$$

$$= 46,714 \text{ eq/kg}$$

Penentuan Cl level rendah Dowex X1 OH

$$\text{EqCl(eq/kg)} =$$

$$\frac{\{(V, \text{AgNO}_3) - V \text{ Blanko AgNO}_3\} \times N \text{ AgNO}_3}{\text{eq/liter}}$$

$$\text{WMoist2OH(gr)}$$

$$= 21 \text{ eq/kg}$$

Data eluen kolom Dowex X1 OH: pH awal ketiga cuplikan 0,20; ditambah indikator pH 0,23; dan sesudah dititrasi pH 0,26. Titrasi eluen kolom volume 10ml dibutuhkan AgNO₃ = 1,43ml. Perubahan warna : jernih → kuning (+ indi K₂CrO₄) → dititrasi dengan larutan AgNO₃ kuning keruh.

Pengukuran effluen Nitrat dengan HCl

Titrasi pertama eluen Nitrat dari kolom Dowex X1 Cl dibutuhkan HCl 0,0167ml, dan titrasi kedua dipakai HCl 0,3ml. Pengukuran pH: 8,62 ; setelah ditambah pp pH 8,28 ; titrasi I HCl pH 3,23 ; dan penambahan mo pH 8,26 ; titrasi II HCl pH 2,46. Perubahan warna: jernih → ungu (+ pp dan NH₄OH) → jernih (titrasi I HCl) → kuning (+ mo dan NH₄OH) → merah orange (titrasi ke II HCl).

Data effluen nitrat 10 ml dari kolom Dowex X1 Cl

Pengukuran pH: 0,01, penambahan indikator pH 0,05 ; dititrasi pH 0,14. Titrasi dengan AgNO₃ + K₂CrO₄ dibutuhkan AgNO₃ 0,86ml. Perubahan warna : jernih → kuning (+ indi K₂CrO₄) → dititrasi dengan AgNO₃ kuning keruh.

Penentuan OH dan CO₃ resin Dowex X1 Cl

Diket : W moist Cl (gram) = 11,83 gram.

Volume Nitrat = 10mL. Volume HCl I = 0,16mL.

Volume HCl II = 0,3mL

$$\text{EqOH(eq/kg)} = \frac{10 \times (2 \times (0,16) - (0,3) \times 0,075) \text{ (eq/liter)}}{0,014 \text{ kg}}$$

$$= 1,0714 \text{ eq/kg}$$

$$\text{EqCO}_3(\text{eq/kg}) = \frac{10 \times 2 \times (0,3 - 0,16) \times 0,075 \text{ (eq/liter)}}{0,014 \text{ kg}} = 1,5105 \text{ eq/kg}$$

Analisis Ukuran Butir: Hasil ayakan resin Dowex X1 Cl sebagai berikut: Berat resin awal 30,07 gr, ukuran 100 mesh (500 μm) 27,95 gr, ukuran 300 μm = 1,19 gr, ukuran 75 μm = 0,45 gr, dan ukuran dibawah 75 μm = 0 gr. Hasil ayakan resin Dowex X1 OH sebagai berikut:

Berat resin awal 30,07 gr, ukuran 100 mesh (500 μm) 25,65 gr, ukuran 300 μm = 1,95 gr, ukuran 75 μm = 1,35 gr, dan ukuran dibawah 75 μm = 0 gr.

Penentuan Cl level rendah Dowex X1 Cl

$$\text{EqCl(eq/kg)} =$$

$$\frac{\{(V, \text{AgNO}_3) - V \text{ Blanko AgNO}_3\} \times N \text{ AgNO}_3}{\text{eq/l}}$$

$$\text{WMoist2OH(gr)}$$

$$= \frac{\{(0,86 \text{ mL} - 1,23 \text{ mL}) \times 0,01 \text{ N}\}}{0,01 \text{ kg}} = -0,37 \text{ eq/kg.}$$

$$0,01 \text{ kg}$$

Tabel 1. Data standar SO₄²⁻ 245 mg/l pada spektrometer UV 420nm volume 5 ml dengan blanko air suling. (Influen nitrat).

SO ₄	A I	A II	A III	Rata	Kor
Blan	0,009	0,010	0,010	0,009	-
0,5	0,016	0,016	0,016	0,016	0,007
1,0	0,009	0,008	0,006	0,008	-
1,5	0,042	0,040	0,039	0,040	0,031
2,0	0,028	0,026	0,026	0,027	0,018
2,5	0,027	0,022	0,020	0,023	0,014
3,0	0,117	0,118	0,117	0,117	0,108
3,5	0,070	0,065	0,067	0,067	0,058
4,0	0,094	0,093	0,093	0,093	0,084
4,5	0,112	0,105	0,108	0,108	0,099
5,0	0,118	0,118	0,118	0,118	0,109

Tabel 2. Absorbansi SO₄ standar pada effluent NO₃ resin Cl.

SO ₄	A I	A II	A III	Rata	Kor
Blan	0,019	0,018	0,018	0,018	-
0,5	0,083	0,081	0,102	0,089	0,071
1,0	0,016	0,031	0,051	0,028	0,010

1,5	0,046	0,043	0,039	0,041	0,023
2,0	0,008	0,010	0,078	0,031	0,012
2,5	0,007	0,008	0,055	0,023	0,005
3,0	0,007	0,046	0,040	0,020	0,002
3,5	0,045	0,067	0,064	0,052	0,034
4,0	0,034	0,033	0,077	0,048	0,030
4,5	0,012	0,011	0,068	0,030	0,012
5,0	0,051	0,049	0,134	0,077	0,059
5,5	0,003	0,045	0,045	0,017	-
6,0	0,120	0,056	0,056	0,077	0,059

Data pengukuran densitas:

a. Resin Cl: densitas basah = 5/5,36 gr/ml = 0,9328 gr/ml. Densitas kering = 5/6,52 gr/ml = 0,7668 gr/ml. % volume kosong = $(1 - 0,7668/0,9328) \times 100\% = 17,80\%$.

b. Resin OH: densitas basah = 0,9090 gr/ml. Densitas kering = 0,9074 gr/ml. % volume kosong = $(1 - 0,9074/0,9090) \times 100\% = 0,18\%$.

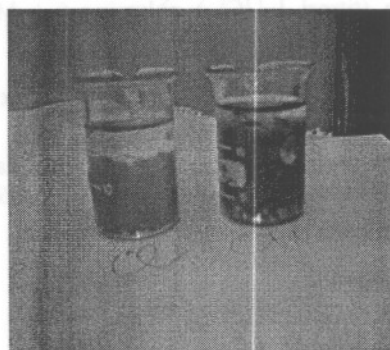
c. Resin Dowex Marathon OH/H: Densitas basah = 0,9041 gr/ml. Densitas kering = 0,9287 gr/ml. % volume kosong = 2,72 %. Analisis Kadar Air Resin Cl: 47,20 %; Resin OH: 66,20 %.
Resin OH/H: 41,20 %.

PEMBAHASAN

Resin Dowex X1 OH menyusut bila dielusi Sodium Nitrat, dan kembali mengembang (*swelling*) dengan eluen air dan NaOH, tetapi pada resin Dowex X1 Cl penyusutan tidak hanya disebabkan elusi nitrat, tetapi juga oleh NaOH. Meskipun demikian kolom resin ini akan kembali mengembang dengan elusi air. Rata rata prosen penyusutan dan pengembangan kedua resin diantara 18-20%. Perhitungan ekivalen OH, CO₃, dan Cl jelas menunjukkan kapasitas resin bentuk OH jauh melebihi resin Cl. Demikian pula pada prosen volume kosong resin yang tidak terisi fungsional quarternary amine, ternyata resin bentuk Cl jauh lebih besar. Resin OH bila dipakai sebagai langkah kondisioning mempunyai afinitas Nitrat lebih besar dari pada kolom resin Cl, dan mampu menggantikannya dengan SO₄²⁻. Pengamatan in-situ perubahan fisik resin selama perlakuan: Kolom Dowex X1 OH : Warna resin bed didalam kolom coklat tua, setelah dialiri Sodium Nitrat dan NaOH warna tetap. Tinggi resin setelah dielusi Sodium Nitrat turun perlahan, lalu dielusi NaOH naik cepat (*swelling*). Kolom Dowex X1 Cl. Warna resin bed didalam kolom kuning, setelah dialiri Sodium Nitrat dan NaOH warna coklat tua. Tinggi resin setelah dielusi Sodium Nitrat turun dengan cepat (resin menyusut), lalu dielusi NaOH naik perlahan.

KESIMPULAN

Resin Dowex X1 Cl harus dikondisikan dengan NaOH pada konsentrasi 0,5 M, sebelum dan sesudah aplikasi proses penukar ion. Kapasitas ion OH, CO₃, dan Cl untuk resin Dowex X1 Cl adalah 1,0714eq/kg; 1,5105 eq/kg; dan 0,37eq/kg. Sedang untuk resin Dowex X1 OH adalah 16,071eq/kg ; 46, 714eq/kg; 21eq/kg. Prosen volume kosong resin Dowex X1 Cl adalah 17,80% sedang pada resin Dowex X1 OH 2,72%. Sementara kadar air resin Dowex X1 Cl 47,20% ; dan pada resin Dowex X1 OH 66,20%. Ukuran butir resin 100 mesh untuk Dowex X1 Cl mencapai 92,95%, dan untuk resin Dowex X1 OH mencapai 85,30%.



Gambar 3. Secara visual warna dan homogenitas kedua resin berbeda, termasuk kecepatan mengendap. Resin Dowex X1 Cl dan OH didalam Toluene.

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Tanya Jawab

Sriyono

- Bagaimanakah penjelasan dari proses penukaran anion yang secara visual bed kolom menyusut dan mengembang?

Sri Sukmajaya

- ✧ *Bed kolom resin Cl menyusut disebabkan terelusi oleh anion nitrat, sampai mencapai 20-30 % kapasitas oksidasi nitrat terhadap gugus fungsional quaternary amina resin lebih besar dari pada Cl sehingga resin menyusut*

Noor Hardjono

- Apa bedanya Dowex X1 Cl dengan Amberlite IRA 402 Cl yang dipakai pada pesawat demin air reaktor?

Sri Sukmajaya

- ✧ *Pada prinsipnya hampir sama. Resin anion adalah proses aminasi ikatan styrene divinil benzene yang menukar gugus fungsional trimetil amina dan quaternary amina. Koefisien selektifitas anion Cl sama. Yang membedakan adalah kapasitas tukar anion kuat dari garam logam lebih aplikatif untuk resin Dowex X1 CL*

Sigit Pramana

- Bagaimana mengatasi saluran tipis terpisah (channel) pada bed kolom resin

Sri Sukmajaya

- ✧ *Channel disebabkan oleh intrusi udara atau perubahan produk reaksi samping yang menghasilkan endapan di dalam bed kolom resin. Cara mengatasi dengan dilakukan siklus regenerasi ke dalam kolom memakai NaOH, HCl, NaNO₃.*

Moer Hantjono
 > Apa bedanya Power XI CI dengan Anberlin
 RA 402 CI yang dibuat pada pesawat domain
 ini bukan?
 Sri Subandjaya
 > Pada prinsipnya hampir sama. Bedanya anberlin
 adalah proses desainnya lebih sistematis
 dibanding yang sekarang. Kalau fungsional
 secara umum dan perawatannya sama
 fungsionalitasnya sama. CI sama. Yang
 membedakan adalah kapasitasnya. Kalau anberlin
 bisa dua belas bagian lebih signifikan untuk
 mesin Power XI CI

Sigit Pramono
 > Bagaimana mengasah anberlin agar lebih tajam
 (dalam) pada bed kelenar mesin

Sri Subandjaya
 > Kalau dibandingkan lebih tajam atau sama
 perbedaannya adalah proses yang
 menggunakan anberlin di dalam bed kelenar
 mesin. Cara mengasah dengan anberlin
 akan tergantung ke dalam kelenar mekanis
 tidak ada bed

Dipet, Jan, and Chemistry, Univ. of
 Pennsylvania, 2001
 > ROBIN AND LAAS COMPANY, Inc
 Exchange Rate, Master Test Method, Total
 Acid Exchange, 2nd, 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th, 13th, 14th, 15th, 16th, 17th, 18th, 19th, 20th, 21st, 22nd, 23rd, 24th, 25th, 26th, 27th, 28th, 29th, 30th, 31st, 32nd, 33rd, 34th, 35th, 36th, 37th, 38th, 39th, 40th, 41st, 42nd, 43rd, 44th, 45th, 46th, 47th, 48th, 49th, 50th, 51st, 52nd, 53rd, 54th, 55th, 56th, 57th, 58th, 59th, 60th, 61st, 62nd, 63rd, 64th, 65th, 66th, 67th, 68th, 69th, 70th, 71st, 72nd, 73rd, 74th, 75th, 76th, 77th, 78th, 79th, 80th, 81st, 82nd, 83rd, 84th, 85th, 86th, 87th, 88th, 89th, 90th, 91st, 92nd, 93rd, 94th, 95th, 96th, 97th, 98th, 99th, 100th, 101st, 102nd, 103rd, 104th, 105th, 106th, 107th, 108th, 109th, 110th, 111th, 112th, 113th, 114th, 115th, 116th, 117th, 118th, 119th, 120th, 121st, 122nd, 123rd, 124th, 125th, 126th, 127th, 128th, 129th, 130th, 131st, 132nd, 133rd, 134th, 135th, 136th, 137th, 138th, 139th, 140th, 141st, 142nd, 143rd, 144th, 145th, 146th, 147th, 148th, 149th, 150th, 151st, 152nd, 153rd, 154th, 155th, 156th, 157th, 158th, 159th, 160th, 161st, 162nd, 163rd, 164th, 165th, 166th, 167th, 168th, 169th, 170th, 171st, 172nd, 173rd, 174th, 175th, 176th, 177th, 178th, 179th, 180th, 181st, 182nd, 183rd, 184th, 185th, 186th, 187th, 188th, 189th, 190th, 191st, 192nd, 193rd, 194th, 195th, 196th, 197th, 198th, 199th, 200th, 201st, 202nd, 203rd, 204th, 205th, 206th, 207th, 208th, 209th, 210th, 211st, 212nd, 213rd, 214th, 215th, 216th, 217th, 218th, 219th, 220th, 221st, 222nd, 223rd, 224th, 225th, 226th, 227th, 228th, 229th, 230th, 231st, 232nd, 233rd, 234th, 235th, 236th, 237th, 238th, 239th, 240th, 241st, 242nd, 243rd, 244th, 245th, 246th, 247th, 248th, 249th, 250th, 251st, 252nd, 253rd, 254th, 255th, 256th, 257th, 258th, 259th, 260th, 261st, 262nd, 263rd, 264th, 265th, 266th, 267th, 268th, 269th, 270th, 271st, 272nd, 273rd, 274th, 275th, 276th, 277th, 278th, 279th, 280th, 281st, 282nd, 283rd, 284th, 285th, 286th, 287th, 288th, 289th, 290th, 291st, 292nd, 293rd, 294th, 295th, 296th, 297th, 298th, 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