



(54)

(1) , (2) (3) , R 2가 , a) R  
 (4A), (4B), (4C), (4D), (4E), (4F), (4G) / (4H) , b)  
 R (5C) / (5D) (5A) / (5B) 가 /가 R  
 , c) R (6) (bridge) ,  
 , R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub>, R<sub>5</sub>, M, X, Y, Z m .

- Q - R (1)

Q , , ,  
 (2)  (3) ,

R 2가 가 .

(1) pyrene) (polyarylene), (polystyrene), (polyvinylpyridine), (polyphenylenevinylene)  
 , Radel( ) R (polysulfone), PEK  
 polyazulene), (polycarbazole), (polybenzimidazole), (polyindophenine), (polypyrrole), (polyazole)

(polyelectrolyte membrane fuel cell)(PEM )

assembly)(MEA)가 (tolerance) 가 (proton conductor) , (membrane electrode (lower upper flow limit),

. DE 196 22 337 (sulfinate) DE 196 22 337, WO 99/02755, WO 99/02756 (ionomer) ( ) (network) 가

WO 99/02756 WO 99/02755 가 ( ) / ( ) 60 90 / 80

25 100 cm

ing property) 가 90 100% (swell

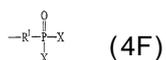
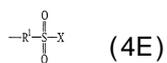
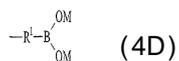
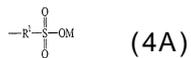
80 가 100

가

가 1

1

a) R (4A), (4B), (4C), (4D), (4E), (4F), (4G) / (4H)



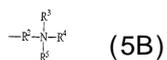
R<sup>1</sup>

1 40

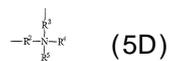
M , , Li<sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Rb<sup>+</sup>, Cs<sup>+</sup> ,

X ,

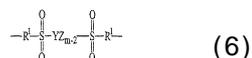
b) R (5A) / (5B) ,



$R^2, R^3, R^4, R^5$  1 40 ,  $R^2, R^3, R^4$  (5C) / (5D) ,



c) R (6) (bridge) ,



R ,

Y 1 40 ,

Z ,



, H, C, O, N, S, P, , 20 g/ ,

m 2 ,

(1) ,

, 가 , 가 . ,

, 가 . 가 ,

(doped polymer membrane) , 25 100 cm

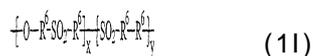
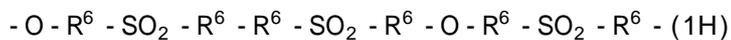
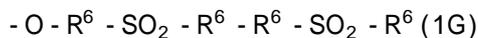
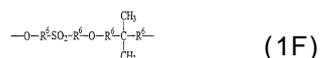
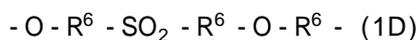
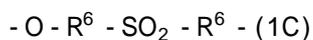
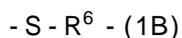
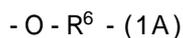
, 가 ,

가 10 100 $\mu$ m , 80 ,

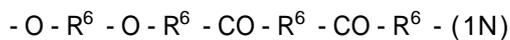
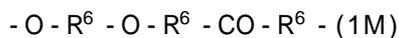
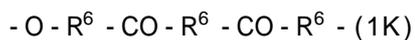
80 , ,

가  
가 " " 1.0 CD Rompp Chemie Lexikon(Stuttgart/New York: Georg Thieme Verlag, 1995) ,

(1) , (1A), (1B), (1C), (1D), (1E), (1F), (1G), (1H), (1I), (1J), (1K), (1L), (1M), (1N), (1O), (1P), (1Q), (1R), (1S) / (1T)



$0 < x, y < 100\%$

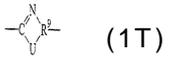
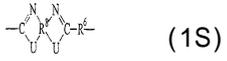


0 < y < 100%

- R<sup>6</sup> - (1P)

- R<sup>6</sup> - CH=CH - (1Q)

- CHR<sup>7</sup> - CH<sub>2</sub> - (1R)



. C<sub>10</sub> 2가 , C<sub>10</sub> R<sup>6</sup> 2가 , C<sub>14</sub> 1,2 - 2가 , 1,3 - / 1,4 - 2가 , 4,4' - (pyrene) ,  
 , R<sup>6</sup> - , - , - .  
 R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup> 1가, 2가 3가 , , , 1 20 ,  
 U , 가 .

(copolymer) , Victrex( (1) ) 720 P Astrel( ) (homopolymer) .



:

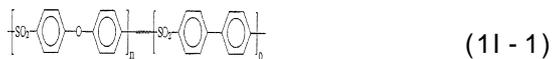


:

Victrex( ) 200 P



Victrex( ) 720 P



$n > 0$

Radel( )



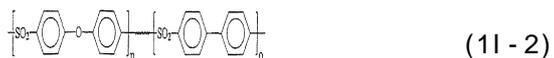
Radel( ) R



Victrex( ) HTA



Astrel( )



$n < 0$

Udel( )

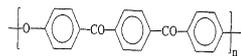


:

PEK

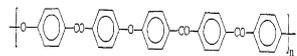


PEKK



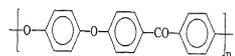
(1K - 1)

PEKEKK



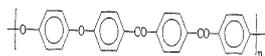
(1L - 1)

PEEK



(1M - 1)

PEEKK



(1N - 1)

:



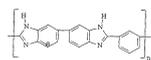
(1P - 1)

:



(1P - 2)

:

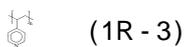
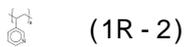
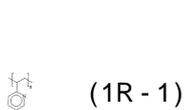
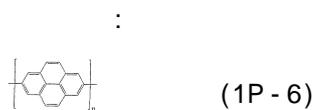
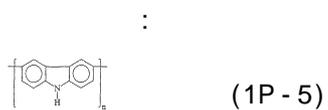
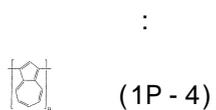
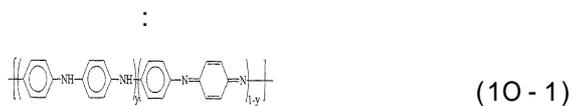


(1S - 1)

:



(1P - 3)



(1A - 1), (1B - 1), (1C - 1), (1I - 1), (1G - 1), (1E - 1), (1H - 1), (1I - 2), (1F - 1), (1J - 1), (1K - 1),  
(1L - 1), (1M - 1) / (1N - 1) 가 .

, n

(1)

10

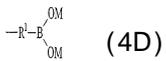
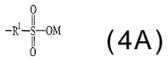
, 100

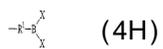
(1A), (1B), (1C), (1D), (1E), (1F), (1G), (1H), (1I),  
(1J), (1K), (1L), (1M), (1N), (1O), (1P), (1Q), (1R), (1S) / (1T) 10 ,  
100 .

0 g/mol , 100,000 g/mol , 25,000 g/mol , 50,00

(1A), (1B), (1C), (1D), (1E), (1F), (1G), (1H), (1I), (1  
J), (1K), (1L), (1M), (1N), (1O), (1P), (1Q), (1R), (1S) / (1T)

(4H), R (4A), (4B), (4C) / (4D), (4A), (4B), (4C), (4D), (4E), (4F), (4G) /  
(4A), (4B) / (4C),  
(4A):

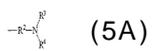




R<sup>1</sup> 1 40 ,  
 , R<sup>1</sup>

M , , Li<sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Rb<sup>+</sup>, Cs<sup>+</sup>,  
 Li<sup>+</sup>,

X , R (5A) / (5B), (5A)  
 /



R (5C) / (5D), (5C)



, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> R<sup>5</sup> 1 40 , R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>

R (5A - 1) / (5A - 2),



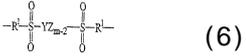
R<sup>10</sup>

R<sup>10</sup>, R<sup>10</sup>, R<sup>11</sup>, R<sup>11</sup>

R<sup>10</sup>  
(5A - 1)

R<sup>10</sup>, R<sup>11</sup>  
(5A - 2) 가

R (6)



R, Y 1 40, 1 6

Z



m 2 H, C, O, N, S, P 20 g/mol

가 (doping agent)가 (proton conductivity) (dopant)

(As, I, P, Se, Si, Te가 ) (Cr, Mo, V, W )  
(12 - tungstophosphoric acid) 12 - (12 - molybdato phosphoric acid) 12 -

가 (H<sub>3</sub>PO<sub>4</sub>)  
(degree of doping) 가 가 가 가  
, 3 15 , 6 12 가

0.5 - 96 , 1 - 72 , 100

0.5 meq/g 1.9 meq/g

25 100 cm , 50 cm , 20 cm

100 가 120 80 , 50 100μm, 10 90μm, 20 90 100%

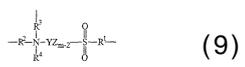
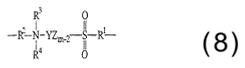
(7) , a), b) d) , d) (6) 가



YLm (7)

L , F, Cl, Br, I, , n 2 , 2 (1)

(5C) , (7) R (8) / (5A) (9)



(5A) / (5C) 가

- 1) a)
- 2) b)
- 3) d)

1) a) b)

2) d)

1) a) d)

2) b)

, 1) a)

2) b) d)

, a), b) d)

(1)

가

(1A), (1B), (1C), (1D), (1E), (1F), (1G), (1H), (1I), (1J), (1K), (1L), (1M), (1N), (1O), (1P), (1Q), (1R), (1S) / (1T)

(1A), (1B), (1C), (1D), (1E), (1F), (1G), (1H), (1I), (1J), (1K), (1L), (1M), (1N), (1O), (1P), (1Q), (1R), (1S) / (1T) 10 , 100

25,000 g/mol,

50,000 g/mol, 100,000 g/mol

a), b) / d)

(aprotic solvent),

(THF)

(1)

, n -

L - (10) ( )

SO<sub>3</sub>

SO<sub>2</sub>

4,833,219 (J. Kerres, W. C

ui, S. Reichle,

), "

) PSU Udel(

)" J. Polym. Sci.:

A: Polym. Chem. 34, 2421 - 2438 (1996 ), WO 00/09588 A

1 (

).

0.1 3 (group) ,  
 a) 0.2 0.2 2.2 가 , 0.8 2.2 b)  
 가 , 0.8 1.3 d)  
 가  
 , N,N- , N,N- , N  
 (sulfolane)

a) (substrate),  
 b) , 25 / 1000 mbar 가

a) 1 ,  
 b) 가 , 1

가 , 25 가  
 , 100 cm , 2 , 가

tration), (electrodialysis) (pervaporation), (膜抽出, perstraction), (nanofil 가  
 (diffusion dialysis)

가 가

(IEC) , , H<sup>+</sup> 가 , 1mg  
 50ml NaCl , 24 ,  
 가 , 0.1 - NaOH

IEC

$$IEC(\text{meq/g}) = \{ \text{NaOH} (\text{meq/g}) * \text{NaOH} (\text{ml}) * \text{NaOH} (\text{factor}) \} / (\text{g})$$

(R<sup>SP</sup>) (IM6 , Zahner elektrik) (0.25cm<sup>2</sup>) (Plexiglas unit)

가 0 , 0.5N HCl ,

Nafion 117 , Nafion 117/ /Nafion 117

Nafion 117 , Nafion  
 25

가 ( $= m^{SWOLLEN}$  ).  
 (=  $m^{dry}$  ).

$$Q = (m^{SWOLLEN} - m^{dry}) / m^{dry}$$

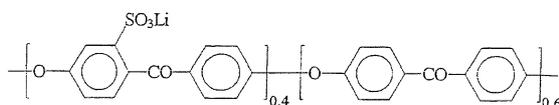
a)

a - 1) PSU Udel( )

PSU P 1800 (Amoco)

a - 2) PEK - SO<sub>3</sub>Li:

PEK;

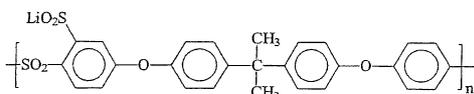


:

0ml	24	1.8 meq SO <sub>3</sub> H/g	Li	PEK - SO <sub>3</sub> H 100g	10	%	LiOH	100
{	, 100	48		PEK - SO <sub>3</sub> Li	,		0.4 SO <sub>3</sub> Li	
		(IEC) = 1.8 meq SO <sub>3</sub> H/g)						

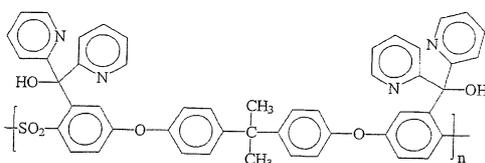
a - 3) PSU - SO<sub>2</sub>Li:

PSU Udel( )



4,833,219 (J. Kerres, W. Cui, S. Reichle, ), J. Po  
 lym. Sci.: A: Polym. Chem. 34, 2421 - 2438 (1996 ) "  
 ) PSU Udel( )" , 가 IEC = 1.95 meq SO<sub>2</sub>Li/g .

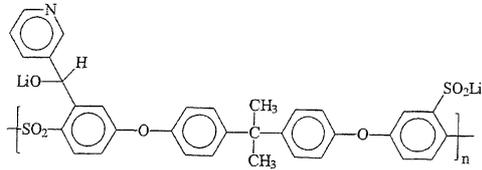
a - 4) PSU - DPK



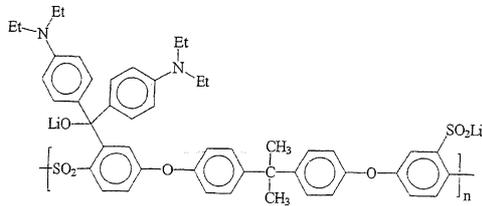
2,2' - PSU Udel (WO 00/09588 A1 ), 2,2' -

a - 5) PSU - P3 - SO<sub>2</sub>Li, PSU - EBD - SO<sub>2</sub>Li

PSU - P3 - SO<sub>2</sub>Li



PSU - EBD - SO<sub>2</sub>Li



PSU Udel( ) THF -75  
 2.5M n- (n-BuLi) 10M n-B  
 uLi (batch) , -3- 4,4' - (N,N-  
 ) 가 . -20 가 .SO<sub>2</sub> ,  
 -75 SO<sub>2</sub>가 가 .  
 , 10ml / , 가 ,  
 , 1H-NMR 가 . 80

[ 1]PSU - P3 - SO

	(BATCH)	
PSU - P3 - SO <sub>2</sub> L i	10ml 10M BuLi1000ml THF22.1g PSU Udel( )5.35g -3- SO <sub>2</sub>	0.8 -3- 1.2 SO <sub>2</sub> Li
PSU - EBD - SO <sub>2</sub> Li	10ml 10M BuLi1000ml THF22.1g PSU Udel( )16.22g 4,4' - (N,N- ) SO <sub>2</sub>	0.4 4,4' - (N,N- ) 1.6 SO <sub>2</sub> Li

b)

PEK - SO<sub>3</sub>Li, PSU - P3 - SO<sub>2</sub>Li, PSU - EBD - SO<sub>2</sub>Li, PSU - DPK / PSU - SO<sub>2</sub>Li가 2 NMP  
 , 1,4 - (1,4 - diiodobutan

e) (doctor blade) 60  
 1 , 가 1 90 , 120  
 (waterbath) 90  
 10% HCl 60

c) (IEC<sup>theo</sup>)  
 2 3  
 , 3 ,  
 , 90

[ 2 ]

		( $\mu\text{m}$ )	IEC <sup>exp</sup> (meq/g)	IEC <sup>theo</sup> (meq/g)	R <sup>sp</sup> (cm)
1(wz054)	0.77g PSU - EBP2.0g PEK - SO <sub>3</sub> Li0.6g 1,4 -	64	1.03	1.09	6.87
2(wz051)	0.77g PSU - Pe2.0g PEK - SO <sub>3</sub> Li0.48g 1,4 -	87	0.81	0.88	3.62
3(wz40)	3g PEK - SO <sub>3</sub> Li0.3g PSUSO <sub>2</sub> Li0.3g PSU - DPK0.205ml 1,4 -	113	1.43	1.4	13.4
4(wz40R)	1g PEK - SO <sub>3</sub> Li0.3g PSUSO <sub>2</sub> Li0.3g PSU - DPK0.205ml 1,4 -	52	0.86	0.89	35.96
1(wz43)	3g PEK - SO <sub>3</sub> Li0.3g PSU - DPK	126	1.52	1.52	7.8
2(wz43R)	1g PEK - SO <sub>3</sub> Li0.5g PSU - DPK	56	0.92	0.79	24.5
3	PEK - SO <sub>3</sub> H	82	1.63	1.8	7.13

IEC<sup>exp</sup> :

R<sup>sp</sup> :

[ 3 ]

	(%)			
	25	40	60	90
1(wz054)	40.79	46.05	46.05	59.21
2(wz051)	38.46	44.61	44.61	61.54
3(wz40)	42	42.48	58.41	151.33
4(wz40R)	22.9	27.1	29.2	35.9
1(wz43)	95.9	110.4	161.09	224.43
2(wz43R)	29	33.77	34.2	48.05
3PEK - SO <sub>3</sub> H	107.32	122	129.27	139.02

가

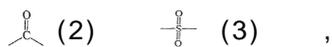
, 25 , 100 cm , , ,  
 (swelling property) , , ,

(57)

1.

- Q - R (1)

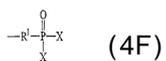
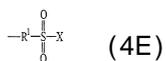
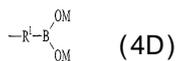
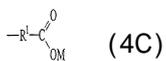
Q , , ,



R

2가 , ,

a) R (4A), (4B), (4C), (4D), (4E), (4F), (4G) / (4H)

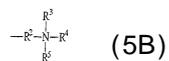
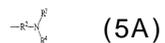


R<sup>1</sup> 1 40

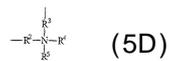
M, Li<sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Rb<sup>+</sup>, Cs<sup>+</sup>,

X,

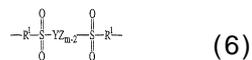
b) R (5A) / (5B),



R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> R<sup>5</sup> 1 40  
 / R R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> (5C) / (5D)



c) R (6) (bridge),



R,

Y 1 40,

Z



, H, C, O, N, S, P, , 20 g/ ,

m 2

2.

1, (1) (1A), (1B), (1C), (1D), (1E), (1F), (1G), (1H), (1I), (1J), (1K), (1L), (1M), (1N), (1O), (1P), (1Q), (1R), (1S) / (1T)

- O - R<sup>6</sup> - (1A)- S - R<sup>6</sup> - (1B)- O - R<sup>6</sup> - SO<sub>2</sub> - R<sup>6</sup> - (1C)- O - R<sup>6</sup> - SO<sub>2</sub> - R<sup>6</sup> - O - R<sup>6</sup> - (1D)- O - R<sup>6</sup> - SO<sub>2</sub> - R<sup>6</sup> - O - R<sup>6</sup> - R<sup>6</sup> - (1E)
$$\text{---O---R}^6\text{---SO}_2\text{---R}^6\text{---O---R}^6\text{---}\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}}\text{---R}^6\text{---} \quad (1F)$$
- O - R<sup>6</sup> - SO<sub>2</sub> - R<sup>6</sup> - R<sup>6</sup> - SO<sub>2</sub> - R<sup>6</sup> (1G)- O - R<sup>6</sup> - SO<sub>2</sub> - R<sup>6</sup> - R<sup>6</sup> - SO<sub>2</sub> - R<sup>6</sup> - O - R<sup>6</sup> - SO<sub>2</sub> - R<sup>6</sup> - (1H)
$$\left[ \text{---O---R}^6\text{---SO}_2\text{---R}^6\text{---} \right]_x \left[ \text{---SO}_2\text{---R}^6\text{---} \right]_y \quad (1I)$$

0 &lt; x, y &lt; 100%

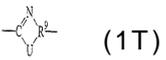
- O - R<sup>6</sup> - CO - R<sup>6</sup> - (1J)- O - R<sup>6</sup> - CO - R<sup>6</sup> - CO - R<sup>6</sup> - (1K)- O - R<sup>6</sup> - CO - R<sup>6</sup> - O - R<sup>6</sup> - CO - R<sup>6</sup> - CO - R<sup>6</sup> (1L)- O - R<sup>6</sup> - O - R<sup>6</sup> - CO - R<sup>6</sup> - (1M)- O - R<sup>6</sup> - O - R<sup>6</sup> - CO - R<sup>6</sup> - CO - R<sup>6</sup> - (1N)
$$\left[ \text{---R---NH---R---NH---} \right]_y \left[ \text{---R---N---} \langle \text{benzene ring} \rangle \text{---N---} \right]_{100\% - y} \quad (1O)$$

0 &lt; y &lt; 100%

- R<sup>6</sup> - (1P)

- R<sup>6</sup> - CH=CH - (1Q)

- CHR<sup>7</sup> - CH<sub>2</sub> - (1R)



2가, C<sub>10</sub>, R<sup>6</sup>, 2가, C<sub>14</sub>, 1,2-, 1,3-, 1,4-, 4,4' - (pyrene), R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, 1가, 2가, 3가, U, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

a) b) 1 ,

d) (6) ,

$\frac{0}{-2-5-04}$  (6)

YLm (7)

L , n 2 , .

8.

7 ,

1) a) ,

2) b) ,

3) d) 가 , .

9.

7 ,

1) a) b) ,

2) d) 가 , .

10.

7 ,

1) a) d) ,

2) b) 가 , .

11.

7 ,

1) a) ,

2) b) d) 가 , .

12.

7 , a), b) d) 가 , .

13.

7 12

, N- (sulfolane) N,N- , N,N-

14.

13

a) (substrate)

b) , 25 / 1000 mbar 가

15.

7 14

a) 1

b) 가

1

16.

7 15

17.

1 6

, 2 , ,

18.

1 6

(nanofiltration), (electrodialysis) (pervaporation), (膜抽出, perstraction), (diffusion dialysis)