

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
23 February 2006 (23.02.2006)

PCT

(10) International Publication Number
WO 2006/019367 A3

(51) International Patent Classification:

C08F 8/36 (2006.01) *C08F 212/08* (2006.01)
B01J 39/20 (2006.01) *C08F 212/36* (2006.01)
C08F 257/02 (2006.01)

(21) International Application Number:

PCT/US2004/021564

(22) International Filing Date: 6 July 2004 (06.07.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/485,166 7 July 2003 (07.07.2003) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

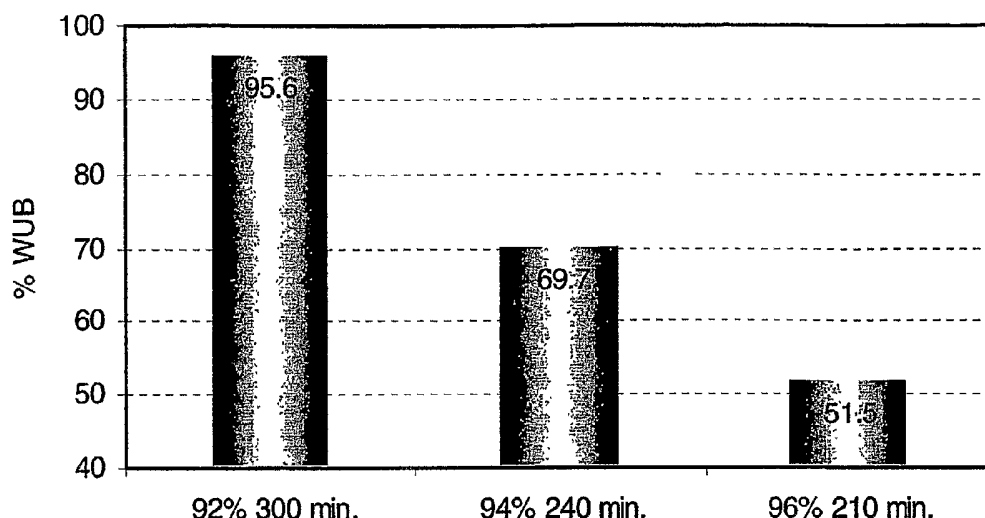
Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report:
8 June 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: IMPROVED SOLVENTLESS SULFONATION OF EXCHANGE RESINS



(57) Abstract: A process for the preparation of styrene-divinylbenzene gel cationic exchange resins by sulfonation in sulfuric acid, without the addition of a swelling agent or acrylic co-monomers, with relatively fast hydration rate. The use of temperature and acid concentration to increase the rate of sulfonation while controlling the side reaction of sulfone bridging minimizes reaction time while maximizing bead quality.

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/021564

A. CLASSIFICATION OF SUBJECT MATTER
C08F8/36 B01J39/20 C08F257/02
//(C08F257/02,C08F212:08,C08F212:36)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C08F B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 270 609 A (ROHM AND HAAS COMPANY) 2 January 2003 (2003-01-02) claims 1-3,7,8,10; examples tables I-II, resins "SAC-2", "SAC-4" and "SAC-4A" page 2, lines 20-23 page 4, line 38 - page 5, line 57 -----	1,3,4,6, 12
X	US 3 238 153 A (HAGGE WALTER ET AL) 1 March 1966 (1966-03-01) cited in the application claims; examples 1,2; table ----- -/--	1,3,4,6, 11,12

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
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- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the international search

3 April 2006

Date of mailing of the international search report

19/04/2006

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INTERNATIONAL SEARCH REPORT

Int. Patent Application No
PCT/US2004/021564

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 228 896 B1 (BACHMANN REINHARD ET AL) 8 May 2001 (2001-05-08) cited in the application claims 1,3-5,7; examples 1,2; tables 1,2 column 1, lines 4-50 column 2, line 42 - column 4, line 12 -----	1,3,4
X	US 2 500 149 A (BOYER RAYMOND F) 14 March 1950 (1950-03-14) cited in the application examples 2,3; tables I,II column 4, lines 32-37 column 5, lines 4-75 -----	1,3,4,6, 12
A	DATABASE CA [Online] CHEMICAL ABSTRACTS SERVICE, COLUMBUS, OHIO, US; 12 May 1984 (1984-05-12), TSUTSURA, KAZUO ET AL: "Cation exchangers" XP002375416 retrieved from STN Database accession no. 86:141282 abstract -& JP 52 017380 A (ASAHI CHEMICAL INDUSTRY CO., LTD., JAPAN) 9 February 1977 (1977-02-09) -----	1,2,5-7
A	"CHROMATOGRAPHIC HYDRATION OF SULFONATED CATION EXCHANGE RESINS" RESEARCH DISCLOSURE, MASON PUBLICATIONS, HAMPSHIRE, GB, no. 361029, 1 May 1994 (1994-05-01), pages 253-254, XP000453967 ISSN: 0374-4353 the whole document -----	1-3,5
A	US 4 157 432 A (BOCK, JAN ET AL) 5 June 1979 (1979-06-05) claims 1,7 column 6, lines 2-10 -----	1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2004/021564

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-4

A process as defined in independent claim 1, i.e. a process for preparation of gel cationic exchange resins by sulfonation of styrene divinylbenzene copolymer gel resin beads comprising reacting sulfuric acid with the beads, without the addition of a chlorine-containing swelling agent, in a mixture of the sulfuric acid and the beads, at a temperature above the glass transition temperature of the copolymer beads.

2. claim: 5

A process as defined in independent claim 5, i.e. a process for preparation of gel cationic exchange resins by sulfonation of gel-like styrene-divinylbenzene copolymer beads comprising reacting sulfuric acid with the beads, without the addition of a chlorine-containing swelling agent, in a mixture of the sulfuric acid and the beads wherein concentrated sulfuric acid is added to the mixture during sulfonation to maintain a concentration of sulfuric acid in the mixture of greater than about 90 percent by weight.

3. claims: 6-16

A process as defined in independent claim 6, i.e. a process for preparation of gel cationic exchange resins by sulfonation of gel-like styrene-divinylbenzene copolymer beads having cross-link density of greater than 5 percent, the process comprising sulfonating the bead copolymers in sulfuric acid, for less than 8 hours at 125 to 160°C, without the addition of a chlorine-containing swelling agent.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US2004/021564

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