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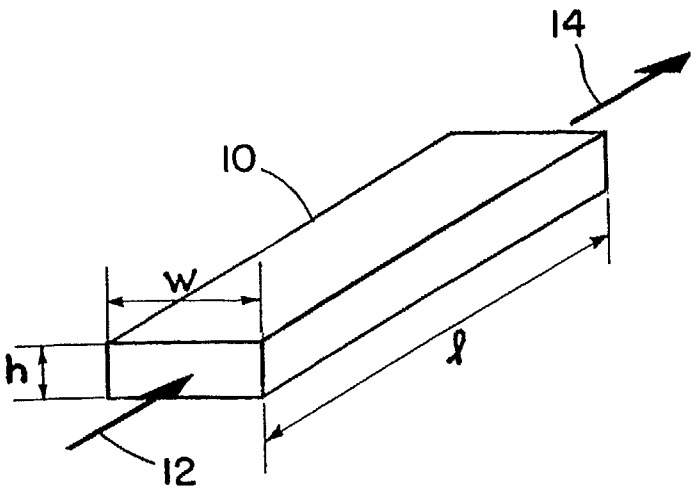
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*[Continued on next page]*

(54) Title: CATALYTIC REACTION PROCESS USING MICROCHANNEL TECHNOLOGY




(57) Abstract: The disclosed technology relates to a process for conducting a chemical reaction between at least one liquid reactant and at least one gaseous reactant in a process microchannel containing at least one catalyst, the catalyst comprising a solid phase catalyst or a homogeneous catalyst immobilized on a solid. In one embodiment, the process microchannel comprises a processing zone containing one or more structures for disrupting fluid flow and a reaction zone containing one or more structures for contacting and/or supporting the catalyst, the one or more structures for contacting and/or supporting the catalyst containing openings to permit the reactants to flow through the one or more structures and contact the catalyst. The process comprises: forming a reactant mixture comprising at least one liquid reactant and the at least one gaseous reactant; flowing the reactant mixture in the processing zone in contact with the one or more structures for disrupting fluid flow to enhance mixing of the liquid reactant and the gaseous reactant; flowing the reactant mixture in openings in the one or more structures for contacting and/or supporting the catalyst in contact with catalyst; and reacting the at least one liquid reactant with the at least one gaseous reactant to form at least one product. In one embodiment, the process relates to a process for conducting a Fischer-Tropsch synthesis in a process microchannel containing at least one Fischer-Tropsch synthesis catalyst, the catalyst comprising a solid phase catalyst or a homogeneous catalyst immobilized on a solid, the process comprising: flowing reactants comprising H2 and CO in the process microchannel, the inlet superficial velocity of the reactants being at least about 0.1 m/s; contacting the Fischer-Tropsch synthesis catalyst with the reactants; and reacting the reactants in the presence of the catalyst to form at least one product.

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Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| P,X | WO 2005/075606 A1 (VELOCYS INC [US]; WANG YONG [US]; TONKOVICH ANNA LEE [US]; MAZANEC TER) 18 August 2005 (2005-08-18) the whole document | 1-217 |
| X | WO 2004/103549 A2 (VELOCYS INC [US]; LONG RICHARD Q [US]; TONKOVICH ANNA LEE [US]; DAYMO) 2 December 2004 (2004-12-02) the whole document | 1-217 |
| X | EP 1 382 382 A (CONOCO PHILLIPS COMPANY [US]) 21 January 2004 (2004-01-21) the whole document | 1,68,98 |
| E | WO 2006/127889 A2 (VELOCYS INC [US]; TONKOVICH ANNA LEE [US]; JAROSCH KAI TOD PAUL [US];) 30 November 2006 (2006-11-30) the whole document | 1-217 |

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☒ See patent family annex.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

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| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 2005075606 A1 | 18-08-2005 | AU 2004315214 A1 | 18-08-2005 |
| | | CA 2552283 A1 | 18-08-2005 |
| | | CN 1906271 A | 31-01-2007 |
| | | EP 1713883 A1 | 25-10-2006 |
| | | US 2006251552 A1 | 09-11-2006 |
| | | US 2005165121 A1 | 28-07-2005 |
| WO 2004103549 A2 | 02-12-2004 | AU 2004241941 A1 | 02-12-2004 |
| | | CA 2525256 A1 | 02-12-2004 |
| | | EP 1628755 A2 | 01-03-2006 |
| EP 1382382 A | 21-01-2004 | AU 2003213550 A1 | 05-02-2004 |
| WO 2006127889 A2 | 30-11-2006 | NONE | |