

The
United
States
of
America



**The Director of the United States
Patent and Trademark Office**

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, or importing into the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

Michelle H. Lee

Deputy Director of the United States Patent and Trademark Office



US008921635B2

(12) **United States Patent**
Ordonskiy et al.(10) **Patent No.:** **US 8,921,635 B2**
(45) **Date of Patent:** **Dec. 30, 2014**

- (54)
- ONE-STEP METHOD FOR BUTADIENE PRODUCTION**
-
- (75) Inventors:
- Vitaly Valerievich Ordonskiy**
- , Moscow (RU);
- Vitaly Leonidovich Sushkevich**
- , Minsk (BY);
- Irina Igorevna Ivanova**
- , Moscow (RU)

2,421,361 A * 5/1947 Toussaint et al. 585/327
2,436,125 A 2/1948 Spence et al.
2,438,464 A * 3/1948 Spence et al. 585/607
2,477,181 A 7/1949 Holman
2,548,883 A 4/1951 Harlow

- (73) Assignee:
- Obshchestvo S Ogranichennoy Otvetstvennostju "Unisit"**
- , Moscow (RU)

FOREIGN PATENT DOCUMENTS

FR 925617 9/1947
GB 573631 11/1945
JP 57102822 6/1982
JP 58059928 4/1983
SU 68428 1/1947

- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

- (21) Appl. No.:
- 13/812,310**
-
- (22) PCT Filed:
- Jul. 27, 2011**
-
- (86) PCT No.:
- PCT/RU2011/000565**
-
- § 371 (c)(1),
-
- (2), (4) Date:
- Jan. 25, 2013**

OTHER PUBLICATIONS

Ohnishi, Ryuichiro, Takao Akimoto, and Kozo Tanabe. "Pronounced Catalytic Activity and Selectivity of MgO-SiO₂-Na₂O for Synthesis of Buta-1,3-diene from Ethanol." *Journal of the Chemical Society, Chemical Communications* 22 (1985): 1613.*
Corson, B. B., H. E. Jones, C. E. Welling, J. A. Hinckley, and E. E. Stahly. "Butadiene from ethyl alcohol." *Industrial and Engineering Chemistry* 42 (1950): 359.*
Sheng, P.-Y., G.A. Bowmaker, and H. Idriss. "The Reactions of Ethanol over Au/CeO₂." *Applied Catalysis A: General* 261.2 (2004): 171-81.*
Athina Nickitas-Etienne, International Preliminary Report on Patentability in PCT/RU2011/000565, Jan. 29, 2013, 5 pages, The International Bureau of WIPO, Geneva, Switzerland.
Paul O'Sullivan, International Search Report in PCT/RU2011/000565, Dec. 2, 2011, 2 pages, European Patent Office, Rijswijk, Netherlands.
Paul O'Sullivan, Written Opinion in PCT/RU2011/000565, Jan. 29, 2013, 4 pages, European Patent Office, Rijswijk, Netherlands.

- (87) PCT Pub. No.:
- WO2012/015340**
-
- PCT Pub. Date:
- Feb. 2, 2012**

- (65)
- Prior Publication Data**
-
- US 2013/0123554 A1 May 16, 2013

- (30)
- Foreign Application Priority Data**
-
- Jul. 29, 2010 (RU) 2010131711

- (51)
- Int. Cl.**
-
- C07C 1/20**
- (2006.01)
-
- C07C 11/16**
- (2006.01)
-
- C07C 1/207**
- (2006.01)
-
- (52)
- U.S. Cl.**
-
- CPC
- C07C 1/20**
- (2013.01);
- C07C 2523/64**
- (2013.01);
- C07C 2523/52**
- (2013.01);
- C07C 2523/50**
- (2013.01);
- C07C 2523/72**
- (2013.01);
- C07C 2523/644**
- (2013.01);
- C07C 2523/63**
- (2013.01);
- C07C 11/16**
- (2013.01);
- C07C 1/2072**
- (2013.01);
- C07C 1/207**
- (2013.01)
-
- USPC
- 585/609**
- ; 585/607

- (58)
- Field of Classification Search**
-
- CPC
- C07C 1/2072-1/2076**
- ;
- C07C 11/16**
- ;
- C07C 1/207**
-
- USPC 585/607, 609
-
- See application file for complete search history.

- (56)
- References Cited**
-
- U.S. PATENT DOCUMENTS**

2,357,855 A 9/1944 Szukiewicz
2,374,433 A 4/1945 Ipatieff
2,403,743 A * 7/1946 Hitcheock et al. 585/607

* cited by examiner

Primary Examiner — In Suk Bullock
Assistant Examiner — Eric McCullough
(74) *Attorney, Agent, or Firm* — Florek & Endres PLLC(57) **ABSTRACT**

This invention relates to gas-phase synthesis of butadiene from ethanol or ethanol and acetaldehyde mixture. The method of synthesis includes ethanol or ethanol and acetaldehyde mixture conversion in the presence of a catalyst, which differs from the known methods by the carrying out of the interaction in the presence of the solid catalyst, which contains metal, chosen from the group of silver, gold or copper, and metal oxide, chosen from the group of magnesium, titanium, zirconium, tantalum or niobium oxides. The method announced is used for condensation process under the conditions of continuous flow fixed bed reactor. The invention allows to reach high yield and selectivity to butadiene and high level of conversion of the feed.

16 Claims, No Drawings