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(54) **CATALYST COMPOSITIONS FOR CONVERTING SYNGAS TO PRODUCE HIGHER ALCOHOLS**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

3,787,332	A	1/1974	Sugier
4,126,581	A	11/1978	Sugier et al.
4,257,920	A	3/1981	Sugier et al.
4,346,179	A	8/1982	Sugier et al.
4,590,314	A	5/1986	Kinkade
4,593,015	A	6/1986	Hardman et al.
4,607,055	A	8/1986	Grazioso et al.
4,609,678	A	9/1986	Hardman et al.
4,661,525	A	4/1987	Grazioso et al.
4,675,344	A	6/1987	Conway et al.
4,725,625	A	2/1988	Simon
4,749,724	A	6/1988	Quarderer et al.
4,751,248	A	6/1988	Lin et al.
4,752,622	A	6/1988	Stevens
4,752,623	A	6/1988	Stevens et al.
4,825,013	A	4/1989	Quarderer et al.
4,883,533	A	11/1989	Kosin et al.
5,627,295	A	5/1997	Sofianos et al.
5,851,382	A	12/1998	Sudhakar
6,927,048	B2	8/2005	Verser et al.
7,196,122	B2	3/2007	Ryoo et al.
7,314,960	B1	1/2008	Lin et al.
7,449,425	B2	11/2008	Wang et al.
7,569,318	B2	8/2009	Michel et al.
7,658,776	B1	2/2010	Pearson
7,682,812	B2	3/2010	Verser et al.
7,700,810	B2	4/2010	Kourtakis et al.
7,700,811	B2	4/2010	Kourtakis et al.
7,700,813	B2	4/2010	Kourtakis et al.
7,705,192	B2	4/2010	Kourtakis et al.
7,717,971	B2	5/2010	Aasberg-Petersen et al.
7,718,832	B1	5/2010	Hurley et al.
2007/0004588	A1	1/2007	Wang et al.
2010/0075837	A1	3/2010	Meitzner et al.
2010/0280287	A1	11/2010	Kharas et al.

FOREIGN PATENT DOCUMENTS

CN	101020139	A	8/2007
EP	0119609	A1	9/1984
EP	0149256	A2	7/1985
EP	0172431		2/1986
WO	WO-2007/127479	A2	11/2007

OTHER PUBLICATIONS

Abdel-Rahman, International Journal of Energy Research, 1997, vol. 21, Issue 1, p. 31-40.
Bang-Quan, Atmospheric Environment, 2003, vol. 37, p. 4965-4971.
Bao, Topics in Catalysis, 2009, vol. 52, p. 789-794.
Bezemer, Chemical Communications, 2005, p. 731-733.
Cavani, Catalysis Today, 1991, vol. 11, Issue 2, p. 173-301.
Christensen, Applied Catalysis A: General, 2009, vol. 366, Issue 1, p. 29-43.
Cortes-Jacome, Catalysis Today, 2008, vol. 130, p. 56-62.
Danilov, Chemistry and Technology of Fuels and Oils, 2001, vol. 37, Issue 6, p. 444-455.
Fan, Catalysis Today, 2009, vol. 147, p. 86-93.
Fang, Catalysis Today, 2009, vol. 147, Issue 2, 133-138.
Forzatti, Catalysis Reviews: Science and Engineering, 1991, vol. 33, Issue 1&2, p. 109-168.
Gomez-Hortigu, Journal of the American Chemical Society, 2009, vol. 131, p. 16509-16524.
Haider, Journal of Catalysis, 2009, vol. 261, Issue 1, p. 9-16.
Herman, Catalysis Today, 2000, vol. 55, Issue 3, p. 233-245.
Iranmahboob, Applied Catalysis A: General, 2002, vol. 231, p. 99-108.

(Continued)

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(57) **ABSTRACT**

Catalyst compositions for production of higher alcohols comprise a hydrotalcite or hydrotalcite-like support impregnated with molybdenum and an alkali metal. When the compositions are used to convert syngas, selectivity to higher (C2+) alcohols is increased in comparison to conversions accomplished over many other catalyst systems.

7 Claims, No Drawings