Contents lists available at ScienceDirect

journal homepage: www.keaipublishing.com/en/journals/petroleum-science

College of Chemistry and Chemical Engineering, Taiyuan University of Technology, Taiyuan, 030024, Shanxi, China
School of Pharmacy, Changzhi Medical College, Changzhi, 046000, Shanxi, China

ARTICLE INFO

Article history:

Keywords:

ABSTRACT

E-mail addresses:

2. Experimental section

2.1. Materials

2.2. Catalyst preparation

t/ -5 t t t t

t t tC 6

(0) t t -5- -x

-5- -x( ) t t t t t t

t t 30 °C t t t

t t t t 70 °C 8

t t 350 °C t -

t t t / (0

) t 350 °C t t t

t/ -5- -x t/ -5- -x t t t

t/γ- 3 t/ t/ -5- t/

t/ β t t t

t t t 0 t t

2.3. Characterization

t t -6000 -

t t ( ) t

t t - 800 t ( )

t - t t t

00 t (t) -

t ( ) t 0

( ) t t - t -

t (- C) C

9 3 t t - t t t ( ) t-

t t

C 50 t t t t -

t / (3- / - / -C -

t) -9 7

t ( ) t

C 00 t t ( )

6- t t- t ( ) t t

t - t

t C 6300 ( )

t t t t (C -

) t t t t

2.4. Catalytic reaction tests

t 00 -

t (-C t t C t) t

t t t t t t 700 t t t

t t (t t)

t 0 05 t t (>300) 0 0 -

t 0 t t t

t t t t t t t

t t t t t t

t t t t t t

t t t t t t

t t t t t

t t t 78 0

t t -5

(30 × 0 5 × 0 5 μ)

2.5. Computations

t t t t ( ) t

t t

3. Results and discussion

3.1. Physicochemical properties of HZSM-5-F-x and HZSM-5-E-x

-5 -5- -x -5- -x

t t t t

t

( ) t tt -5- -x -

5- -x t t t t t

(C -00) t $\theta = 7\,9° \; 8\,8° \; 3° \; 3\,8°$ °

(t 0 9) t -5- -x t t t

t t t -5- -x

t t t -5- -x

-5- -x 3– t t

3– -5- -x -5- -x t

t t t

t t -5 t t

3– 99

t - t t ( ) 5

t t t t -5 t

t t p/p_0 < 0 0 t t

t t t - t t t -

t t 0 8–0 95 t

t t -5- -x

t -5- -x t t t t t

t - t t t - -

t (C t 0 7 t 0 7 t 0 3)

t t t t t t t

t t

-5- -x -5- -x

t t t C t t t t

/ t -5- -x -5- -x

7 (( ) 6) t t t t

-5 t t t

t 5 t t 0

t t t t t -

t t t t -

t t t t ( ) t t t t

t -5- -x -5- -x t t

t t t t ( )

t t 5 (5 t 65)

t -5- -x -5- -x

t t t 5 5 56 58

t (( )–( ) 6) t t

t t 5

t t t t t t t t t

t t 56 t t

t t) t3 ( )03(59((t 9

09(5 _ 9 0 (3_ 9 9 9 9 9

Table 2
t -5- -x -5- -x

	t 3- μ /	
t		t
-5- -50	85	67 7 7 7
-5- -50	8 0	6 5 8 5
-5- -80	53 8	5 6 0
-5- -80	0 3	9 6 90 7
-5- - 50	33	0 7 5
-5- - 50	5 5	8 5 07 0

t t t t t
t 0–300 °C 300–550 °C t

Table 3
t t

	t - μ /	t - μ /
t	t ¨ t	t z t
-5- -50	87 5 80 59 5	9 5
-5- -50	80 8 5 9 5 9	0

t z t t t - t
t 50 °C
t t z t t - t
t 50 °C

t t (3) t t -
t -5 (0 56) t t t
t t t -5
t t t z t
t t t (´ - t 0)
t t t t t
t t -5 t -
t t -5- -50 -5- -50 t
t - t 3 t
z t t t t t -
5- -50 t t t -5- -50
t t t t t t t
t t t t t t
t (99) t
t - t t
t t t -
t t t t
t t t t t t
t ( ) (t
98 t 00) t t t t -
t t t t -5 t t
t t t t t t t t
– + t – t t t -
t t t + t t t t t
t – + + t – t
t t - t t t t + t
t t
(t 0 ˇ ˇ t 0 9)

3.2. Physicochemical properties of HZSM-5-F-x or HZSM-5-E-x supported Pt catalysts

tt ( ) t t t t
t/ -5 t t (t/ -5- -x t/ -5- -x)
t t t t t
t t t t t t
t t tt t t t -
t t t t t t (t 0 9) t t/ -5 t t t
t t t t t
(3) t t -
t (( ) 5) t t t t/ -
5- -x t/ -5- -x t t t t t t t
t t t t t t t
t/ -5- -x t/ -
5- -x t -5- -x -5- -x
t t t t t t t
t t t t t t t -
t t t/ -5- -50 t/ -5- -50
( ) t t t/ -5- -50 t/ -5-
-50 t 3 t
t t t t t t ( ) t t
t t -5 t t t
t t/ -5- -50 t/ -5- -50 t t
t t t -5 t
t t t/ -5- -50 t/ -5- -50
t t ( ) t t t 5/
t t t t t t 7/
t t t t t t t t t t -
( ) t t t 7/ t/
-5- -50 t/ -5- -50 t 7 7
t t 7 0 (t0) t
t t t - t t t t
t/ -5 t t tt t t t t
t t t -5 t t t t t
t t t t t (t 006)
t t/ -5- -50 t t 7/
t/ -5- -50 t t (.
0) t t t t t t t
t t t t/ -5- -50 (t 0)
- t/ -5- -50 t/ -5- -50
t t ( ) ( ) t t/ -
5- -50 t/ -5- -50 t t t t t
t t t t t
tt t t t t t t
t t t t t t
t t t t t t t
t t t t (t
993) t t/ -5- -50 t t -
t t t/ -5- -50 t t t
t/ -5- -50 t t t t/
-5- -50 tt t t t
t t t t t
t t t t t t t t
(0 t 0)

3.3. Catalytic performances

t t ( ) t -
t t t 9 0- t
( ) 3 -t t t ( ) -
t t (t t t -
t (/ -) t
( )) (t 0 5 0 9)

t t t t -
t 5 5 t t
t t t t -
-5- -x -5- -x (t –3).
t t t t t t t t/ -5- -x
t/ -5- -x t t t t t
t t t t t t t
t t t/ -5- -x
t t t/ -5- -x t
t t 0 (t –9) t t

Table 5

C . t t t t t . t

t		t t	C	t t				
						. -	. -	
		0	–					
	-5- -*x*	0	–					
3	-5- -*x*	0	–					
	t/ -5- -50	0	70 6	5 7	6 8	5 9	5 6	–
5	t/ -5- -50	0	7 8	59 6	3 9			

3.4. Discussion on the different hydrogenation performance of Pt/HZSM-5-F-50 and Pt/HZSM-5-E-50

t - t t t t t (t 0 0 t 0) t t t (- t) t t/ -5 t t t t t C t t/ -5- - 50 t/ -5- -50 t t t t t t t t t t - t t t t t t t/ -5- -50 t/ -5- -50 t t t/ -5- -50 t/ -5- -

50 t - t / C t t 3- t t t t t t t t -5 t -5 (0) t/ -5- -50 t/ -5- -50 t t t t t t t t t t t t t t t t t t/ -5 t t t t t t t t t t t t t t/ - 5- -50 t/ -5- -50 t t t t t t t t t ( ) t t t/ -5 t t t t t t t t t t t t t t t

t t t t t t t t t t t t t t t - t t t t t t t t t t t t t t t t t t t t t t t t/ -5 t t -5 t t (0 70) t t -5 (0 56) t t t t t t -5 (( )) t t t t t t t t t t t t t t t -5- -*x* -5- -*x* t t t t t t - t t t/ -5- -*x* t/ -5- -*x* t t - t t t t t t -5 t -5- - 50- t t t -5- - 50 t t t t t t t (t 0 6 t 0) t t t t - t 3- - C - 5- - 50- t t t -5- - 50- t t t t (3 5) t t t t -5- - 50 t - t t t t t / t t t t t t t t t t - (3 5) ( )–( ) t t t t

3.5. Reusability and parameter optimization for the conversion of PHE over Pt/HZSM-5-F-50