

Supporting information

Side-chain alkylation of toluene with methanol over cesium ion-
exchanged zeolites LSX and X catalysts

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Table S1 The physicochemical characteristics and catalytic activities of different catalysts.

Table S2 GC-MS analysis of the soluble coke on used CsX catalyst

Synthesis of LSX

LSX zeolite was synthesized with the following steps. First, 18.33 g sodium hydroxide (96 wt.%) and 21.78 g potassium hydroxide (85 wt.%) were added into 54.98 g deionized water, stirred until dissolved; Second, a sodium aluminate solution was prepared by adding 24.87 g sodium aluminate (41 wt.% Al₂O₃, 30 wt.% Na₂O) into 30 g deionized water under agitation for 1 h. Then a sodium aluminate alkaline solution was obtained by mixing the alkaline solution with sodium aluminate solution thoroughly. Third, 66.09 g sodium silicate (20 wt.% Na₂O, 20 wt.% SiO₂) dissolved in 70 g deionized water. The sodium aluminate alkaline mixture solution was dropped into the sodium silicate solution and mixed thoroughly. The system was treated at 343 K for 3 h, then heated up to 363 K rapidly and stood for 2 h under autogenous pressure. Finally, the LSX zeolite was obtained after filtrating, washing, drying, and calcining in the air at 773 K for 4 h.

Table S1 The physicochemical characteristics of different catalysts.

Samples	S _{BET} (m ² ·g ⁻¹) ^a	V _{micro} (cm ³ ·g ⁻¹) ^b	V _{meso} (cm ³ ·g ⁻¹) ^b	CsED (%) ^c	Si/Al ^c
LSX	505	0.18	0.03	-	1.01
CsLSX	231	0.08	0.14	65.4	1.07
NaX	487	0.22	0.15	-	1.27
CsX	387	0.14	0.12	62.8	1.29

^aCalculated using the BET method.

^bDetermined using the *t*-plot method.

^cObtained from ICP-AES results.

^ccesium ion exchange degrees(CsED)was calculated by
$$CsED(\%) = \frac{W_{Na,i} - W_{Na,t}}{W_{Na,i}} \times 100$$
, where

$W_{Na,i}$ and $W_{Na,t}$ were the mass percentage of Na in the initial LSX or NaX and treated zeolites,

respectively.

Table S2 GC-MS analysis of the soluble coke on used CsX catalyst

Monocyclic aromatic compound	Polycyclic aromatic compound	
tetramethylbenzene	pyrene	1,2-dipropylbenzenealkanes
Trimethyl isopropyl benzene	1-hydroxy-1H-indene	3,4-diisopropylbiphenyl
4-Ethyl-o-xylene	1-Naphthalenyl	Diisopropyl dimethyl biphenyl
diisopropyl phenol	fluoranthene	-