Upgrading of Napier grass pyrolytic oil using microporous and hierarchical mesoporous zeolites: products distribution, composition and reaction pathways

MOHAMMED, Isah Yakub, ABAKR, Yousif Abdalla, YUSUP, Suzana, ALABA, Peter Adeniyi, MORRIS, Kenobi Isima, SANI, Yahaya Muhammad and KABIR, Feroz Kabir <http://orcid.org/0000-0002-3121-9086>

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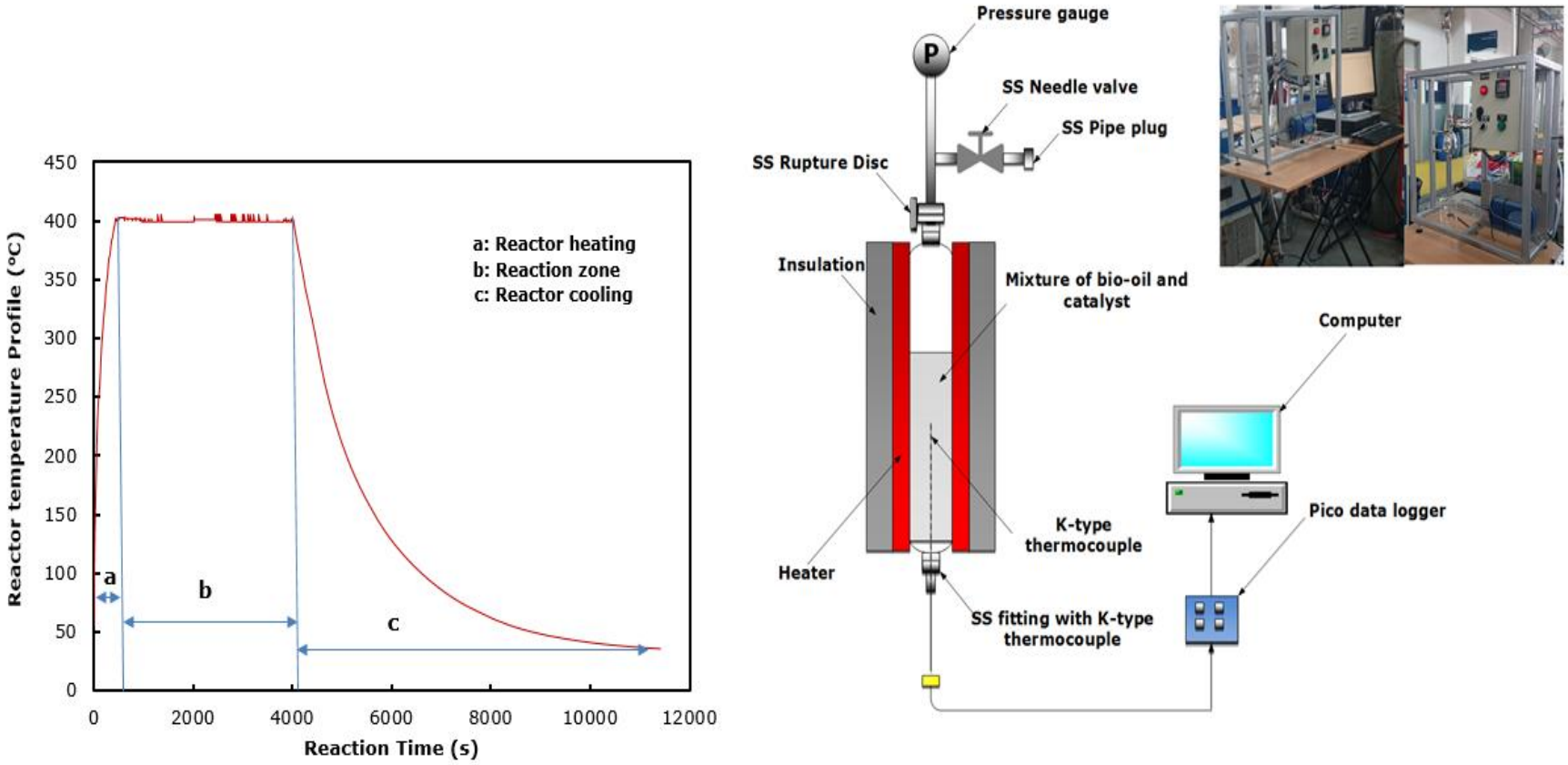
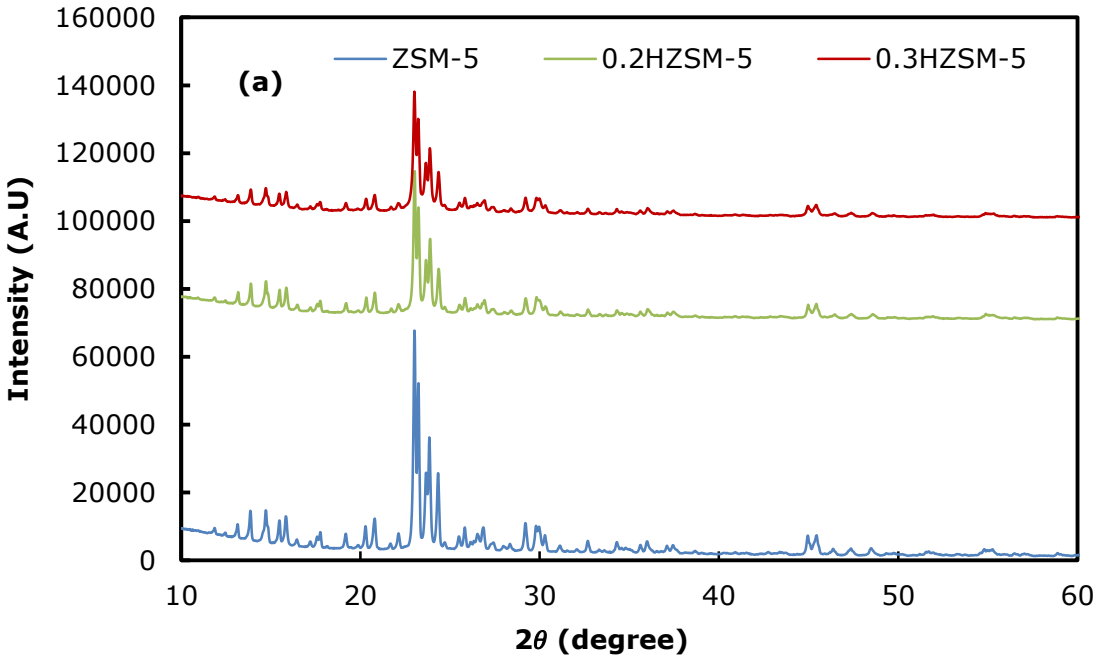
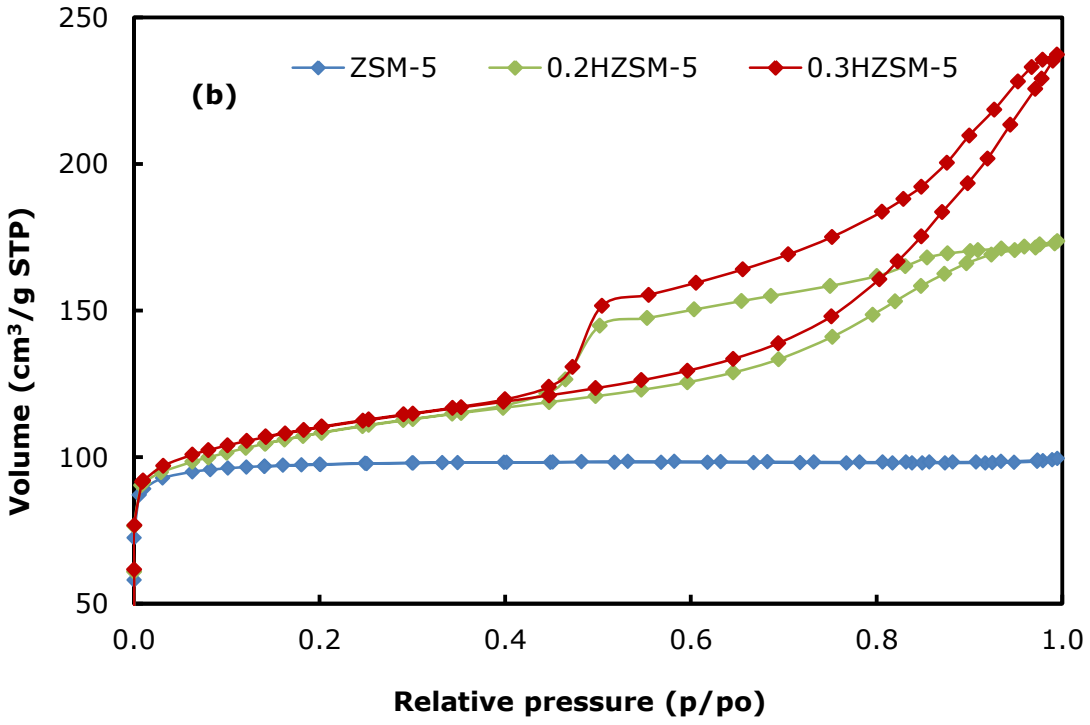
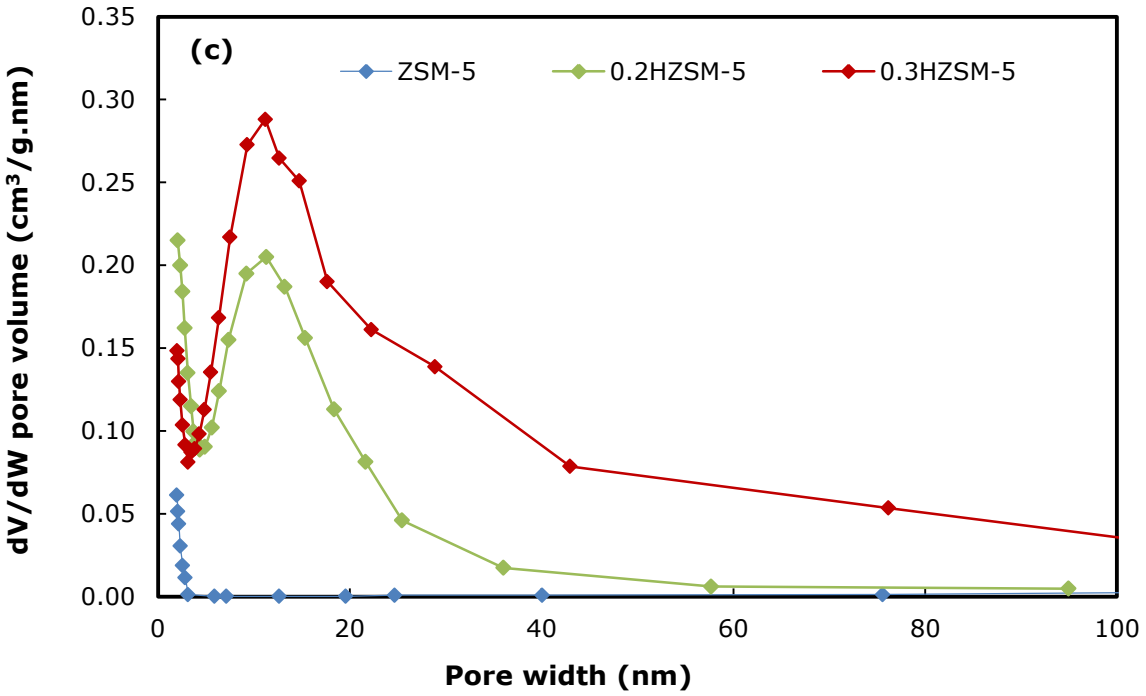


Figure 1: Schematic diagram of experimental set-up of pyrolytic oil deoxygenation


(a)
ZSM-5
0.2HZSM-5
0.3HZSM-5
Intensity (A.U)
160000
140000
120000
100000
80000
60000
40000
20000
0
10
20
30
40
50
60
2θ (degree)


(b)
ZSM-5
0.2HZSM-5
0.3HZSM-5
Volume (cm³/g STP)
250
200
150
100
50
0.0
0.2
0.4
0.6
0.8
1.0
Relative pressure (p/po)



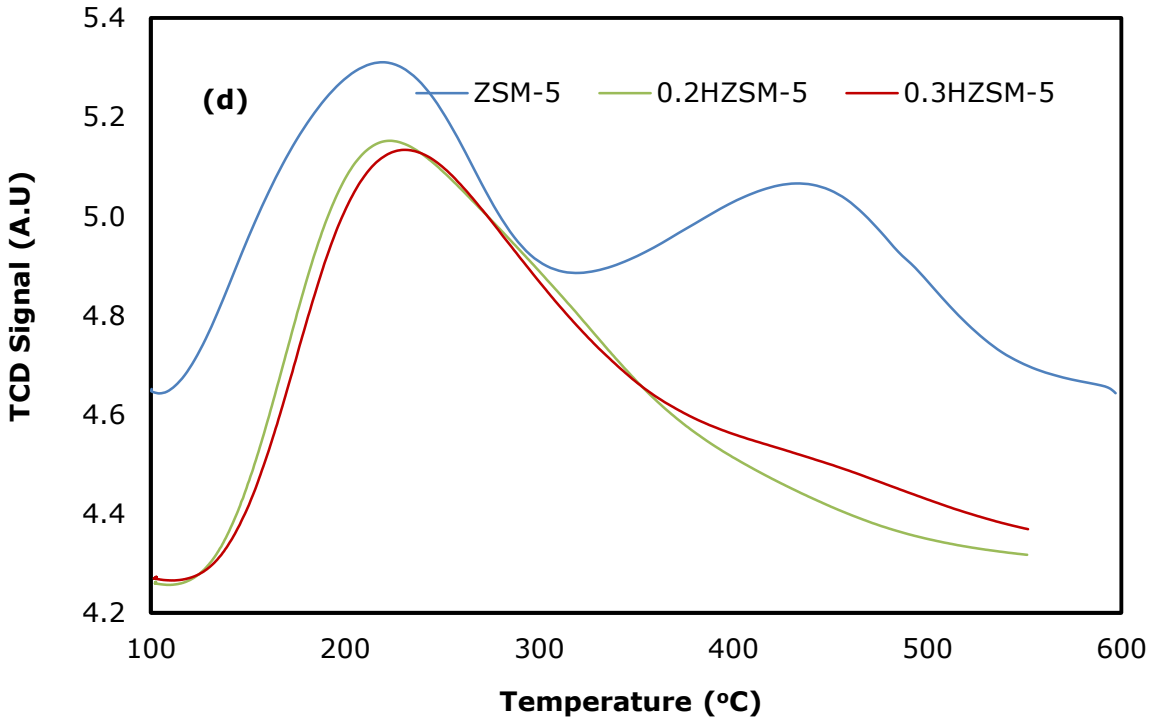


Figure 2: Characteristics of ZSM-5 and Modified ZSM-5. (a) XRD diffractogram, (b) Isotherms of N_2 adsorption/desorption, (c) BJH Pore size distribution (d) NH_3-TPD temperature-programmed desorption curves analysis

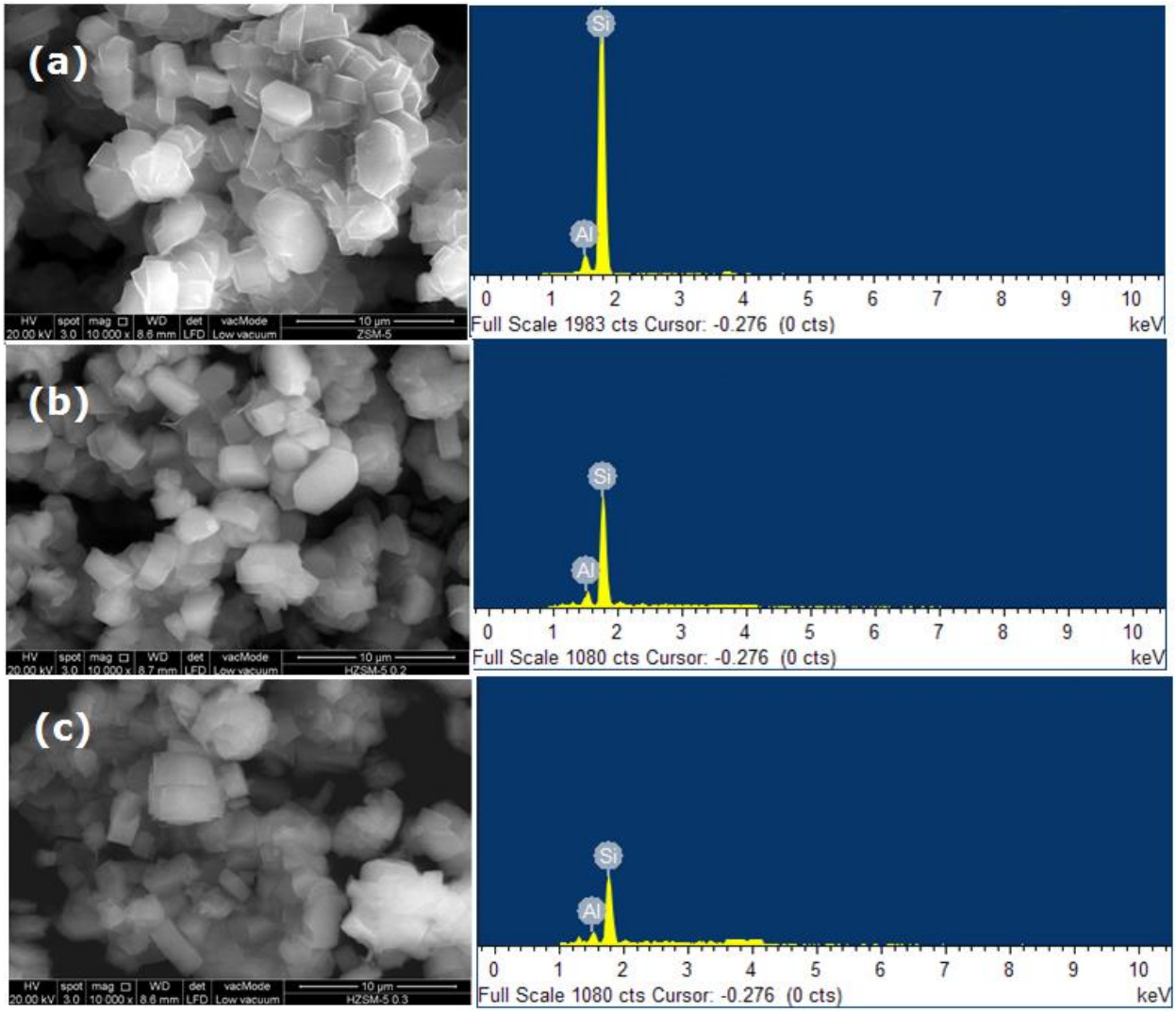


Figure 3: SEM-EDX images of (a) ZSM-5, (b) 0.2HZSM-5 and (c) 0.3HZSM-5

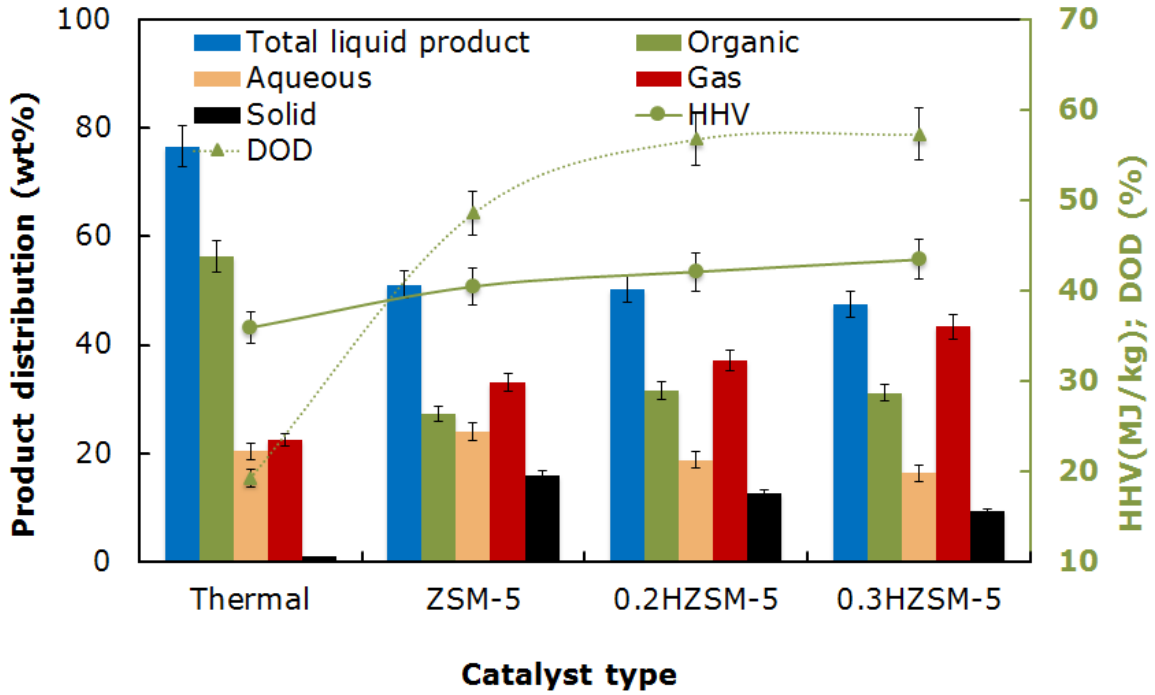


Figure 4: Effect of catalyst on deoxygenation of bio-oil at 400°C. Feed: 30 g pyrolytic oil, catalyst loading: 2.0 wt%. Solid: char and tar. Values are the means (n =3)

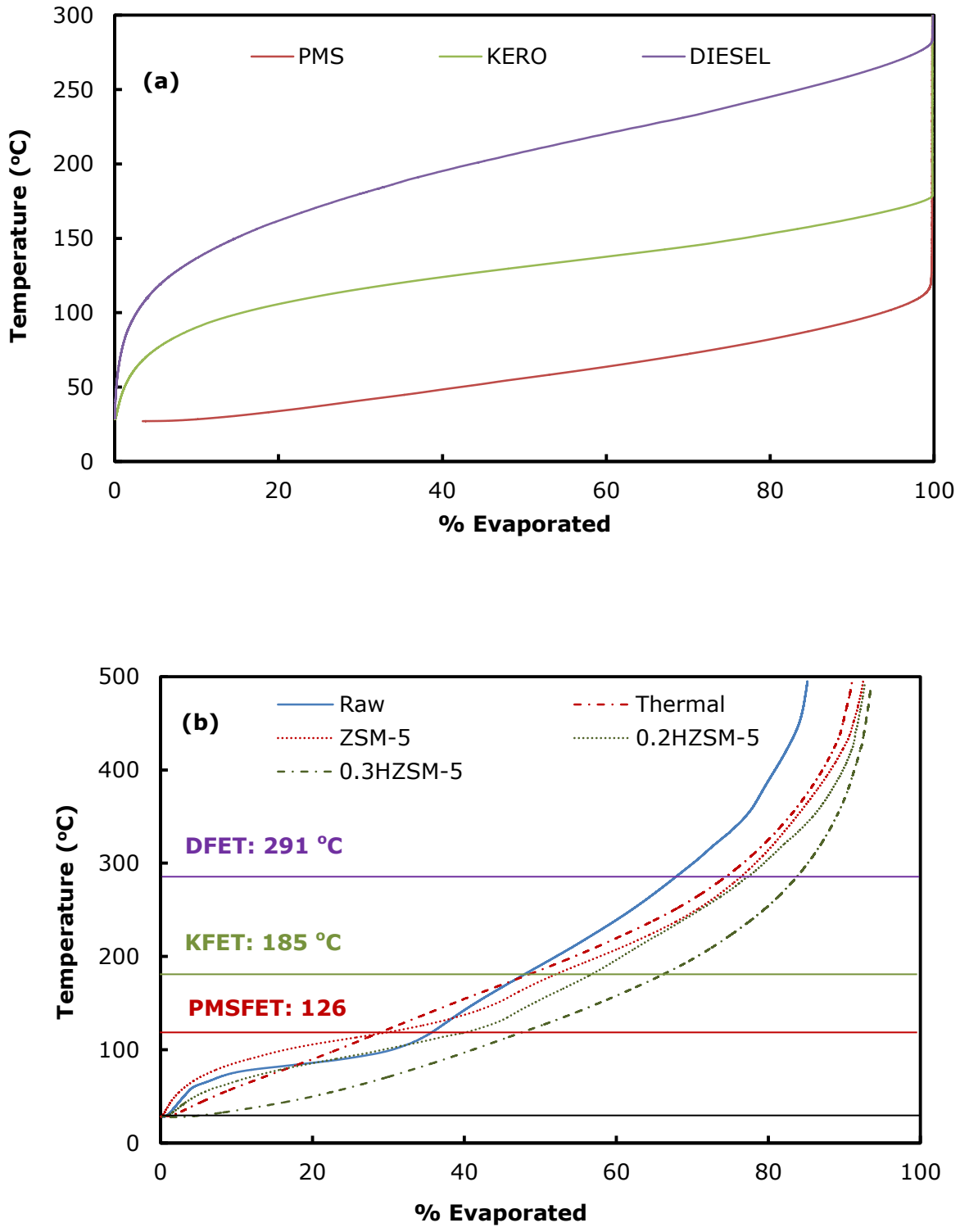


Figure 5: Simulated distillation using TGA. (a) Premium motor sprit-PMS, kerosene and diesel (b) Raw and upgraded organic phase pyrolytic oil. DFET, KFET and PMSFET: diesel, kerosene and PMS final evaporation temperature.

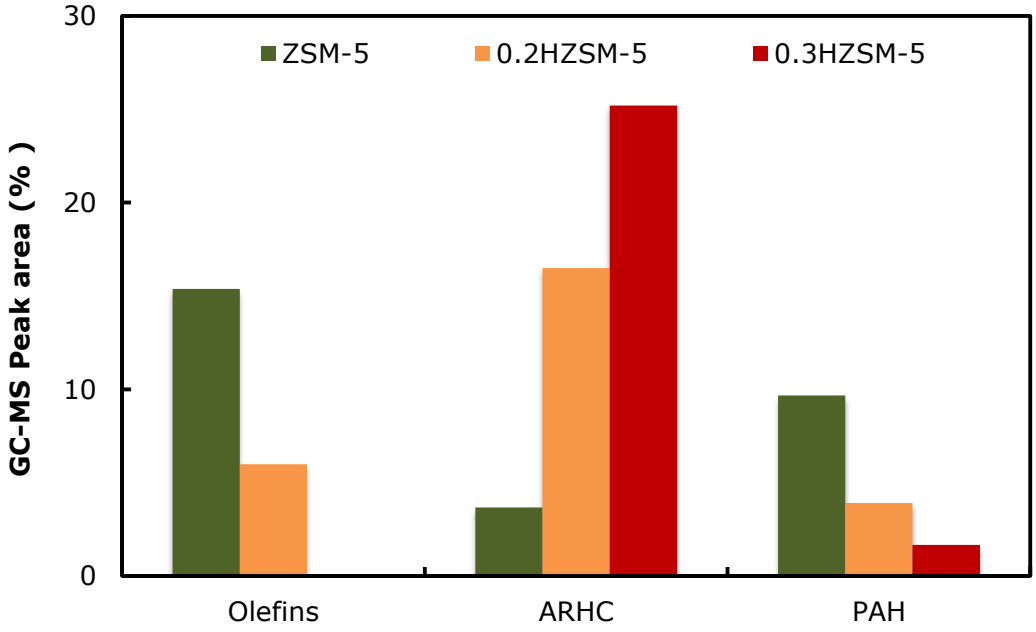


Figure 6: Selectivity of olefins and aromatic hydrocarbons

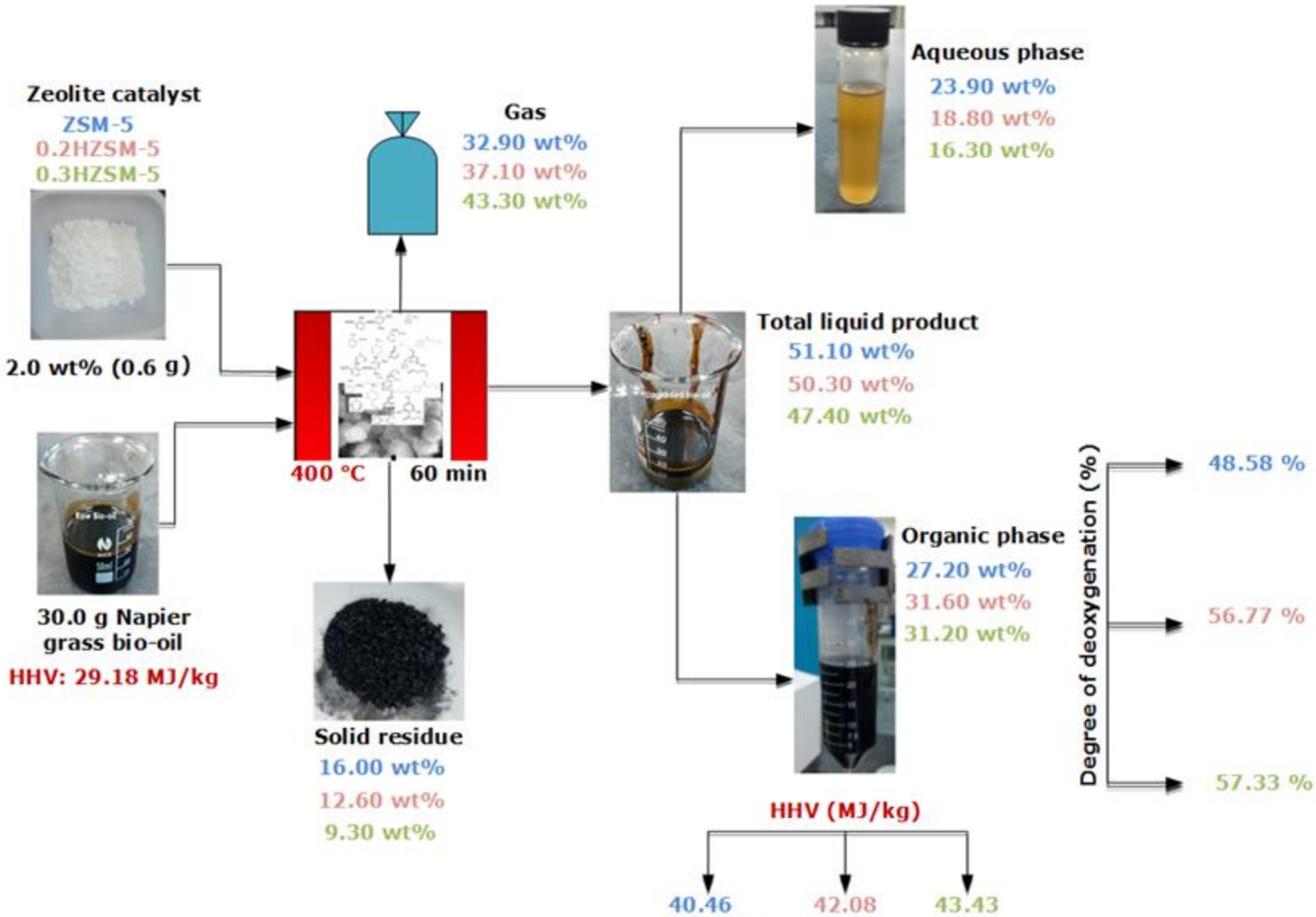


Figure 7: Summary of material, heating value and degree of deoxygenation

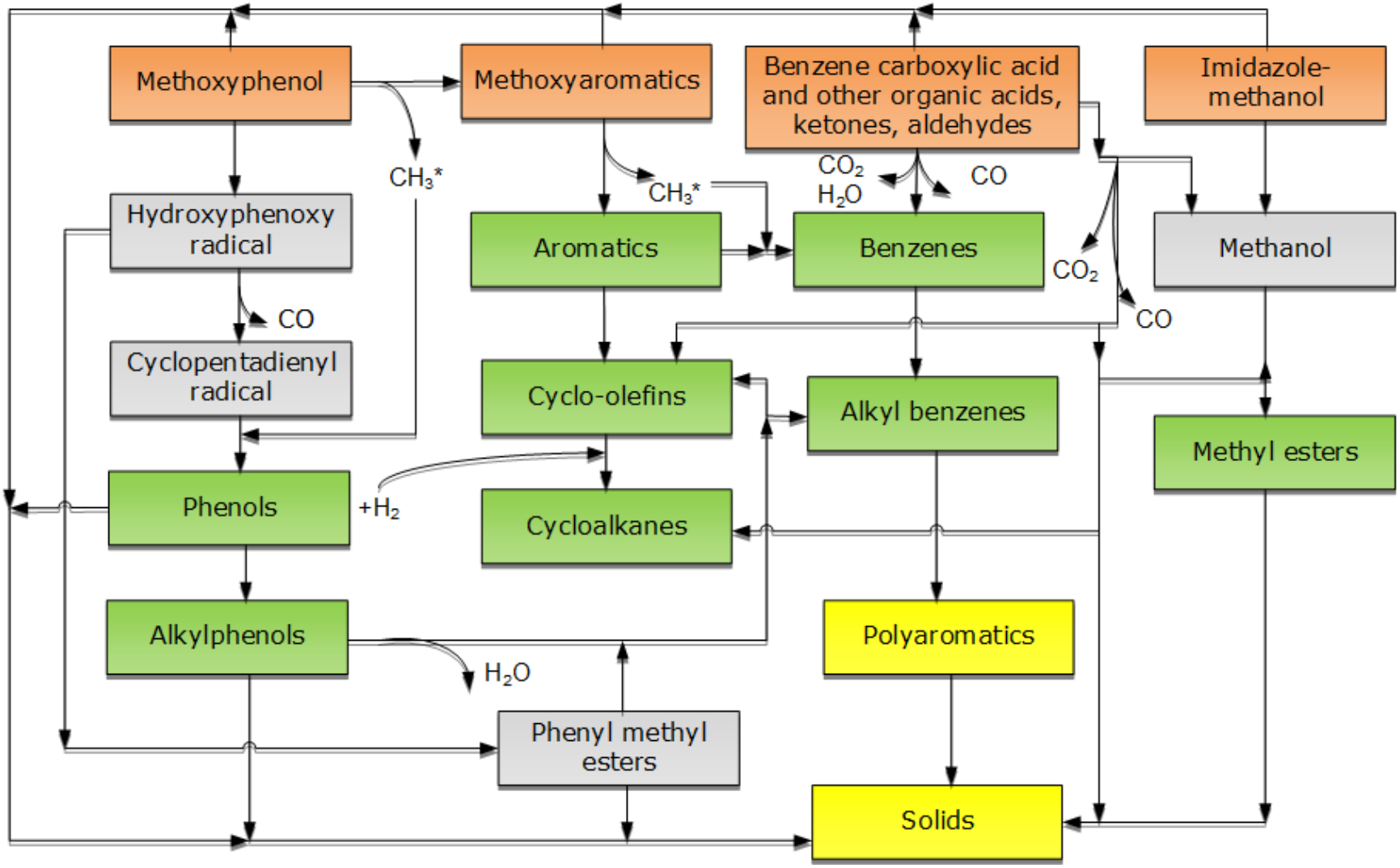


Figure 8: Possible reaction pathways of thermal and catalytic ex-situ upgrading of pyrolytic oil. Component in the raw pyrolytic oil, intermediate products, desired products, undesired products

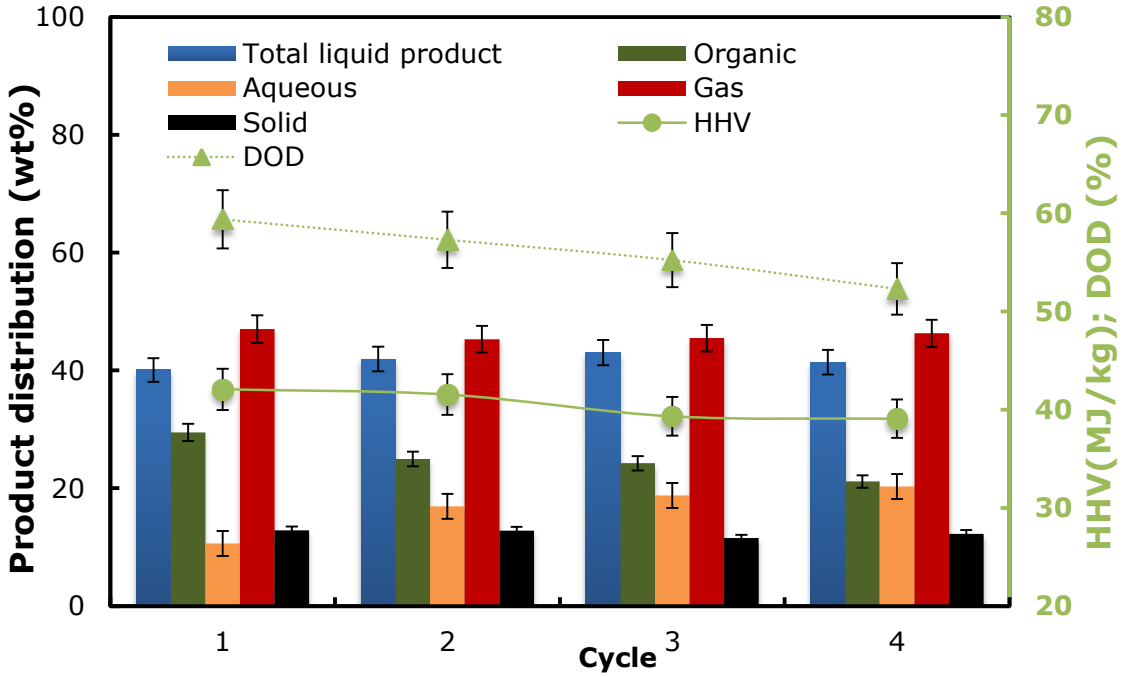


Figure 9: Reusability of 0.3HZSM-5 on deoxygenation of pyrolytic oil at 400 °C. Catalyst loading (catalyst/pyrolytic oil): 4.0 wt%

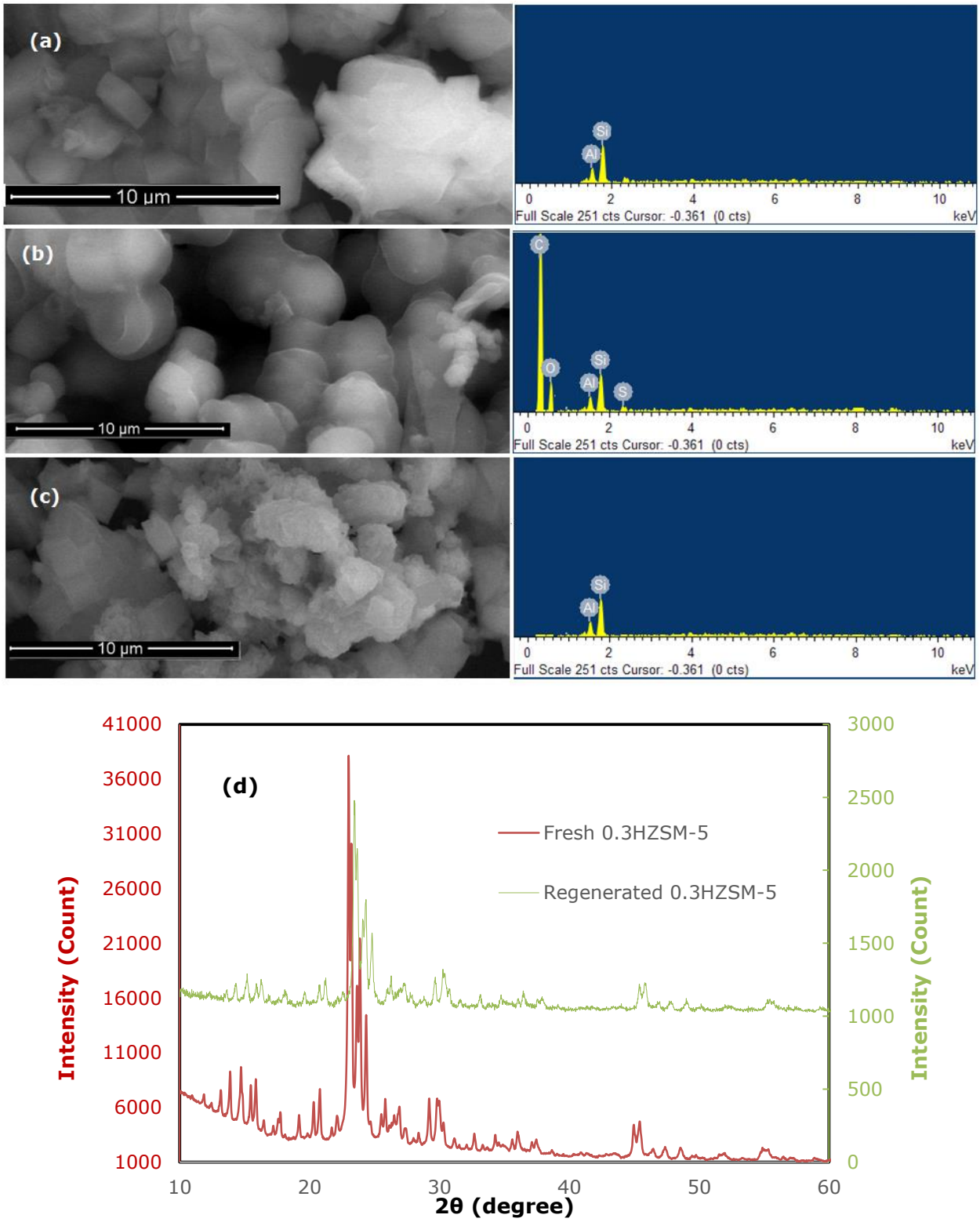


Figure 10: Characteristics of 0.3HZSM-5 catalyst. SEM-EDX (a) fresh catalyst, (b) spent catalyst, (c) regenerated catalyst after 4 cycle, (d) diffractogram of fresh and regenerated sample.