Analysis and characterisation of crude oil from the Kurdistan Region of Iraq

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The quality of crude oil is affected by post accumulation alteration processes. The oil composition changes due to in-reservoir cracking, thermochemical sulphate reduction, gas de-asphalting, gravity segregation, phase separation, water washing and biodegradation. There are two main types of crude oil: Light crude oil and Heavy crude oil.
The aims of this project are to assess the quality of crude oil samples from Kurdistan in terms of TAN, wax and aromatic content and to determine to which extent these important parameters can be predicted using IR and/or NMR spectroscopy combined with PCA/PLS methods.
Composition of crude oil

1- Total acid number: Acids in crude oil have harmful effects on refinery and transporting pipelines. They cause corrosion and therefore the acidity of crude oil has been limited and should be below 0.5mg KOH/g crude oil. 

2- Wax: Crude oil naturally consists of n-paraffins (n-alkanes) in a low percentage range (10-20%). Wax can separate when the temperature of petroleum goes below the wax`s freezing temperature. This causes a severe problem in the refinery fields because of the wax`s precipitation in the pipelines. The standard range of wax in crude oil is estimated to be 0-30% .

3- Aromatics: Crude oil samples are very rich in aromatic compounds such as mono-aromatics, di-aromatics, tri-aromatics and so on. Crude oil with a high proportion of aromatic content is more expensive than that with a low percentage of aromatics. The most common aromatic contents of crude oil are benzene, styrene (polystyrene), phenols, cyclohexane and xylene .
Composition of crude oil

Wax

The effect of Acids
Analytical techniques

- According to ASTM method D664-09, the TAN was determined, a manual titration method with a potentiometer was used.
- Solvent extraction was used for crmination wax%.
- For determining the aromatic% $^1$H NMR was used.
- PCA & PLS were used to predict the parameters above based on spectra.
## Results

<table>
<thead>
<tr>
<th></th>
<th>Kurdistan</th>
<th>North America</th>
<th>South America</th>
<th>Saudi Arabia</th>
<th>Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of samples</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>A%</td>
<td>35.16</td>
<td>16.54</td>
<td>41.54</td>
<td>38.50</td>
<td>18.21</td>
</tr>
<tr>
<td>Wax%</td>
<td>13.49</td>
<td>8.98</td>
<td>23.76</td>
<td>15.01</td>
<td>8.84</td>
</tr>
<tr>
<td>TAN</td>
<td>0.18</td>
<td>0.33</td>
<td>1.52</td>
<td>0.28</td>
<td>0.27</td>
</tr>
<tr>
<td>Parameter</td>
<td>IR</td>
<td>$^1$H NMR</td>
<td>$^{13}$C NMR</td>
<td>IR &amp; $^1$H NMR</td>
<td>$^1$H &amp; $^{13}$C NMR</td>
</tr>
<tr>
<td>-----------</td>
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<td>-----------</td>
<td>-------------</td>
<td>-----------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>A%</td>
<td>0.95</td>
<td>0.96</td>
<td>0.73</td>
<td>0.97</td>
<td>0.87</td>
</tr>
<tr>
<td>Wax%</td>
<td>0.95</td>
<td>0.69</td>
<td>0.87</td>
<td>0.87</td>
<td>0.89</td>
</tr>
<tr>
<td>TAN</td>
<td>0.91</td>
<td>0.98</td>
<td>0.87</td>
<td>0.93</td>
<td>0.92</td>
</tr>
</tbody>
</table>
Correlation plot of the experimentally determined wax (Wax%) by using a 75% MEK/Toluene mixture (actual response) and those predicted by a PLS model. The PLS model was built with the $^1$H and $^{13}$C NMR and IR spectral data (full spectra) of the corresponding samples.
Conclusion

In this project the characterisation of Kurdistan`s crude oil has been done and was compared with those of other countries` petroleum. Until now there is no publication about the characteristics of Kurdish crude oil available which has one of the highest qualities according to the results in this project. PLS can be used to predict TAN, A% and wax% based on IR spectra instead of the manual methods. This method is very accurate and fast.
References


Thank You for Listening!

Any questions?