Innovative study for the prediction of bond order in case of oxide based acid radicals have been discussed here.\textsuperscript{1-3}

**Bond Order (B.O.) = Valency of the peripheral atom + (Charge on Acid Radical / Total number of peripheral atoms)**

\textbf{Eg.}:

\quad \bullet \text{ClO}_4^\text{-}: (Valency of one Peripheral atom Oxygen = 2, Charge on acid radical = -1, Total Number of Peripheral atoms = 04), Therefore B.O. = 2 + (-1/4) = 1.75

\quad \bullet \text{ClO}_3^\text{-}: (Valency of one Peripheral atom Oxygen = 2, Charge on acid radical = -1, Total Number of Peripheral atoms = 03), Therefore B.O. = 2 + (-1/3) = 1.66

\quad \bullet \text{ClO}_2^\text{-}: (Valency of one Peripheral atom Oxygen = 2, Charge on acid radical = -1, Total Number of Peripheral atoms = 02), Therefore B.O. = 2 + (-1/2) = 1.5

\quad \bullet \text{AsO}_4^{3\text{-}}: (Valency of one Peripheral atom Oxygen = 2, Charge on acid radical = -3, Total Number of Peripheral atoms = 04), Therefore B.O. = 2 + (-3/4) = 1.25

\quad \bullet \text{AsO}_3^{3\text{-}}: (Valency of one Peripheral atom Oxygen = 2, Charge on acid radical = -3, Total Number of Peripheral atoms = 03), Therefore B.O. = 2 + (-3/3) = 1.0

\quad \bullet \text{SO}_4^{2\text{-}}: (Valency of Peripheral atom Oxygen = 2, Charge on acid radical = -2, Number of Peripheral atoms = 04), Therefore B.O. = 2 + (-2/4) = 1.5

\quad \bullet \text{SO}_3^{2\text{-}}: (Valency of Peripheral atom Oxygen = 2, Charge on acid radical = -2, Number of Peripheral atoms = 03), Therefore B.O. = 2 + (-2/3) = 1.33

\quad \bullet \text{PO}_4^{3\text{-}}: (Valency of Peripheral atom Oxygen = 2, Charge on acid radical = -3, Number of Peripheral atoms = 04), Therefore B.O. = 2 + (-3/4) = 1.25

\quad \bullet \text{BO}_3^{3\text{-}}: (Valency of Peripheral atom Oxygen = 2, Charge on acid radical = -3, Number of Peripheral atoms = 03), Therefore B.O. = 2 + (-3/3) = 1

\quad \bullet \text{CO}_2^{2\text{-}}: (Valency of Peripheral atom Oxygen = 2, Charge on acid radical = -2, Number of Peripheral atoms = 03), Therefore B.O. = 2 + (-2/3) = 1.33

\quad \bullet \text{SiO}_4^{4\text{-}}: (Valency of Peripheral atom Oxygen = 2, Charge on acid radical = -4, Number of Peripheral atoms = 04), Therefore B.O. = 2 + (-4/4) = 1

**Relation (Bond order vs. Bond length, Bond Strength, Bond energy, Thermal stability and Reactivity)**

\quad B.O. \propto 1 / \text{Bond length or Bond distance};

\quad B.O. \propto \text{Bond strength};

\quad B.O. \propto \text{Bond Energy};

\quad B.O. \propto \text{Thermal Stability}; B.O. \propto 1 / \text{Reactivity}
Correlation (Literature values of bond-distances of some oxide based acid radicals with their predicted bond order values)

Literature values of the Cl-O average bond lengths in ClO$_4^-$, ClO$_3^-$ and ClO$_2^-$; As-O bond lengths in AsO$_4^{3-}$ and AsO$_3^{3-}$ with respect to their bond order values suggest that with increasing bond-order M-O bond length (Where M = Cl, As etc.) decreases which is shown in Table-1.

Table 1: Bond-distances and their predicted bond order values

<table>
<thead>
<tr>
<th>Oxide Based Acid Radicals</th>
<th>Bond-Order Values</th>
<th>Avg. M-O Bond-Distances As per Literature (Å)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ClO$_4^-$</td>
<td>1.75</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>ClO$_3^-$</td>
<td>1.6</td>
<td>1.57</td>
<td></td>
</tr>
<tr>
<td>ClO$_2^-$</td>
<td>1.5</td>
<td>1.64</td>
<td></td>
</tr>
<tr>
<td>AsO$_4^{3-}$</td>
<td>1.25</td>
<td>1.75</td>
<td></td>
</tr>
<tr>
<td>AsO$_3^{3-}$</td>
<td>1.0</td>
<td>1.77</td>
<td></td>
</tr>
</tbody>
</table>

Increasing Bond-Order decreases Bond Length

References

1. **Arijit Das**, ‘New Methods for Prediction of Bond Order of Mono and Diatomic Homo and Hetero Nuclear Molecules or Ions Having (1-20)e-s and Oxide Based Acid Radicals Without MOT – a Rapid Innovative Approach’, IJAR, 2013, 3(11), 41-43, ISSN-2249-555X.


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