Mild steel corrodes in all the investigated acids and its corrosion rate in different acids is as given below:

<table>
<thead>
<tr>
<th>Acids Used (1M)</th>
<th>Corrosion Rate at 30°C (mpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) H₂SO₄</td>
<td>2355.3</td>
</tr>
<tr>
<td>2) HCl</td>
<td>233.1</td>
</tr>
<tr>
<td>3) HClO₄</td>
<td>702.1</td>
</tr>
<tr>
<td>4) H₃PO₄</td>
<td>945.8</td>
</tr>
</tbody>
</table>

The effectiveness of methylene blue, auramine O, methyl red, rhodamine B and turquoise blue as corrosion inhibitors for mild steel in sulphuric acid, hydrochloric acid, perchloric acid and phosphoric acid have been described in the chapters III, IV, V and VI of the thesis. In general, the effectiveness of various dyes as corrosion inhibitors in acidic medium varies depending upon the molecular structure of the dye, adsorption characteristics of the dye on mild steel surface, concentration of the acid and dye and temperature of the corroding system.

1) Methylene Blue

Molecular structure of methylene blue is given below:
Two resonating structures are possible for methylene blue i.e.

In acid medium protonation of methylene blue will occur at the tertiary nitrogen in ring A and C as well as at the S atom of ring B. After protonation these atoms i.e. N in ring A and ring C and S in ring B will have positive charge on them as has been represented in the above figure. Thus there is a possibility of adsorption of methylene blue molecule on the metal surface through tertiary nitrogens of ring A and C and sulphur of ring B. However, electron density will be higher on nitrogen atoms present on the two ends of the molecule in comparison to that on S in ring B. Due to the rigidity of the molecule it is quite possible that all the three charged atoms (Fig. ii) will be in one plane and molecules of methylene blue will be strongly adsorbed on the surface of mild steel through nitrogen atoms of ring A and C and sulphur of ring B thus providing a higher inhibition efficiency for the corrosion of mild steel in acids. It explains the reason why methylene blue shows maximum efficiency among all the investigated dyes as inhibitor.

2) Rhodamine B

Rhodamine B also provides a good inhibition efficiency towards the corrosion of mild steel in various acids though it is less effective in comparison to methylene blue.

Molecular structure of rhodamine B is shown below
In acid medium protonation of rhodamine B will take place.

\[
\text{In acid medium protonation of rhodamine B will take place.}
\]

\[
\begin{align*}
\text{[Structure Image]}
\end{align*}
\]

High percentage inhibition efficiency of rhodamine B can be explained on the basis of presence of oxygen in ring B. Due to higher electroragativity of oxygen the electron density will be maximum at oxygen in the central ring in comparison to any other part of the molecule. It is also possible that adsorption may take place from three points i.e. two nitrogen atoms and oxygen atom due to rigidity and planner structure of the molecule. It will facilitate adsorption of rhodamine B molecules on the surface of mild steel thus providing a good protection to mild steel surface.

3. Auramine O

The molecular structure of auramine O is shown in Fig.

\[
\text{[Structure Image]}
\]

When added in acids, the molecule will be protonated as shown below:

\[
\begin{align*}
\text{[Structure Image]}
\end{align*}
\]

The imino nitrogen in this structure is likely to have higher electron density in comparison to other two nitrogen atoms present in the molecule. The point of adsorption in this molecule will be imino nitrogen as it is in the least sterically hindered part of the molecule. In comparison to methylene blue and rhodamine B the adsorption of auramine O on the surface of mild steel will be weaker. It is further confirmed by heat of adsorption values for methylene blue, rhodamine B and auramine O on mild steel in acidic solutions.
4. Turquoise blue

Molecular structure of turquoise blue is as shown below:

\[
\text{(CH}_3\text{)}_2\text{N} - \text{C} - \text{N(CH}_3\text{)}_2\text{Cl}^- \\
\text{H}_2\text{C} - \text{NO}_2
\]

In presence of acid it will be protonated as

\[
\text{(CH}_3\text{)}_2\text{N} + \text{N(CH}_3\text{)}_2\text{C} + \text{H}^+ \\
\text{H}_2\text{C} - \text{NO}_2
\]

The lower efficiency of this dye in comparison to methylene blue and rhodamine B may be due to the fact that the structure of turquoise blue is not rigid. Due to steric hindrance also the point of attachment of turquoise blue molecules on mild steel surface will be only one i.e. from any of the tertiary amino nitrogen. It explains the low efficiency observed with turquoise blue for the corrosion of mild steel in acids.

Methyl red

Molecular structure of methyl red is as shown below

\[
\text{(CH}_3\text{)}_2\text{N} - \text{N} \equiv \text{N} - \text{COOH}
\]

Possible resonance structures of methyl red are

\[
\text{(CH}_3\text{)}_2\text{N} \equiv \text{N} \equiv \text{N} - \text{COOH} \leftrightarrow \text{(CH}_3\text{)}_2\text{N}^+ - \text{N} \equiv \text{N}^-, \text{COOH}
\]
On protonation of methyl red following structures are obtained

\[ \text{(1)} \xrightarrow{H^+} (\text{CH}_3)_2\text{N} \text{H} \begin{array}{c} \text{N} = \text{N} \text{H} \\ \text{COOH} \end{array} \]

\[ \text{(2)} \xrightarrow{H^+} (\text{CH}_3)_2\text{N} \begin{array}{c} \text{N} = \text{N} \\ \text{COOH} \end{array} \]

The percentage inhibition efficiency of methyl red is comparatively less than other dyes used. This behaviour may be due to the presence of charge on only one nitrogen atoms i.e. tertiary amino nitrogen which is the active centre for adsorption of the inhibitor molecule on the surface of mild steel. Thus the molecule of methyl red will not project itself on the surface of mild steel in a manner so as to provide high surface coverage. It explains the relatively lower efficiency of methyl red.