Closed loop cooling systems have very minimal water losses of 5% per month or less. In a closed loop, atmospheric evaporation is not the method used for heat rejection. The heat that is absorbed by the water is transferred out through a heat exchanger to another water loop or air.

Closed loop heating systems have heat added to the loop, and the heat is then removed from the water by a heat exchanger into another water loop or into air.

Some closed loop water systems include chilled water, engine jacket cooling, brine water systems, compressor cooling, hot water heating, power supply cooling, and other industrial processes.

The main advantage of a closed loop is the use of high quality water without concentrating dissolved and suspended solids. The closed loop does not lose water to evaporation and does not scrub dirt out of the air, so scaling or sludging should not be a problem.

Corrosion control is important since corrosion by-products would remain in the system and could lead to fouling.

Since the system is closed, the water typically is not constantly being resaturated with oxygen. This reduces corrosion potential.

Corrosivity increases with increasing temperatures. If the water temperature exceeds 170°F, it is important to vent the system to relieve oxygen being liberated from the water or corrosion can be much more severe.

### Corrosion in Closed Loop Systems

![Corrosion Graph](Corrosion_Closed_Loops.png)
Corrosion inhibitors are added at high enough concentrations to keep corrosion to a very minimal. Some closed loop inhibitors include:

1. Nitrite
2. Molybdate
3. Silicates
4. Chromate
5. Borate
6. Azoles

Typically, the pH is maintained in the alkaline range of 7 - 9.5 to minimize corrosion tendency. If aluminum components are in the system, the pH should be held below 8.5, since aluminum is corroded by elevated pH.

Scale inhibitors such as phosphonates and polymers lose their functionality over time, becoming ineffective after several days to several weeks. For this reason, they have limited application in closed loops.

If scaling is a concern, softened or demineralized water should be used to fill and make up the closed loop.

Glycol antifreezes are sometimes used in closed systems where freeze protection is needed. Care must be taken to keep the glycol from decomposing to corrosive organic acids. The pH must be held above 7.5 and appropriate inhibitors maintained. Exposure to oxygen and high temperatures of 180°F and above both greatly increase the rate that glycols degrade.

The two most frequently used glycols are ethylene glycol and propylene glycol. Ethylene glycol has better heat transfer properties, but propylene glycol is less toxic. Glycol solutions have a lower specific heat than water and their heat transfer characteristics are less efficient, so higher flows or greater heat transfer surfaces are needed.

Because corrosion rates for uninhibited glycols are significantly greater than those of water, a good quality inhibited glycol should be used. It should then last in excess of 15 years and perhaps, indefinitely.
Corrosion Rates of Heat Transfer Fluids

<table>
<thead>
<tr>
<th>Metal</th>
<th>Tap Water</th>
<th>Uninhibited Propylene Glycol</th>
<th>Inhibited Propylene Glycol</th>
<th>Uninhibited Ethylene Glycol</th>
<th>Inhibited Ethylene Glycol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>9.69</td>
<td>9.80</td>
<td>0.04</td>
<td>44.50</td>
<td>0.03</td>
</tr>
<tr>
<td>Copper</td>
<td>0.08</td>
<td>0.16</td>
<td>0.20</td>
<td>0.16</td>
<td>0.12</td>
</tr>
<tr>
<td>Brass</td>
<td>0.22</td>
<td>0.20</td>
<td>0.16</td>
<td>0.46</td>
<td>0.11</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>21.20</td>
<td>16.20</td>
<td>0.15</td>
<td>55.70</td>
<td>0.13</td>
</tr>
<tr>
<td>Aluminum</td>
<td>13.20</td>
<td>1.80</td>
<td>0.26</td>
<td>19.80</td>
<td>0.44</td>
</tr>
<tr>
<td>Solder</td>
<td>3.14</td>
<td>34.70</td>
<td>0.03</td>
<td>56.50</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Microbiological control is also important to maintain in closed systems. Bacteria testing is helpful in determining the necessity of biocide addition. The biocide must be compatible with the pH and corrosion inhibitors. The use of chlorine or other oxidizing biocides must be considered carefully to avoid increased corrosion.