

## HAZOP: UV Photocatalytic Reactor

Deviation	Causes	Consequences	Safeguards	Actions
No Flow	<ul style="list-style-type: none"> <li>One (or more) reactor's quartz tube gets clogged by sediment or sludge</li> </ul>	<ul style="list-style-type: none"> <li>No reactor flow</li> </ul>		<ul style="list-style-type: none"> <li>Add a filter to the process</li> </ul>
	<ul style="list-style-type: none"> <li>The reactor contents freeze, and the quartz tube gets an ice block in it</li> </ul>	<ul style="list-style-type: none"> <li>No reactor flow</li> </ul>		<ul style="list-style-type: none"> <li>Add process control for opening outlet valve if temperature goes to low</li> <li>Add a temperature gauge</li> <li>Add insulation blanket (Reflectix)</li> </ul>
	<ul style="list-style-type: none"> <li>Latch fails</li> </ul>	<ul style="list-style-type: none"> <li>Process flow leaks out to the side</li> </ul>		<ul style="list-style-type: none"> <li>Redundant latches</li> </ul>
	<ul style="list-style-type: none"> <li>Quartz tube breaks/cracks</li> </ul>	<ul style="list-style-type: none"> <li>Reactors contents spill</li> <li>Operator injury</li> </ul>		<ul style="list-style-type: none"> <li>Add guide ridges into the reactor body</li> <li>exercise careful installation practices</li> </ul>
	<ul style="list-style-type: none"> <li>Pump fails</li> </ul>	<ul style="list-style-type: none"> <li>There is no flow through the reactor</li> </ul>		<ul style="list-style-type: none"> <li>Alarm activates</li> </ul>
More Flow	<ul style="list-style-type: none"> <li>Pump flow fails high</li> </ul>	<ul style="list-style-type: none"> <li>Reactor walls are weakened</li> <li>Reactor begins to leak</li> </ul>		<ul style="list-style-type: none"> <li>Rotameter</li> </ul>
High Temperature	<ul style="list-style-type: none"> <li>Filament melts</li> </ul>	<ul style="list-style-type: none"> <li>Reactor leaks</li> </ul>	<ul style="list-style-type: none"> <li>ASA filament – 100C glass transition point</li> </ul>	<ul style="list-style-type: none"> <li>Print with white filament to reduce light absorbance</li> </ul>
Increased Pressure	<ul style="list-style-type: none"> <li>Due to vaporization</li> </ul>	<ul style="list-style-type: none"> <li>Reactor walls weaken</li> </ul>		<ul style="list-style-type: none"> <li>Install a pressure relief on the outlet of the reactor</li> </ul>
No UV Light	<ul style="list-style-type: none"> <li>Urine leaks onto the power supply</li> </ul>	<ul style="list-style-type: none"> <li>Electrical system shorts</li> </ul>	<ul style="list-style-type: none"> <li>The transformer might have circuit protection that would serve as a safeguard</li> </ul>	<ul style="list-style-type: none"> <li>Include a light on the outside of the reactor to indicate if UV light is on</li> </ul>
	<ul style="list-style-type: none"> <li>UV light breaks</li> </ul>	<ul style="list-style-type: none"> <li>Mercury spill inside the reactor</li> </ul>		<ul style="list-style-type: none"> <li>Leave the area for 30 minutes, before cleaning up the spill, while wearing PPE, with duct tape and cardboard</li> </ul>