AquaCritox® H
Advanced oxidation of resilient COD
Carbon dioxide forms sodium carbonate. Organic compounds can be either fully oxidised to carbon dioxide or partially oxidised to low toxicity compounds suitable for biological treatment. Toxic and odorous compounds are neutralised.

The Technology
The waste liquid and hydrogen peroxide are pumped to 4.0 barg and pass to the reactor via an inline mixer. At the heart of the AquaCritox® H process is the pressurised water jacketed reactor. The helical tubular reactor is located within a water filled pressure vessel (jacket) which also contains an

AquaCritox® H advanced oxidation of resilient COD

Optimised performance for small scale systems

AquaCritox® H is a modern advanced oxidation process optimised to provide efficient and reliable destruction of COD in spent caustic and other liquid waste treatment applications. Supplied in a single “plug and play” container AquaCritox® H minimises installation time and operator intervention.

Field of Application
AquaCritox® H is an advanced oxidation process using hydrogen peroxide (H₂O₂) as the oxidant and is targeted at the treatment of small volume sulphidic spent caustic and other liquid waste treatment applications. Spent caustic is a noxious and toxic waste product generated by the oil and gas industry as a by-product. With a purely sulphidic spent caustic feed, AquaCritox® H offers COD reduction in excess of 99% and sulphide reduction to less than 1 ppm thus allowing treated effluent disposal through a conventional wastewater treatment plant or to sewer.

The Process
AquaCritox® H is an oxidation process with a capacity up to 400 litres per hour that treats liquid streams with chemical oxygen demand (COD) up to 30 g/l. Waste liquid is treated in a jacketed tubular reactor at a pressure of 4 barg and a temperature of 140 °C using hydrogen peroxide as the oxidant. The tubular reactor residence time is typically 15 minutes which is optimal for ensuring maximum destruction of COD. The sulphur-containing compounds, as they occur in spent caustic for example, are oxidized and form sulphate and water. Together with the remaining free sodium hydroxide in the spent caustic, carbon dioxide forms sodium carbonate. Organic compounds can be either fully oxidised to carbon dioxide or partially oxidised to low toxicity compounds suitable for biological treatment. Toxic and odorous compounds are neutralised.
electric heater. This configuration allows the tubular reactor temperature to be maintained at 140°C using the electric heater which does not come into contact with the waste stream. Heating the waste stream to 140°C activates the hydrogen peroxide and ensures maximum destruction of waste contaminants. To avoid boiling of the liquid the entire system operates at elevated pressure. The water pressure within the reactor pressure vessel is maintained at 4.5 barg by an external reservoir tank and pump system. The use of a tubular reactor allows for reliable temperature control, maintains plug flow which eliminates back mixing allowing shorter reaction times and minimises the potential for solids deposition and accumulation. Locating the reactor within a pressurised jacket also provides secondary containment of the hazardous process stream which increases overall safety. Using hydrogen peroxide immediately overcomes any gas/liquid mass transfer limitations ensuring maximum availability of oxidiser for reaction and results in almost no off-gas production at the package discharge. The oxidation reaction is exothermic, for high COD effluents the energy released during oxidation will reduce or even eliminate the requirement for electrical heating. The treated effluent is cooled and depressurised before passing to the gas/liquid separator. This separator allows any gas generated to leave the process separate to the effluent stream. The electrochemical potential of the liquid effluent stream is continuously monitored and used to optimise the H₂O₂ addition, allowing the process oxidant consumption to be near stoichiometric.

**Hydrogen Peroxide Oxidation**

Hydrogen peroxide is a powerful oxidising agent with an electrochemical potential of 1.78V, this compares to just 1.23V for oxygen. This high potential makes hydrogen peroxide an aggressive oxidiser that is widely used in oxidation systems worldwide in every engineering sector. Although not typically required for the oxidation of a broad range of contaminants, the performance of the hydrogen peroxide reaction can be enhanced by the addition of Fenton’s reagent. This involves injecting a solution of ferrous iron (typically iron (II) sulphate or chloride) as a catalyst. Hydroxyl radicals are formed which increase the electrochemical potential from 1.78V up to 2.80V, greatly increasing our ability to oxidise complex organic components. In all cases hydrogen peroxide decomposes to water with no harmful by-products.

**The Package**

The AquaCritox® H System is supplied factory tested, preassembled as a skid-mounted unit or containerised in a standard 20 ft shipping container ensuring optimised on-site installation and
commissioning periods. This format eases transportation and allows the unit to be relocated if required. The AquaCritox® H process is fully automated allowing safe and easy operation and maintenance with minimal operator training requirements. The start-up procedure can be initiated at the local control panel, which also allows the verification of key operating parameters during steady-state operation.

**Laboratory Testing**

In our facilities in Cork, Ireland, we currently operate laboratory scale AquaCritox® test units. Laboratory testing may be planned as standalone activity or as precursor to progressing to large scale testing. The laboratory unit usually utilises small scale samples ranging from 10 to 25 L. The test rigs allow us to study the effect of pressure, temperature and residence time on oxidation efficiency.

### Design Summary

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowrate</td>
<td>up to 400 l/hr (Design)</td>
</tr>
<tr>
<td>COD Feed Concentration</td>
<td>10 g/l</td>
</tr>
<tr>
<td>Hydrogen Peroxide Consumption (50 wt%)</td>
<td>8.5 l/hr</td>
</tr>
<tr>
<td>Cooling Water Consumption</td>
<td>2500 l/hr (Design)</td>
</tr>
<tr>
<td>Electrical Consumption</td>
<td>80 kW (Maximum)</td>
</tr>
<tr>
<td>Instrument Air Consumption</td>
<td>Minimal for valve actuation</td>
</tr>
<tr>
<td>Package dimensions (L x W x H)</td>
<td>6.1 m x 2.4 m x 2.9 m (20 ft x 8 ft x 9.5 ft)</td>
</tr>
</tbody>
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### Features and benefits

- **Feature**
  - Packaged skid/container
  - Electric heating
  - Fully automated and factory tested
  - Tubular reactor
  - Oxidation at elevated temperature and pressure
  - H₂O₂ used as the oxidant
  - Fine control of H₂O₂ dosing
  - Secondary containment
  - Designed for continuous processing

- **Benefit**
  - Quick and easy site installation
  - Easy installation and no steam requirement
  - Ready for site deployment, short commissioning period
  - Plug flow with no back-mixing
  - COD reduction up to 99.9% can be achieved
  - Near elimination of off gas from treatment unit
  - Cost savings from avoiding oxidant excess
  - Improved safety
  - Eliminates accumulation of hazardous waste

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