Protea Series
The green fuel oil additives for power generation
SystemSeparation

SystemSeparation is an innovative speciality chemical company that provides a unique platform for creating more financial and environmental benefits for our customers in power generating, oil refining and the marine industry.

This platform is based on our Protea Series products, our in-house competence, extensive field experience, our knowledge of product applications and our global references.

Who we are
SystemSeparation Sweden AB is a wholly-owned subsidiary of CleanTech East Holding AB, operating in the Power Chemicals business area, with our head office located in Stockholm, Sweden.

We develop, manufacture and market cutting-edge chemical products and services for customers that use fossil and biomass fuels. Products and services are developed and produced using the highest standard of quality, safety and environmental awareness.

Our business idea is to provide special chemical products, our Protea Series, and services to customers that use combustion technology. We aim to increase power plant or vessel profitability by increasing efficiency, operability and availability as well as reducing environmental impact.

Our strengths at SystemSeparation are not only our well-proven, innovative high-performance additives, but also our competence and our associated services.

Our core business areas for fuel additives are:
- gas turbine power plants
- steam boiler power plants
- oil refining
- marine industry
Our solutions

Power plant safety and operational excellence are important for us and our customers, and we aim to increase power plant profitability by increasing efficiency, operability and availability as well as reducing environmental impact.

Consequently, SystemSeparation has developed a state-of-the-art product series for fuel oil additives called Protea Series. These products are developed to meet different needs in the power industries.

The Protea Series is divided into the following categories:

- dispersants/stabilisers/PPD (R-series)
- combustion improvers (RF-series)
- demulsifiers/emulsion breakers (WO-series)
- vanadium/corrosion inhibitors (M-series)
- combustion catalysts (F-series)

Our Protea Series is used successfully in gas turbine and steam boiler power plants throughout the world.

Benefits of Protea Series

- increase in power plant efficiency
- reduction in fuel consumption
- less power degradation
- increase in operating time between washing cycles
- reduction in maintenance costs
- improved combustion
- fewer emissions and less environmental impact
Protea product range

**R-series – dispersants/stabilisers/PPD**
The Protea R-series includes products that improve the handling of fuel and crude oils, along with products that stabilise fuel oils and prevent the formation of sludge in pipes and tanks. The R-series also has pour point depressants to prevent the crystallisation of paraffins and waxes at lower temperatures.

**RF-series – combustion improvers**
The Protea RF-series improves the handling and combustion of fuel and crude oils due to the high performance of combination stabilisers and combustion catalysts. The products combine the best performance and benefits from both the F-series and the R-series.

**WO-series – demulsifiers/emulsion breakers**
Protea Aqua Split, WO-series, is a unique range of products which are used in fuel oil treatment systems (fuel washing) for gas turbine power plants. The products ensure a good separation of water from the fuel oil, which enables the reduction of sodium and potassium to less than 1 ppm as specified by gas turbine manufacturers. As well as providing dry oil with low salt content, the WO-series also reduces the amount of oil in the spent effluent water.

**M-series – vanadium/corrosion inhibitors**
The Protea M-series is an oil soluble vanadium and corrosion inhibitor based on magnesium, which is designed to increase the melting point of deposits on surfaces and make them porous and more friable, which results in reduced energy losses. The products prevent hot corrosion and reduce hard deposit build-ups in oil-fired gas turbines and steam boilers. The products also protect against acidic corrosion on the cold end side of steam boilers.

**F-series – combustion catalysts**
The Protea F-series improves combustion and reduces emissions of soot and unburned carbon at lower air excess. Along with a more complete combustion of the fuel oil, it not only increases combustion efficiency, it also prevents and reduces the formation of deposits on tubes and corrosion on the cold end side of the boiler system.
**Gas turbine application**

**Protea fuel oil additives**

Gas turbine power plants that utilise crude or heavy fuel oils suffer from combustion-related problems due to the presence of vanadium, salts and other contaminants in the fuel oil. These compounds increase power degradation due to deposit build-ups and risk hot corrosion on turbine blades. Other problems relating to fuel oils include the sedimentation of asphaltenes in storage tanks, filter plugging and the coking of fuel pre-heaters.

The Protea Series from SystemSeparation provides solutions for many problems relating to heavy fuel oils. The excellent performance of these fuel oil additives improves operations in power plants due to fewer problems during handling and combustion. Customers benefit from more efficient power production with enhanced combustion efficiency, increased power output and less wear on vital components, which prolongs the life of the power plant. Environmental aspects also improve due to fewer emissions into the atmosphere.

### Gas turbine flow chart

<table>
<thead>
<tr>
<th>Area</th>
<th>Storage Tank</th>
<th>Strainers / Filters</th>
<th>Fuel washing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problems</strong></td>
<td>• Sedimentation</td>
<td>• Plugging</td>
<td>• Salt content too high after treatment</td>
</tr>
</tbody>
</table>
| **Reasons**         | • Low quality fuel  
|                     | • Asphaltenes  
|                     | • Waxes and paraffins | • Asphaltenes  
|                     | • Waxes and paraffins | • Waxes and paraffins | • Emulsions |
| **Consequences**    | • Waste handling | • Frequent cleaning | • Alternative fuel or shut-down |
| **Solutions**       | • Protea R-series | • Protea R-series | • Protea WO-series (Aqua Split) |
| **Dosing point**    | Tank | Tank | Online |
### Fuel pumps, filters and heaters
- Plugging
- Coking
- Plugging filters
- Coking on pre-heaters
- Low preheating temperature
- Protea R-series

### Gas turbine
- Hot corrosion
- Deposit build-ups
- Vanadium impurities in fuel oil
- Maintenance cost
- Power degradation
- Protea M-series

### Heat recovery unit
- Fouling on heat exchanger tubes
- Vanadium impurities in fuel oil and soot
- Less heat recovery
- Protea M-series
- Protea F-series

### Emissions
- Black smoke
- High CO
- Incomplete combustion
- High environmental impact
- Protea F-series

<table>
<thead>
<tr>
<th>Fuel pumps, filters and heaters</th>
<th>Gas turbine</th>
<th>Heat recovery unit</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Plugging</td>
<td>• Hot corrosion</td>
<td>• Fouling on heat exchanger tubes</td>
<td>• Black smoke</td>
</tr>
<tr>
<td>• Coking</td>
<td>• Deposit build-ups</td>
<td>• Vanadium impurities in fuel oil</td>
<td>• High CO</td>
</tr>
<tr>
<td>• Plugging filters</td>
<td>• Vanadium impurities in fuel oil and soot</td>
<td>• Incomplete combustion</td>
<td></td>
</tr>
<tr>
<td>• Coking on pre-heaters</td>
<td>• Maintenance cost</td>
<td>• Less heat recovery</td>
<td></td>
</tr>
<tr>
<td>• Low preheating temperature</td>
<td>• Power degradation</td>
<td>• High environmental impact</td>
<td></td>
</tr>
<tr>
<td>• Protea R-series</td>
<td>• Protea M-series</td>
<td>• Protea M-series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Protea F-series</td>
<td></td>
</tr>
</tbody>
</table>

- **Dosing point**
  - Tank
  - Online

- **Protea R-series**
- **Protea WO-series**
- **Protea M-series**
- **Protea F-series**
- **Aqua Split**
**Protea fuel oil additives**

Steam boiler power plants that utilise crude or heavy fuel oils suffer from different combustion-related problems due to variations in quality and contaminants in the fuel oil. The presence of vanadium, sodium and sulphur causes problems with high and low temperature corrosion. Asphaltenes and other heavy hydrocarbons cause problems such as sedimentation in storage tanks, filter plugging and coking of fuel pre-heaters. These heavy carbons are also more difficult to combust, which results in further problems, such as the formation of deposits and high emissions of soot and unburned carbons. These problems reduce power plant performance and profitability over time.

The Protea Series from SystemSeparation provides solutions for many different problems relating to heavy fuel oils. The excellent performance of these fuel oil additives improves operations in power plants due to fewer problems during handling and combustion. Customers benefit from more efficient power production with enhanced combustion efficiency, increased power output and less wear on vital components which prolongs the life of the power plant. Environmental aspects also improve due to fewer emissions into the atmosphere.

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**Steam boiler flow chart**

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<th>Fuel pumps and heaters</th>
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</thead>
<tbody>
<tr>
<td>Problems</td>
<td>Sedimentation</td>
<td>Plugging</td>
<td>Plugging, Coking</td>
</tr>
<tr>
<td>Reasons</td>
<td>Low quality fuel, Asphaltenes, Waxes and paraffins</td>
<td>Asphaltenes, Waxes and paraffins</td>
<td>Asphaltenes</td>
</tr>
<tr>
<td>Consequences</td>
<td>Increased waste handling</td>
<td>Frequent cleaning</td>
<td>Low preheating temperature</td>
</tr>
<tr>
<td>Solutions</td>
<td>Protea R-series, Protea RF-series</td>
<td>Protea R-series, Protea RF-series</td>
<td>Protea R-series, Protea RF-series</td>
</tr>
<tr>
<td>Dosing point</td>
<td>Tank</td>
<td>Tank</td>
<td>Tank</td>
</tr>
</tbody>
</table>
Area Storage Tank Strainers / Filters  Fuel pumps and heaters  Burners  Boiler tubes  Economizer and  Emissions

**Problems**

- Sedimentation
- Plugging
- Coking
- Hot corrosion
- Cold corrosion
- Black smoke
- Deposits
- High CO
- NOx
- Incomplete atomization
- Less heat recovery
- Increased maintenance
- Increased differential pressure
- High environmental impact

**Reasons**

- Low quality fuel
- Asphaltenes
- Fuel instability
- Vanadium impurities in fuel oil
- High fly ash content
- Incomplete combustion
- Waxes and paraffins
- Incomplete preheating temperatures
- Acid condensation
- High CO

**Consequences**

- Increased waste handling
- Frequent cleaning
- Incomplete atomization
- Less heat recovery
- Increased maintenance
- Increased differential pressure
- High environmental impact
- High emission of soot

**Solutions**

- Protea R-series
- Protea M-series
- Protea RF-series
- Protea F-series

**Dosing point**

- Tank / Online
Other applications

Our broad product range includes products for marine and diesel power applications, as well as oil refineries.

Oil refineries
The increase in demand for lighter petroleum fractions and improved refinery processes has resulted in heavier residuals and a higher content of impurities. Producers of heavy fuel oils, bunker fuels etc. are therefore facing new problems in blending processes to fulfill fuel standards, requirements and expectations in the handling and combustion of the fuel oils. Our Protea fuel additive technology has been developed to help customers overcome problems with fuel stability, sedimentation, coking and uncompleted combustion.

Marine and diesel power application
Our Protea products for marine and diesel power applications have been specially developed to treat crude and marine bunker fuel. Our broad product range can help and solve many complex problems during the handling, storage and combustion of fuels at sea and on shore. Protea Marine and Diesel additives optimise engine performance and reduce the cost and time of maintenance.

Service and support

SystemSeparation also provides associated services and support linked to our Protea fuel treatment. Our concept is to provide our customers with a complete solution to overcome problems relating to heavy fuels and combustion. We have broad experience in power plant operation and performance optimisation. We can proudly offer the following services:

Dosing system
Suitable dosing systems can be provided to give an accurate and optimised performance of the fuel treatment.

Testing
The performance of the combustion is measured, tested and evaluated before and after treatment using well-known test methods and instruments.

Inspections
Inspections can be performed by our technical group which has extensive experience in the treatment of fuel and crude oils for gas turbines and boilers.

Optimising combustion
In combination with our Protea fuel treatment, combustion efficiency can be optimised and fine-tuned with help from our Technical Service Group which has many years of experience in power plant operation.

Laboratory testing and analysis
The analysis of fuel oils, deposits and fly ashes is evaluated to offer the best recommendations in terms of finances and performance.