High Efficiency ReCyclone System
Numerically optimized cyclones with recirculation for high efficient particle capture
Advanced Cyclone Systems

Total particle capture with cyclone systems

Advanced Cyclone Systems (ACS) is exclusively dedicated to the development of the most efficient cyclone systems worldwide.

- European company with 15-20 installations
- Supported by a major University
- Ph. D. Supplied Particulate Study
- Full Laboratory Support
- Pilot Capabilities
- Extensive scientific knowledge in cyclone design and particle agglomeration modeling (Published papers, patents)
- Improved Cyclone Systems reach bag filter redundancy in the most demanding operating processes.
Applications include particulate matter (PM) emission control in boilers and furnaces and product recovery in the chemical and pharmaceutical industries.

Products include numerically optimized cyclones – Hurricanes – and mechanical or electrostatic recirculating cyclones – ReCyclone Systems.

Anguil/ ACS will work with client in order to design a custom made cyclone system that meets their needs.

Anguil/ ACS provides efficiency collection forecasts and particle emission guarantees for clients’ operating conditions.

Dusts which efficiency capture is very difficult to predict can be further tested in a pilot station.
Two main problems related with fine particles emissions:

**Hazardous Health Effects**

Increasingly stricter Particulate Matter (PM) emission limits

**Serious economic costs**

60% of the chemical industries handle product in fine powder and many face high product losses
Reverse Flow Cyclones Benefits:

- Robust
- Absence of maintenance
- No temperature restrictions
- Direct product recovery
- No pressure problems
- No moving parts (filters)

Wide industrial application

Problem: Low efficiency for particles < 10 µm
Sources of PM emissions are regularly inspected

**Example:** Biomass Boilers: big sources of PM emissions

- District heating
- Heat production in the industry
- Electricity production in power plants

**PM emission control existing solutions:**

- Cyclones and Multicyclones – *Low efficiency*
- Bag filters– *Critical operational problems*
- Electrofilters (ESPs) – *High investment cost*
Powder products are recovered from drying gases.

**Example:** Pharmaceuticals & Fine Chemicals Production

- Spray Dryers
- Fluid Bed Dryers

**Product recovery existing solutions:**

- High Efficiency Cyclones – *Low efficiency in fine particles*

**Product degradation**
- Product contamination
- Production downtime
- Cleaning costs
Solution for both emission control and product recovery:

Much more efficient cyclones!
The Solution
High Efficiency ReCyclone System

1. Hurricane Cyclone
   - Collected particles
   - Air and dust from boiler/dryer

2. ReCyclone (Mechanical)
   - Global Efficiencies
     - Hurricanes - 83.2%
     - Mechanical ReCyclone - 93.3%
     - Electrostatic ReCyclone - 97.5%

3. ReCyclone (Electrostatic)

Data from a cork waste boiler

Diameter (µm)
Single hurricane for pharmaceutical powder recovery spray dryer. It was installed to replace an existing high efficiency cyclone from the spray dryer manufacturer in order to increase powder recovery.

Features
- Very high efficiencies
- Custom designs
- Low pressure drop (< 5” w.c.)
- Direct product discharge
- Avoids product degradation and contamination by filters
- Very smooth surface finishing to meet requirements
- Absence of condensation with heat tracing mechanisms
- Clean in Place (CIP) cleaning systems
The Solution
Mechanical ReCyclone (MH)

Features

- Very high efficiencies
- Pressure drop (5-7” w.c.)
- Robust construction with abrasion resistance
- Low operation costs
- Near zero maintenance and downtime costs
- Low investment costs
- Normal materials of construction in Carbon or Docol Steel
- Modular design

Mechanical ReCyclone for PM emission control in a cork waste boiler. It is composed by a 4 Hurricane battery and 1 mechanical recirculator.
The Solution
Electrostatic ReCyclone (EH)

Features
- Very high efficiencies
- Pressure drop (7-8” w.c.)
- Low gas velocities
- Electrical field power consumption equals 5% of fans
- Robust construction with abrasion resistance
- Very low operation costs
- Near zero maintenance and downtime costs
- Reasonable investment costs
- Normal materials of construction in Carbon or Docol Steel
- Modular design

Electrostatic ReCyclone System for PM emission control in a 9 MWth wood waste boiler.
### ReCyclone® Systems
Comparative Example

<table>
<thead>
<tr>
<th>Technology comparison for biomass combustion</th>
<th>Multicyclones</th>
<th>Bag Filters</th>
<th>ESP’s</th>
<th>High Efficiency ReCyclone System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capture efficiency (%)</td>
<td>50-80</td>
<td>98-99+</td>
<td>95-99</td>
<td>95-99</td>
</tr>
<tr>
<td>Emissions (lbs/MMBTu)</td>
<td>&gt; 0.200</td>
<td>0.030-0.070</td>
<td>0.030-0.070</td>
<td>0.030-0.070</td>
</tr>
<tr>
<td>Temperature limitations (ºF)</td>
<td>No</td>
<td>&lt; 482</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Fire risk</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Movable / Replacement parts</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Pre-separation needed</td>
<td>No</td>
<td>Always</td>
<td>Frequently</td>
<td>No</td>
</tr>
<tr>
<td>Resistivity sensitivity</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Relative investment costs</td>
<td>5/100</td>
<td>70/100</td>
<td>100/100</td>
<td>65/100</td>
</tr>
<tr>
<td>Relative operating costs</td>
<td>2/100</td>
<td>9/100</td>
<td>5/100</td>
<td>5/100</td>
</tr>
<tr>
<td>Downtime costs</td>
<td>Very Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Electrical field failure</td>
<td>None</td>
<td>None</td>
<td>Shut down</td>
<td>Works mechanically</td>
</tr>
</tbody>
</table>

The investment in a ReCyclone EH represents 65 in a basis of 100, where 100 is the cost of an ESP. For a ReCyclone MH, the investment would be 50 approximately.
**Market Opportunity**

**Further Applications**

### Powder Recovery
- Pharmaceutical Ingredients
- Chemicals
- Food Ingredients
- Nanoparticles
- Mineral Processing
- Fertilizers
- Catalysts
- Milling and Drying Processes

### Emission Control & Air Dedusting
- Biomass and Coal Boilers
- Fuel Oil Boilers
- Steel and Ferrous Alloys
- Clinker Cooler Air Dedusting
- Pyrolysis, Incineration and Gasification
- Calcination Processes
- Glass and Ceramic Furnaces
- Air Caption and Dedusting
- High Temperature Separation Processes
Wood Fuel Biomass

- Boiler output 0.45 lbs/ MMBTU
- Know particle size distribution
Efficiency

No Precyclone – Boiler Emission = 0.45 lbs/ MMBTU

- Recyclone MH = 0.06
- Recyclone EH = 0.03

To match ESP at 70-80% of the cost
## Size / Cost Table

<table>
<thead>
<tr>
<th>Temperature °F</th>
<th>450</th>
<th>450</th>
<th>450</th>
<th>450</th>
<th>450</th>
<th>450</th>
<th>450</th>
<th>450</th>
<th>450</th>
<th>450</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Flow Rate (ACFM)</td>
<td>1050</td>
<td>2,500</td>
<td>5,000</td>
<td>7,500</td>
<td>10,000</td>
<td>12,500</td>
<td>15,000</td>
<td>29,429</td>
<td>58,858</td>
<td></td>
</tr>
<tr>
<td>Sell Prices ($) MH</td>
<td>45,800</td>
<td>54,500</td>
<td>70,300</td>
<td>92,500</td>
<td>110,600</td>
<td>130,000</td>
<td>149,300</td>
<td>236,900</td>
<td>447,400</td>
<td></td>
</tr>
<tr>
<td>Sell Price ($) EH</td>
<td>75,600</td>
<td>91,300</td>
<td>119,500</td>
<td>140,600</td>
<td>163,250</td>
<td>185,300</td>
<td>205,300</td>
<td>315,800</td>
<td>596,600</td>
<td></td>
</tr>
</tbody>
</table>
**Client Enquiries:**

“I spend 0 $ in maintenance since I bought the system” Granorte

“The systems satisfies us completely” Granorte

“If we could go back in time we would still have bought it” – every 5 of the enquired

**Market Receptivity**

**PM Emission Control**

**Recent Systems Sold**

- Hydraulic Lime: 1
- Fuel: 1
- Cork: 5
- Wood Waste: 4
- Straw: 1
Client Enquiries:

“The ReCyclone recovers 20 times more product/year than the bag filter...” - CUF

“If we could go back in time we would have bought it again” – CUF

“Efficiency is very high which allows us to comply with emission limits, without the disadvantages of bag filters” - CUF

Recent Systems Sold

Chemicals: 1
Pharmaceuticals: 3
Organic Fertilizer: 1
Nanoparticles (metal oxides): 1
Metakaolin: 1
Food Ingredients: 4
# CYCLONE APPLICATION DATA SHEET

## CONTACT INFORMATION

<table>
<thead>
<tr>
<th>Name:</th>
<th>Title:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company:</td>
<td></td>
</tr>
<tr>
<td>Address:</td>
<td></td>
</tr>
<tr>
<td>City / St / Zip:</td>
<td></td>
</tr>
<tr>
<td>Phone:</td>
<td>Email:</td>
</tr>
</tbody>
</table>

How did you Learn of Anguil?

This Information is Needed By:

## FACILITY INFORMATION

Describe the current situation

<table>
<thead>
<tr>
<th>Installation Location:</th>
<th>Outdoors</th>
<th>Indoors</th>
<th>Site elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of Flue Gas on Normal Operation (Design):</td>
<td>ACFM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Amount of Flue Gas:</td>
<td>ACFM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flue Gas Temperature:</td>
<td>°F (Max.)</td>
<td>°F (Min.)</td>
<td></td>
</tr>
<tr>
<td>Flue Gas Dew Point:</td>
<td>°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Fuel and Moisture Content:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Pressure:</td>
<td>Positive</td>
<td>Negative</td>
<td>* wc</td>
</tr>
<tr>
<td>Oxygen Content:</td>
<td>Vol. % dry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particulate Loading:</td>
<td>lbs/hr</td>
<td>lbs/ACFM</td>
<td></td>
</tr>
<tr>
<td>Particulate Size:</td>
<td>1-10 Microns</td>
<td>1–100 Microns</td>
<td></td>
</tr>
<tr>
<td>Amount of Carbon Monoxide Before Recyclone:</td>
<td>ppmv</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference:</td>
<td>Oxygen Content</td>
<td>Vol. % dry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moisture Content</td>
<td>ppmv</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Particle Size distribution</td>
<td>Sample</td>
<td></td>
</tr>
</tbody>
</table>
Q & A
Discussion

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