

CASE STUDY

AFS Energy Systems | Vermont, USA | 2022

Hurricane EX System to reduce PM emissions from a 25 MMBtu/h biomass boiler under 0.1lb/MMBtu



FOREWORD

Advanced Cyclone Systems, S.A. (ACS) designed and supplied a Hurricane EX Cyclone System for Particulate Matter reduction from the flue gas for the retrofit of a biomass boiler.

AFS Energy Systems, from Pennsylvania, who handled the retrofit, is a leader in renewable energy biomass systems, providing turnkey design/build energy solutions for businesses across North America. Boiler retrofits are an essential service, updating existing systems for a fraction of the cost of a new one. AFS reviews existing combustion systems and provides an accurate analysis of all opportunities to modernize and improve for lower cost and increased compliance.

End customer Columbia Forest Products (CFP) is North America's leading manufacturer of hardwood, plywood and veneer products. With Advanced Cyclone Systems, AFS Energy Systems successfully retrofitted an existing 25.45MMBtu wood fired boiler system, meeting emissions goal and avoiding the additional expense of a ESP.

IDENTIFYING THE PROBLEM AND SOLUTION

In its Newport Plant CFP operated a 25MMBtu Paul Jones wood fired boiler where the existing flue gas cleaning system was not able to comply with emission limits for Particulate Matter.

The only alternative for CFP was to replace it by an ESP, an equipment that requires a large investment.

The retrofit was handled by AFS, who reached out to Advanced Cyclone Systems for the emission control. The objective was to reduce emissions to compliance levels at lower CAPEX for CFP.

Design was for a maximum inlet concentration after the boiler of $534\text{mg}/\text{Nm}^3_{\text{dry}}$ (8.81lb/h) and complying with strict emissions of <2.5lb/h and <0.1lbs/MMBtu.

A Hurricane EX system was successfully optimized for the given conditions at Columbia, and a set of 3 batteries of 4 cyclones was accepted by the regulatory agency.

The system was installed by AFS Energy Systems with support for ACS.

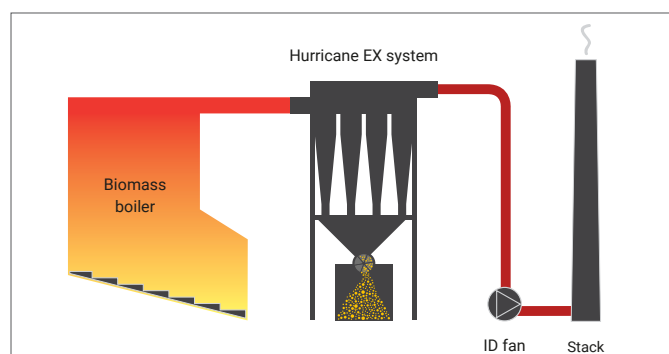


Fig. 1 – Process diagram

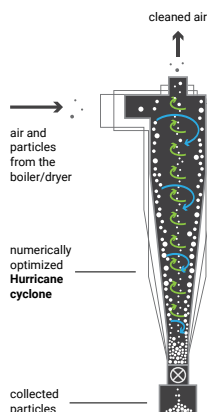


Fig. 2 – Hurricane cyclone

ABOUT HURRICANE CYCLONES

Hurricane cyclones are patented numerically optimized cyclones. **Hurricane** geometries maximize powder collection for each different application, while minimizing reentrainment and keeping pressure drop at reasonable levels. Hurricane cyclones demonstrate impressive efficiencies in capturing very fine powders with a Volume Median Diameter (VMD) of less than $5\mu\text{m}$.

These cyclones are the output of nonconvex nonlinear problems formulated and solved after years of work in partnership with the Faculty of Engineering of Porto and incorporate the most recent findings of the impact of agglomeration in the cyclone collection efficiency (Chemical Engineering Journal 162 (2010) 861–876).

A single Hurricane is more efficient than any other known cyclone available in the market for the same pressure drop.

DESIGN BASIS

- Type of particles **[Fly ash]**
- Particle size distribution **[Fig.3]**
- Gas flow temperature ($^{\circ}\text{C}$ | $^{\circ}\text{F}$) **[254 | 490]**
- Actual flow rate (m^3/h | acfm) **[17 350 | 10 212]**
- Normalized flow rate ($\text{Nm}^3/\text{h}_{\text{dry}}$ | dscfm) **[7 485 | 4 405]**
- Inlet concentration ($\text{mg}/\text{Nm}^3_{\text{dry}}$ | gr/dscf) **[534 | 0.233]**

SYSTEM SPECIFICATIONS | EMISSIONS

- Expected separation efficiency (%) **[>91.2]**
- Expected emissions ($\text{mg}/\text{Nm}^3_{\text{dry}}$ | gr/dscf) **[<50 | <0.022]**
- Emissions to guarantee ($\text{mg}/\text{Nm}^3_{\text{dry}}$ | gr/dscf) **[80 | 0.035]**
(lb/MMBtu) **[<0.1]**
- Expected total pressure drop (kPa | w.g.) **[1.04 | 4.18]**
- Verified results in Dec/2022 ($\text{mg}/\text{Nm}^3_{\text{gr}}$ | gr/dscf) **[77 | 0.034]**
(lb/MMBtu) **[<0.1]**

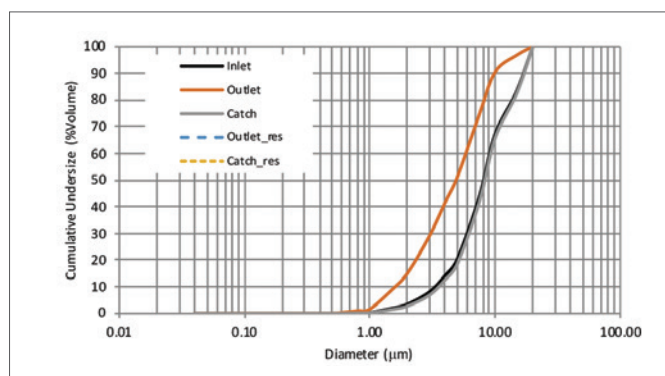


Fig. 3 – Particle size distribution used in simulation

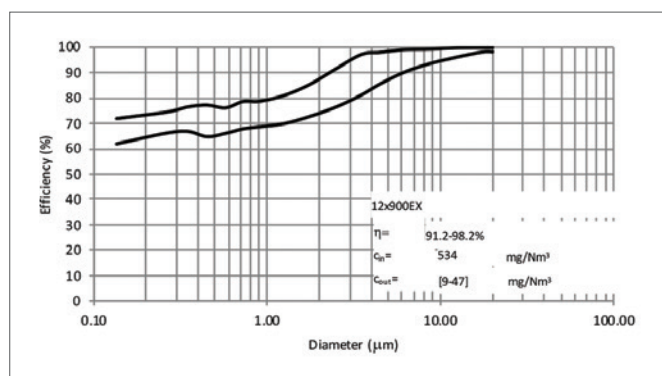
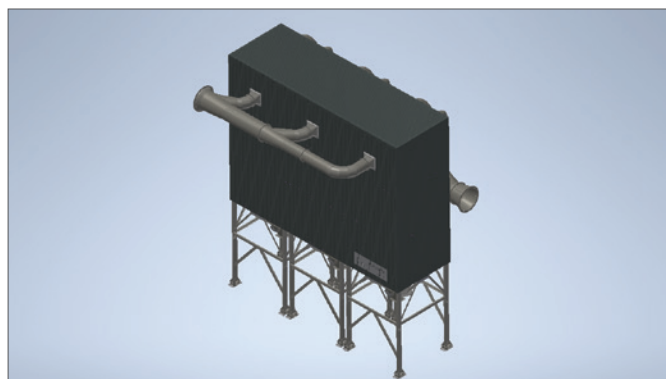


Fig. 4 – Predicted maximum and minimum grade efficiency curves with corresponding global efficiency values

Fig. 5 – System composed by 3 batteries of 4 Hurricane EX numerically optimized cyclones, with a diameter of $\varnothing 900\text{mm}$ (3ft)

CONCLUSIONS

AFS and ACS optimized cyclone systems proved that the retrofit of older boilers can be achieved with Hurricane systems, meeting strict emission limits. The landmark success of the system shows that emission limits can be met at a much lower investment cost and with minimal operation and maintenance costs.