Advanced Cyclone Systems

EMISSION CONTROL

CASE STUDY

ONEFORTYONE PLANTATIONS | Mount Gambier, Australia | 2018

Hurricane EX System to Reduce Particulate Matter from Sawdust & Wood Shavings out of two biomass boilers.

FOREWORD

Advanced Cyclone Systems, designed and supplied a Hurricane EX Cyclone System for **OneFortyOne** (OFO).

OFO is a world-class sustainable forest grower and forest products company with a multi-regional approach to investing and growing its business in Australia and New Zealand.

OFO produces and distributes a range of wood-based building products from Jubilee Highway Sawmill in Mount Gambier.

Facing an environmental problem identified by ACS representative Windsor Engineering, OFO selected an ACS high efficiency cyclone solution to reduce its particulate matter emissions.

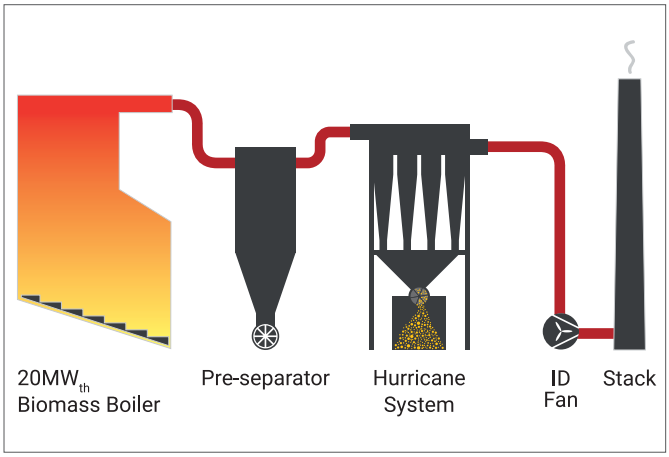

Fig. 1 – Process flow diagram from existing installation (just one boiler represented)

IDENTIFYING THE PROBLEM AND SOLUTION

The current emission legislation in Australia by the Environmental Protection Agency (EPA), made it mandatory for the two 20MW$_{th}$ biomass boilers, which supply steam for the whole plant operation, to comply with less than 133mg/Nm^3 corrected for 12% CO_2. Furthermore, $PM_{2.5}$ emissions need to be under 96mg/Nm^3.

The boilers, two Babcock & Wilcox Bi-Drum type boilers with single pass primary and secondary super heater, with regular cyclones as end stage dedusters, had emissions of near 400mg/Nm^3 (≈650mg/Nm^3 before the cyclones). Combustion was not complete as indicated by the high CO levels reaching 4000mg/Nm^3.

The particles were expected to be very fine due to the presence of soot in the combustion. This restricts the use of usual off-line sizing methods, such as laser sizers after re-dispersion in ethanol with ultrasounds. Therefore, a Cascade Impactor was used to determine the aerodynamical particle size, under the same method used for determination of the PM_{10} and $PM_{2.5}$ (US EPA Method 201A).

The very small particle size (median size of just 4µm) allowed ACS to design a system based on its second most efficient cyclone family – the EX. Each boiler comprises one Hurricane system composed of two SD (ø1900mm) pre-separator cyclones and forty "EX" (Ø950mm) high efficiency cyclones. Despite the very fine particles, this system allows for emissions on site to be under 100mg/Nm^3 at 12% CO_2.

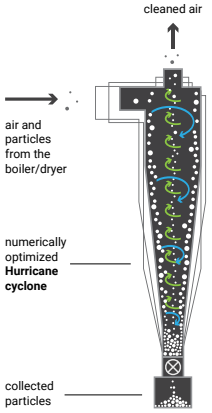

Fig. 2 – Hurricane cyclone

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 efficiency in capturing very fine powders with a Volume Median Diameter (VMD) of less than 5µm.

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 on 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 (FOR ONE BOILER)

- Fuel **[Biomass*]**
- Particle size distribution **[Fig.3]**
- Temperature (ºC) **[200]**
- Actual flow rate (m^3/h_{wet}) **[99 000]**
- Normalized flow rate (Nm^3/h_{dry}) **[46 264]**
- Moisture content in gas (%H2O v/v) **[19%]**
- Concentration at 12%CO_2 into pre-separator (mg/Nm^3_{dry}) **[619]**
- Concentration at 12%CO_2 into final system (mg/Nm^3_{dry}) **[302]**

*mix of green and dry sawdust and wood shavings

SYSTEM SPECIFICATIONS | EMISSIONS

- Expected emissions at 12% CO_2 (mg/Nm^3) **[<100]**
- Guaranteed emissions at 12% CO_2 (mg/Nm^3) **[<120]**
- Guaranteed emissions PM2.5 at 12% CO_2 (mg/Nm^3) **[<75]**
- Verified particles* considering 12% CO_2 (mg/Nm^3_{dry})** **[<84]**
- Verified $PM_{2.5}$ considering 12% CO_2 (mg/Nm^3_{dry})** **[<68]**

* (Total Suspended Particles)

**measured in February 2019

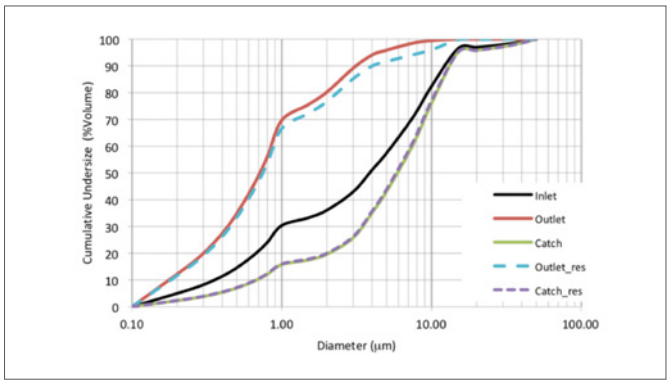

Fig. 3 – Particle size distribution used in simulation

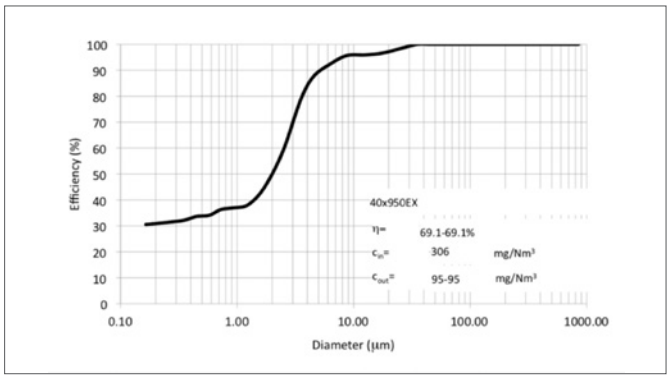

Fig. 4 – Predicted maximum and minimum grade efficiency curves with corresponding global efficiency values

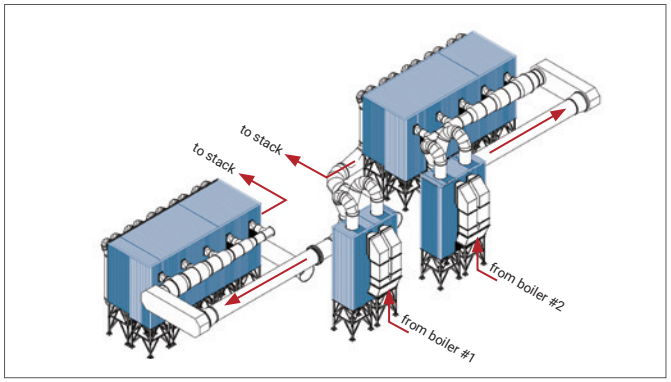

Fig.5 – ACS solution [2SDØ1900 | 40EXØ950] (for two boilers)

CONCLUSIONS

On February 2019 several PM emissions measurements were done confirming Total Suspended Particles below 100mg/Nm^3 at 12% CO_2 and PM2.5 under 70mg/Nm^3 at 12%CO_2 for both boilers.

The results confirm ACS Hurricane EX cyclones as a viable alternative to ESP's in PM emission compliance, with a lower total cost of acquisition.