Advanced Cyclone Systems
PART OF SUNDS FIBERTECH

CASE STUDY

Hurricane SD System to Pre-separate Particulate Matter Emissions from 109MWth BFB biomass boiler

Foreword

ACS designed and supplied a **Hurricane 2 SD 4000 Cyclone System** to **Valmet Technologies Oy. Valmet** is the leading global developer and supplier of technologies, automation and services for pulp, paper and energy industries. The company has over 200 years of history and was reborn through the demerger of businesses from Metso Group in December 2013. Valmet's net sales in 2018 were about EUR 3.3 billion.

ACS's system was installed to **pre-separate particulate matter from BFB boiler's emissions in the new 109MWth / 34.5MWe Thermoelectric Biomass Power Plant at CELBI** (Celulose Beira Industrial S.A.) in Figueira da Foz, Portugal. **CELBI** was formed in 1965 and is one of the most efficient global producers of eucalyptus pulp, with installed production capacity of over 700 thousand tons. With over 50 years of existence, Celbi is a reference producer in the European market.

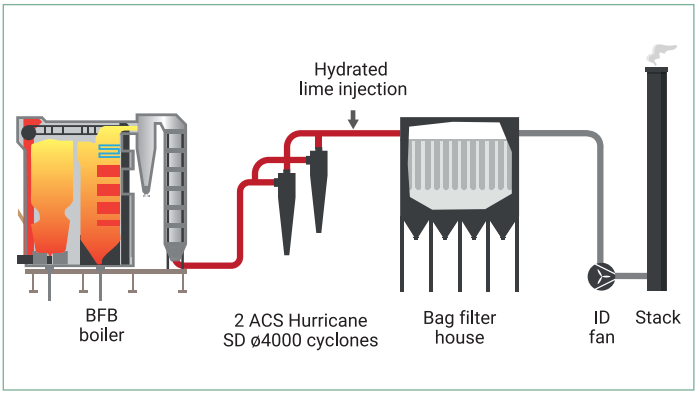


Fig. 1 – Process diagram

Problem and Solution

ACS was challenged by Valmet to design a solution to be installed in the flue gas treatment of the Thermoelectric Biomass Plant. The raw flue gas coming from the 109MWth BFB boiler (bubbling fluidized bed combustion technology) carries high load of fly ash and sand particulate. These elements are particularly abrasive and could not be directly treated by the final filter due to high wear and clogging. Furthermore, other gaseous effluents as acid gas (HCl, HF and H_2SO_2), needed to be cleaned through feeding hydrated lime. Therefore, the global dry flue gas treatment solution consisted of the following sequence of: ACS cyclones to pre-separate the high load of abrasive dust, then a hydrated lime feeding system for acid gas reduction, followed by final bag house filter to remove residual dust (Fig. 1).

The dust is very abrasive, ACS designed a special cyclone system, optimized for this process, with a geometry that provides low pressure drop and low gas velocity, while minimizing re-entrainment effect. Furthermore, a wear protection lining consisting of 30mm of a cement hard compound was applied in the inner surface of the cyclones and hoppers.

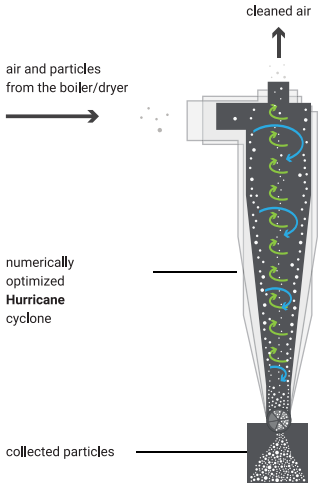
The general solution was a **Hurricane 2 SD 4000 cyclone system**: a battery of two SD cyclones with a diameter 4000mm, installed in parallel, each one with a hopper and air-lock dust discharge system by means of a heavy-duty rotary valve and, as referred above, the wear protection inner lining. Besides the operational features, this system was compliant with Valmet's performance requirement of 50% minimum dust separation, while providing expected separation efficiency of 66.3 – 67.2%, as simulated by ACS' proprietary PACyc model.

ACS 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 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 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

Solids	**Eucaliptus wood waste and bark, forest residues**
Particle size distribution	**Fig. 2**
Temperature (°C)	**156**
Actual flow rate (m^3/h)	**422 121**
Normalized flow rate (Nm^3/h_{dry})	**182 295**
Max. dust concentration at inlet (mg/Nm^3_{dry} at 6% O_2)	**21 000**
Max. SiO_2 content in the particulate (%wt)	**29**
Site location	**Outdoors**

System SPECS | Emissions

Expected separation efficiency (%)	**66.3 – 67.2**
Expected emissions (mg/Nm^3_{dry} at 6% O_2)	**7 016**
Guaranteed maximum emissions (mg/Nm^3_{dry} at 6% O_2)	**7 500**
Guaranteed pressure drop at design point (kPa)	**0.8 +/- 0.1**

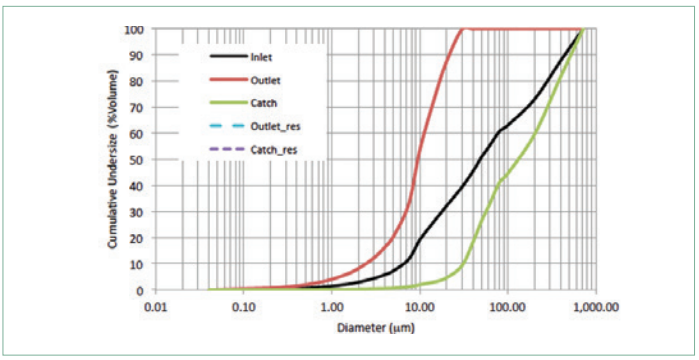


Fig. 2 – Particle size distribution used in simulations

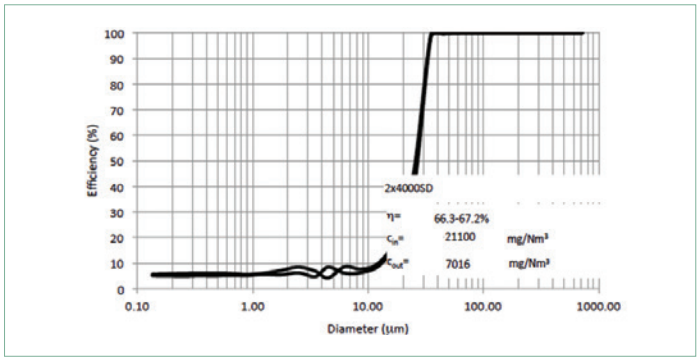


Fig. 3– Predicted max. and min. grade efficiency curves with corresponding global efficiency values.

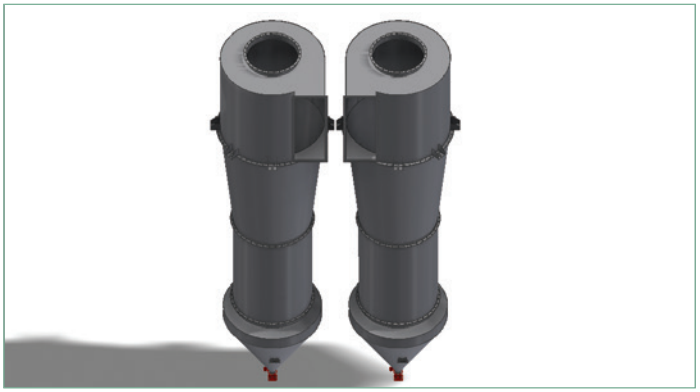


Fig.4 –ACS solution [2 SD ø4000]

Conclusions

The large-scale Hurricane SD cyclones have proven to be an excellent solution. By removing heavy wear particles and abrasive dust upfront, they enable complete flue gas treatment for BFB boilers. When combined with an acid-gas neutralizer and a final baghouse for remaining dust, they prevent excessive wear and clogging in the downstream equipment.