Advanced Cyclone Systems

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 approximately 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, having an installed production capacity superior to 700 thousand tons. With over 50 years of existence, Celbi is a reference producer in the European scene.
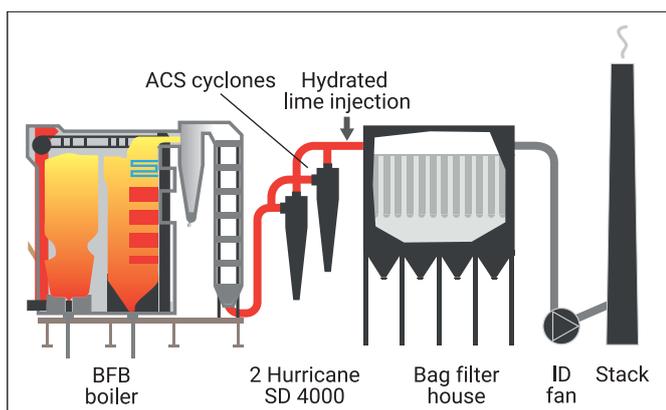

Fig. 1 – Process flow diagram from existing installation

IDENTIFYING THE PROBLEM AND SOLUTION

ACS was challenged by Valmet to design a solution to be integrated 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 ashes and sand particulates. These elements are particularly abrasive and could not be directly treated by the final filter due to high wear and clogging problems. Furthermore, other gaseous effluents as acid gas (HCl, HF and SO_2), needed to be cleaned by feeding hydrated lime. Therefore, the global dry flue gas treatment solution consisted in a 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).

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

The general solution was a **Hurricane 2 SD 4000 cyclone system**: a battery of two SD cyclones with 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 model PACyc
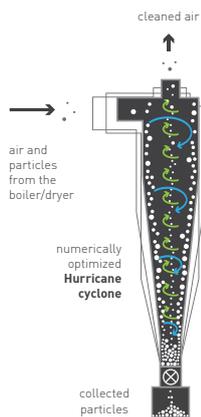
ABOUT HURRICANE CYCLONES

cleaned air ↑

air and particles from the boiler/dryer →

numerically optimized **Hurricane cyclone**

collected particles

Fig. 2 – Hurricane Cyclone

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.3]**
- Temperature (ºC) **[156]**
- Actual flow rate (m³/h) **[422 121]**
- Normalized flow rate (Nm³/h$_{dry}$) **[182 295]**
- Max. dust concentration at inlet (mg/Nm³$_{dry}$ at 6% O$_2$) **[21 000]**
- Max. SiO$_2$ content in the particulate (%wt) **[29]**
- Site location **[Outdoors]**

SYSTEM SPECIFICATIONS | EMISSIONS

- Expected separation efficiency (%) **[66.3 − 67.2]**
- Expected emissions (mg/Nm³$_{dry}$ at 6% O$_2$) **[7 016]**
- Guaranteed maximum emissions (mg/Nm³$_{dry}$ at 6% O$_2$) **[7 500]**
- Guaranteed pressure drop at design point (kPa) **[0.8 +/- 0.1]**
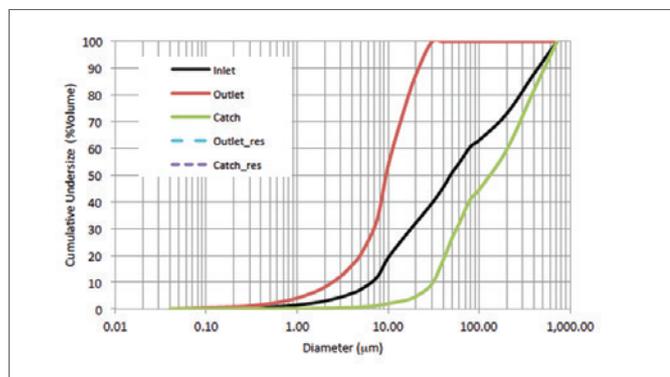

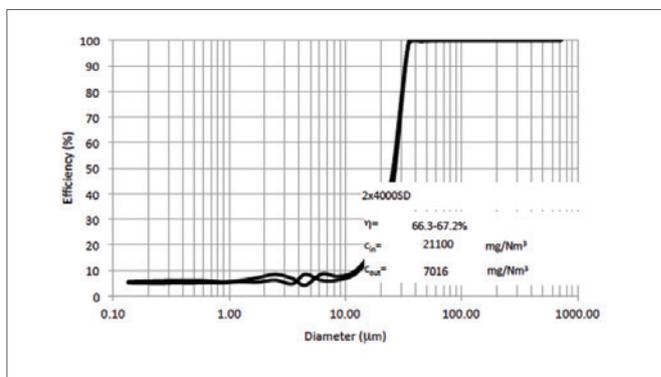Fig. 3 – Particle size distribution used in simulation

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

Fig.5 – ACS solution [2 SD ø4000]

CONCLUSIONS

ACS' solution was installed on the first quarter of 2019 and is running perfectly ever since. After six-month operation, during a programmed stop, inspection to the interior of the cyclones was carried out, to observe the wear protection lining, which was concluded to be in perfect conditions.

The large-scale hurricane SD cyclones is confirmed to be an excellent solution. By pre-separating the heavy wear and abrasive dust, it enables a complete flue gas treatment for BFB boilers, when integrated with the neutralizer for acid gas reduction and a final bag house for residual dust, while saving the latters from wear and blocking problems.