Advanced Cyclone Systems

CASE STUDY

Hurricane and *ReCyclone MH Systems for PM Emission Control on biomass boilers' flue gases*

Total flow 92 132m³/h @ 230°C

FOREWORD

Advanced Cyclone Systems, S.A. (ACS) designed and installed, on a turnkey basis, a *hurricane®* system and a Mechanical ReCyclone (ReCyclone MH) for Particulate Matter (PM) emission control of the flue gases from two biomass boilers. The installation took place in Nelspruit, South Africa, at the wood-based panels plant Sonae Novoboard, owned by **Sonae Indústria (SI).**

Sonae Indústria is one of the largest wood-based panels producers in the world. The product range includes particleboard, MDF (Medium Density Fibreboard), hardboard, OSB (Oriented Strand Board), production and sales of value added products and services - components, solutions and systems - for the furniture, building, decoration and DIY industries as well as production of high pressure decorative laminates and production of chemical products (formaldehyde and formaldehyde based resins).

On December 31st, 2011, SI's workforce numbered around 4,712 employees, on 27 production sites in 7 countries and sales locations in Portugal, Spain, France, Germany, United Kingdom, Canada, Netherlands, Switzerland and South Africa. SI's consolidated turnover totalled 1,364 million euros in 2011.

IDENTIFYING THE PROBLEM AND SOLUTION

The existing boilers (Konus thermal oil heater (KT) running mostly on wood chips and a John Thompson boiler (JT) running mostly on wood waste) had multicyclones (grit collectors) installed, whose efficiencies were not able to meet the newly legislated emission limits (100 mg/Nm³). At the time, emissions were 652 mg/Nm³ and 385 mg/Nm³, respectively, from KT and JT after the multicyclones.

ACS analyzed the case in its PACyc (Particle Agglomeration in Cyclones) model and confirmed that the emission limits could be achieved by installing a *hurricane®* system (prepared with wear resistance features) to replace KT's existing multicyclone and a ReCyclone MH to be installed downstream of JT's existing multicyclone. With this arrangement, ACS models predicted emissions to be significantly below 100mg/Nm³ at the stack.

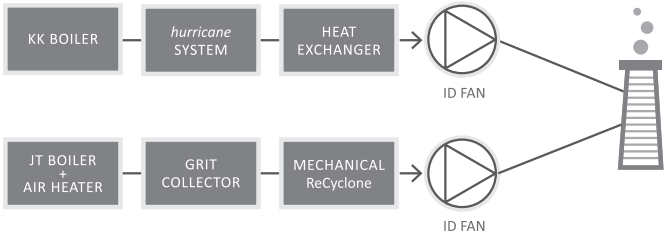

Fig.1 - Process simplified diagram

DESIGN BASIS

KONUS THERMAL OIL HEATER

- Fuel **[Pine wood chips]**
- Type **[Thermal oil heater]**
- Thermal power (MWth) **[2]**
- Particle size distribution of fly ash **[Fig.2]**
- Normal flow rate dry basis (Nm^3/h_{dry}) **[5 561]**
- Actual flow rate (Am^3/h_{wet}) **[12 414]**
- Temperature (ºC) **[230]**
- Site location **[Indoors]**
- Site elevation above sea level (m) **[837]**
- Emissions at 11% O_2 (mg/Nm^3_{dry}) **[652*]**

  (*) downstream boiler

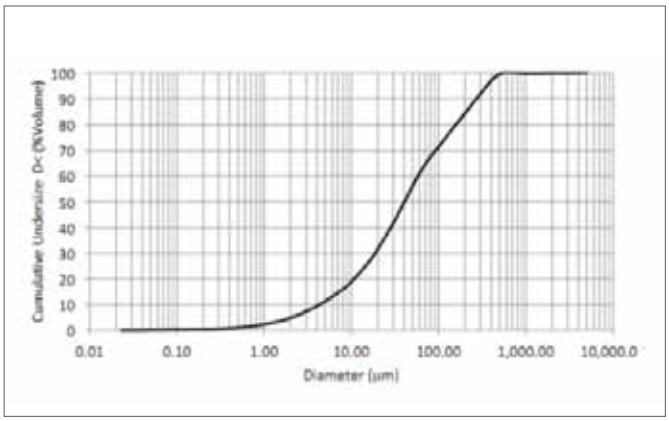

Fig. 2 –Particle size distribution used in simulations for KT (Coulter laser analyser).

JOHN THOMSON BOILER

- Fuel **[Wood chips and waste]**
- Type of boiler **[Multi tubular boiler, grate furnace]**
- Thermal power (MW_{th}) **[NA]**
- Particle size distribution of fly ash **[Fig.3]**
- Normal flowrate dry basis (Nm^3/h) **[35 712]**
- Actual flowrate (Am^3/h) **[79 722]**
- Temperature (ºC) **[230]**
- Site elevation above sea level (m) **[837]**
- Site location **[Outdoors]**
- Maximum emissions at X% O_2 (mg/Nm^3_{dry}) **[385*]**

  (*) Downstream of existent grit collector

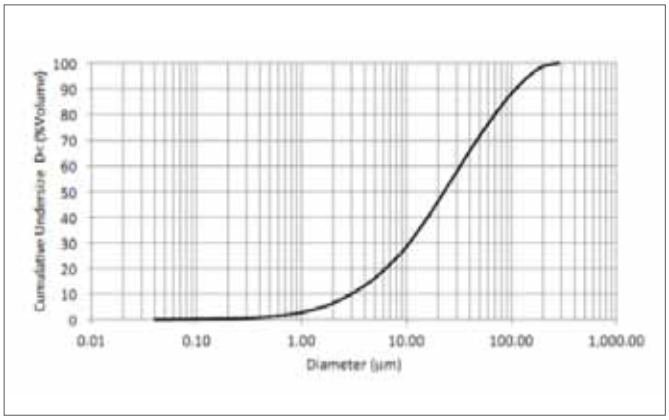

Fig. 3 – Particle size distribution used in simulations for JT (Coulter laser analyser).

RESULTS

KONUS THERMAL OIL HEATER

- Expected emissions at 11% O_2 (mg/Nm^3) **[38]**
- Guaranteed maximum emissions at 11% O_2 (mg/Nm^3) **[100]**
- Expected total pressure drop (kPa) **[1.1]**
- Consumed power of the fan to overcome the pressure drop of hurricane system, at actual temperature (kW) **[5.2]**

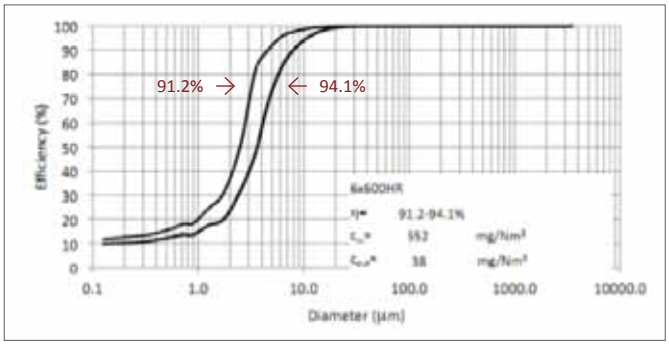

Fig. 4 – Predicted grade and global efficiency for *hurricane* system (KT).

JOHN THOMSON BOILER

- Expected emissions at 11% O_2 (mg/Nm^3) **[29]**
- Guaranteed maximum emissions at X% O_2 (mg/Nm^3) **[100]**
- Expected total pressure drop (kPa) **[1.5]**
- Consumed power of the fans to overcome the pressure drop of ReCyclone MH, at actual temperature:
  - · ID fan (kW) **[45.7]**
  - · Recirculation fan (kW) **[17.2]**

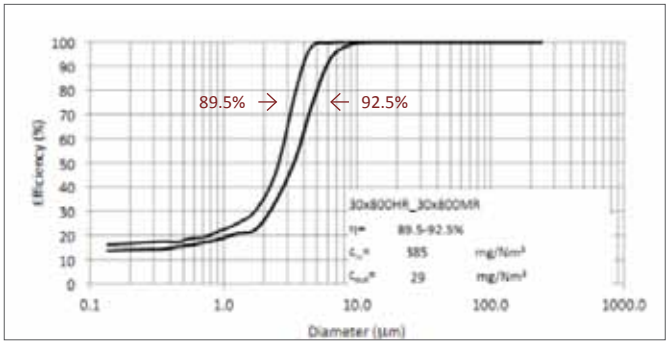

Fig. 5 – Predicted grade and global efficiency for ReCyclone MH system (JT boiler).

GENERAL ARRANGEMENT

The hurricane system for KT is composed of 6 hurricane cyclones with Ø600mm pre-installed in a battery with support structure, hopper and exhaust plenum. Equipment is coated with an inner refractory cement lining for extra protection against abrasion and thermally insulated.

The ReCyclone MH for JT is composed of 30 *hurricane* cyclones and 30 mechanical recirculators, all with Ø800mm disposed in 5 + 5 batteries with support structures (please see next figure). Equipment is thermally insulated. The recirculators are designed to be upgradeable with ceramic insulators and electrodes so that they can be converted into an Electrostatic ReCyclone System if emission limits become more stringent.

Both equipments were supplied on a turnkey basis and ACS' supply included the ductwork with insulation, two lines of redlers to convey the ashes, civil works, and an electric cabinet to monitor and control both systems. The installation included a new ID fan to replace the existing ID fan of the JT boiler.

Fig.6 – Picture of the system.

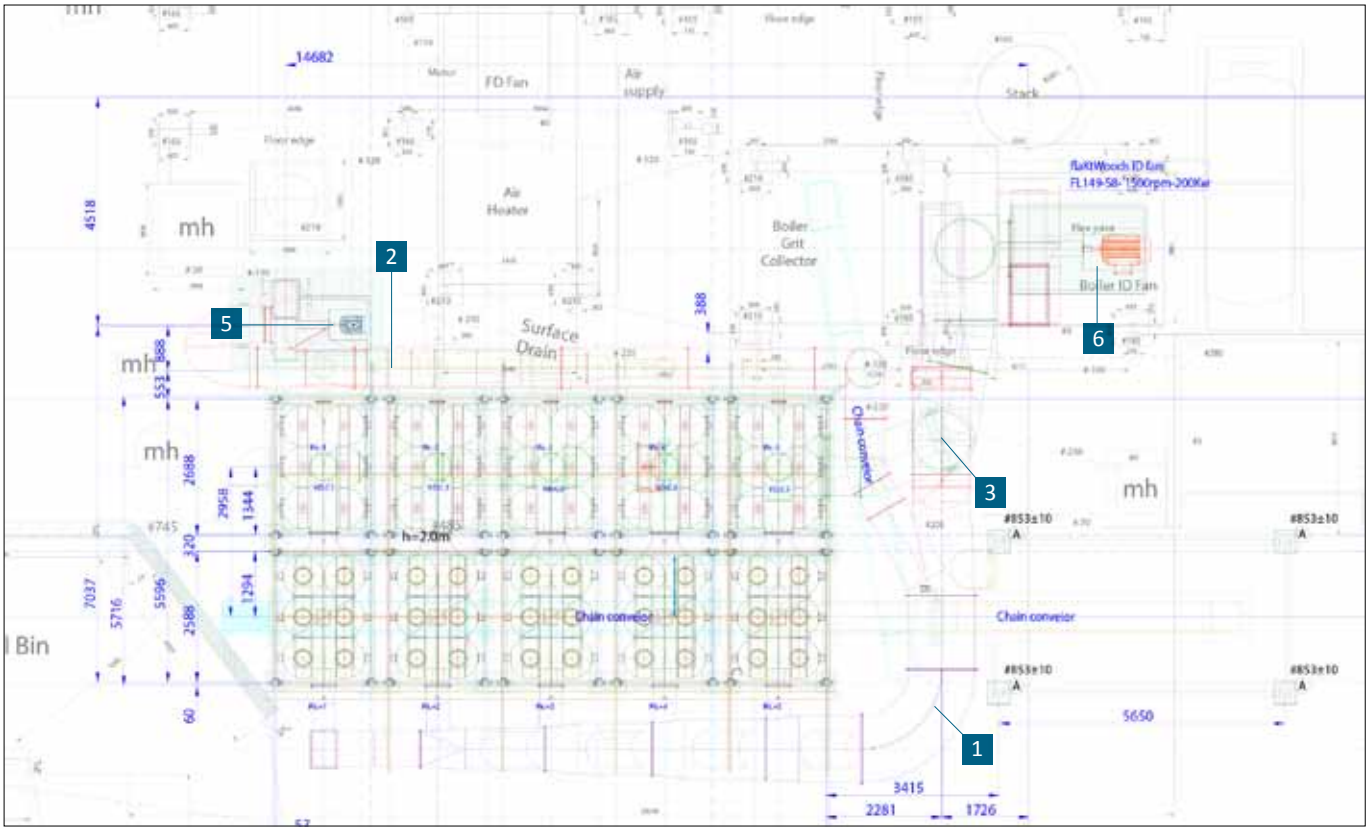

Fig.7 - Drawing of ReCyclone MH System: 1. Inlet Ductwork | 2. Recirculation Ductwork | 3. Outlet Ductwork | 4. Rotary Valves (not visible) | 5. Recirculation Fan | 6.Exhaust Fan

CONCLUSIONS

The *hurricane*® cyclone and the ReCyclone MH installations prove that it is possible to reduce PM emissions of wood chips and waste boilers under 100mg/Nm^3 with optimized mechanical cyclone systems. The client thus avoided investing in systems demanding high maintenance, such as Bag Filters or much more expensive systems such as Electrostatic Precipitators.

In the event the emission limits drop to 50 mg/Nm^3 or even 30 mg/Nm^3, the option to upgrade the system to an Electrostatic ReCyclone will allow these figures to be met.