

ReCyclone® MH_V System

to Reduce Particulate
Matter Emissions from
Palm Biomass Boiler



FOREWORD

LKPP Corporation Sdn. Bhd. is a leading player in Malaysia's thriving palm oil industry, operating the Dominion Square Palm Oil Mill located in Kuantan, Pahang. With a strong presence in the East Coast of Peninsular Malaysia, LKPP manages and operates palm oil processing facilities that contribute significantly to the country's palm oil output – one of Malaysia's key economic sectors.

In line with its commitment to environmental compliance and operational efficiency, LKPP partnered with Advanced Cyclone Systems, S.A. (ACS) to address the challenge of particulate emissions from its biomass combustion process.

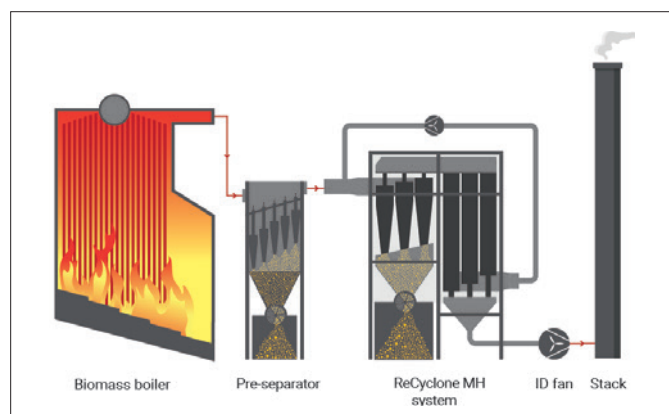


Fig. 1 – Process diagram

IDENTIFYING THE PROBLEM AND SOLUTION

The Dominion Square Palm Oil Mill faced the need to reduce PM emissions from biomass boiler exhaust gases. The boiler, manufactured by Boilmec, combusts a high-dust-load mixture of 80% mesocarp fibre and 20% palm shell, producing a flow rate up to 183 600 m³/h at 320 °C. The ash-laden flue gas carried significant levels of fine particulates, with typical emissions reaching 400 mg/Nm³ at 12% CO₂ – above regulatory thresholds.

ACS proposed a ReCyclone® MH_V System, which combines 32 Hurricane® numerically optimized cyclones (Ø1000mm) with 32 compact V-Type mechanical recirculators, specially developed to reintroduce fine, uncollected particles into the cyclones for enhanced separation. This purely mechanical solution avoids the complexity of electrostatic or wet systems and is particularly well-suited for high-temperature and high-dust-load environments like palm oil mills.

Thanks to the recirculation effect and agglomeration mechanism, the ReCyclone® system enhances particulate capture, achieving emission reductions of 40–60% compared to cyclones alone, with no moving internal parts and minimal space requirement.

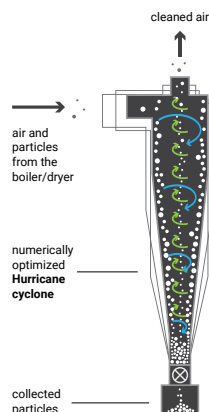


Fig. 2 – Hurricane cyclone

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 (Fuel and Operating Conditions)

- Fuel **[80% mesocarp palm fibre*, 20% palm shell**]**
- Gas temperature ($^{\circ}\text{C}$) **[320]**
- Max. actual flow rate ($\text{m}^3/\text{h}_{\text{Wet}}$) **[183 600]**
- Moisture content in flue gas (%) **[20.4]**
- Moisture content (% H_2O v/v) **[20]**
- Site location **[Outdoors]**

* $\leq 40\%$ moisture ** $\leq 15\%$ moisture

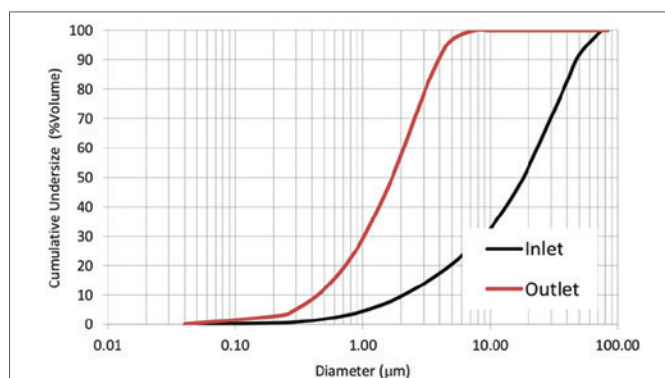


Fig. 3 – Particle size distribution used in simulation

EMISSIONS AND PERFORMANCE TARGETS

- Inlet emissions (mg/Nm^3 at 12% O_2) **[400]**
- Guaranteed outlet emissions (mg/Nm^3 at 12% O_2) * **[150]**
- Expected outlet emissions (mg/Nm^3) **[<100]**
- Pressure drop across system (kPa) **[1.56]**
- Recirculation flow rate (%) ** **[29]**

*for both nominal and maximum loads ** for nominal load

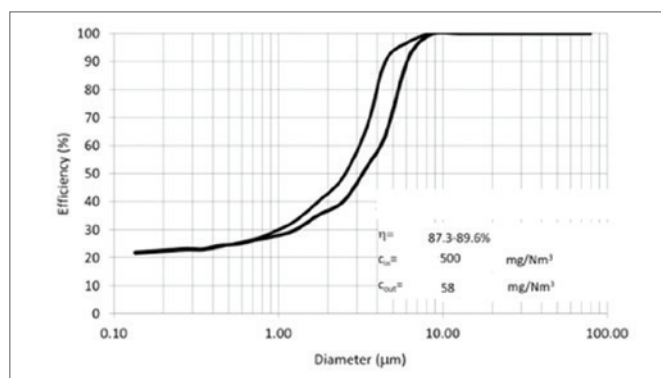
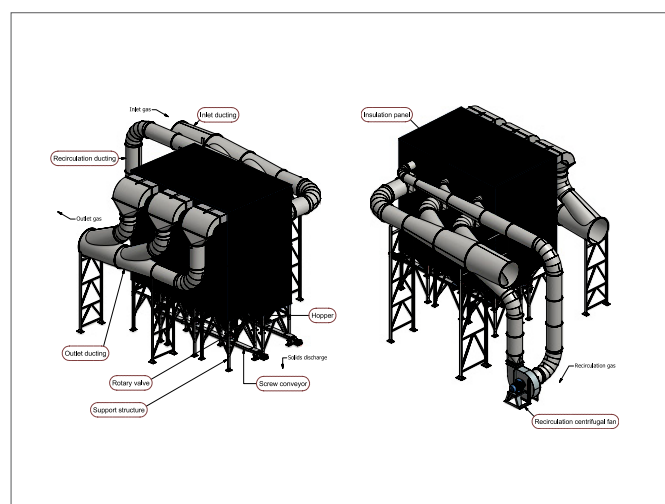


Fig. 4 – Predicted maximum and minimum grade efficiency curves with corresponding global efficiency values

Fig.5 – ACS solution [32 HR $\phi 1\ 000$ + 32 compact V-Type mechanical recirculators]

CONCLUSIONS

The ReCyclone® MH_V system was successfully installed and commissioned at the Dominion Square Palm Oil Mill, with full mechanical and electrical supervision from ACS in collaboration with O'REC IND SDN. BHD., ACS's representative in Malaysia. The system was pre-assembled for simplified on-site installation and integrated seamlessly with the existing boiler and multicyclone configuration.

Initial performance measurements confirmed that particulate matter emissions were brought safely below $150\text{ mg}/\text{Nm}^3$, fully meeting Malaysian environmental standards. The robust operation of the system – even under fluctuating loads – demonstrates the effectiveness and reliability of ACS's mechanical dust collection technology.

LKPP's investment in ACS's solution not only ensures regulatory compliance but also contributes to reduced maintenance and enhanced efficiency of the downstream equipment, reinforcing the company's commitment to sustainable and responsible industrial operations.