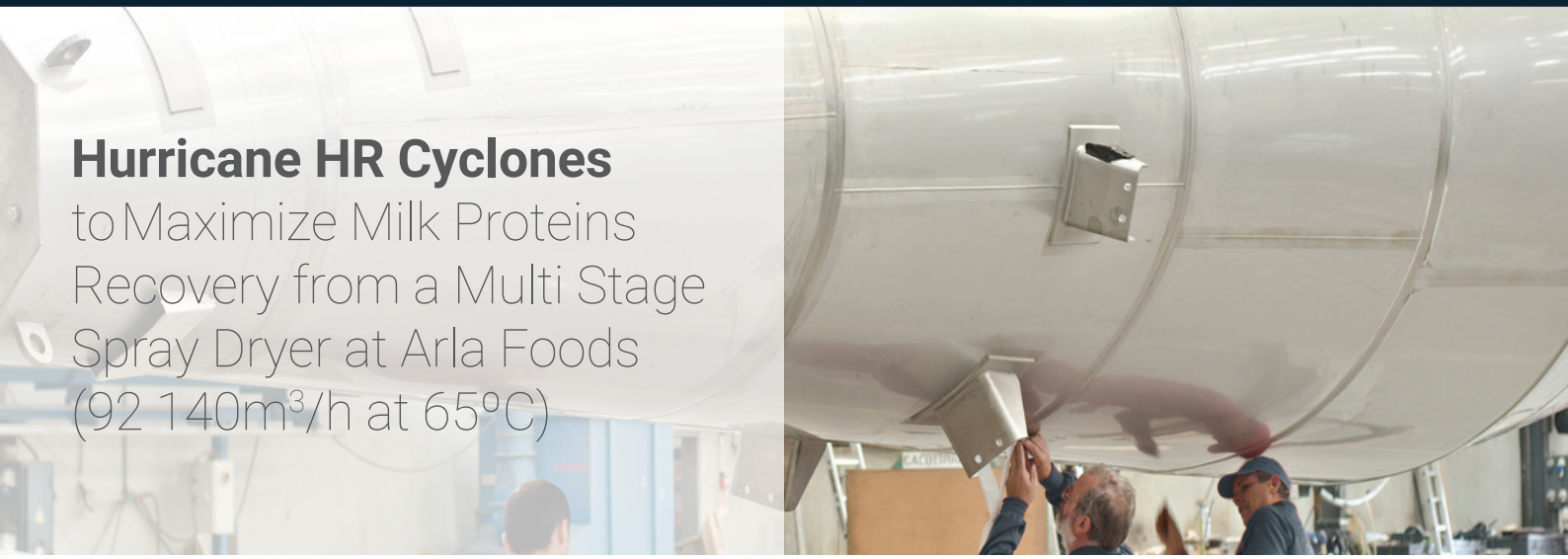
Advanced Cyclone Systems

EMISSION CONTROL

CASE STUDY

Arla Foods | Holstebro, Denmark | 2012



Hurricane HR Cyclones to Maximize Milk Proteins Recovery from a Multi Stage Spray Dryer at Arla Foods (92 140m³/h at 65ºC)

FOREWORD

Advanced Cyclone Systems, S.A. (ACS) designed and supplied a Hurricane Cyclone System to maximize milk proteins recovery from a multi stage (MSD) Niro spray dryer for **Arla Foods** in Holstebro, Denmark. Arla Foods is a global dairy company and a co-operative owned by dairy farmers, with production facilities in 13 countries and addicional sales offices in 20 more countries, with a total of more than 19,000 employees. Products are sold under the well-known brands Arla®, Lurpak® and Castello® in over 100 countries. The net turnover in 2011 was DKK 64 billion (including turnover from MUH and Milk Link), with 12 billion kg milk sold.

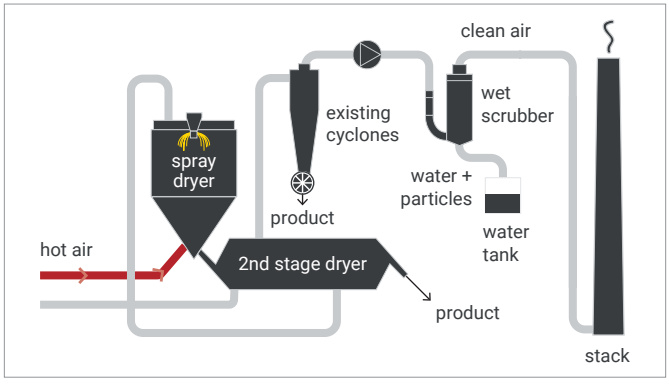


Fig. 1 – Existing process scheme

IDENTIFYING THE PROBLEM AND SOLUTION

The existing cyclones installed on the MSD Spray Dryer 3 (SD3) provided a 96.9% capture efficiency (emissions of about 500mg/Nm³). The remaining product (emissions from existing cyclones) was being lost, captured in a wet scrubber installed downstream (Fig. 1).

Total annual losses reached 320 tons of caseinate per year, estimated in several millions of Euros.

In order to design the most efficient system for this case, a dust sample was collected from the existing cyclones, either from powder discharge as from gas outlet and measured in a laser sizer to obtain the Particle Size Distribution (PSD). With the information of the recovery rate of the existing cyclones and of the current emissions, ACS could reconstruct the PSD and solids concentration (in mg/Nm³) at the exit of the dryer (Fig. 3).

ACS further analyzed the case and confirmed that the separation efficiency could be increased with two new numerically optimized cyclones (hurricanes). ACS efficiency model predicted a global collection efficiency of approximately 98.9-99.27% (Fig. 4) for the hurricanes, at the same operating conditions and pressure drop.

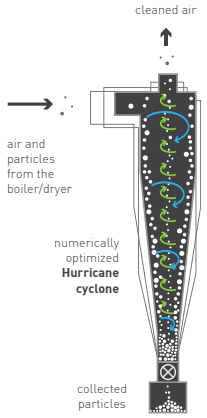


Fig. 2 – Hurricane Cyclone

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 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 recenet 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.

For more information please visit our website: www.acsystems.pt

DESIGN BASIS

- Powder **[Milk Proteins]**
- Particle size distribution **[Fig. 3]**
- Site location **[Indoors]**
- Actual flow rate (Am^3/h) **[92 140]**
- Temperature (ºC) **[65]**
- Inlet concentration, dry basis (mg/Nm^3) **[16 928]**

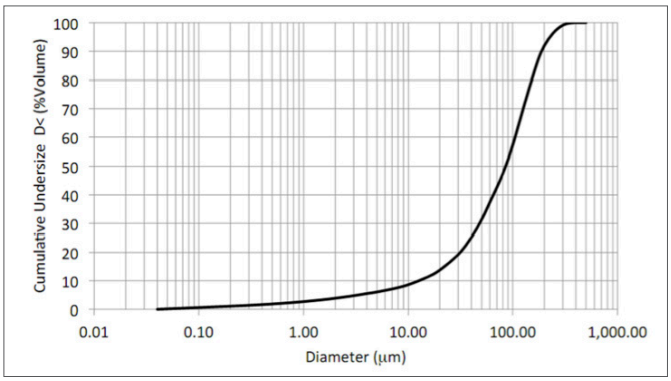


Fig. 3 - Particle size distribution used in simulations (Coulter)

RESULTS

- **Previous situation as reference:**
  - Separation efficiency of existing cyclones (%) **[96.9]**
  - Emissions of existing cyclones (mg/Nm^3) **[500]**
- **Expected results:**
  - Predicted efficiency with new Hurricane cyclone (%) **[98.9-99.27]**
  - Expected total pressure drop (kPa) **[1.9 +/- 20%]**
  - Expected emissions (mg/Nm^3) **[117-156]**
- **Verified results:**
- Measurements confirm a 70% reduction of emissions and an efficiency over 99.1%

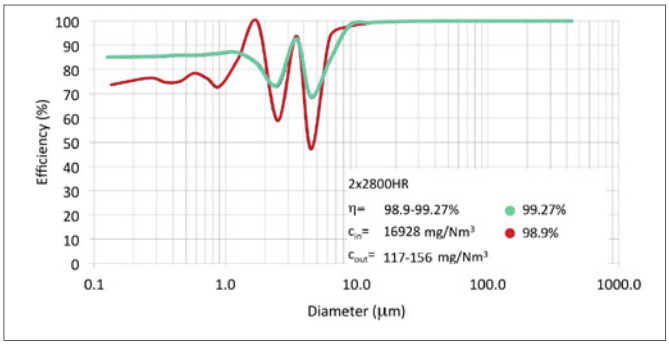


Fig. 4 – Predicted maximum and minimum grade efficiency curves with corresponding global efficiency values

GENERAL ARRANGEMENT

The system is composed by 2 Hurricane cyclones ø2800mm installed in parallel, each one with a hopper for rotary valve air lock, 2 inspection doors on top and CIP nozzles for automatic cleaning. All equipment was manufactured in stainless steel AISI 316L with food grade finishing.

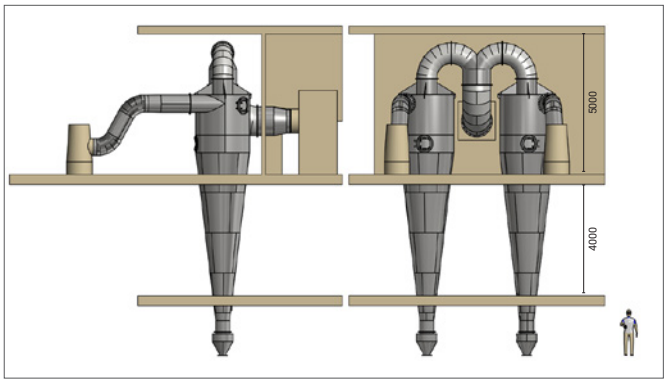


Fig. 5 – General arrangement drawing

CONCLUSIONS

The separation efficiency predictions matched the experimental results. The improved separation efficiency of the Hurricanes provided a reduction of product losses of about 70% resulting in considerable savings for the company.

The success verified in this installation, lead to another supply of 2 Hurricane cyclones (HR ø2100mm designed for 57 878m^3/h at 75ºC) for another spray dryer at the same production facility.

ADDED VALUE FOR ARLA CAN BE CALCULATED BY THE REDUCTION IN LOST CASEINATE TO THE WET SCRUBBER (WHICH DAMAGES THE POWDER). THE ESTIMATED TOTAL INVESTMENT OF 0,6M€ BY THE CLIENT HAD A PAYBACK OF 6 MONTHS.

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OPERATING CONDITIONS & REFERENCE COSTS:

Average Flowrate [Am³/h]:	92 140
Average Flowrate [Nm³/h]:	67 580
Powder concentration into cyclone [mg/Nm³]:	16 928
Caseinate Reference Cost [€/kg]	5,5

POWDER RECOVERY COMPARISON:

	Cyclone dryer from supplier	With ACS
Average pressure drop [kPa]	1,5	**1,5**
Collection efficiency [%]	96,9	**99,1**
Powder losses [%]	3,1	**0,9**
Emissions [mg/Nm3]	525	**152**
Losses per year @ 360 days operation [kg/year]	306 407	**88 957**
Losses per year @ 360 days operation [€]	1 685 241€	**489 263€**
Total Savings per Year [€]		**1 195 977€**

