



**HURRICANE SYSTEMS
FOR PRODUCT RECOVERY**



Advanced
Cyclone
Systems

THE PROBLEM WITH EFFICIENT POWDER RECOVERY



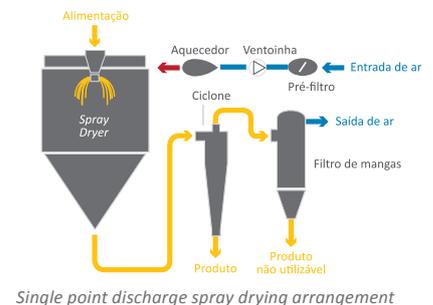
© Courtesy Hovione

Efficient recovery of **Active Pharmaceutical Ingredients (APIs)**, **chemical substances** and **food powders** after drying applications, such as spray and fluid bed drying, is frequently a problem. **Powder losses** also occur in milling, micronization and tablet pressing applications. To recover these sensible products, cyclone collectors are frequently mandatory, as they allow for a direct powder capture, avoiding product holdup of filters. That means also no contamination of filter fibers, product cross contamination and product degradation with temperature. However, cyclones' low efficiency results in economic losses due to the high value of the powder. Where applicable, cyclones have to be complemented with expensive "food grade" bag filters to increase yield or to avoid emissions to the atmosphere.

A Typical Spray Drying Arrangement

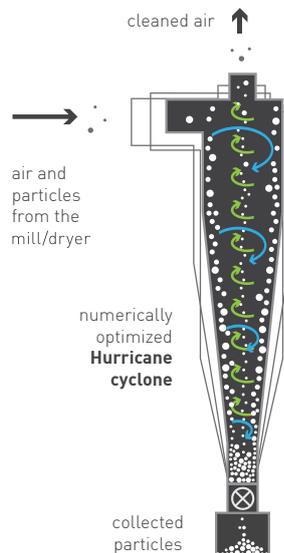
Usual spray drying arrangements (single point, two point and closed cycle) include a high efficiency cyclone and/or a bag filter. The cyclone serves the purpose of separating and collecting the dried powder originated in the spray drying chamber. In pharmaceutical powders and in many food ingredients, the fraction of product escaping to the bag filter is not considered 1st grade product, but as loss.

For fine powders with a median volume diameter (MVD) of less than 5 μm , losses due to low cyclone efficiency can rise to more than 25 %.



Single point discharge spray drying arrangement

THE SOLUTION WITH A NEW APPROACH TO CYCLONE DESIGN



Understanding how cyclones work

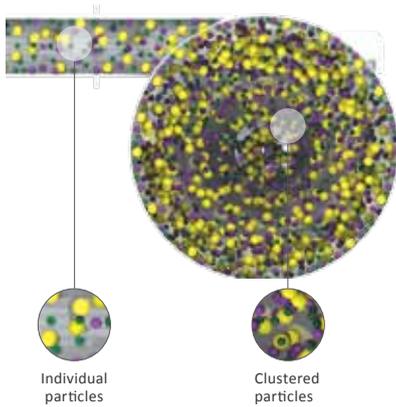
The separation dynamics inside a cyclone is very difficult to model. Cyclones are usually designed empirically or, less often, according to models which do not consider the interparticle agglomeration inside the cyclone. ACS has developed its own unique model for cyclone efficiency prediction which takes into account agglomeration in turbulent flow fields – **The PACYC MODEL (Chemical Engineering Journal 162 (2010) 861–876).**

Optimizing cyclone efficiency

Supported by the PACyc Model, ACS can rapidly generate millions of virtual prototypes (cyclone geometries) and, through numerical optimization, select the best geometry for each given case. The design takes into consideration several economical and operational constraints, such as size, pressure loss or manufacturing cost.

ACS Hurricane HR cyclones have demonstrated to be more efficient than any other known cyclone available in the marketplace for the same pressure drop and manufacturing cost.

ACS' competitive advantage is sustained by a unique ability to **accurately estimate – and consequently guarantee – a requested efficiency**, resulting in better cyclones, tuned for their specific application. Two cyclone geometries are exemplified ahead for a API spray drying case.



hurricane MK

THE AGGLOMERATOR CYCLONE

The new agglomerator cyclone

In 2014, a better understanding of agglomeration has allowed ACS to develop a completely new line of cyclone geometries, different from any other in the world: the **Hurricane MK**. It was obtained by combining stochastic numerical optimization with the PACyc model and it represents a giant leap in terms of efficiency.

Hurricane MK cyclones, once adjusted for a particular process, maximize particle agglomeration. For clustering favourable PSDs, as powder milk and several APIs, emissions can be further reduced in up to 75%, when compared with a Hurricane HR

TECHNOLOGY COMPARISON

Comparison of Fine Powder Recovery Technologies	High Efficiency competitor Cyclone	Hurricane Cyclone HR	Bag Filter	Hurricane Cyclone MK	
Efficiency (%)	83	96	>99	99	Maximize Powder Recovery
Product Losses (%)	17	4	<1	1	
Use of Separated Product	First Grade	First Grade	Second Grade	First Grade	Improve Powder Quality
Sanitary Conditions	Very Good	Very Good	Less Good	Very Good	
Restricted Applicability due to Temperature?	No	No	Yes/powder degradation	No	
Cleaning	Suitable for CIP	Suitable for CIP	Difficult	Minimal	
Investment Costs	Low	Low	High	Reasonable	Minimize Total Cost of Ownership
Maintenance & Operating Costs	Minimal	Minimal	High	Minimal	
Auxiliary Equipment Needed?	None	None	Compressed Air	None	

Performance of different equipments for the collection of an Active Pharmaceutical Ingredient for the same pressure drop.
Median Particle Size in Volume (MVD) = 5,5µm; 7% submicrometer; $\rho = 1,680 \text{ kg/m}^3$ | Inlet Concentration: 3,5 g/m³



Hurricane MK cyclone designed for API inhalable powder recovery on a GEA Niro SD Micro spray dryer, processing 39 m³/h @ 165°C. MVD=1.7µm| ρ =450kg/m³.
Efficiency: > 75%

Mankind Pharma | USA



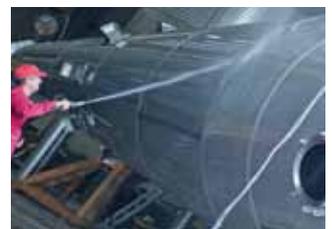
Hurricane HR optimized cyclone for API recovery after a mixer with 3,400 Am³/h flow rate @ 75 °C. The cyclone is ø 800 mm, manufactured in AISI 316L under the most strict pharmaceutical quality standards.
Expected efficiency: 98.6-98.8 %

Merck | France



3 **Hurricane HR** cyclones, ø 1,000 mm, designed for increasing fat powder recovery. Design flow rate 4,875 m³/h @ - 5.5 °C, 180 mm w. g..
Efficiency: 99,94 % collection

Confidential | UK



Hurricane HR system aiming to increase the recovery of milk proteins' powder after a spray dryer. The equipment is composed by 2 cyclones and has a capacity of 92,000 m³/h @ 65 °C effective flow rate.
Expected efficiency: 99.4-99.8 %

Arla Foods | Scandinavia

ABOUT ADVANCED CYCLONE SYSTEMS

Advanced Cyclone Systems, S. A. (ACS) is a company exclusively dedicated to the development of high efficiency cyclone systems worldwide. ACS' mission is to achieve total particle capture exclusively with cyclone systems through continuous investment in Innovation and R & D.

Numerically optimized cyclones (Hurricane) and ReCyclone® systems contradict the general thinking that cyclones are inefficient powder collectors. These cyclone systems can replace bag filters in many demanding operating processes.



PHARMACEUTICAL INGREDIENTS **CHEMICALS** FOOD INGREDIENTS **NANOPARTICLES** MINERAL PROCESSING **FERTILIZERS**
CATALYSTS **MILLING AND DRYING PROCESSES**

Advanced Cyclone Systems

Development, Commercialization and
Installation of Industrial Filtering Systems

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