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Reducing pressure loss

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(= company name before 1st June 2005).

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Reducing pressure loss

Dr Günther Schwaiger, Zyklontechnik, Austria

Reducing pressure loss, providing for enhanced energy savings and improving separation efficiency with the HURRICLON system have all been proven. In this latest report, Dr Schwaiger, of Zyklontechnik, Austria, looks at some of the basic design principles and outlines some of the latest successful operational results.

The most important dimensional factors in centrifugal separators are the throughput volume, the pressure loss and the degree of fraction separation. Of these, pressure loss increasingly constitutes the most significant economic element, both in existing plants and newly designed centrifugal separators. In particular, the dip tube and the intake form both have a decisive effect on flow behaviour.

The reason for the economic significance of this measure is primarily because during the service life of the separator, around 90 per cent of total costs derive from the energy required to compensate for pressure losses.

The problem in state-of-the-art cyclones is that better fractional separation efficiencies can be achieved parallel with increased pressure drops, while in low pressure cyclones also, the fractional separation efficiencies are decreased. That means that the economic performance with low pressure losses is, in certain cases, contrary to the required high separation efficiency. In many practical cases, both aims ie low pressure drop and high efficiency, cannot be realised with conventional cyclones.

The Hurriclon principle

With the HURRICLON principle, two essential constructive developments both can be achieved: high separation efficiency combined with reduced pressure losses.

Double dip tube: With the double dip tube principle, the cleaned gas stream leaves in conventional cyclones by the dip tube in the top of the cyclone. The Hurriclon guides divide the cleaned gas stream into two parts. Whereas one part leaves by the dip tube on the top, the second part is exiting via the dip tube on the bottom side of the Hurriclon. With the same comparable outside diameter, the double gas stream can be put through at the same pressure drop level compared of a normal cyclone. Furthermore, the gas streams are exactly defined which again positively influences the separation efficiency.

Hurriclon vortex finder vanes

This system is a simple tube, which takes in the gas flow just within the dip tube radius where the flow losses are small, and creates a favourable flow path into the exhaust itself. During recent comparative testing, the new, low-resistance value for the exhaust flow was established and then implemented in accordance with the model laws in the actual large-scale sizes, required under practical operational conditions. Operational measurements confirm the fundamental information gathered during comparative testing and are thus the springboard for the new technology demonstrated under practical conditions (Figure 1).

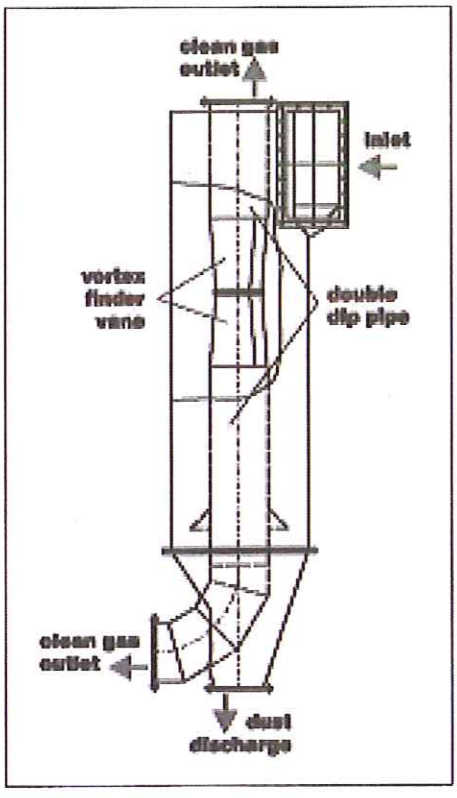
The HURRICLON with double dip pipe and 2-unit vortex finder vanes provides up to 50 per cent pressure loss reduction and improved efficiency.

Operational results summary

Five projects have been specifically studied where HURRICLON or HURRICLON vortex finder vanes have been installed.

- two at Dyckerhoff Zement Gmbh. Göllheim plant
- one at Lafarge Perlmooser Zementwerke AG, Mannersdorf plant
- one at the plant of Cementos Hispania in Yeles, Spain.
- one at Wietersdorfer Zementwerke in Austria

Below: Hurriclon with vortex finder vanes (VFV)/Zeichnung Hurriclon



Application	Deciding criteria
Raw meal grinding:	Less kW/h per tonne
Preheater:	Less kW/h per tonne and less kcal/ kg clinker, increased production
Clinker cooling dedusting:	Less residual dust, less wear after cyclones
Dedusting before coal mill	Less residual dust, more efficient coal burning and better clinker quality

Table 1: Applicationsof HURRICLON technology in the cement industry

Project 1: ***Dyckerhoff Zement GmbH Göllheim plant, Germany.***
Preheater: optimisation of the cyclone intake configuration and retrofitting of the preheater at kiln No 2, stage 1, with the HURRICLON vortex finder vanes.

Kiln No 2: Rotary kiln with 4-stage preheater, kiln 4.4 m diameter x 71 m long, capacity approximately 1800tpd, installation 1965.

In 1991, the cyclones in stage 1 were modernised, but no results regarding pressure loss reduction could be achieved.

In 1996, stage 1 was modernised using the HURRICLON vortex finder vanes. The good results in Kiln No 1's preheater have influenced the decision to introduce the same technology in the Kiln No 2 preheater. The pressure drop in stage 1 had been 30mbar. The original constructor of the preheater had also performed some modernisation work on this stage.

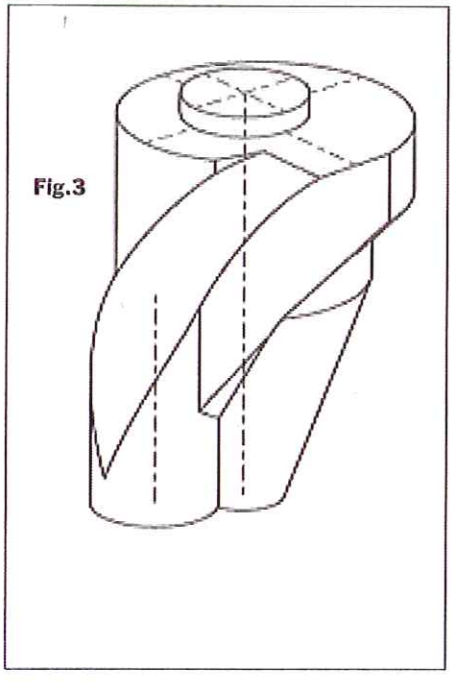


Fig.3

The biggest effect in pressure loss reduction could be achieved by introducing HURRICLON vortex finder vanes in combination with optimisation of the entrance part of the cyclone. Reduction of pressure loss of more than 15mbar could be achieved in this stage after project realisation. The pressure loss after installation had been 14mbar, 16mbar less than before.

Table 2

	Before modernisation		After modernisation			
	Pressure loss mbar	Residual dust	Pressure loss mbar	Reduction in %	Residual dust	Energy savings per year (kWh)
Project 1	30	30-35g/Am^3 82g/Nm^3	14	53	30-35g/Am^3 82g/Nm^3	1.6 million (kWh)

Operational review

In Project 1, for the first time, a cyclone intake was designed in accordance with the demand that an optimum uniform distribution of the rotation flow had to be achieved in the separation chamber above the cyclone level. At 23-35 metres/sec, the intake velocity is extremely high, as the existing cyclone was relatively small.

This project demonstrates that if the flow guidance is in order, then, despite the highest intake speeds, pressure losses are not astronomic. The measured pressure loss is divided 66 per cent in the cyclone and 34 per cent in the offtake pipe. In case of normal intake speeds and cyclone sizes, pressure losses of half of this size can be expected, as evidenced in Projects 1 and 3. In these, the intake design was not altered, as the initial situation was perfectly acceptable.

The effect on separation caused by the retention of the dip tune diameter is negligible. Measurements taken during all application show that residual dust levels are the same as in cyclones without the HURRICLON vortex finder vanes. Although in theory an improvement with the guide device could be anticipated due to the avoidance of peak flows in the vicinity of the edge of the dip tubes, the computer programs indicate the effect on separation performance can only be in the tenths of a percentage range.

It has also been shown in extensive laboratory testing that for optimum overall function, the design of the dip tube intake is of even greater importance than was previously thought. However, under practical conditions, it has long been established that especially unfavourable intake designs caused marked increases in pressure loss in the intake area, and these were then removed by geometrical optimisation.

Project 2: ***Cementos Hispania - Yeles, Spain***
Preheater: optimisation of riser pipe and cyclone intake situation in a preheater with five top cyclones and retrofitting the preheater cyclones with HURRICLON vortex finder vanes.

In this case, the pressure drop before the modification had been in the cyclones about 16mbar. After modification, the pressure drop in the cyclones had been reduced to about 50 per cent, but parallel increasing the raw mill feed by about 18 per cent, having the same fan consumption after the modification. If the volume stream and raw mill feed would have remained on the same level as before, the pressure drop would have been after modification about 7mbar, that means almost 60 per cent less then before.

Whereas in Project 1 the mill used the pressure drop reduction mainly for saving energy, in this case, the mill essentially uses the same

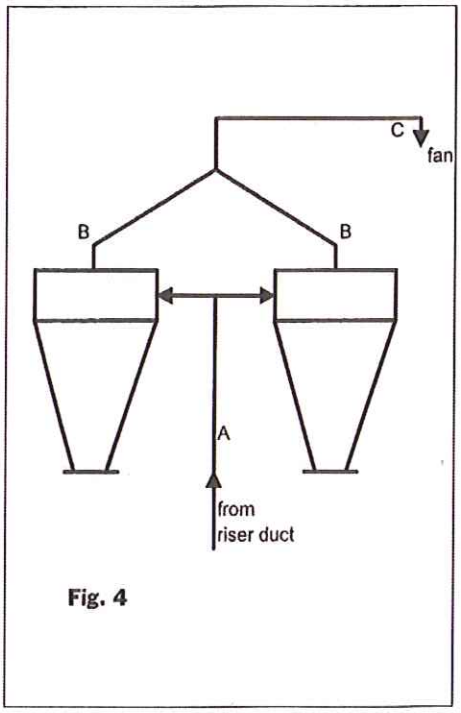


Fig. 4

finder vanes to achieve optimal results.

Project 4 + 5: results obtained with a HURRICLON centrifugal separator when dedusting the grate cooler exhaust air in Dyckerhoff AG Lengerich Cement works and Wietersdorfer Cement works in Austria.

In both cases the multicyclone systems for dedusting the grate cooler exhaust air have been replaced by plants using HURRICLON centrifugal separators. In both plants the wear in the multicyclone system had been considerable. This was the reason new solutions for this application needed to be found.

With the HURRICLON principle, two essential developments both can be achieved: high separation efficiency combined with reduced pressure losses.

precise specification. This governs whether a high or low centrifugal force field is used for the separation, and whether each separator can handle a gas flow of 20,000 or 40,000 m^3/h.

As a rule, 2 to 6 HURRICLON centrifugal separators are used for cooler exhaust air volumes of 80,000 to 40,000 m^3/h. It can be cost-effective to use dust extraction gates under each separator unit as this guarantees reliable plant functioning and eliminates any disruptive effects in the area of the dust discharge device. With this type of plant layout the residue in the particle size range larger than 15µm can be kept very small, causing only a small amount of wear on the downstream sections of plant. With 2 to 6 HURRICLON centrifugal separators it is also economically justifiable under these conditions to use appropriately wear-resistant materials to achieve long service lives.

The substantially simpler structure of the separating system makes it simple to check the conditions of the plant. The maintenance costs can be considerably reduced as there is no need for continuous maintenance.

Table 3

	Before modifcation		After modification		Difference	Theoretical	Difference
Raw meal feed (tph)	56		66		+18%	56	0
Fan consumption (kW)	524		513			374	-150
Manual measurement of static pressure							
	[Pa]	[%]	[Pa]	[%]	[%]	[Pa]	[Pa]
A (before cyclones)	-3150	basis	-4000	basis	-58%	-3150	
B (after cyclones)	-4780	+52%	-4860	+22%		-3827	
Pressure drop	1630		860			677	-953

for increasing raw mill feed and production. This project was realised in January 1998.

Project 3: *Lafarge Perlmooser Zementwerke AG Mannersdorf Plant Austria*

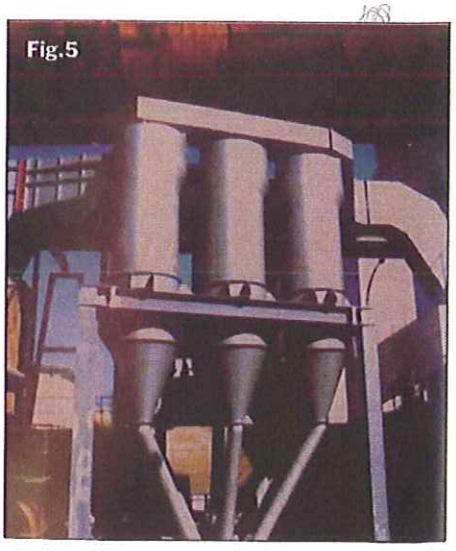
Raw mill: Introduction of vortex finder vanes in 4 raw mill cyclones. In this project the cyclone intake had been of optimum design which helped the Hurriclon vortex

Meeting the requirements of the Hurriclon centrifugal separator

It is basically possible to reach the required separating performance with the Hurriclon twin outlet duct principle by using high swirl velocities. The effect on the downstream plant and the dust loading in the clean gas, is of prime importance for a more

Operating results

A new HURRICLON dedusting system was installed in Dyckerhoff AG's Lengerich cement works in 1994 to replace the existing multicyclone system. The system was designed for a nominal air flow of 120,000 m^3/h at 350°C. The old multicyclone system was worn out and had to be replaced. When the HURRICLON centrifugal separator system was being designed, particular emphasis was placed on achieving the highest possible separation efficiency in order to increase the service life of the fan.



	Before modernisation		After modernisation			
	Pressure loss mbar	Residual dust	Pressure loss mbar	Reduction in %	Residual dust	Energy savings per year
Project 3 Mannersdorf plant	14	44g/Am³	7	50	36g/Am³	750,000 kWh

Parameter	Units system	Multicyclone system Lengerich	Hurriclon® system	Multicyclone system Wietersdorf	Hurriclon® system
Volume throughput	m^3/h	120,000	120,000	100,000	100,000
Dust loading	g/m^3	5	5	5	5
Pressure drop	Pa	550	450	600	500
Main dimensions	mm	3000 x 4000	6 x Ø 1320	2000 x 4000	3 xØ1590
D97 residual dust carry-over	µm	40-50	15-20	35-45	20-25
Residual dust quantity	mg/m^3	500	100-200	700	200-400
Clinker throughput	tpd	1500	1500	1200	1200
Separation efficiency	%	90	98	85	96

Table 5: Comparison of the technical parameters of conventional multicyclone systems with those of HURRICLON dedusting systems in the Lengerich and Wietersdorf cement works

A reduced pressure drop was also achieved by fitting an inlet guide device to the outlet duct. Under these conditions it was not necessary to alter the performance of the radial fan.

Using similar criteria, the existing multicyclone system with about 100 cyclone inserts downstream of the clinker cooler in the Wietersdorf cement works was also replaced in 1994 by a Hurriclon dedusting system designed for a nominal air flow of 80,000 m^3/h. Here again, the prime object was to improve the separating efficiency with reduced pressure drop and to achieve a slightly increased gas flow without changing the characteristic curve of the radial fan. This problem was solved by using three HURRICLON separators, each designed for a volume throughput of 25,000 to 35,000 m^3/h.

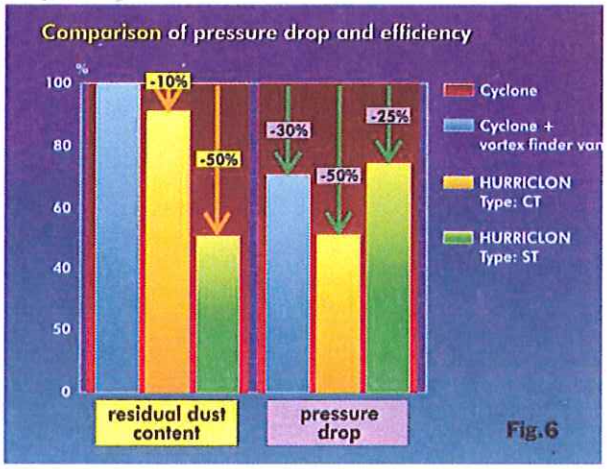


Fig.6

Summary

Comparison of efficiencies and separation between state-of-the-art cyclones and Hurriclon can be seen from the chart opposite.

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