Tailor-made HEAVY DUTY DAMPERS allow reliable and cost-effective operation

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Giornata di Studio: Valvole di intercettazione e di regolazione e relativi attuatori per l'industria di processo
Milano 8 luglio 2015

ABSTRACT

Among valves' world, Heavy Duty DAMPERS are largely used as isolation and regulation devices in process plants, facing specific operating conditions and design parameters that differentiate them from standard valves.

Plant Owners and Operators keep on pushing the requirements on Dampers, for example asking for *better performance, increased reliability* and *low maintenance*, as well as *low initial cost*.

This turn out as the need for **continuous innovation**, performed on fabrication of single piece equipment (tailor made) usually with limited time for development.

To answer these requests, the Manufacturer need to combine its previous experience in many different fields and different technologies with significant flexibility in design and fabrication activities.

The key studies we're going to show
are examples of this process and of the possible achievements for the Customer.

Heavy duty dampers are largely used as isolation and regulation devices in process plants, facing specific operating conditions and parameters.

Among industrial isolation and regulation devices (cumulatively called “valves”) the name of “dampers” is used whenever the construction form is not comparable to standard types or normalized sizes.

Standard Valves are typically high pressure devices installed on process piping (by flanged or welded connection), therefore in most cases built in circular shape and in comparatively small nominal bore dimension.

Valves’ body size and shape is normally dictated by functional requirements and usually seen by Customers as components with limited choices allowed, mostly in the form of “off-the shelf” equipment (for example std body).

Valves’ fabrication is usually based on standardization, for example based on few technologies of main body (e.g. casting, forging and machining of metal pieces)

That’s not the case for Dampers

Dampers are not confined to a specific shape or to a range of sizes.
for example, they are able to cope with:

- non-circular ducting,
- low operating pressure,
- large sizes

It is clear that there is an intermediate application field where dampers and standard valves overlap but even when both devices are available for the specific case, each one has specific features that could drive the choice.

In general, Dampers are used in application fields where:

- mass-production valves are not available or not cheap enough
- plant requirement or interface constraints don’t allow using standard valves.

The design and fabrication features of heavy-duty dampers are typical of small-scale production (sometimes they are unique units), hence allow maximum flexibility.

Dampers can be tailor-made right for the Customer's needs:
heavy-duty Dampers are mostly fabricated by welding together semi-worked elements (plates, bars, pipes, shaped steel profiles etc.), unlike cast valves' body.

As a consequence of this lack of standardization:

- design and labor costs have the largest influence,
- material cost can usually be of low to mid influence,

(even special materials, e.g. high-cost alloys, can be used in a small section of the damper, that is only where actually useful or needed)

Design and fabrication flexibility is needed to combine technologies from different fields (steel-carpentry, pressure vessels, machining equipment and industrial automation) in the most functionally and economically-effective way

Specific engineering is mandatory but:

- almost any damper shape/size can be addressed
- material / overall cost are minimized without trade-offs on functionality and reliability

Bottom line:

Customers can have the Damper built exactly for their needs.

Let’s look instead at **standard valves** in a specific project:

The valve will not be built exactly for the Customer’s needs: as a minimum, body will be already defined, usually according to oversized specs.

As a consequence of valve standardization:

- design cost is mostly divided on several different units but very few shapes/sizes can be addressed and material / overall cost will vary very little from case to case
- labor cost is minimized by series manufacturing
- material cost can be therefore be of medium to high influence (the valve body is designed for covering as much different cases as possible)
- design and fabrication are bound by manufacture technology, with few flexibility and optimization opportunities.

Except for ordinary piping cases, buying a standard valve (if available) instead of a Damper, could ask for difficult interfacing, sub-optimal features and usually oversized pressure bearing capability: only small, mass-produced valves can be competitively priced against dampers of similar sizes and design parameters.

This can even be not possible whenever a special size / shape is required or if fixed face-to-face dimension cannot fit into available space.

In the end,

If a Customer need small quantities of isolation/regulation device, with special non-standard dimension, shape or large size, and/or with any other additional specific requirement,

he could have an Heavy-duty Damper suitable for the scope, Designed, optimized and fabricated exactly for its needs :

this will have a positive impact on both:

initial cost (installation c.)

and

long-term cost (operating c.)

H.D. Dampers:
product development driven by the Customers

Plant Owners and Operators keep on pushing the requirements on dampers, for example asking for :

higher operating parameters
better performance
increased reliability
lower maintenance
(always at lowest initial and lifetime cost)

Plant Profitability could often be increased operating the plant nearer to its limit: (higher product flows, speeds, pressures, temperatures etc.)

De-bottlenecking activities, performed to increase the operating life of plants or their profitability, require similar modifications to existing plants (but usually bound also by space constraints and difficult insertion into already crowded plants).

A tailor-made Damper can be the simplest if not the only solution to these needs: new or special requirements can as well be addressed by tailor-made Dampers.

Different performances require a radically new design, not only on structural part, but also on accessories and layout.

For example, it often happen to face the lack of suitable accessories (for example actuators, bearings, seals etc.) whenever the project performances differ significantly from the previous project.

These performances or design parameters restrict the choice of available products and push the devices near or above their allowable limits:

As a consequence:
Dampers need to be designed and fabricated in radically different ways
to face:

- higher temperatures (or other rough conditions)
- different operation parameters
- different installation layout

The same can happen due to applicability of:

local Regulations (Global market)
specific Customer Standards

Larger unit sizes, typical of newly-built plants, ask for new technical solutions in every field, from structural point of view and for accessory choice.

(Increasing the actual size of an existing design / equipment will often put outside of the proven solutions, for example whenever the accessories available off-the-shelf are not large enough or when their loading parameters were already near to the limit in the previous (smaller) application.

=> Different accessories' sub-Suppliers must be found,
or different solutions for the same problem must be developed.

The same applies when the increase in **size**, in **shut-off pressure**, in **temperature** or in **fluid speed** ask for increased strength of structural parts (either static or movable ones):

one Bar of Dp = 10.000 kg thrust for each square meter of cross section
(affecting structural strength, stiffness, sealing capability).

In many cases, it could also happen that plant requirements could change during the project construction, (parameters, layout, interferences etc.) with Customers forced to ask for modifications to the device during the fabrication phase. This is usually not addressable by standard valves but can be done with Dampers within very large limits.

(actual examples of such a process can be given)

In a world of fast changes, the capacity to modify the plant quickly and effectively could be the key to increased competitiveness for the Owner;

These requests are transferred to the Damper Manufacturer who must answer in the best way:

quickly,
effectively
with the lowest cost / time impact

Technical constraints and **Economical constraints**

Ask for continuous effort in job engineering and in proposals' management

- **analysis and clarifications of the requests and of every hidden need**
  to avoid difficulties from surfacing only after the first stage

- **technical feasibility study**
  it should include evaluation of alternative / innovative solutions, price and performance comparisons

- **involvement of cooperating suppliers**
  continuous in-deep look at the components and technologies available in sub-suppliers' market, to be ready to answer to new requests or to reduce the fabrication cost of existing solutions; it will reduce also the time needed to specify and select accessories

- **iterative development of the final solution**
  sometimes (or often) during the actual project execution

To answer these requests, the **Manufacturer** need to combine :

- Previous experience in many different fields and technologies
- Development of new solutions in every field of said activity
- Significant flexibility in both design and fabrication activities.

He will need innovation in every field of its work:

- basic Engineering design, simulation etc
- Materials / technologies / fabrication features,
- Accessories and arrangement
- Testing and validation

in order to give suitable and effective answers to Customers' requirements.

(example later on in this document)

Specific needs,
Special dimensions
Special operating requirements

can better be addressed by tailor-made Heavy-duty Damper

The key studies we're going to show are examples of this process and of the possible achievements for the Customer.

Case Study: Request for REGULATING DAMPERS

The actual case here described is relevant to the supply of eight (8) Dampers to be installed, as a retrofit, inside a Chemical Plant in Italy.

An existing thermal oxidizer needed **revamping** of combustion air-flow control system, due to malfunctioning / damages and defects of the existing throttling device.

The requirements included:

- improved rangeability,
- predictable and validated performance (measured regulation curves)
- very low leakage
- higher reliability

and, last but not least,

- very small dimension
- ease of installation, set-up and tuning (drop-in replacement of existing ones)

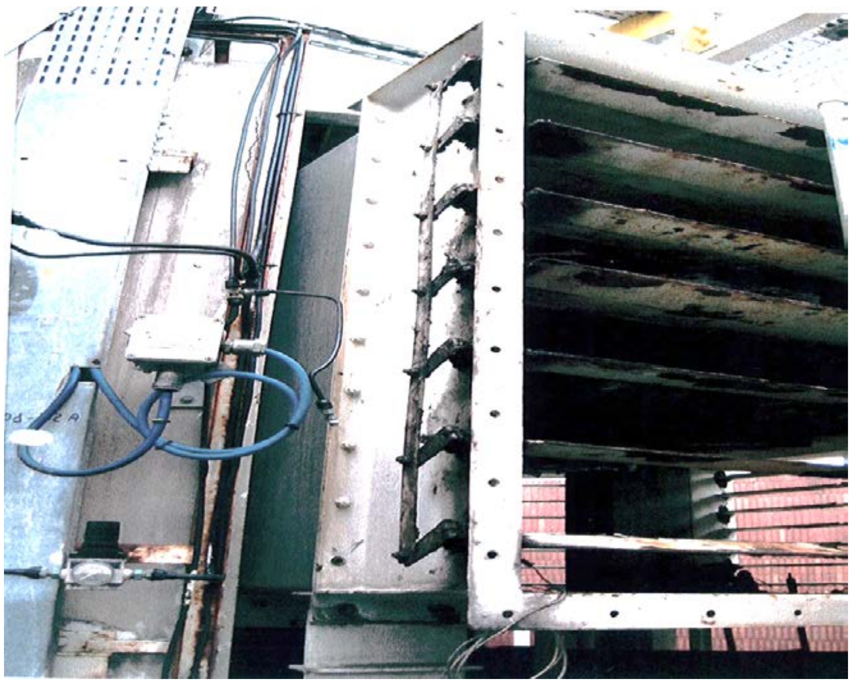
EXISTING DAMPER: issues

Customer complained unsatisfactory operating performance of existing damper (from a Competitor) :

a) Unsatisfactory flow control / limited sealing

➔ poor combustion control - insufficient pollution control

b) Performance degradation during operating life, mechanical damages, heavy maintenance



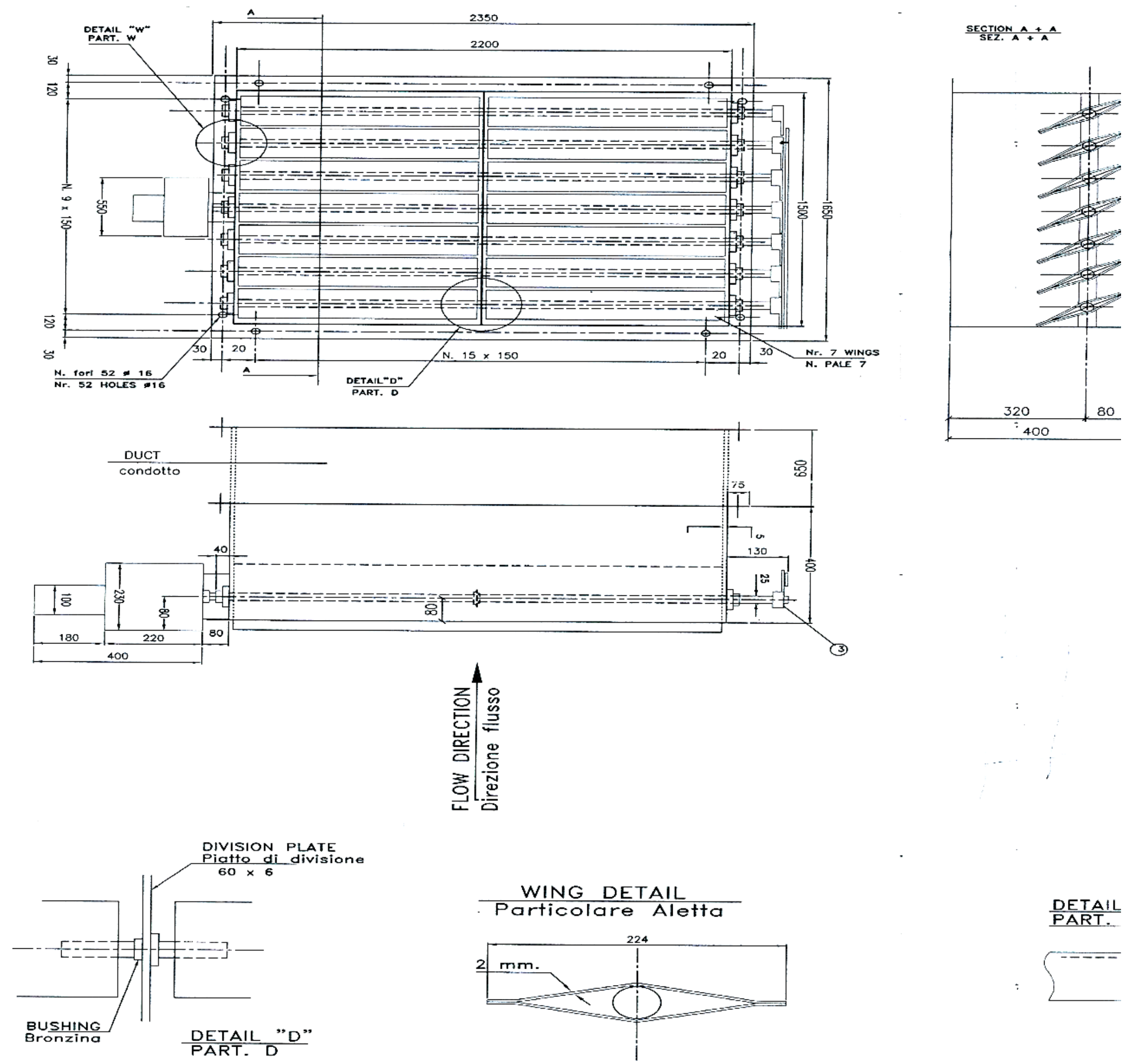
EXISTING DAMPER: size and shape

Lightweight, flexible structure,

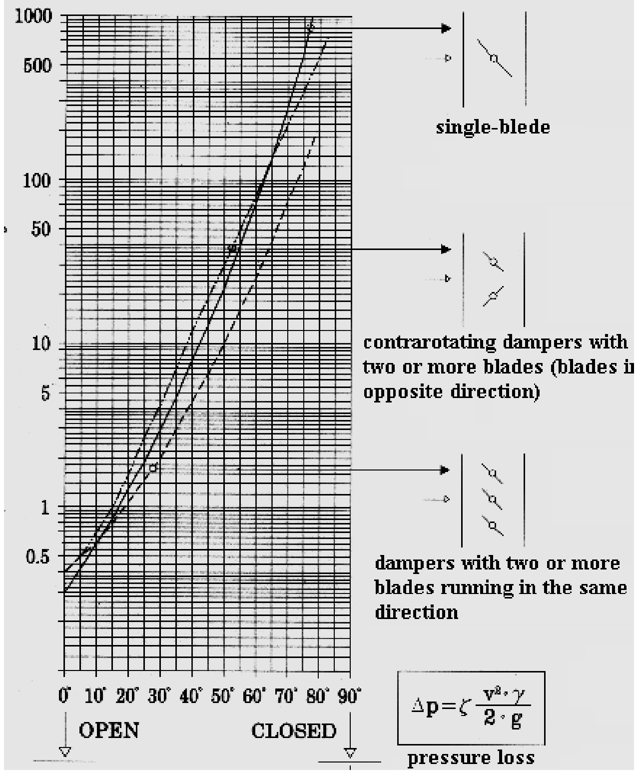
Single actuator for 7 blades, hence many mechanical joints between the blades

28 bushings to be greased
(on each one of the eight dampers)

Lack of sealing devices,
difficult sincronyzation of closure between the eight blades,
multiple large leackage paths



Requirements for NEW REGULATING DAMPER



1) Constant performance during oper.life and low maintenance

2) Satisfactory flow control

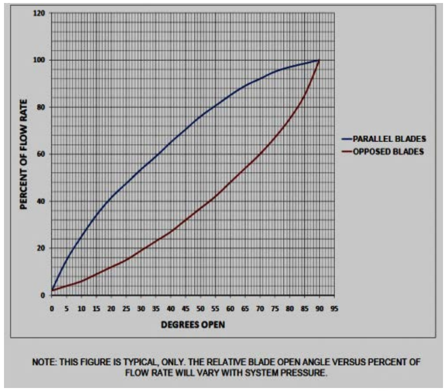
3) Adequate sealing

➔ good combustion control / pollution control

Maximized regulating performance of dampers (single / multi-blade and parallel / opposed blades)

Constraints:

No way to change the process circuit other than the damper.
Limited available space
Insure continuous running of chemical plant



Many possible options could be chosen based on price / performance balance

Requisites:
1) Constant performance / low maintenance
2) Satisfactory flow control
3) Adequate sealing
4) Drop-in replacement

➔ Solution chosen for New Damper

- Three blades per damper

- Independent opening with three individual actuators for each damper

- Linear actuators with positioners

- Sealing strips on all sides of blade

- Stiff construction - reliable mechanism

- Reduced overall dimension of damper, fully assembled and tested in shop

➔ ➔ ➔ good combustion control and pollution control over expected operating life

VALIDATION TESTS of REGULATING DAMPER

Specific solutions, engineering efforts, cooperation with Suppliers for:

- → Good regulation
- → Reliable operation
- → High Sealing degree
- → Flexibility of actuation
- → Fine-tuning

Keys to successful achievement:

- ❑ Previous experience in demanding situations
- ❑ Design innovations
- ❑ Internal testing capability (extensive set-up, testing, validation and performance measurement campaign)

DESIGN FEATURES

Damper designed for low initial cost **and** for maximum reliability:

(proven solutions for fabrication and accessories: shafts, blades and seals
→ cost-effective device
→ high reliability
→ negligible maintenance

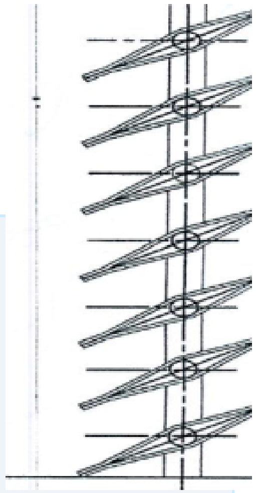
Always considering foreseeable operating life
(continuous movement to keep combustion parameters -polluting emissions strictly controlled)

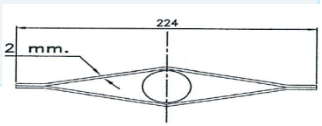
Choice and sizing of (well proven) pneumatic actuators with closed-loop positioners,
directly connected to the damper blades with specifically chosen hinges and lever arms.
Antifriction type, life lubricated bearings
Blades, shafts and bearing supports sized to minimize static and dynamic flexibility
→ good regulation capability and
→ Reduced maintenance

Example:

Sleeve bearings would give slightly lower initial cost but would ask for periodic greasing and would have increasingly higher friction during service life, requiring larger actuator for reliable operation and stiffer, heavier structures to stand the higher thrust.
The chosen bearings allowed lightweight construction and quick movement of rotating parts without negative side-effects; the lower structural weight slightly reduced damper's fabrication cost and also allowed easier installation procedures.
This example show how small details, seemingly of almost negligible importance, can have an impact on both initial and long-term operating costs, hence on satisfaction of the Customer and of plant Owner.

Case study : SEALS and LEACKAGE comparison



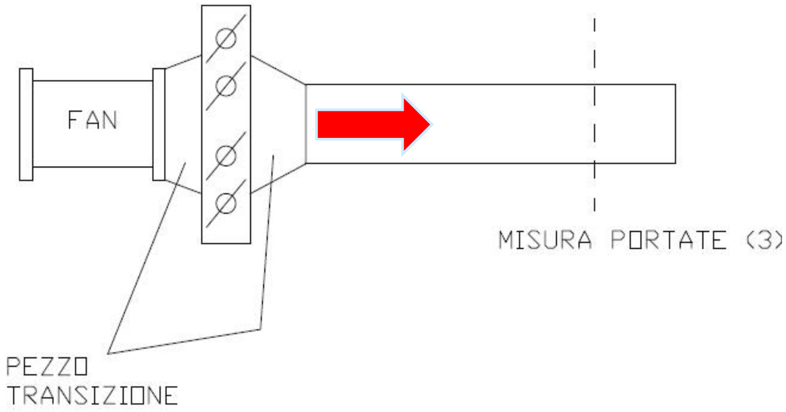


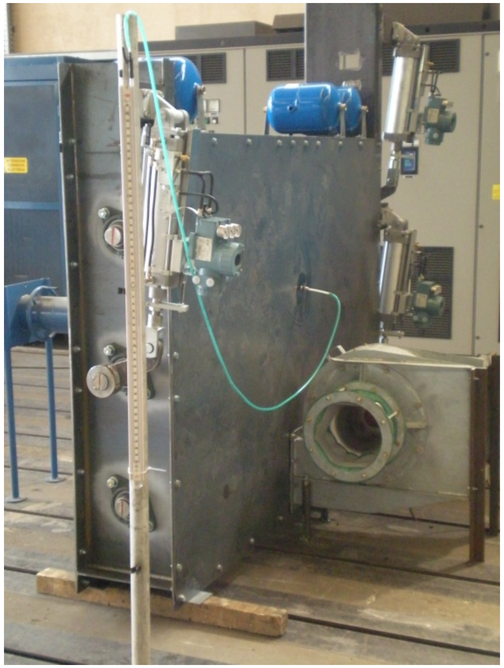
Existing damper

Replacement damper

LEACKAGE TEST of REGULATING DAMPER
performed in closed position

TEST BENCH





LEACKAGE TEST of REGULATING DAMPER
performed in closed position

BOLDROCCHI	DAMPER SEAL TEST			DOCUMENT N°	
	CUSTOMER: [redacted]			AC81701/DST	
	JOB: AC81701	ITEM: FV 9501-1A/B/C		Sh. 3 of 3	rev.0

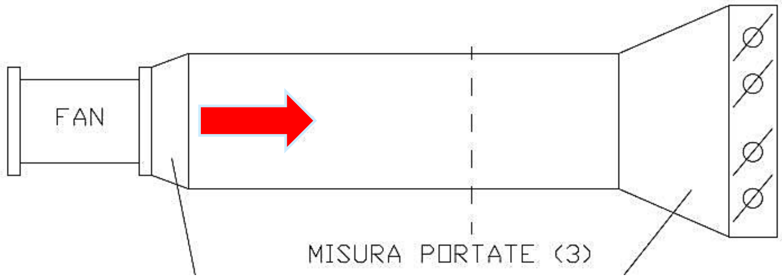
STATEMENTS DUE TO THE TYPE OF INSTALLATION		
Tot. Pressure at Fan Inlet 'Pt1' = 0	Pa	0
Tot. Temperature at Fan Inlet 'tt1' = td0	°C	28.2
Air Density in 1 'ro1' = ro0	kg/m^3	1.156
CALCULATION OF ATMOSPHERIC AIR DENSITY		
Saturated Vapour Pressure at tw0 'pe'	Pa	2247
Partial Vapour Pressure 'pp'	Pa	1643
Atmospheric Air Density 'ro 0'	kg/m^3	1.156
CALCULATION OF FAN FLOW RATE AT TEST CONDITIONS		
Average Static Pressure in 3 'ps3'	Pa	0.0
Average Velocity Pressure in 3 'pv3'	Pa	5.8
Air Density in 3 'ro 3'	kg/m^3	1.157
Average Air Velocity in 3 'V3'	m/s	3.178
Flow Rate in 3 'Q3'	m^3/s	0.064
Fan Air Density 'ro'	kg/m^3	1.156
SEAL DEGREE CALCULATION		
Damper Design Mass Flow Rate	kg/h	75000
Mass Flow Rate through closed damper	kg/h	198.97
Seal Degree	%	99.735

LEACKAGE TEST RESULTS:
(measured according to AMCA 500 std)

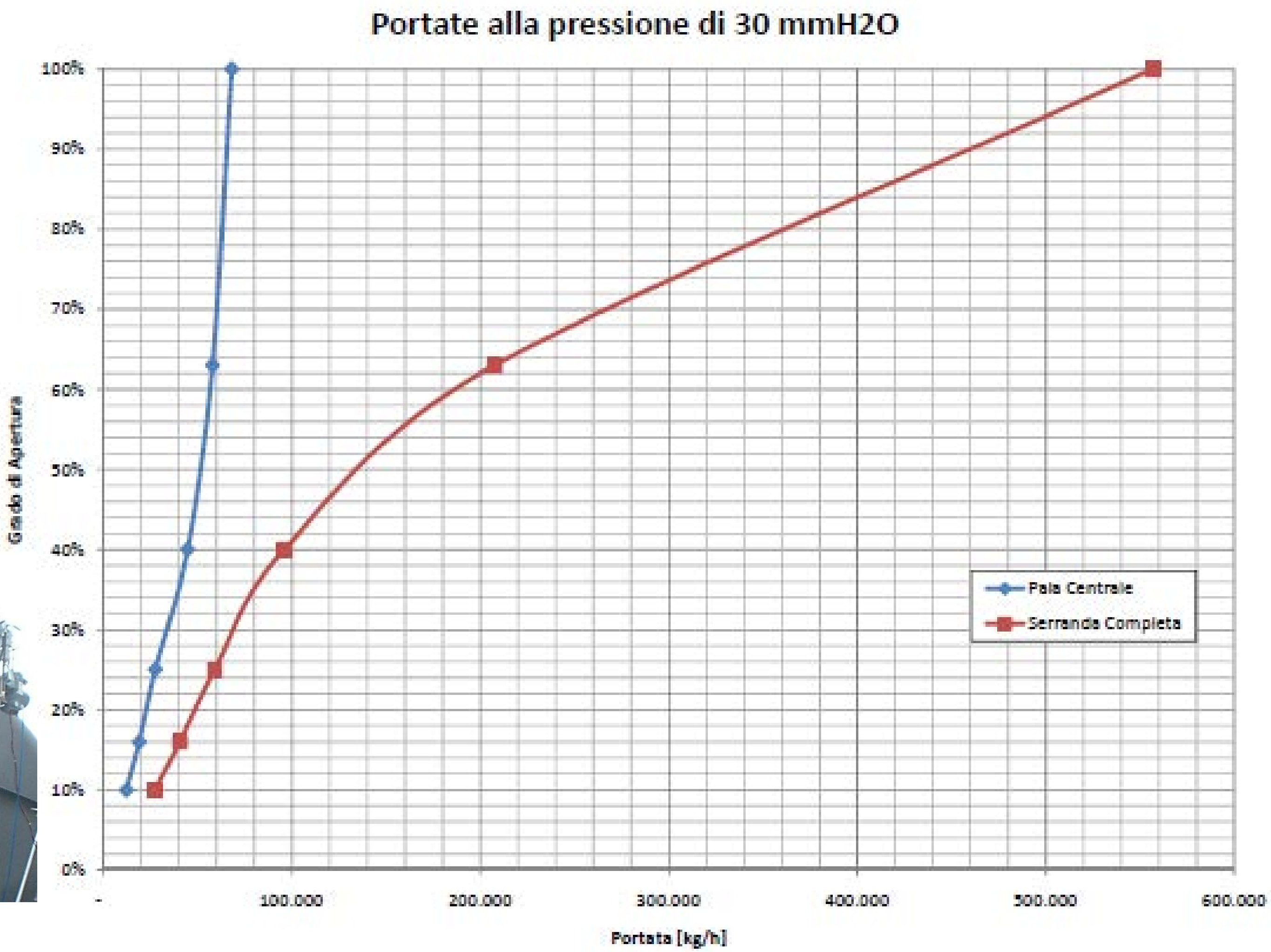
Nominal flow rate:	75.000 kg/h
Measured flow rate (closed damper):	99 kg/h
Sealing degree (flow percentage):	99,735 %

MEASURED LEACKAGE : LESS THAN 0,3 % on flow

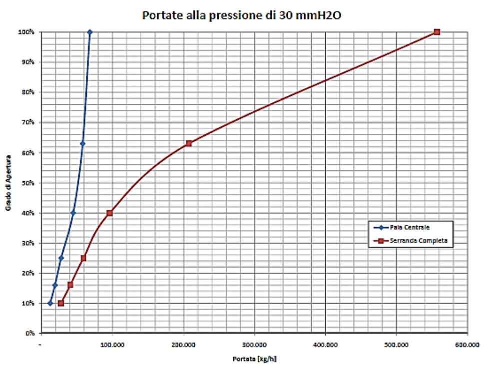
Test-stand and flow-control performance measurement

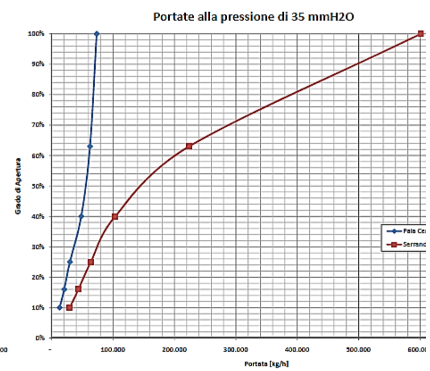


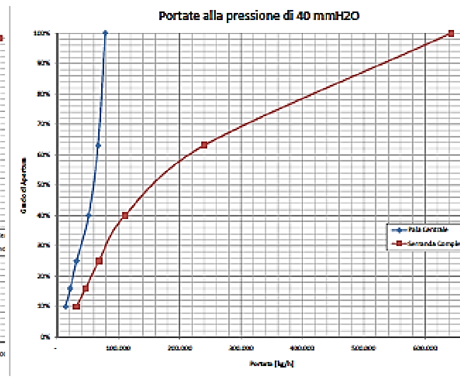
Test-stand and flow-control performance (fixed Dp)

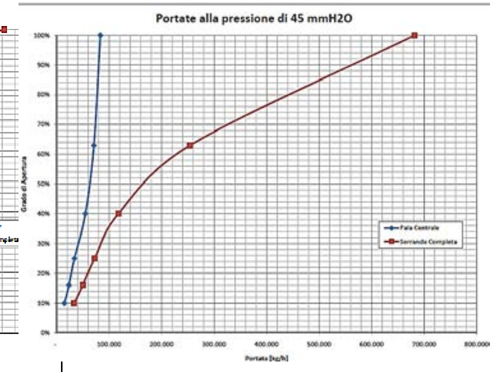


Test-stand and flow-control performance

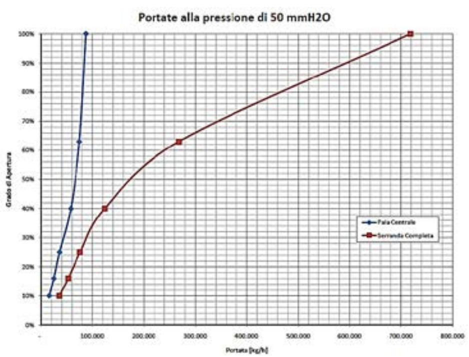


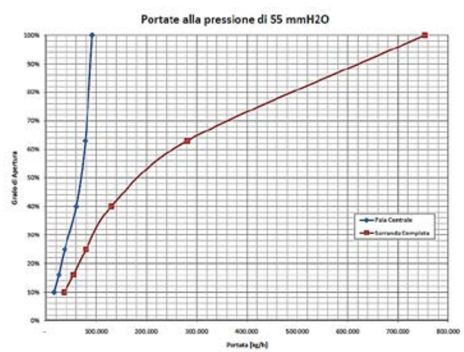


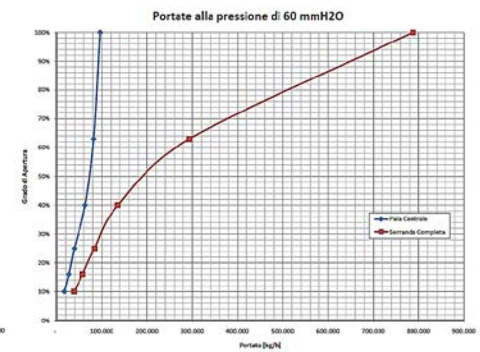




Measures taken at many different differential pressures
with differential movement of blades







MEASURED INHERENT CHARACTERISTIC of REGULATING DAMPER

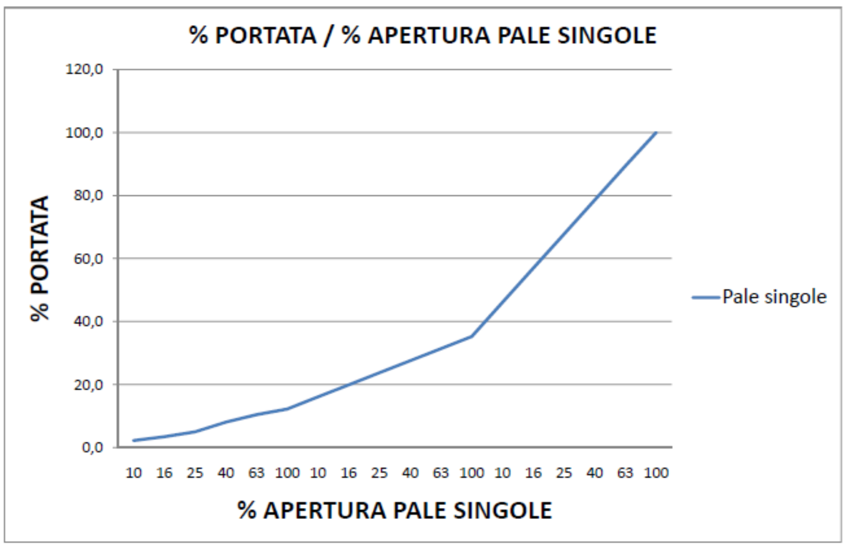
CURVE DI FUNZIONAMENTO SERRANDE

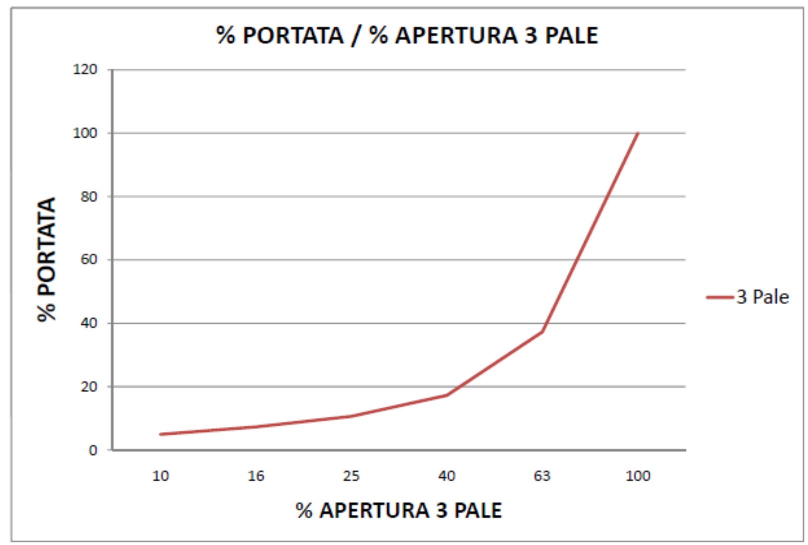
Parallel moving of three blades at a time

	3 Pale					
% Apertura	10	16	25	40	63	100
% Portata TOT	5	7	11	17	37	100

Staged movement of the three blades

	1 Pala						2 Pala						3 Pala					
% Apertura	10	16	25	40	63	100	10	16	25	40	63	100	10	16	25	40	63	100
% Portata TOT	2,2	3,4	5,0	8,0	10,4	12,2	16,0	19,9	23,7	27,5	31,4	35,2	46,0	56,9	67,7	78,5	89,4	100,0





Customer could hence reliably obtain every operating flow by simply acting on PLC software as actual performance curves has been effectively measured with extensive testing.

In the end,

when a Customer need single units or small quantities of isolation/regulation devices,
with special / non-standard dimensions or shape or very large sizes,
with any additional specific requirement or constraint

he could find it convenient to have an Heavy-duty Damper suitable for the scope
designed and fabricated exactly for its needs
Optimized to have a positive effect on both initial and long-term operating cost.

- ✓ specific needs,
- ✓ non-standard sizes
- ✓ special design requirements

can better be addressed by **tailor-made Heavy-duty DAMPERS**

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