

Wolfensberger

HIGH GRADE STEEL & PRECISION CASTING

**CASTING
ENGINEERING
INNOVATION**



TECHNICAL BULLETIN NO.6



Exacast[®] Ceramic Precision Casting

Investment casting precision even with small quantities, with high casting weights and with various steel and iron materials. Casting material in ceramic moulds offers crucial advantages regarding design options, process-workflow reliability and machining costs.

Lower machining costs and additional design freedoms

Exacast® – The most important advantages

Machining by metal cutting is one of the most complex and expensive operations among the finishing processes. The Exacast® process allows production of complex castings with thin sections, free-form surfaces cast ready for installation and precise dimensions which necessitate only a fraction of the machining effort and expense of sand casting or machining solid metal.

Investment Casting

Precision

The ceramic moulding material used with the Exacast® process features excellent reproduction accuracy and minimal dimensional variations after removal from the mould. The near-net-shape method also reduces machining effort.

Possible casting weights up to 400 kg

By comparison with investment casting, the Exacast® process allows casting weights up to 400 kg and part diameters up to 1,000 mm – thanks to the use of solid and stable casting moulds.

Additional design options

Since moulds heated up to 1,000 °C are used for casting with the Exacast® process, the metal flows even into ultra-fine contours and long, narrow ducts without “freezing”. The designer thus has valuable, additional freedom of scope and has to worry less about material accumulations, small wall thicknesses, changing wall-thickness, castable radii or space for risers. This – for instance – allows thin-walled sections of 1 mm or 3 mm (with unit weights of 10 kg or 200 kg) in the case of steel castings, depending on the relevant part geometry.

Economical even with small batch sizes

One other essential advantage by comparison with the investment process is the simple and cost-saving patternmaking. The patterns are made of wood, aluminium, synthetic resins or silicone rubber and can be adjusted easily if needed.

Process reliability thanks to well-established processes

The patented Exacast® process has already been used for over 30 years at Wolfensberger and has been constantly further-developed by our engineers. This sophisticated development status guarantees short development times for new products and ensures that production targets are reliably achieved.

Broad range of material groups

The Exacast® process is suitable for the entire range of materials comprising around 100 grey casting, ductile graphite iron and steel casting materials as well as nickel-base alloys, offered by Wolfensberger. State-of-the-art computer-aided methods such as CAD, FEM strength analysis and solidification simulation are used for a partnership based development of castings and casting processes.

Examples of the EXACAST® precision casting process



Pelton impeller

Duplex steel, 30 - 400 kg, energy generation

Special feature: Bowl sections cast by near-net-shape method saves rework



Combustor component

Nickel alloy, 3 kg, heat-protection elements for gas-turbine combustion chamber

Special feature: Thin-walled casting, reproduction of ultra-fine part sections saves expensive rework



Nozzle ring

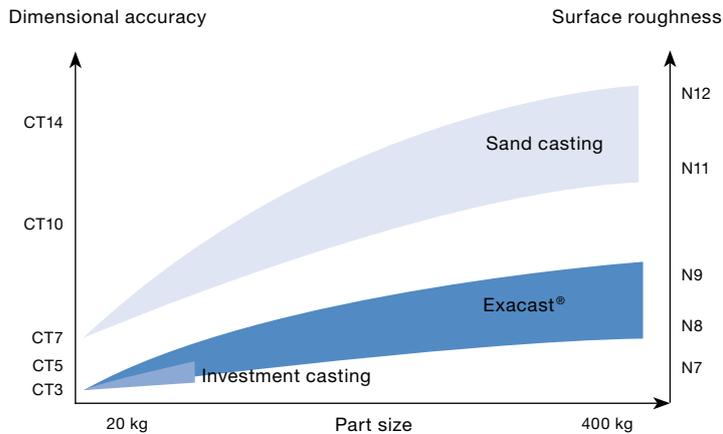
Heat-resistant steel and nickel-base alloy, 5 - 300 kg, large turbocharger

Special feature: Very broad part diversity, model combinations saves model costs, very thin-walled steel casting

Achievable properties

The very finest precision

The ceramic moulding material used for the Exacast® process offers excellent reproduction accuracy. Consequently, Wolfensberger thus guarantees compliance with the dimensional tolerances applicable to investment casting in accordance with degree of accuracy D1 to D3 of VDG Code of Practice P690 for the castings produced with this process. The surface roughness also complies with the requirements conventional for investment castings; at Ra 3.2 to 6.3 µm, it lies between N8 and N9. Thus, in many cases, this largely supersedes the need for mechanical machining.



Surface condition

Surface normals	Material group D	
	CLA [µinch]	R _a [µm]
N7	63	1.6
N8	125	3.2
N9	250	6.3

Material group D:
Iron, nickel, cobalt and copper-base alloys

A very fine surface (N8 to N9) is achieved in casting state by the use of ceramic moulds, i.e. rework by metal cutting is not necessary in many cases.

Exacast® precision

Nominal size (L,W,H)	Linear tolerances		
	D1 Tolerance	D2 Tolerance	D3 Tolerance
up to 6	0.3	0.24	0.2
6 to 10	0.36	0.28	0.22
10 to 18	0.44	0.34	0.28
18 to 30	0.52	0.4	0.34
30 to 50	0.8	0.62	0.5
50 to 80	0.9	0.74	0.6
80 to 120	1.1	0.88	0.7
120 to 180	1.6	1.3	1.0
180 to 250	2.4	1.9	1.5
250 to 315	2.6	2.2	1.6
315 to 400	3.6	2.8	—
400 to 500	4.0	3.2	—
500 to 630	5.4	4.4	—
630 to 800	6.2	5.0	—
800 to 1000	7.2	—	—

(dimensions in mm)

Tolerances

It is largely possible to comply with the tolerances listed in VDG P690. Deviations of dimensions only occur in sections which are affected by mould or core parting, but these deviations are still within the targets of the tolerances D1. If this precision investment casting tolerance does not suffice a machining allowance must be added.

Degree of accuracy D1: Applies for all free sized dimensions

Degree of accuracy D2: Applies for all dimensions to be tolerated

Degree of accuracy D3: This very narrow tolerance level can be met for certain dimensions but not for all dimensions of a precision casting. D3 corresponds to the scatter band of various production batches and generally requires model optimisation with the aid of trial casting operations or a pilot series. Individual tolerance bands can even be set more narrowly by corresponding model optimisations after production and gauging of prototypes.

Source: VDG Reference Sheet P690



Regulating blade

Stainless-steel casting and austenitic cast iron, 5 - 200 kg, air / gas compressor

Special feature: Higher efficiency thanks to fine surface quality, without any machining processes



Stator

Sphaerolitic cast iron and stainless-steel casting, 5 kg, hydrodynamic brakes for commercial vehicles

Special feature: Ductile graphite iron of investment casting quality, maximum efficiency thanks to ultra-fine blade tips and surfaces



Spindle housing

Heat-treatable steel, 17 kg, mechanical engineering

Special feature: Near-net-shape casting, perfect surfaces for visible areas



Wankel rotor

Sphaerolitic cast iron, 3 kg, Wankel rotary engines for special applications

Special feature: Inaccessible sections featuring investment casting quality, maximum dimensional accuracy means smooth running for rotation component

Exacast® – How it works

The essential unique feature of the Exacast® process is the mould making technology. By contrast with sand casting, the load-bearing structure of the mould consists of a high-temperature-resistant supporting mould. A thin fluid ceramic slurry is cast between this and the model. This slurry reproduces all contours precisely. The melt is cast into the hot mould after removing the mould from the pattern and after a burning process of the mould.

1 Pattern Shop

Permanent patterns made of various materials result in two-part or multi-part moulds.



2 Mould production

The spaces between supporting mould and model are filled with a ceramic slurry.



3 Assembly of the mould

The halves of the mould are also fitted with cores depending on requirements and are then joined.



4 Burning the mould and casting

The material is cast into the preheated mould. This means that the melt flows even into extremely thin-walled areas and reproduces ultra-fine contour details. In addition, it is possible to exclude the possibility of gas blisters induced by the moulding material since it is inert.



5 Finishing

The operations typical in a foundry follow after removal from the mould – separating the risers, fettling, sandblasting, and – depending on requirements – heat treatment and mechanical machining.



6 Customised quality inspection

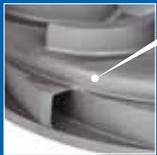
Every casting is subjected to the required quality inspection. This extends – depending on customer requirements – from simple visual inspection to X-ray inspection. All tests and inspections are documented pursuant to quality assessment in accordance with EN 10204.



Exacast® precision casting guarantees customer value

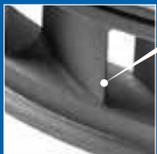
The ceramic precision casting process is used profitably by customers in many respects: Enhanced efficiency of components subject to flow of media, reduced machining expenditure and greater design freedom are only a few of the advantages.

10 advantages and their customer values



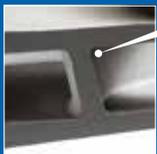
First-class surface roughness

- Higher efficiency on components subject to media flow
- Minimal subsequent machining
- Minimal material fatigue owing to optimised crystalline surface structure



Filigree sections

- Weight saving
- Cost saving thanks to lower material share
- Substitution of complex welded designs and manufacturing from solid metal



Small radii

- Greater design options favours establishing new and / or more economical design solutions
- Higher degree of efficiency and larger unobstructed passage in narrow sections



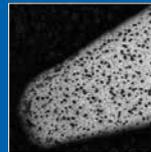
Major wall-thickness differences

- Favours establishing new and / or more economical design solutions
- Avoiding welding-together of individual components



Hydrodynamic sections in inner areas

- No rework necessary at inaccessible points and undercuts
- Cost saving
- Hydrodynamically optimised design freedom



No casting skin owing to the inert moulded material

- Increased bending strength of the castings
- Reduction in material fatigue
- Optimum material properties on part surfaces (for example corrosion resistance)



Largely free selection of materials

- Perfect adaptation of the material to the field of application of the parts
- Development of customised materials
- Broad diversity of materials: From cast iron to cast stainless steel



30 years experience of precision casting

- Competent advice throughout the entire value chain: From design development through to final assembly
- Determining cost-optimisation potentials as early as during part development / design



Near-net-shape technology

- Reduction in machining of materials difficult to machine
- Lower machining costs



Swiss Made

The Exacast® process developed by Wolfensberger AG is unparalleled and is a convincing process for customers all over the world thanks to its maximum quality and reliability.

Wolfensberger AG – Convincing casting solutions



Wolfensberger's headquarters.
In Bauma near Zurich, Switzerland, since 1924.

Wolfensberger

Innovative by tradition

Founded in

1924

2 casting processes

Sand casting and Exacast® ceramic precision casting

A workforce of

200

(foundry and machining) and 2,000 tons per annum at two plants in Bauma, Switzerland

100

different cast steel and cast iron materials

Satisfied customers

ABB Turbo Systems AG, MAN Energy Solutions SE, Voith Turbo GmbH, Mitsui E&S Machinery Co., Ltd., Burckhardt Compression AG, Bühler AG, General Electric (Switzerland) GmbH etc.

What we offer...

Casting engineering

Our specialists will assist you in:

- Specific selection of materials
- Optimised cross-sectional and mass distribution using 3D casting and filling simulation
- Design of the casting contour for rational machining
- Initial-sample development through to series release

Exacast® ceramic precision casting

- Advantages: Small and medium series in investment casting quality but higher casting weights and also cast-iron materials besides cast-steel materials
- Suitable for parts with stringent dimensional-tolerance, surface-quality and thin-walled-section demands
- Weights: 2 to 400 kg

Sand casting

- Small and medium series
- Manually and machine-formed with cold-resin-bound sand
- Weights: 20 to 800 kg
- Rapid prototyping for spare parts, prototypes and small series of complex components

Machining

- Cubic and rotationally symmetric CNC machining
- State-of-the-art flat and profile grinding shop
- Subcontracting

Diverse range of materials

- Broad wealth of experience in the sectors of metallurgy, casting engineering and materials application
- Laboratory with state-of-the-art facilities
- Approximately 100 material variants (cast steel and cast iron)

What we stand for...

Competence

Our staff convinces our customers with their proven technical competence and guarantee highest-quality products.

Advice from casting professionals

From our initial contact with you, we foster active cooperation and provide advice in design (casting optimisation) and in selection of the right material (optimisation regarding wear, corrosion resistance and castability etc.).

Quality

Wolfensberger focuses on a process-orientated management system in accordance with ISO 9001:2015. The constantly updated instruments include:

- Computer-aided planning and control
- Metallurgical laboratory
- Non-destructive tests PT, MT, UT and RT

Sustainability

We endeavour to achieve cooperation on a partnership basis and cultivate long-lasting relationships with customers.



For further information
www.wolfensberger.ch

