



Founded in 1996, OTEC has quickly established itself as one of the market's technology leaders by developing new machine concepts, inventions and improvements. OTEC delivers machine concepts carefully tailored to the needs of specific industrial sectors, offering solutions which are truly impressive in terms of cost-effectiveness, handling and precision and which are far superior to conventional systems. Some 70 members of staff are employed at the company's headquarters in Southern Germany and a worldwide sales network ensures that excellent service, expertise and top-quality finishing are always available.



Perfect surfaces. Worldwide.
Perfect surfaces. Worldwide.



SF Stream Finishing

THE COMPANY



Product range:

► **OTEC DF SERIES**
Drag finishing unit for finishing tools – with up to 10 clamping devices for workpiece holders.



► **OTEC SF SERIES**
(Stream finishing) Drag finishing units for improved, selective mass finishing. Ideally suited to complex geometries.



► **OTEC CF SERIES**
For precision engineered workpieces



OTEC Präzisionsfinish GmbH | Dieselstraße 8-12 | 75334 Straubenhardt-Feldrennach | Germany
Phone +49 7082 4911-20 | Fax +49 7082 4911-29 | E-mail: info@otec.de | www.otec-online.com



Powered to Perfection

A new Machine Generation

SF (stream finishing) technology is the basis of an innovative new generation of drag finishing machines. The key differences to previous concepts can be summed up as follows:

1. **The amazing power of the machine**
2. **Selective targeting of surface areas by means of a path-controlled sequence of movements**

The SF machine was specially developed for applications for which no satisfactory process previously existed and where the very best surface quality has to be obtained right down to the tiniest of geometries. The SF enables processing to be carried out in a very short time; the machine is easy to automate and at the same time guarantees extremely reliable finishing. The very high processing forces generated mean that extremely fine surfaces with a Ra value of $< 0.01 \mu\text{m}$ can be obtained even in the smallest flutes.

THE PROCESS

Highlights:

- ▶ More targeted material removal than with any other surface finishing machine
- ▶ Faster material removal than with any other surface finishing machine
- ▶ Wide range of processing applications from deburring to mirror-finish polishing
- ▶ Edge rounding of cutting tools
- ▶ Smoothing and polishing



Wide range of processing applications:

The SF enables several stages of processing to be carried out very quickly in a single operation. For example, a workpiece can be successively deburred, edge-rounded, smoothed and polished without further intervention.

Path-controlled sequence of movements

The path-controlled movement sequence enables individual parts of a workpiece to receive intensive selective finishing. In order to ensure uniform material removal over the whole of the workpiece surface, this movement is carried out parallel to the "regular" finishing and is automatically monitored.

The special design of the machine enables the angle of incidence of the grinding or polishing medium to be adjusted, thus regulating the amount of material removed right down to the μm level.

High processing forces

SF (stream finishing) technology harnesses the power of high-speed streams of grinding and polishing media. This generates powerful forces which enable even the smallest and least accessible surfaces and recesses (e.g. flutes and grooves) to be finished with the utmost precision. This is achieved through the high contact forces pressing the fine-grain polishing medium into even the very tiniest of recesses and polishing the surfaces there. This makes surface qualities of $Ra < 0,01 \mu\text{m}$ a reality (see the examples on page 7).

Extremely short finishing times

A high degree of automation, fast tool change on the fly and powerful processing forces result in extremely fast and economical finishing of the workpieces.



SF – A new Machine Generation

SF machines are available in a wide variety of models, meaning that there is one to meet the requirements of almost any type of workpiece. For example, the machines are available with three basic sizes of processing drum:

- ▶ 680 mm for up to 2 workpiece holders, for workpieces measuring 100 x 200 mm max.
- ▶ 1050 mm for up to 5 workpiece holders, 400 x 400 mm
- ▶ 2000 mm for up to 3 workpiece holders, 400 x 400 mm max.



INNOVATIVE DETAILS

Attachment for mirror-finish polishing of long workpieces

This attachment enables long, intricate workpieces to be finished with ease without any danger of them breaking. The workpiece holder is pivoted so that the workpiece itself automatically aligns to the direction of the media stream. This neutralizes the effect of transverse forces and eliminates the risk of the tool breaking or becoming deformed.

Typical application: polishing long carbide drills up to 350 mm in length. Special lengths on request.



High-speed spindle attachment

This attachment allows the workpiece to rotate at speeds of up to 8,000 rpm. This can increase the average speed by up to 20 m/s.

Typical application: concave workpieces such as shoulder joints, hollow parts with an internal diameter of 15 mm or more, rotation-symmetrical workpieces such as forming taps and bone screws.

Multi-head attachment

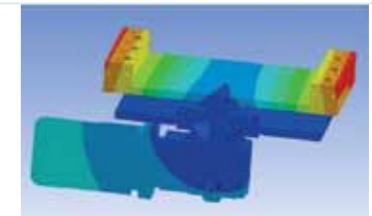
This attachment enables up to six workpieces to be processed at the same time in a single holder fitted with a quick-release mechanism. In order to ensure that the workpieces are finished evenly over the entire surface, they rotate around their own axis and at the same time describe a planetary orbit.

Typical application: workpieces of up to 150 mm in length and 50 mm in diameter.

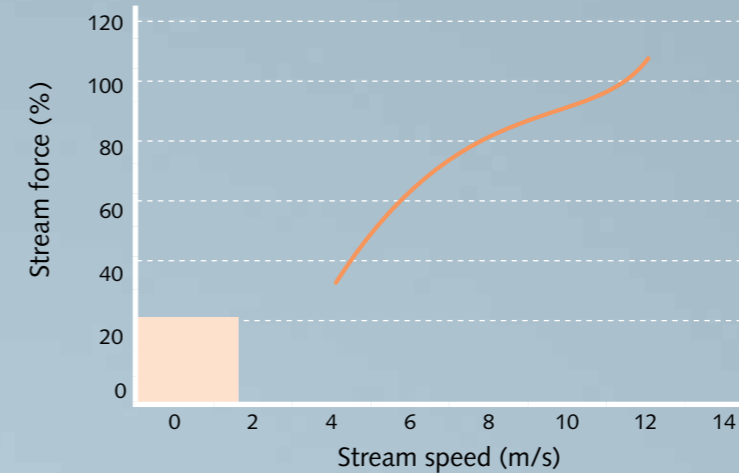


Design Principle

Drum diameters of up to two meters and rotary speeds of **15m/s** release tremendous forces. Designs and calculations using FEM (finite element method) analysis were used to simulate real conditions and optimize the geometries of both machine and housing.



Structural approximation of the container holder for the purposes of stress analysis.



- ▶ OTEC SF units
- ▶ Conventional drag finishing units

The graph shows the operating range of the SF machine. This clearly indicates that the processing speeds of the SF are many times faster than those of conventional drag finishing machines. This is the result of the higher speeds and consequently greater forces obtained.

ADVANCED TECHNOLOGY

Fast drum change

It is an easy matter to change the process container without the need for tools – simply pull on two levers and the drum is already released and can easily be moved on casters and transferred to a trolley.

Workpieces can be positioned on the fly

In order to obtain the best possible quality of finish and the shortest processing times, it is often necessary to adjust the position of the workpiece in order to align it in the media stream. The SF machine offers a number of ways of carrying out this adjustment, e.g.:

- ▶ Workpiece immersion angle; swivel around the X axis, the tool can be immersed in the medium at any angle within the range 0 – 35°.
- ▶ Angle of rotation; swivel around the Y axis, this enables the workpiece to be positioned as close as possible to the drum wall.
- ▶ Six-axis finishing by integrated robot. This makes it possible to move the workpiece through freely programmable paths during processing.



Overview of SF Machines:

Technical Specifications

SF MACHINES	SF 1/1-68	SF 2/2-68	SF 3/1-105	SF 4/1-105	SF 5/1-105
L x w x h in mm	1620x1210x2100	1620x1210x2100	1870x1520x2600	1870x1520x2600	1870x1520x2600
Weight	600 Kg	730 Kg	1300 Kg	1400 Kg	1500 Kg
Mains voltage	400 V	400 V	400 V	400 V	400 V
Output	16 A	16 A	32 A	32 A	32 A
Output in KVA	4.2	5.5	11.4	11.6	11.8
Holder interfaces	1	2	3	4	5
Process container Ø in mm	680 mm	680 mm	1050 mm	1050 mm	1050 mm
Max. workpiece length with 450 mm lift	-	-	250 mm	250 mm	250 mm
Max. workpiece length with 600 mm lift	400 mm	400 mm	400 mm	400 mm	400 mm
Max. workpiece weight including holder, approx.	12 kg	12 kg	10 kg	10 kg	10 kg
Max. workpiece length with drum height 350 mm	250 mm	250 mm	250 mm	250 mm	250 mm
Max. workpiece length with drum height 500 mm	-	-	400 mm	400 mm	400 mm
Maximum diameter	100 mm	100 mm	400 mm	400 mm	300 mm
Clamping Ø of collet chuck	max. 13 mm	max. 13 mm	max. 13 mm	max. 13 mm	max. 13 mm
Clamping Ø of three-jaw chuck	max. 50 mm	max. 50 mm	max. 50 mm	max. 50 mm	max. 50 mm

Standard equipment

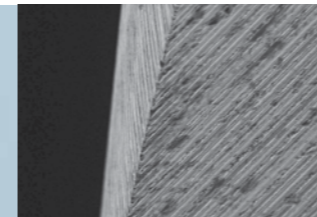
- ▶ Process container (drum) for dry finishing – in steel, painted exterior with stripper brush
- ▶ Process container (drum) for wet finishing – in steel, painted exterior, interior coated with PU
- ▶ Manual workpiece clamping
- ▶ Workpiece angle adjustable up to a maximum of 35°
- ▶ Electromechanical immersion by means of lift system
- ▶ Operated via touch screen using Siemens S7-1200
- ▶ Rotary speed infinitely adjustable via frequency converter
- ▶ Automated process control
- ▶ Direction of rotation can be preset with automatic reversal of drag direction

Optional extras

- ▶ Additional process container (drum) for wet or dry finishing
- ▶ Trolley for changing the drum
- ▶ Collet chuck with diameter of 1.5 – 13 mm diameter
- ▶ Three-jaw chuck d = 4 – 50 mm
- ▶ Holder for chucks d = max. 28 mm for d = 3 – 28 mm, also suitable for air purging
- ▶ Holder for chucks d = max. 45 mm for d = 20 – 45 mm, also suitable for air purging
- ▶ Indexing function for workpiece drive for selective finishing of specific surfaces and continuous movement with adjustable angle areas and speeds
- ▶ Workpiece immersion angle automatically adjustable via control unit from 0 to 35° (not for SF 4 and SF 5)
- ▶ PROFI BUS interfaces for automatic loading
- ▶ Dosing unit for automatic water/compound change in programmable cycles

Typical Applications

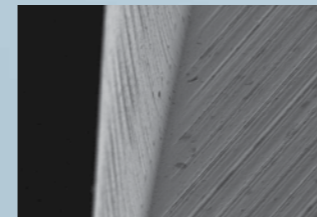
Images: Fraunhofer IPK



Circumferential cutting edge, ground



Circumferential cutting edge, slightly rounded 3 µm



Circumferential cutting edge, rounded 5 µm



Drill with coolant holes



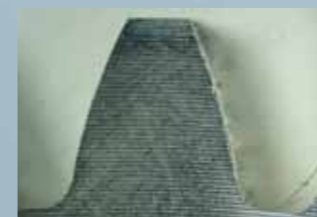
Unfinished Ra 0.35 µm



Finished Ra 0.04 µm

Result:

The required surface quality of Ra <0.2 µm is easily surpassed with values of Ra 0.04 µm. Because of the tremendous forces involved (up to five times greater than in conventional drag finishing machines and up to seven times the speed), the surface finishing of intricate external contours is especially intensive.



Tooth flanks, unfinished



Tooth flanks, finished

Result:

Short finishing times of only two minutes. The ability to simultaneously finish up to five workpieces which can be inserted and removed on the fly means that the effective throughput time is only 24 seconds per workpiece. The roughness value at the tooth flanks was reduced from Rz = 1.5 µm to Rz = 0.4 µm.

Rounding the cutting edges of cutting and stamping tools

Task:

Selective rounding of the cutting edges of tools in order to obtain a considerable increase in tool life.

Finishing process:

The tool (e.g. a carbide drill) is clamped in a chuck and immersed in the streaming media. The process is usually complete in just a few seconds. The air purge option ensures that the coolant holes can be kept clear of media during finishing. The considerable advantages of this technology are the ease with which the process can be automated, the extreme reliability of the process and the ability to achieve very smooth surfaces at the cutting edge (e.g. Ra = 0.05 µm).

Injection molding tool for PET bottles and screw caps

Task:

Smooth and polish tools in hardened steel. The special characteristic of these workpieces lies in the extremely narrow and almost inaccessible grooves. The goal is to achieve a surface quality of less than Ra 0.2 µm. The initial value was Ra 0.35 µm.

Finishing process:

30 minutes dry grinding in HSC 1/300 then 5 minutes dry polishing in M4/300

Cog wheels: deburring, rounding and smoothing of tooth flanks

Task:

Carry out a number of processing stages (deburring, rounding, smoothing of tooth flanks) in a single operation, reduce the finishing times whilst retaining the best possible surface quality.

Finishing process:

The tools are clamped onto an angled holder. During finishing, the workpiece rotates around its own axis according to a programmed sequence (e.g. 30 seconds clockwise, then 30 seconds counter-clockwise).

Other typical applications:

- Finishing gearbox and engine parts
- Finishing aerospace engine components, blisks etc.
- Polishing ceramic workpieces