

YOUR PARTNER IN THE **TURBINE INDUSTRY**

Products and Process know how for grinding

- ┌ Aircraft turbine parts
- ┌ Industrial gas turbine parts

TYROLIT

THE MARKET LEADER IN THE TURBINE INDUSTRY

TYROLIT, market leader in grinding technology for turbine parts and a global player in this industry sector, manufactures and supplies grinding and dressing tools for specific customer requirements. Additionally TYROLIT offers deep process know-how and a program of comprehensive support tailored to individual requirements.

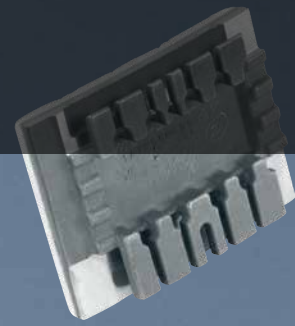
TECHNOLOGY LEADER AND PARTNER

Through basic research and optimization of production runs, we as the technology leader, together with the relevant machine manufacturers, universities and customers, are the driving force behind advancements in the grinding processes for the turbine industry.

The latest technical expertise from the world of abrasives and new grinding processes are put into practice by our team of application engineers whose professional competence is valued by our customers.

TYROLIT expertise in grinding processes

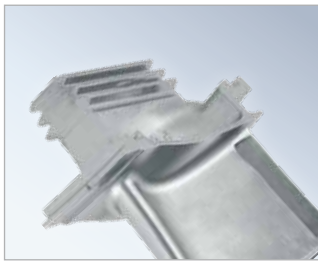
Grinding process Features	HSCD Creep Feed	VIPER		Prokos	Creep Feed		CBN Creep Feed
		CD	Non CD		CD/IPD	Non CD	
Max. material removal rate (mm ³ /smm) [inch ³ /min inch]	300 27,9	100 9,2		330 30,5	70 6,5	40 3,7	15 1,4
Characteristics	Profile holding very high High motor power	Profile holding high Wheel size max. 300 mm Wheel size max. 220 mm Coolant 70–100 bar [1015–1450 psi]		Profile holding high Cool grinding Low motor power High cutting speed & table speed	Profile holding very high	Profile holding low	Profile holding high Normal forces high No dressing
Grinding speed (m/s) [SFPM]	45 - 80 8858 - 15748	30 - 60 5905 - 11811		60 - 80 11811 - 15748	15 - 35 2953 - 6890	20–35 3937–6890	50–80 9842–15748
Table speed (m/min) [ipm]	5 196,85	1,5 - 2 59,06 - 78,74		60 - 96 11811 - 3779,5	1,2 - 1,8 47,24 - 70,9	1,2 - 1,5 47,24 - 59	0,2 7,87
Infeed (mm) [inch]	5 0,197	2 0,079		<0,2 <0,0079	2 - 8 0,079 - 0,315	2 - 5 0,079 - 0,197	2 0,079
Continuous Dressing Infeed (µm/rev) [microinch/rev]	1,5 - 2,5 0,059 - 0,098	0,6–1,2 0,024–0,047			0,6–1,2 0,024–0,047		
Typical parts	Gas turbine blades	Turbine blades and NGVs, structural parts		Turbine blades and NGVs	Turbine blades and NGVs, structural parts	Turbine blades and NGVs, structural parts	NGV, structural parts
TYROLIT top products	STRATO Ultra	VIPER Ultra		STRATO Pro	STRATO Ultra	STRATO Ultra	STRATO SA



TYROLIT AND THE TURBINE INDUSTRY

Aircraft Turbine

From engines for business jets to the world's most advanced turbo-fans for long haul aircraft, including the military sector, TYROLIT plays a leading role supporting the engine manufacturers and their subcontractors with continuous development of products and process knowledge.



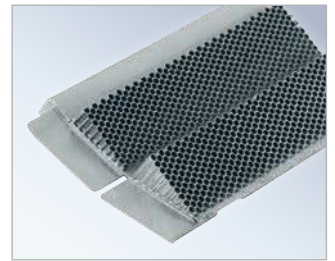
Aircraft turbine blade



Nozzle guide vane (NGV)



Structural parts



Honeycomb

Industrial Gas Turbine

Today, the largest and most powerful gas turbines are built with a capacity up to 375 megawatts.

With an efficiency factor of more than 60% these high-tech power stations set new benchmarks for ecological and cost-effective power generation.



Extreme grinding lengths and deep profiles present a significant challenge in terms of grinding technology, one which TYROLIT has already mastered for some decades.

STRATO ULTRA

TOP PERFORMANCE IN CREEP FEED GRINDING

CD CREEP FEED GRINDING

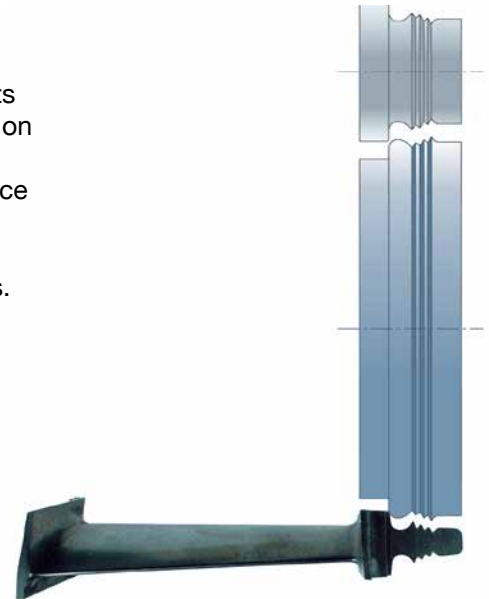
Continuous Dressing creep feed grinding sharpens and cleans the wheel continuously due to the constant contact with the roller dresser. This permits the highest profile accuracy to be achieved and maintains the optimal form on the grinding wheel.

Only with the vitrified bonded STRATO Ultra grinding wheels top performance can be reached while CD creep feed grinding.

This process is mainly used on Blohm, Danobat, Elb and Mägerle machines.

Advantages

- Grinding wheel topography remains effective due to continuous action of the roller dresser
- Shorter grinding times, as very high feeds are possible
- Excellent form stability and cool cutting



CD grinding process



HSCD CREEP FEED GRINDING

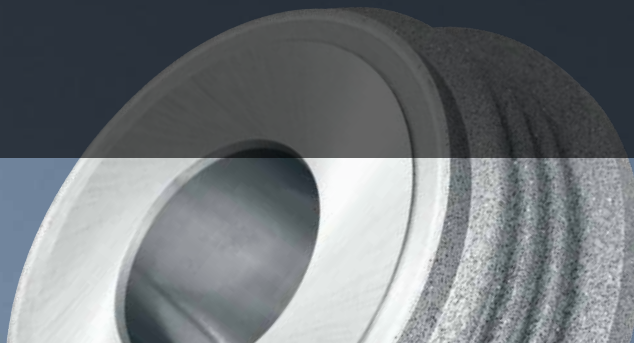
The High Speed Continuous Dressing (HSCD) grinding process – patented by TYROLIT – combines CD creep feed grinding with higher table speed. This becomes possible due to higher roller dresser infeed rates in order to maximize the material removal rates.

Advantages

- High MRR up to 300 mm³/smm [27,9 inch³/min inch]
- High profile holding capability
- VIPER grinding possible

The HSCD creep feed grinding process is mainly used for roughing of high stock removal in very short time.

References are available with stiff and high powered machines like Blohm, Mägerle and Makino.

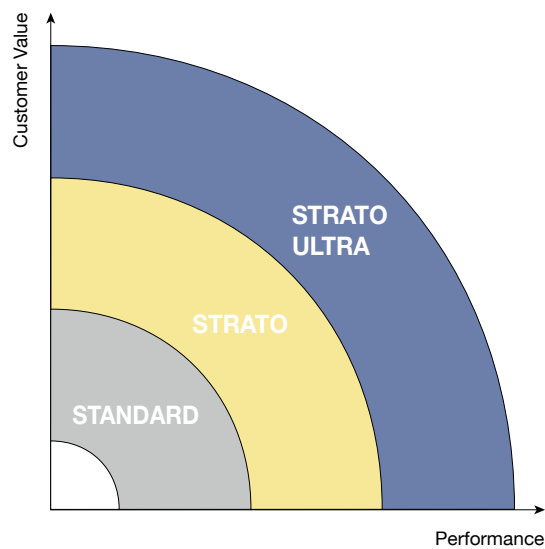


STRATO PRODUCT LINES TOP PERFORMANCE IN CREEP FEED GRINDING

TYROLIT offers three major product lines for different requirements of turbine industry customers.

The blue STRATO Ultra product line represents the latest generation of creep feed grinding tools. The high porosity of the Ultra bond system allows better absorption of grinding coolant, improving profile retention and maintaining lower grinding zone temperatures. Therefore highest stock removal rates and most economic processes can be reached.

The TYROLIT Standard and yellow STRATO product completes the TYROLIT program for the turbine industry.



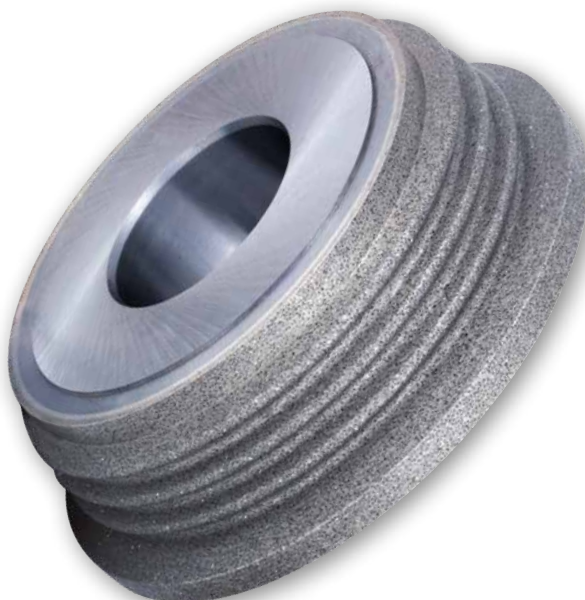
DIAMOND ROLLER DRESSER FOR MAXIMUM PROFILE ACCURACY

In the turbine industry high accuracy of the workpiece profile is necessary. To reach these requirements TYROLIT diamond roller dresser are manufactured by the reverse plating process.

When used in combination with TYROLIT STARTO Ultra grinding wheels both geometric profile accuracy and the desired wheel topography can be achieved. The resultant effect means that close tolerances and reduced thermal stress of the workpiece are achieved with ease.

Advantages

- High profile accuracy
- Reduced dressing costs
- Long life
- Reduces thermal stress on the workpiece



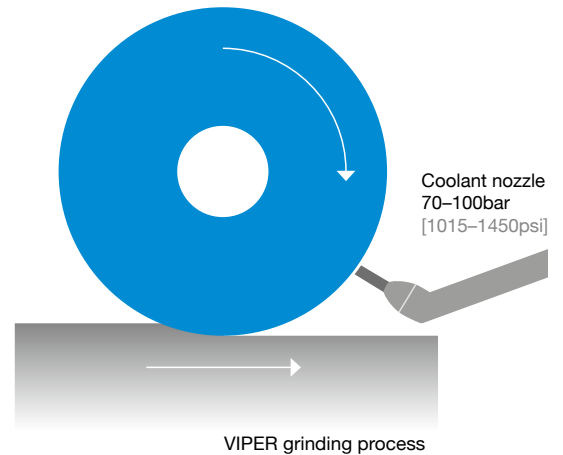


VIPER ULTRA BEST FOR VIPER GRINDING

VIPER Grinding is a special designed creep feed grinding process mainly applied for Ni-based alloy materials used for aircraft engine components. The process was developed in a joint venture between TYROLIT, Rolls Royce UK and the engineering company Raysun. The VIPER grinding process is a patented process and becomes only effective if the VIPER grinding system is applied.

VIPER Grinding System contains following elements

- Special TYROLIT VIPER grinding wheels
- Special TYROLIT Roller Dresser
- High coolant pressure power
- Special coolant nozzles, specifically directed
- Flexible machining center



VIPER GRINDING

The VIPER system allows cool grinding with excellent form holding and profile retention. Cool cutting is particularly important when grinding nickel based aerospace components such as turbine blades, rotor blades and nozzle guide vanes which are primary applications for VIPER grinding.

Special nozzles are used to inject the cooling lubricant at 70 to 100 bar [1015 to 1450 psi] at right angles into the grinding wheel and away from the grinding zone. As a result, machining times can be reduced and the high demands for profile accuracy and surface quality can be met.

Advantages of VIPER grinding

- Used on flexible machining center
- Greatly minimized risk of surface damage due to special cooling lubricant nozzle application
- HSCD possible (Makino A99)

The VIPER System is currently licenced for use on Bridgeport-Hardinge and Makino machines.



MAKINO iGrinder G5



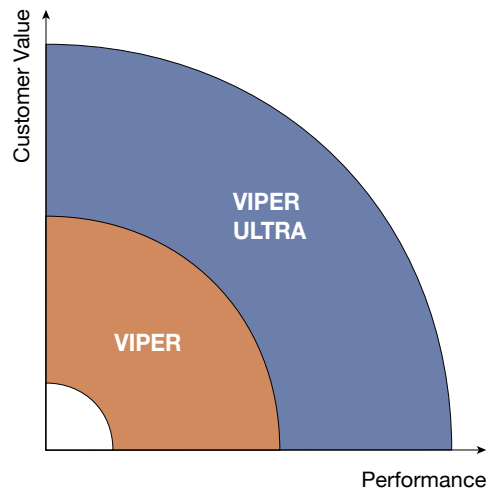
BRIDGEPORT FGC2



VIPER PRODUCT LINES BEST FOR VIPER GRINDING

With the launch of the blue VIPER Ultra product TYROLIT has created a further step change in the evolution of the VIPER grinding process. The product features of these high-porous grinding tools are exceptional. Firstly the coolant can be absorbed and carried into the grinding zone and secondly grinding chips and debris are efficiently transported by means of the open pore structure, result- outstanding profile retention.

VIPER Ultra grinding wheels combine the latest production technology with the VIPER grinding system. This results in optimal use of the abrasive grain, high MRR and cool grinding conditions.



The orange VIPER Standard wheel completes the TYROLIT program for the turbine industry.

This unique bond system is capable of achieving the same high-performance associated with sintered aluminum oxides without compromising performance.

The alternative high priced sintered aluminium oxides also have a very aggressive effect on the dressing tool and consequently promote increased diamond wear and higher dressing costs.



STRATO PRO DESIGNED FOR HIGH SPEED RECIPROCATING GRINDING

New high speed grinding philosophy engineered by the machine builder Blohm advances the reciprocating grinding process with the use of the latest technology of linear drives and the advantage of TYROLIT high speed grinding wheel technology. With high speed reciprocating grinding, less heat is transferred to the work piece due to the small contact length and contact time due to the rapid stroke and low infeed.

Additionally the power consumption is less and the lower heat input to the workpiece minimizes the risk of burning. When grinding nickel based aerospace components such as turbine blades, rotors and nozzle guide vanes, cool cutting is of paramount importance.



BLOHM PROKOS

Advantages

- Cool cutting ability due to high table speed
- Flexible machining center
- Cutting speed up to max. 80m/s available

STRATO Pro grinding wheels are especially designed for the highspeed reciprocating grinding process.

This STRATO Pro enables high dynamic loads to be absorbed without damaging or breaking the bond bridges, resulting in optimal use of the abrasive grain. The TYROLIT technology of high speed grinding wheels allows the use of speeds up to 80 m/s [SFPM 15748] in combination with this high speed reciprocation grinding technology.





STRATO SA CBN GRINDING WHEEL FOR CREEP FEED GRINDING

TYROLIT electroplated CBN grinding wheels fulfill the requirement of grinding deep radial slots on Nozzle Guide Vanes (NGV) as well as the grinding of structural parts which are difficult to grind with conventional grinding wheels.



The STRATO SA grinding wheels consists of a high precision long lasting metal core and a single layer of special CBN grain. This grain is extremely free cutting, reducing thermal stresses on the work piece. The CBN grain is the second hardest grain after diamond and produces extended wheel life compared to conventional wheels. This feature reduces downtime on the machine and improves the rate of production.

When the CBN grain is worn out the steel core can be replated several times. Replating of electroplated CBN wheels offers an economic cost benefit in the use of this product.

Advantages

- Intricate wheel geometries can be produced
- No dressing unit is required
- Reduced thermal stress on the workpiece
- Grinding wheel can be replated
- High cutting ability
- High working speed

The single layer of the special CBN grain and the very small wear allows the grinding of complex profiles with the highest accuracy during the complete life of the wheel.

This technology does not require the wheel to be dressed which shortens the process time.





GRINDING MONITOR ADVANCED GRINDING PROCESS CONTROL

The TYROLIT grinding monitor assists the TYROLIT application engineers to improve work piece quality and productivity of the grinding process.

Grinding Monitor functions

- Monitoring of vibration
- Monitoring of power consumptions
- Monitoring of acoustic emission signal

The TYROLIT application engineer already has a detailed knowledge about the machine system, the grinding wheel and the interaction of all dynamic process parameters. In addition to this deep grinding process know how, the TYROLIT Grinding Monitor informs the engineer about important hidden process details, which influence every grinding process.

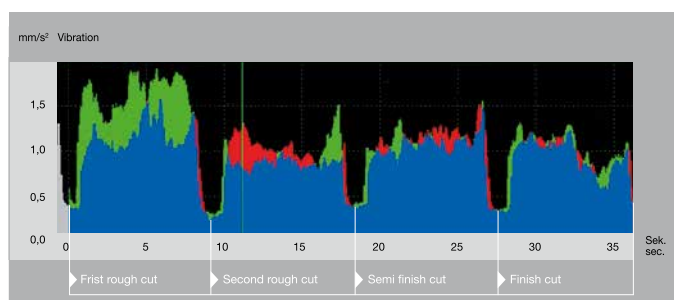
Measured values can be visualized with this Grinding Monitor and helps to structure and prioritize further necessary adjustments in order to reach a better control of advanced grinding processes.

Advantages

- Portable equipment
- Grinding process can be monitored at customer site
- Allows deeper analysis of critical grinding processes
- Assists to improves workpiece quality and productivity
- Documents the improved process parameters



Grinding monitor



Grinding monitor graph



APPLICATION ENGINEERING SOLUTIONS EXPERTISE

Successful enterprises expect not only top products from their partners, but also process know-how and a program of comprehensive support for their individual requirements.

Concentration on the production and supply of top quality tools is in itself no longer sufficient. Good “software” has to be offered alongside the “hardware”. With the wealth of process expertise commanded by our team of application engineers we are able to provide our customers with sustained solutions in line with today’s demanding technical and economical expectations.



Clarify the task

We place great emphasis on knowing the targets of our customers. Application engineering specialists analyze the task in detail. A requirements profile which takes technological and profitability aspects into account is then drawn up together with the customer.



Define the concept

The team of experienced application engineers defines approaches to the solution, calling on the additional input from our specialists from R & D and our in-house test center as required.



Realize the solution

The process solution is then taken direct to the customer where it is put into practice on the relevant machine. Within the scope of a sustained process optimization the application engineer sets the mode of operation for the grinding tool, the interaction between machine, workpiece, material, cooling lubricant and kinematical parameters.



Share the know-how


Our know-how in the field of grinding technology is crucial to successful cooperation. A one-off optimization is not the solution for the customer. Sustained results come from the continuous application of the experience on a broad basis. Service is also offered to our customers by way of practice-oriented information, data preparation, trainings and seminars.

TYROLIT SCHLEIFMITTELWERKE SWAROVSKI K.G.

Swarovskistraße 33 | 6130 Schwaz | Austria
Tel +43 5242 606-0 | Fax +43 5242 63398

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our website at www.tyrolit.com



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