TECHNICAL SOLUTIONS FOR CREEPFEED GRINDING

IN THE AEROSPACE & TURBINE MARKETS

TECHNICAL GUIDE

NORTON®
SAINT-GOBAIN

™

SAINT-GOBAIN ABRASIVES PROVIDES SOLUTIONS FOR TODAY'S MOST ADVANCED GRINDING PROCESSES IN THE AEROSPACE AND TURBINE MARKETS.

CREEPFEED GRINDING IN THE AEROSPACE & TURBINE MARKETS

Creepfeed grinding is a typical process in the aerospace and turbine markets. It is characterized by deep-cutting at low table speed and a large arc of contact between the wheel face and the work-piece.

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INTRODUCTION

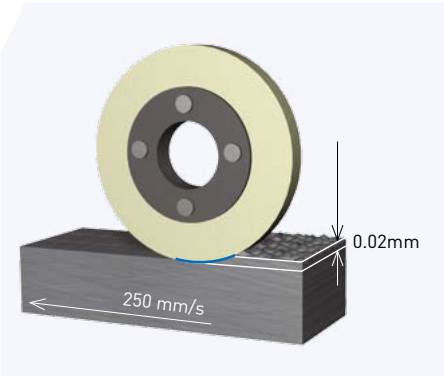
CREEPFEED GRINDING

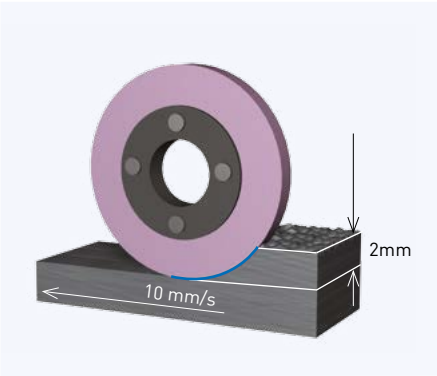
Creepfeed grinding is a significant departure from conventional surface grinding applications in which the wheel traverses the workpiece many times at very shallow infeed to remove small amounts of material. The machine tool plunges a soft, open structure grinding wheel deep into the workpiece to remove a large amount of material in a few passes.
Creepfeed grinding is an extremely effective method of removing large amounts of metal very quickly. The process produces better quality parts with lower grinding stresses, reducing the chance of metallurgical damage due to burn. The wheel must be very soft and have an open structure and high porosity.

Grinding the fir tree root of a turbine rotor blade

CREEPFEED CHARACTERISTICS

Creepfeed grinding is characterized by a deep pass and slow table speed surface grinding with high material removal rates (MRR' or Q'w in $mm^3/mm/s$).





1.5 $mm^3/mm/s$ .... 10 $mm^3/mm/s$

Surface Grinding

10 $mm^3/mm/s$ .... 50 $mm^3/mm/s$

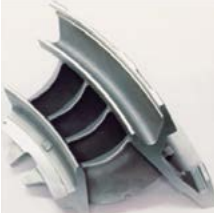
Creepfeed Grinding

TYPICAL PARTS MACHINED

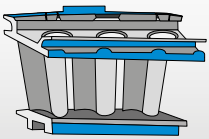
Turbine rotor blades and nozzle guide vanes (NGV) are exposed to enormous stress during operation: high temperatures of up to 1400°C, high pressure and tremendous centrifugal force above the speed of sound. These 'hot' components are usually made of high performance nickel super alloys that are hard to grind. Machining of turbine blades requires great precision and cool-cutting to maintain component integrity.

Turbine rotor blade

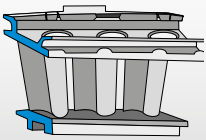
Nozzle guide vane (NGV)



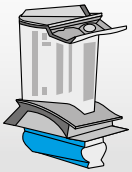
NGV all features except wedge faces



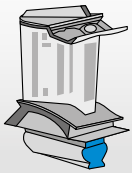
NGV wedge faces



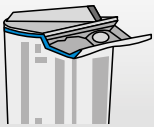
Rotor blade - fir tree serrations



Rotor blade - root face & shroud edge



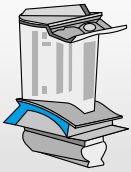
Rotor blade - - z notch

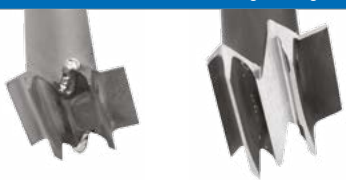


Rotor blade - - sealing fins

Rotor blade radial seal tip & root end

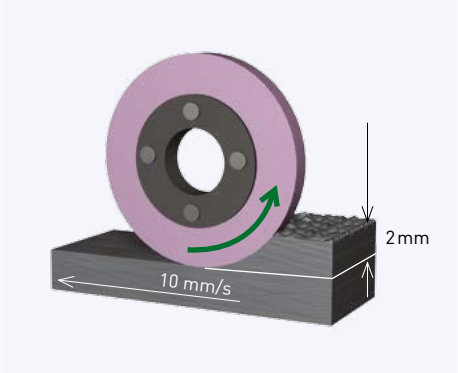
Rotor blade - wedge faces



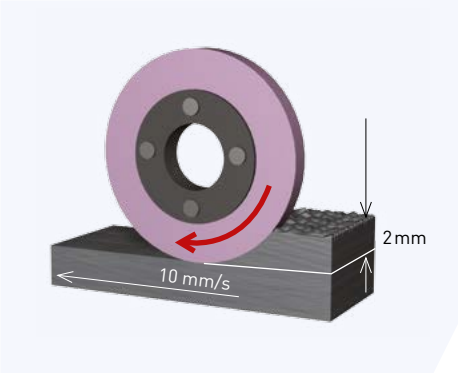
Fir tree before and after grinding	Z-notch before and after grinding
	

DIRECTION OF CUT

An important factor in the grinding process is the direction of cut.



Up Cutting
The wheel and the workpiece move in opposite directions through the arc of contact.



Down Cutting
The wheel and the workpiece move in the same direction through the arc of contact.

Down cutting is generally more common in creepfeed grinding:

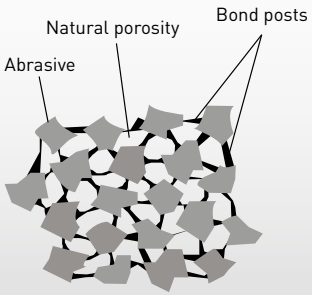
- Coolant is most effective where material removal is highest.
- Maximum chip thickness is immediately achieved.
- Constant chip thickness is maintained through length of contact.
- Allows coolant nozzle to be placed according to wheel direction.

GRINDING WHEEL CHARACTERISTICS

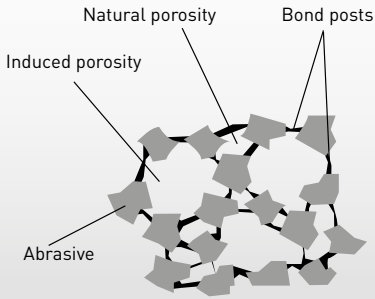
Saint-Gobain Abrasives offers a range of high porosity vitrified bonded wheels for creepfeed applications. The wheels provide the optimum cool, fast cut for maximum productivity and quality, and reduce the risk of metallurgical damage due to burn.

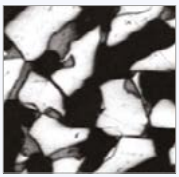
In creepfeed grinding, the wheel must be very soft due to the large contact area and the need to limit pressure on the workpiece. The wheel should also have an open structure and high porosity to transport coolant in and chips out. Manufacturing, and in particular pressing requirements, limit the natural porosity level. Pore inducers help increase manufacturing porosity limits, and engineer pore size and distribution.

NORMAL STRUCTURE

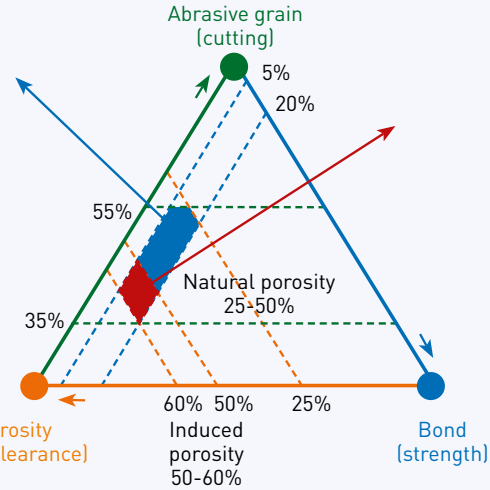


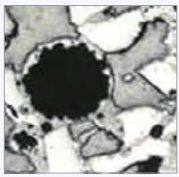
STRUCTURE WITH INDUCED POROSITY





Natural porosity





Induced porosity

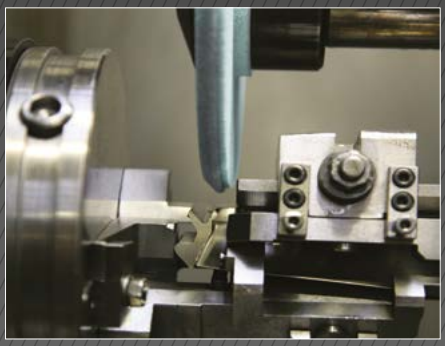
Pore inducers can increase porosity limit to 60%

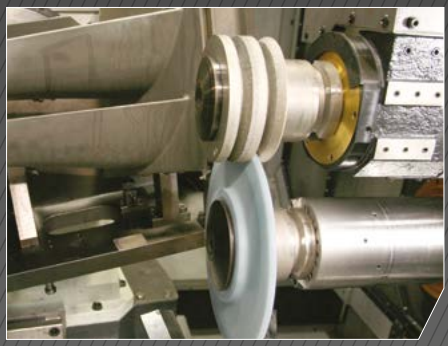
NORTON VORTEX™ 2 & ALTOS IPX: THE NEW HAWK SOLUTION

Developed by Saint-Gobain Abrasives, HAWK combines the cutting edge technology of Norton Vortex™ 2 and Altos IPX bonded wheels to offer the ultimate high technology solution for grinding on multi-axis CNC machines working with high pressure coolant.

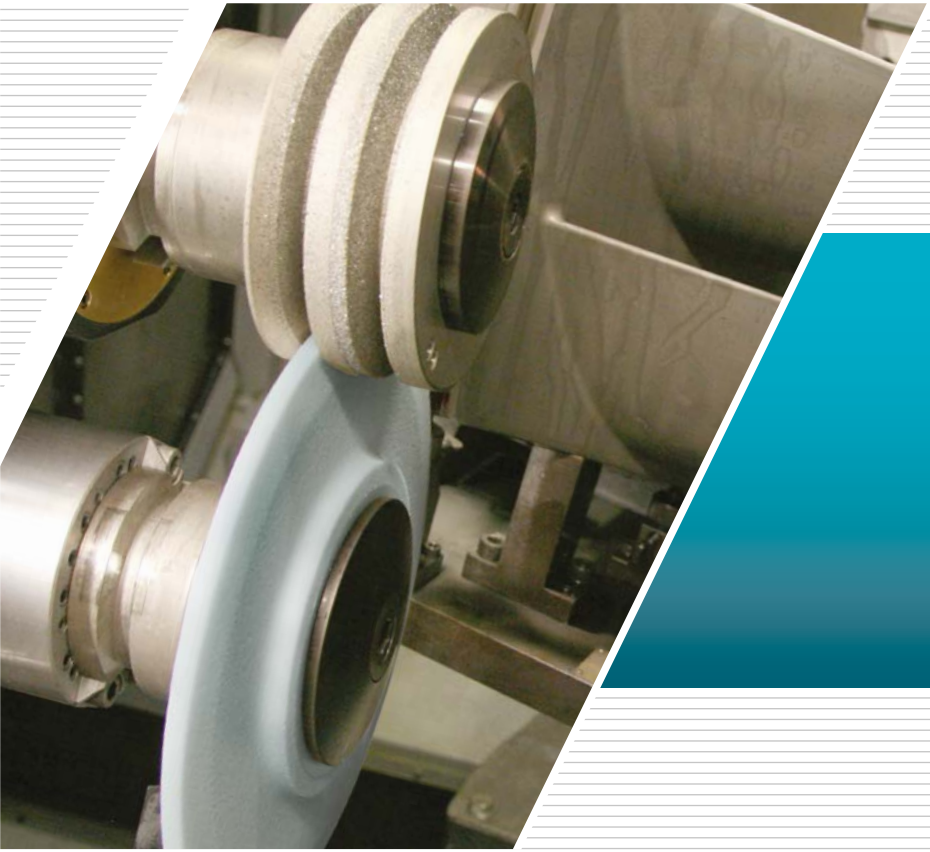
PROVIDING QUALITY AND PRECISION EXCELLENCE:

- High metal removal rates and reduced heat generation
- Efficiency on large surface areas including creepfeed and surface grinding
- Reduced cycle times of up to 50%
- Reduced production time and grinding costs





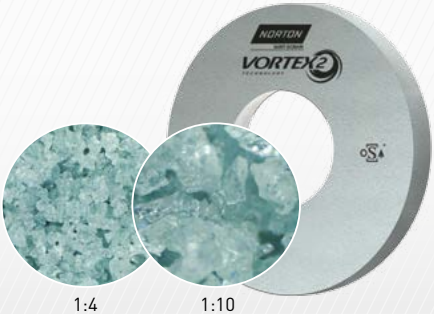
PRODUCT SELECTION GUIDE



NORTON WHEELS FOR CREEPFEED GRINDING

Saint-Gobain Abrasives offers a specific range of high porosity vitrified bonded wheels for creepfeed grinding in the aerospace & turbine markets. Norton Vortex 2 and Altos IPX wheels are manufactured without chemical pore inducers, resulting in an extremely consistent and even macrostructure. They are ideal for use in aerospace and power generation industries, where exact precision and stability is required.

The advanced high performance bond in Vortex™ 2 Technology, developed by Saint-Gobain Abrasives, maximises profile holding, significantly increasing metal removal rates and wheel life, raising productivity to a new level.



1:4 1:10

Vortex 2 microstructure

Norton Altos IPX is an extruded ceramic that is capable of very high material removal rates.

The unique grain shape gives the wheel a very high level of permeability.

Altos IPX microstructure 1:10

This revolutionary bond platform features an exclusive chemistry that delivers an entirely new grain adhesion science, resulting in improved product versatility across a wide range of precision grinding applications.

Vitrium^3 microstructure 1:10

VCF2

Only natural pore inducers are used in VCF2 wheels to increase the level of permeability.

VCF2 microstructure 1:10

OUR COMMITMENT: SAFETY, QUALITY AND ENVIRONMENT PRESERVATION

SAFETY

The personal safety of workers using abrasive cutting and grinding wheels is our primary concern. All Norton abrasive wheels are developed, manufactured and safety tested in accordance with the European standard EN12413, safety requirements for bonded abrasive products. In addition, all Norton products meet stringent requirements of the Organization for the Safety of Abrasives (oSa). Saint-Gobain Abrasives is a founding member of the oSa organisation.

www.fepa-abrasives.org

www.osa-abrasives.org

QUALITY

Saint-Gobain Abrasives is fully ISO accredited:

ISO 9001:	certifies Quality Management system is in accordance with requirements of quality standards.
ISO 14001:	certifies Environmental Management system is in accordance with requirements of environmental standards.
OHSAS 18001:	health and safety at work certification.

ENVIRONMENTAL BENEFITS

Pore inducers used in the manufacture of many high porosity products are harmful to the environment. The abrasive types used in Norton Vortex2 and Altos IPX require no articificial pore inducers (naphthalene) to achieve the highest level of permeability. The technologies Norton Vitrium3 and VCF2 do not require harmful naphthalene to achieve a high level of permability, unlike other standard porous vitrified products.

PRODUCT DESCRIPTION

Dimensions (mm): 01 _ 500 x 95 x 203.2

Type — Diameter (D) — Thickness (T) — Bore (H)

Specification: IPX 80 F 13 VCF5

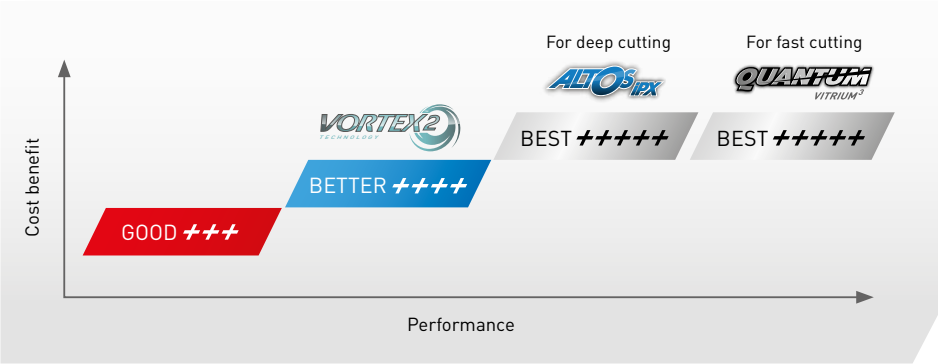
Grain Quality — Grit Size — Grade — Structure — Bond

GRIT SIZE SELECTION

Grit size selection is governed by the minimum form radius required rather than surface finish.

MINIMUM WORKPIECE RADIUS (mm)	GRIT SIZE FEPA F
2	46
1	60
0.6	80
0.4	100
0.3	120

PRODUCT RECOMMENDATION



PRODUCT DESCRIPTION

TIER	NAME	FEATURES	BENEFITS
BEST +++++	NORTON QUANTUM with VITRIUM³	• Lastest generation bond and engineered microstructure grain • Vitrified durable bond • Compatible with all Alox from conventional to Quantum • Available with porous structures	• Optimize costs savings and maximise performance • Form holding • Free cutting action • Well suited for high-speed operations (80m/s)
BEST +++++	ALTOS IPX	• Engineered ceramic grain • Natural porosity • Structure control • Grain position control	• Excellent for fast and deep cutting • Self sharpening • Higher G ratio • Very long wheel life
BETTER ++++	VORTEX 2	• New bond formula • Patented grain technology • Very high levels of open porosity	• Excellent profile holding • Unrivalled homogenity • Very fast and cool cut • Gentle on dressing tool
GOOD +++	VCF2	• Induced porosity • High temperature bond	• Cool and free cutting • Form holding

Norton Vortex™ 2 and Altos IPX are also available in the HAWK product offering, see your local sales representative for details.

GRINDING WHEEL SPECIFICATION RECOMMENDATION

COMPONENT	PART POSITION	GRINDING PROCESS
Turbine rotor blade Ni-Cr alloy (Inconel)	Fir Tree Serration	Creepfeed
		High Pressure Coolant
		Fast reciprocation
	Notch Z shape	Creepfeed
		High Pressure Coolant
		Fast reciprocation
	Lock plate Groove	Creepfeed
		High Pressure Coolant
		Fast reciprocation
	Sealing fins	Creepfeed
		High Pressure Coolant
		Fast reciprocation
	Wedge Faces	Creepfeed
		High Pressure Coolant
		Fast reciprocation
	Radial seal tips & root end	Creepfeed
		High Pressure Coolant
		Fast reciprocation
	Root face & shroud edge	Creepfeed
		High Pressure Coolant
		Fast reciprocation
Other Inconel parts (segments, NGV,...)	All	All processes
TiAl (all components)	All	All processes

MACHINE BRAND / MODEL												
ABA		BLOHM			DANOBAT	ELB	HAAS	JONES & SHIPMAN	MÄGERLE	MAKINO		
Easyline / Ecoline	Mutliline & Powerline	Profimat MC / MT / RT	Planomat HP	Prokos	MC / MT	Micro-Cut	Multigrind CA / CB	Dominator 624/634/644	MFP / MFR / MFS	A99ε	iG5 / iG7	RECOMMENDED STARTING SPEC.
												IPA 60 [ME-HA] 29 VTX2
												IPA [60-80] EH 20 VTX2
												5NQM [60-80] L 8 VS3
												IPA 60 [EH-XH] 17 VTX2
												IPA [60-80] EH 20 VTX2
												5NQM [60-80] L 8 VS3
												IPA 60 [HA-EH] [17-20] VTX2
												IPA 60 EH 20 VTX2
												5NQM [60-80] L 8 VS3
												IPA [60-80] HA 26 VTX2
												IPA 60 HA 20 VTX2
												5NQM [60-80] L 8 VS3
												IPA 60 HA 20 VTX2
												IPA 60 HA 20 VTX2
												5NQM [60-80] L 8 VS3
												IPA 60 HA 20 VTX2
												IPA 60 HA 20 VTX2
												5NQM [60-80] L 8 VS3
												IPA 60 HA 20 VTX2
												IPA 60 HA 20 VTX2
												5NQM [60-80] L 8 VS3
												IPA [60-80] [HA-EH] [17-20] VTX2
												39C [60-80] [J-L] VS

PRODUCT AVAILABILITY

SELECTION GUIDE

	DESCRIPTION	DETAILS
Abrasive type	IPX	Extruded microcrystalline aluminium oxide
Grain size	80*, 120	
Grade	C to J	
Structure	12 13* 14	Less open structure for improved form holding and wheel wear More open structure for higher MRR and heat sensitive parts
Bond type	VCF5	High performance vitrified bonding system
Colour	–	Lilac

Form holding

MRR increases

* Most common specification: IPX80F13VCF5

AVAILABILITY

	SPECIFICATION AVAILABILITY							
Grain type	IPX							
Grain size	80, 120							
Grade	C	D	E	F	G	H	I	J
Structure 12	■	■						
Structure 13	■							■
Structure 14							■	■

■ Not available Available

	DIMENSION AVAILABILITY	
Diameter (mm)	Thickness min (mm)	Thickness max (mm)
200-299	6	80
300-609	10	200
610-900	20	150

MAXIMUM OPERATING SPEEDS (M.O.S)

For a 500 (D) x 25 (T) x 203.2 (H) mm wheel*

STRUCTURE	GRADE				
	D	E	F	G	H
12	N.A.	40m/s	45m/s	50m/s	50m/s
13	35m/s	40m/s	45m/s	50m/s	50m/s
14	35m/s	40m/s	40m/s	45m/s	45m/s

According to EN12413

* M.O.S is dependant on wheel dimensions, grade, structure and grit size

SELECTION GUIDE

	DESCRIPTION	DETAILS
Abrasive type	38A	White friable aluminum oxide
	27A	Monocristal durable aluminum oxide
	3NQM / 5NQM*	Quantum ceramic grain blended with 27A
Grain size	46 to 180	
Grade	G to N	
Structure	6 to 9 (Form holding)	Non porous stuctures for high profile accuracy and high speed work (MRR increases)
Bond type	VS3 / VS3P	Last generation vitrified bond for optimized performances
Colour	-	White to light lavander

* Most common specification: 5NQM80L8VS3

AVAILABILITY

	SPECIFICATION AVAILABILITY				
Grain type	38A, 27A, 3/5 NQM				
Grain size	46 to 180 (46 to 120 with VS3P)				
Grade	D to F	G	H	I to K	L to N
Structure 6					
Structure 7					
Structure 8					
Structure 9					
Structure 10 to 13					

Not available Available

	DIMENSION AVAILABILITY	
Diameter (mm)	Thickness min (mm)	Thickness max (mm)
100-199	6	80
200-299	8	100 / 80 with VS3P
300-609	10	200 / 80 with VS3P
610-900	20	150 / 80 with VS3P

MAXIMUM OPERATING SPEEDS (M.O.S)

For a 300 (D) x 40 (D) x 76.2 (H) mm wheel, protected machine with 5NQM grit 80*

STRUCTURE	GRADE		
	G	H	I to N
6			80m/s
7		80m/s	80m/s
8	80m/s	80m/s	80m/s
9		80m/s	80m/s

According to EN12413

* M.O.S is dependant on wheel dimensions, grade, structure and grit size

SELECTION GUIDE

	DESCRIPTION	DETAILS
Abrasive type	IPA	High purity white aluminium oxide
Grain size	46, 60*, 80, 100, 120	
Grade	ME	Medium
	HA*	Hard
	EH	Extra hard
	XH	Extra extra hard
Structure	17	Less open structure for improved form holding and wheel wear
	20	
	26*	More open structure for higher MRR and heat sensitive parts
	29	
Bond type	VTX2	High performance vitrified bond with exceptional form holding and wheel life
Colour	–	Green

Form holding

MRR increases

* Most common specification: IPA60HA26VTX2

AVAILABILITY

	SPECIFICATION AVAILABILITY			
Grain type	IPA			
Grain size	46 - 120			60 - 120
Grade	ME	HA	EH	XH
Structure	17, 20, 26, 29			

	DIMENSION AVAILABILITY	
Diameter (mm)	Thickness min (mm)	Thickness max (mm)
up to 249	6	102
250-399	8	150
400-599	10	300
600-900	15	150

CONVERSION OF POROS II & VCF2 TO VORTEX 2

If you are a user of Poros II, select a Vortex 2 wheel with the specification:

STRUCTURE 1ST NUMBER	STRUCTURE 2ND NUMBER (POROSITY)	GRADE						
		F	G	H	I	J	K	L
6	4					ME17	EH17	XH17
7	3					HA17	XH20	
7	4			ME20	HA20	EH20	XH20	
8	5	ME26	HA26	EH26	EH26	XH26	XH26	
8	6	ME29	HA29	EH29		XH29		

If you use VCF2, select a Vortex 2 wheel with the following specification:

STRUCTURE 1ST NUMBER	GRADE						
	C	D	E	F	G	H	I
16				ME17	HA17	EH17	XH17
19			ME20	HA20	EH20	XH20	
25			HA26	EH26	XH26		
28	ME29	HA29	EH29	XH29			

MAXIMUM OPERATING SPEEDS (M.O.S)

For a 500 (D) x 25 (T) x 203.2 (H) mm wheel*

STRUCTURE	GRADE		
	ME	HA	EH/HX
17	50m/s	50m/s	50m/s
20	45m/s	50m/s	50m/s
26	40m/s	45m/s	50m/s
29	40m/s	40m/s	45m/s

For a 220 (D) x 20 (T) x 32 (H) mm wheel*

STRUCTURE	GRADE		
	HA	EH	XH
17	50m/s	63m/s	63m/s
20	50m/s	63m/s	63m/s
26	50m/s	50m/s	50m/s
29	45m/s	50m/s	50m/s

According to EN12413

*M.O.S is dependant on wheel dimensions, grade, structure and grit size.

VCF2 SELECTION GUIDE

	DESCRIPTION	DETAILS
Abrasive type	7A	Semi-friable aluminium oxide, light brown
	9A*	High purity & friability white aluminium oxide, white
	10A	High performance mono-crystalline aluminium oxide, light grey
Grain size	46 - 150	
Grade	D-M	
Structure	16 19 25 28*	Less open structure for improved form holding and wheel wear More open structure for higher MRR and heat sensitive parts
Bond type	VCF2	High temperature vitrified bonding system

Form holding

MRR increases

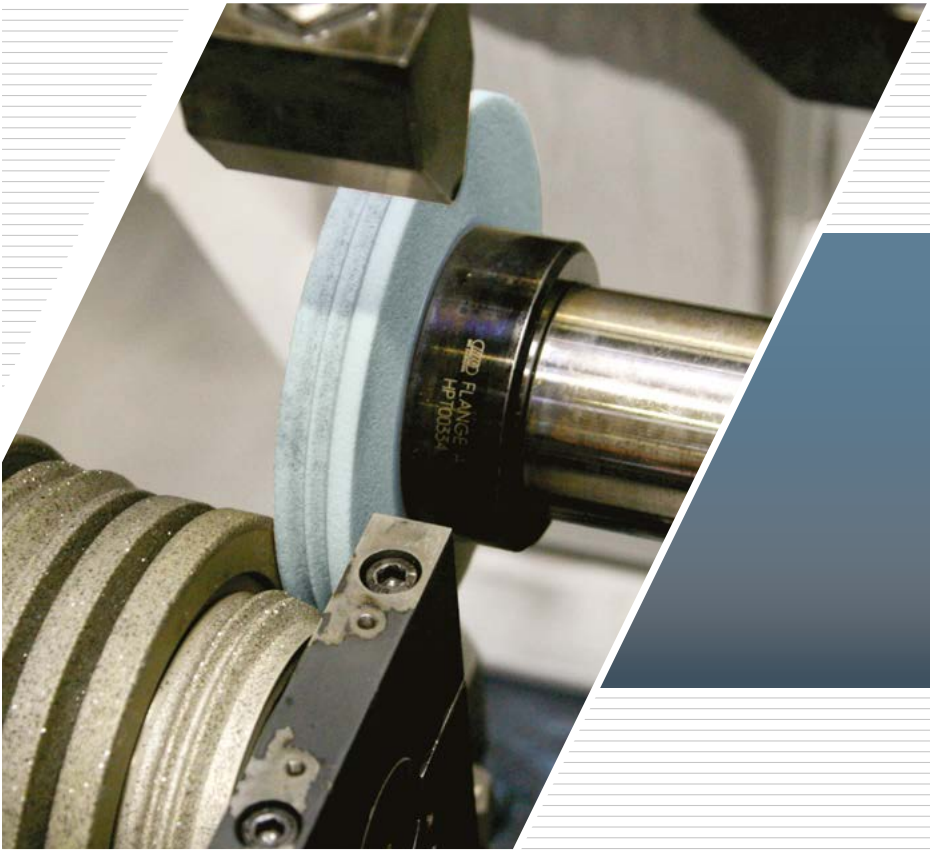
* Most common specification: 9A60D28VCF2

AVAILABILITY

	SPECIFICATION AVAILABILITY				
Grain type	7A, 9A, 10A				
Grain size	46 - 150				
Grade	D	E	F-J	K-L	M
Structure	25, 28	19, 25, 28	16, 19, 25	16, 19	16

	DIMENSION AVAILABILITY	
Diameter (mm)	Thickness min (mm)	Thickness max (mm)
up to 249	6	102
250-399	8	152
400-599	10	152
600-900	20	102

DIAMOND ROLLER DRESSERS



To ensure that tight dimension tolerances are held, the grinding wheels are dressed using rotating roller dressers which have the same profile as the workpiece.

DIAMOND ROLLER DRESSER TYPES UZ AND TS

	TYPE	MANUFACTURE	BOND	GRIT DISTRIBUTION	GRIT DENSITY
	UZ	Reverse process	Electroplated	Statistical	Maximum
	TS	Reverse process	Infiltrated	Statistical /controlled	Maximum / controlled

UZ VERSION

The diamond grit is statistically distributed over the surface of the profile roller dresser.
The distance between the grits is determined by the grit size used. The dense coating of diamonds means that the diamond content is greater than in profile roller dressers with manually applied diamonds. The manufacturing process is possible for a wide range of shapes and profiles. Concave radii ≥ 0.03mm and convex radii ≥ 0.08mm are possible.

TS VERSION

In contrast with the UZ version, the diamonds can also be set according to a defined pattern. This requires certain minimum diamond sizes so not all profile shapes are available in this version. The concentration of the diamond coating can be influenced by changing the distance between diamonds. Profile accuracy is achieved by grinding the diamond coating. Convex and concave radii ≥ 0.3mm are possible. The diamond coating can be re-machined, depending on its condition.

TOP TIP

Use in applications with the most stringent surface and geometry requirements to achieve profile accuracy of ≥ 0.8µm.

TOP TIP

Use in applications with very stringent surface and geometry requirements, to achieve a profile accuracy of ≥ 2 µm.

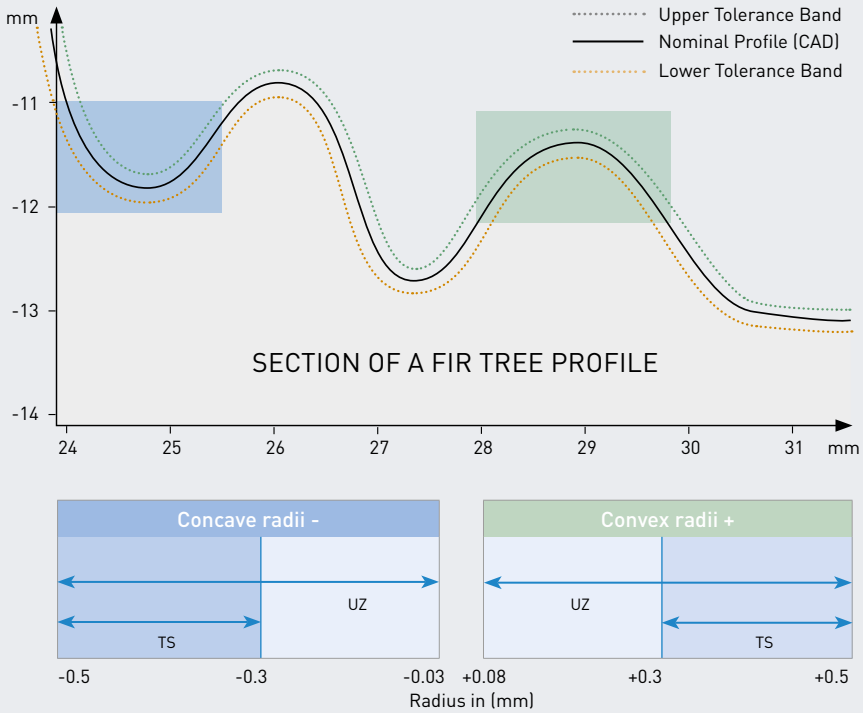
PRODUCT RECOMMENDATION

Depending on the profile accuracy required, select the most appropriate roller dresser using the table below:

	TYPE	PROFILE ACCURACY
	UZ	+/- 1µm
	TS	+/- 2µm

Depending on the profile concave and convex radii required, select the most appropriate roller dresser using the table below:

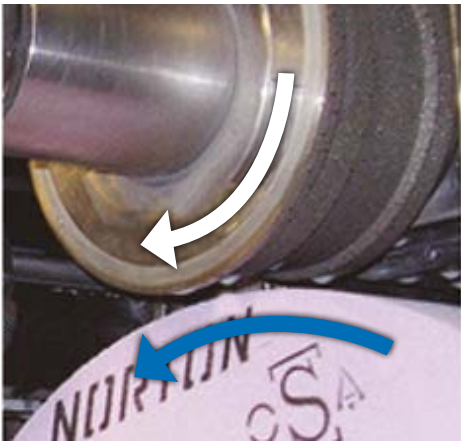
FIR TREE ROOT FORM – EXAMPLES OF CONCAVE AND CONVEX RADII.



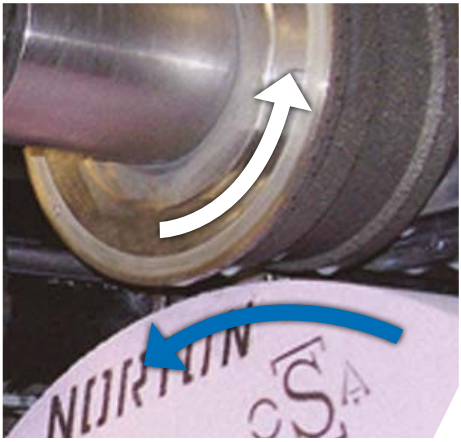
Radii range for the diamond roller dressers types UZ, TS

ROLL ROTATION DIRECTION

The diamond roll rotates either in the same direction as the grinding wheel or in the opposite direction:

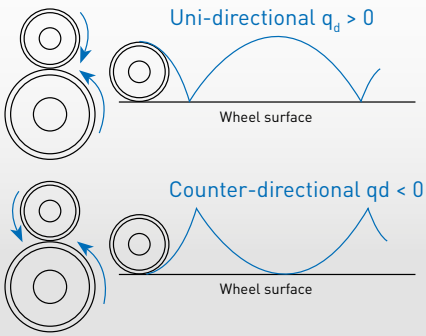


Uni-directional



Counter-directional

The different dressing forces are explained by the different paths (cycloids) of the grinding wheel and roller dresser.



q_d Dressing speed ratio $\mathbf{q_d = \frac{V_r}{V_{sd}}}$

V_r Circumferential speed of the roller dresser (m/s)

V_{sd} Circumferential speed of the grinding wheel when dressing (m/s)

q_d:
- > 0: Uni - directional
- = 1: Crushing
- = 0: Stationary dresser
- < 0: Counter - directional

UNI-DIRECTIONAL DRESSING

During uni-directional dressing the diamond moves along a shorter path (epicycloid), causing it to penetrate the grinding wheel surface at a steep angle and producing a highly aggressive active surface roughness on the grinding wheel.

- Higher dressing forces
- Higher stresses on the roller dresser
- Wheel is more aggressive

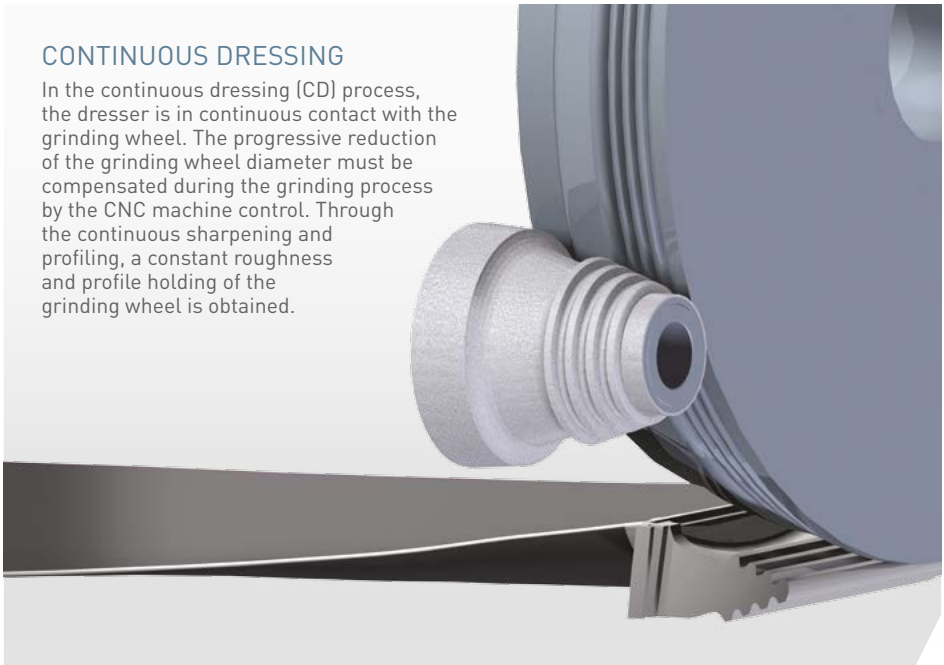
COUNTER-DIRECTIONAL DRESSING

During counter-directional dressing the path is much longer (hypocycloid) and the diamond penetrates the grinding wheel at a much flatter angle, producing a lower active surface roughness, on the grinding wheel.

- Lower dressing forces
- Lower stresses on the roller dresser
- Better surface finish

CONTINUOUS DRESSING

In the continuous dressing (CD) process, the dresser is in continuous contact with the grinding wheel. The progressive reduction of the grinding wheel diameter must be compensated during the grinding process by the CNC machine control. Through the continuous sharpening and profiling, a constant roughness and profile holding of the grinding wheel is obtained.



SPEED RATIO (q_d) OF ROTARY DRESSING TOOLS

The speed ratio (qd) between the rotary dressing tool and the grinding wheel has a considerable influence on the grinding wheel topography and consequently on the dressing and grinding result.

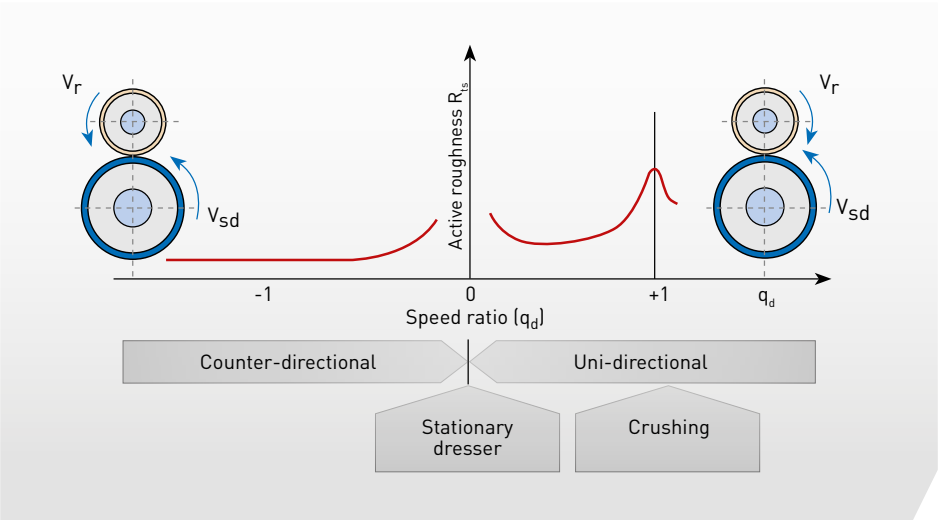
Recommended values for the speed ratio, $q_d = \frac{V_r}{V_{sd}}$

Uni-directional +0.3 to +0.8

Counter-directional -0.3 to -0.5

TOP TIP

A speed ratio of +1 leads to increased dressing forces and can damage the tools.

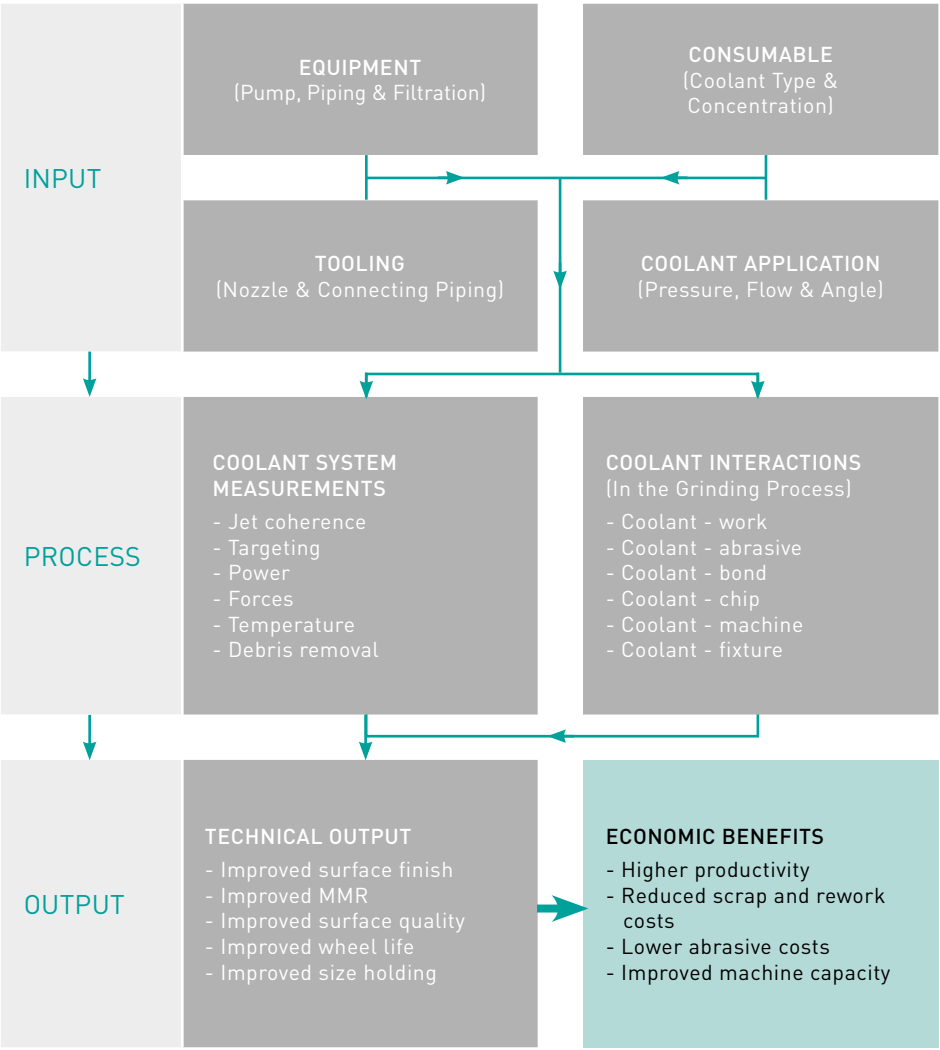


COOLANT

Correct use of grinding fluid is critical in achieving satisfactory results. Quite often, difficult grinding problems can be solved by the use of coolant. Grinding fluids serve four important functions:

1. Lubrication: reduce grinding forces
2. Cooling: remove heat from the grinding zone
3. Cleaning: proper coolant application removes chips
4. Rust prevention: chemicals used in the coolant help protect ferrous surface

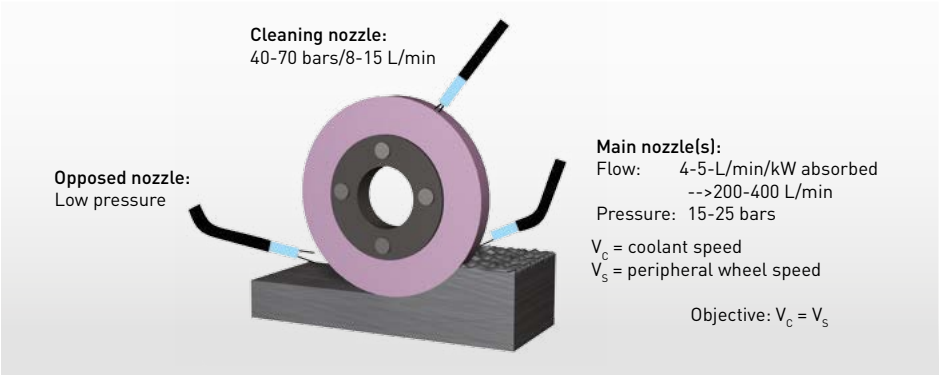
SYSTEMATIC APPROACH TO COOLANT APPLICATION



TOP TIP

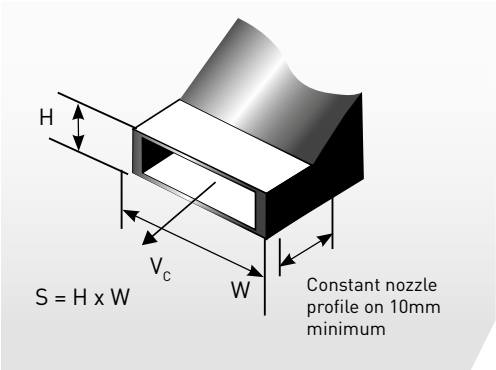
Coolant pump pressures are required in the order of 15 bar as a minimum. Flow should be kept as coherent as possible at the grinding zone and should match closely the shape of the component. Recommended pressure at cleaning nozzle: 40 to 70 bars

GENERAL RECOMMENDATIONS



Coolant speed V_C should match the peripheral speed of the wheel V_S so that the air barrier generated by the wheel is overcome.

Coolant nozzle should be positioned close to the interface between wheel and workpiece so that the maximum amount of coolant enters the cutting zone.
Temperature should be controlled to keep the fluid at around 20ºC.



Coolant flow Q_C calculation:

The recommended coolant flow value depends on the installed spindle power. The coolant has to remove all heating energy produced during the grinding cycle.

Recommendation Q_C > 4 to 5 L/min/kW

Nozzle calculation:

$$S = \frac{16.6 \times (Q_P \times 0.9)}{V_C}$$

S - Surface of coolant of nozzle (mm^2)
V_C - Coolant speed at the exit of the coolant nozzle in (m/s)
Q_P - Pump capacity (L/min)
Q_C - Coolant flow rate at the exit of the coolant nozzle (L/min)
Approximately 0.9 X Q_P (partly due to pressure losses in the pipe transmission)

COOLANT METRIC OPTIMIZATION CHART

Metric flowrate chart for a nozzle with a coefficient of discharge of 0.90.

JET SPEED (M/S)	COOLANT NOZZLE PRESSURE (BAR)			FLOWRATE (L/MIN) FOR LISTED NOZZLE AREAS (MM²)							
	Water	Miner. oil	Ester oil	0.8	3.1	7.1	13	28	50	79	113
	SG = 1.0	SG = 0.87	SG = 0.93								
20	2	2	2	0.9	3.5	8.1	15	33	57	90	129
30	5	4	4	1.4	5.3	12	22	49	86	134	193
40	8	7	7	1.8	7.1	16	29	64	115	179	258
50	13	11	11	2.2	9.0	20	36	80	144	224	322
60	18	16	16	2.6	11	24	43	97	172	268	386
80	32	28	28	3.6	14	32	57	129	229	358	516
100	50	44	44	4.4	18	40	72	162	287	448	645

EXAMPLE

For a wheel speed of 60 m/s, the coolant speed target should be 60 m/s. For a water based emulsion, coolant pressure at the nozzle should be 18 bar. As the spindle power is 10 kW, following the recommendation 'Qc > 4 to 5 L/min/kW', the coolant flow rate should be 40 to 50 L/min. According to the flowrate chart, the nozzle area should be 13 mm².

TROUBLESHOOTING

TROUBLESHOOTING: GRINDING WHEEL

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Burning, burnishing or cracking	Lack of coolant	Check delivery pressure and coolant pipe positions
	Coolant mixture out of specification	Check dilution
	Hard wheel specification	Reduce wheel speed
	Coolant deterioration	Replace
	Wrong feeds and speeds	Adjust to suit wheel grade
	Dressing amount low	Increase
	Dresser to wheel speed ratio too low	Increase towards +0.6 to +0.8 (uni-directional)
Loss of form	Dressing rate low	Increase dressing rate or reduce table speed
	Work speed too high	Reduce work speed or increase wheel speed
Bounce, chatter and ripple	Coolant film boiling	Check delivery and quantity of coolant
	Too large depth of cut	Reduce cut
	Instability	Check rigidity of set up
	Dressing amount low	Increase
	Dresser to wheel speed ratio too low	Increase towards +0.6 to +0.8 (uni-directional)
Excessive power being drawn and wheel stall	Infeed high	Reduce infeed
	Work speed high	Reduce work speed
	Dressing rate too low	Increase dressing rate
Surface pick up	Slow wheel speed	Increase surface speed
	Excessive dressing	Reduce dressing rate
	Coolant deterioration	Replace coolant
	Coolant application	Check dressing/grinding nozzles

TROUBLESHOOTING: DRESSERS

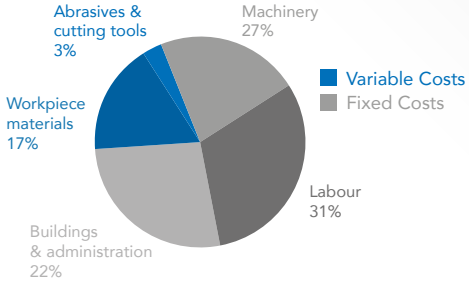
PROBLEM	CAUSE AND CORRECTIVE ACTION
Machine generates increased noise when dressing	Imbalance or radial runout of diamond roller dresser grinding wheel, or excessive dressing forces.
Constant dressing noise	Correct imbalances and/or runout. Change direction of rotation from uni-directional to counter-directional. Reduce dressing feed.
Louder at the start, then gradually fading	Arrangement is not rigid enough Reduce dressing forces (see 1.1).
Workpiece profile deviates from target	Grinding wheel too soft: grinding wheel profile collapses. Grinding wheel too hard: excessive grinding pressure.
Workpiece shows chatter marks	Machine vibrations caused by: • Inadequate bearing arrangement for the grinding spindle or holding fixture. • Inadequate rigidity of the machine or dressing unit. • Insufficient dressing spindle driving power. • Radial runout of the diamond roller is too high.
Deviating width dimension at slots or ribs	Axial play in the grinding spindle or holding fixture bearings. Diamond roller dresser has axial run out failure.
Burn marks on workpiece	Insufficient coolant supply (pressure, flow rate or nozzle position).
	Unsuitable grinding wheel structure and hardness.
	Unsuitable workplace – grinding wheel-diamond roller dresses arrangement.
	Spark-out time too long, dressing feed too short.
	Unsuitable speed ratio qd selected.
Increased surface waviness and peak-to-valley height	Worn diamond coating on roller dresser. Contaminated coolant. Insufficient sparking out time when grinding.

PSP process solutions program

Typical cost reductions

On average abrasives and cutting tools only account for about 3% of total manufacturing budgets. Norton Vitrium³, Altos IPX and Vortex 2 products optimised with Norton's proprietary PSP (process solutions program) helps to optimise your total cost and improve your productivity.

For information on how to achieve the greatest overall cost savings, see the example below or go to **www.saint-gobain-abrasives.com/psp-eu.aspx**.



Decreasing the price of abrasives
A 30% price reduction will only reduce costs per part by 1%.

Increasing the life of abrasives
Even a 50% increase in product life will only reduce costs per part by 1%.

Increase overall productivity through PSP
With a 20% decrease in cycle time per part there will be a reduced total cost per part of more than 15%.

IMPROVING OUR CARBON FOOTPRINT

Increased productivity with existing customer machine capacity. Able to work with higher feed rates, speed and pressure, to significantly increase production while using fewer wheels. Reduced energy consumption with optimal firing temperatures during manufacturing of Norton Vitrium³, Altos IPX and Vortex 2 wheels.

By choosing Norton Vitrium³, Altos IPX and Vortex 2 technology for your grinding operation, you help to preserve the environment. In addition, Norton Vitrium³, Altos and Vortex 2 eliminate costly re-validation of processes associated with using chemical pore inducers such as naphthalene.

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