

TEHNIČKE INFORMACIJE

KONTROLA TOCILA

Završnu kontrolu tocila delimo na:

- a) kontrolu sigurnosti tocila
 - b) kontrolu kvaliteta tocila (tvrdoća, balansiranost, dimenzije).
- Kontrolu sigurnosti tocila vršimo po JUS propisima i uz vođenje računa o FEPA (Federacije evropskih proizvođača abraziva) i DSA (Deutsche Schleifscheibenausschuss) normama.

Propisane norme moraju uvažavati i proizvođač i korisnik tocila.

ODGOVORNOST PROIZVOĐAČA TOCILA

- garancija faktora sigurnosti tocila
- ispitivanje tocila kod povećane obodne brzine
- ispitivanje tocila kod povećane obodne brzine do raspada tocila (test destrukcije)
- označavanje oblika, dimenzija, dozvoljene radne brzine i kvaliteta na prapatnom listu, etiketi ili tocilu
- odgovarajuće pakovanje tocila.

Za oštete u transportu pravilno pakovanih tocila proizvođač ne odgovara.

ODGOVORNOST KORISNIKA TOCILA

- propisno skladištenje tocila
- pregled tocila pre montaže zbog eventualnih oštećenja za vreme transporta (proba na zvuk)
- pravilna montaža i balansiranje tocila
- pravilna priprema mašine za brušenje
- ispitivanje tocila bez opterećenja (prazan hod)

PROBA NA ZVUK

Tocila obično pakujemo u kartonsku ambalažu ili drvene sanduke i šaljemo na paletama. Ambalaža omogućuje bezbedan transport, ali svejedno moramo paziti da se prilikom pretovara sanduci i kutije ne bacaju. Naročitu pažnju obraćamo na tocila u keramičkom vezivu, koja su po lomljivosti slična porcelanu i zato iziskuju još posebno pažljivo rukovanje.

Po prijemu u skladište, a posebno neposredno pre montiranja na mašinu za brušenje neophodno je izvršiti vizuelni pregled tocila i proba na zvuk.

TECHNICAL INFORMATION

TESTING OF GRINDING WHEELS

Final testing of grinding wheels can be divided into:

- a) testing of grinding wheel s safety
- b) testing of grinding wheel s quality (hardness, balance, size)

Testing of the grinding wheel s safety is performed according to the JUS standards (Jugoslav Industrial Norms) with the consideration of FEPA (Federation of European producers of abrasives) and DSA (Deutscher Schleifscheibenausschuß) regulations.

The prescribed norms must be considered by the producer and the user of the grinding wheels.

RESPONSIBILITY OF THE GRINDING WHEEL MANUFACTURER

- warranty of the grinding wheel security factor
- grinding wheel test at increased peripheral speed
- grinding wheel test at increased peripheral speed until bursting up (destruction test)
- proper information on shape, dimension, maximum permissible operational speed and quality on the attached rectangular or circular label or on the grinding wheel
- proper packing of grinding wheels

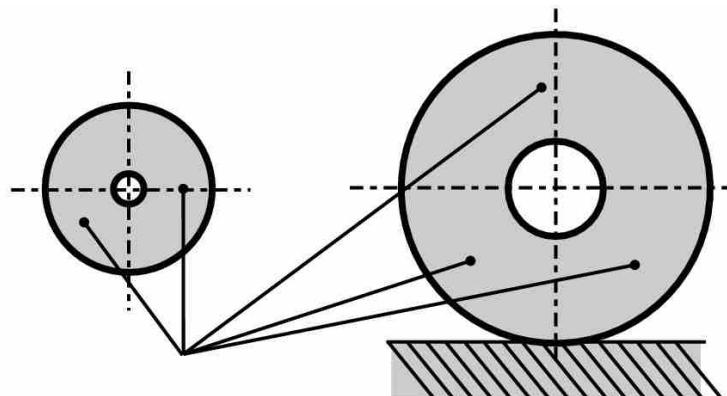
The responsibility of the manufacturer does not include damage caused to properly packed wheels while transporting them.

RESPONSIBILITY OF THE GRINDING WHEEL USER

- proper storage of grinding wheels
- testing of the grinding wheel before mounting it for the sake of possible damages caused by transport (sound test)
- correct mounting and balancing of the grinding wheel
- correct preparation of the grinding machine
- testing of the grinding wheel without loading (neutral run)

SOUND TEST

Grinding wheels are usually packed in cardboard or wooden boxes and shipped on the pallets.



Mesta udaranja
Points of tapping

Time otkrivamo eventualne naprsline, koje su posledica neadekvatnog transporta.

Proba na zvuk se izvodi na taj način što se tocilo u slobodno visećem položaju ovlaš udara malim drvenim čekićem ili sličnim predmetom. Neoštećeno tocilo pri udaru daje jasan, a oštećeno tupi zvuk. Tocila u bakelitnom vezivu nemaju tako jasan zvuk kao tocila u keramičkom vezivu.

MONTAŽA TOCILA

Kada se operator uverio da tocilo nije oštećeno i verifikuje njegove karakteristike (tip, dimenzije, maksimalna dozvoljena obodna brzina, maksimalni dozvoljeni broj obrtaja, kvalitet,) može otpočeti sa montažom tocila na mašinu.

Najpre mora očistiti prirubnicu, kontrolisati njihovo stanje, paralelnost ravnih strana prirubnica, uveriti se da su kartonski podmetači čisti i debljine 0,3-0,8 mm, proveriti da li je minimalni zazor između otvora tocila i osovine u granicama tolerancije (H=11, 12, 13). Uopšte nije dozvoljeno montiranje tocila na osovinu sa pritiskom. Naime tocilo se za vreme rada zagreva, što izaziva dodatne napone, koji mogu da dovedu do razletanja tocila.

Između prirubnica i tocila operator mora da postavi kartonske podmetače i da stezne matice pritegne ravnomerno. Zatim vrši još balansiranje tocila.

Although such packing ensures safety transport, the boxes should be reloaded carefully. Special attention must be paid to vitrified grinding wheels which are fragile like porcelain. After receiving the grinding wheels at the warehouse and especially before their mounting on the grinding machine, the visual and sound test should be performed. These tests can reveal eventual cracks which may have occurred during the transport.

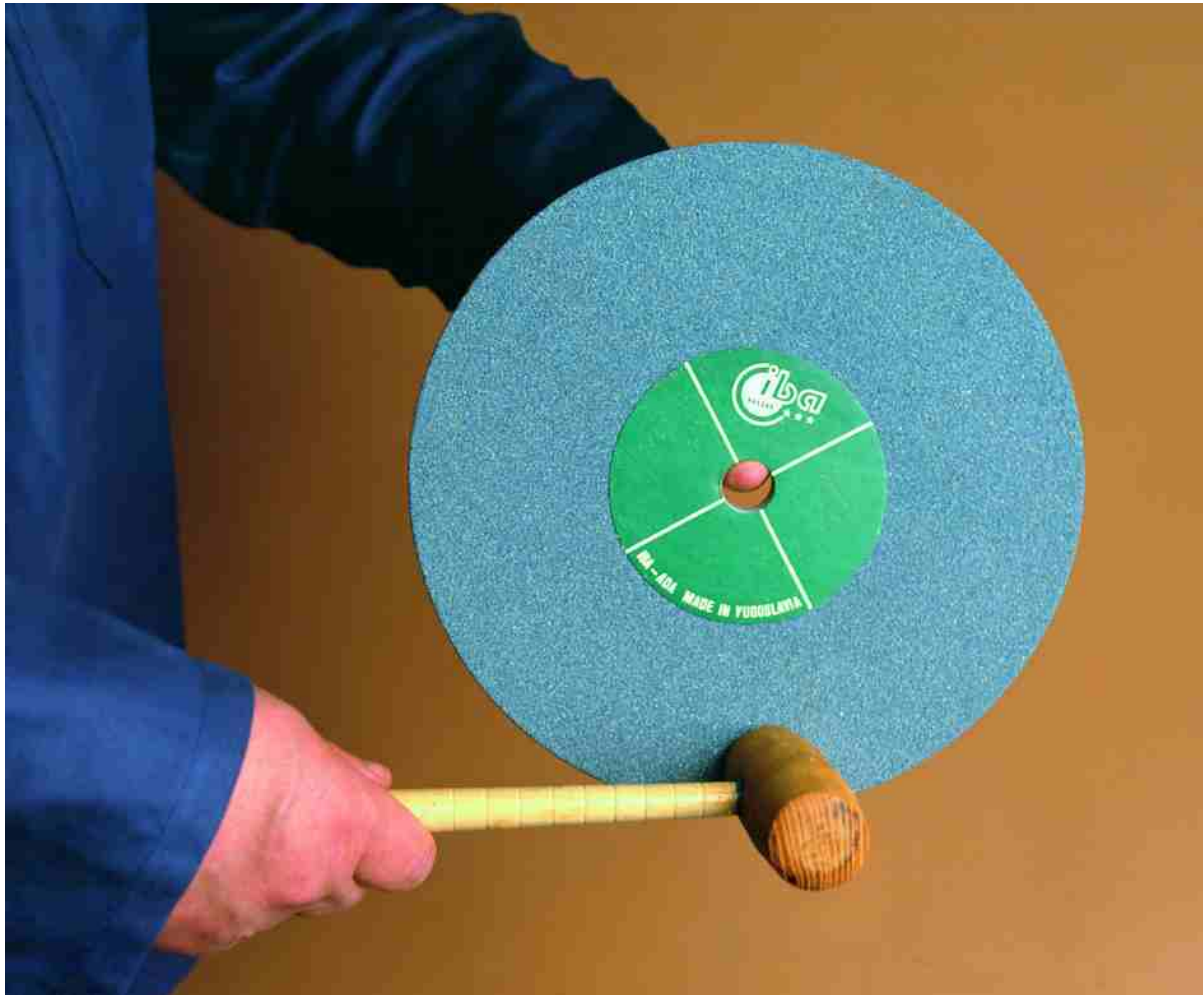
The sound test is performed by tapping lightly on the grinding wheel with a wooden hammer or some similar object. A crack-free wheel will emit a clear sound, a damaged wheel will sound cracked. Resinoid bonded wheels do not emit the same clear sound as the vitrified ones do.

MOUNTING OF GRINDING WHEELS

Mounting on a grinding machine can be realized when the worker has checked the grinding wheel and its quality (type, dimension, max. permissible peripheral speed, max. permissible operating speed, quality).

Fastening flanges should be cleaned and checked, cardboarded separators should also be cleaned and their thickness should not be more than 0,3 - 0,8 mm. The tolerance between the grinding wheel and the spindle must be within the limits (H=11, 12 or 13).

The grinding wheel is not permitted to be mounted on to the spindle with violence. During the operation it gets warmer what causes some additional tensions



Kod preciznog brušenja balansiranost tocila je od velike važnosti i dobri rezultati mogu se postići samo sa besprekorno izbalansiranim točilom. U zavisnosti od načina brušenja (fino brušenje, grubo brušenje, sečenje) i tipa mašine (stabilna, prenosna), dozvoljena nebalansiranost se kreće u granicama od jednog promila do dva procenta težine tocila (standard FEPA).

POČETAK BRUŠENJA

Pre početka brušenja moramo uzeti u obzir sledeća uputstva:

- podesiti mašinu tako da se točilo okreće sa maksimalnom radnom obodnom brzinom. Pri tome operator mora biti na bezbednom mestu.
- ostaviti točilo da se nekoliko minuta okreće
- otvoriti slavinu sredstva za hlađenje
- kontrolisati vibracije
- poravnati točilo
- prilaz tocila predmetu obrade treba da je postepen, da bi mu omogućili da se polako zagreva; grub prilaz može biti uzrok razletanja tocila.

Pridržavanje ovih uputstava naročito je značajno kod tocila u keramičkom vezivu.

PORAVNAVANJE TOCILA

Kada točilo izgubi svoj pravilan geometrijski oblik ili svoju sposobnost rezanja, moramo ga poravnati poravnivačem, dakle, obnavljamo pravilan geometrijski oblik, odnosno profil tocila i time uklanjamo sa njegove radne površine zaobljena (istrošena) brusna zrna.

U zavisnosti od željene preciznosti brušenja poravnavanje tocila vršimo na više načina:

- palicama
- segmentima
- točkicama
- dijamantskim jednozrnim i višezrnim poravnivačima.

Mašine za precizno brušenje imaju već ugrađene uređaje za poravnavanje.

that can lead to an explosion of the grinding wheel. Cardboard separators have to be inserted between the fastening flanges and the grinding wheel and then nuts are to be stretched equably. The grinding wheel has to be balanced.

The balance of grinding wheel is of great importance. Only by means of well balanced grinding wheels good results are obtained. Maximum permissible unbalance of grinding wheels can be between one thousandth and two percent (FEPA standard), which depends on grinding mode (fine or rough grinding, cutting) and type of the grinding machine (stationary, portable).

STARTING OF GRINDING

Before starting, the following instructions should be taken into consideration:

- *grinding machine must be set to achieve maximum operation speed, the worker must be in a safe pace:*
- *let the wheel run for few minutes;*
- *open the pipe for cooling oil;*
- *vibrations have to be controlled;*
- *grinding wheel has to be leveled;*
- *approaching of the grinding wheel to the processed object should be performed gradually to ensure its slow warming; sudden approach can cause explosion of the grinding wheel.*

These instructions are especially important for vitrified grinding wheels.

LEVELING OF GRINDING WHEELS

A grinding wheel has to be leveled when it loses its correct geometric shape or its cutting performance.

With the leveling tool incorrect geometric shape or profile can be restored and round (used) abrasive grains removed from the grinding wheel surface.

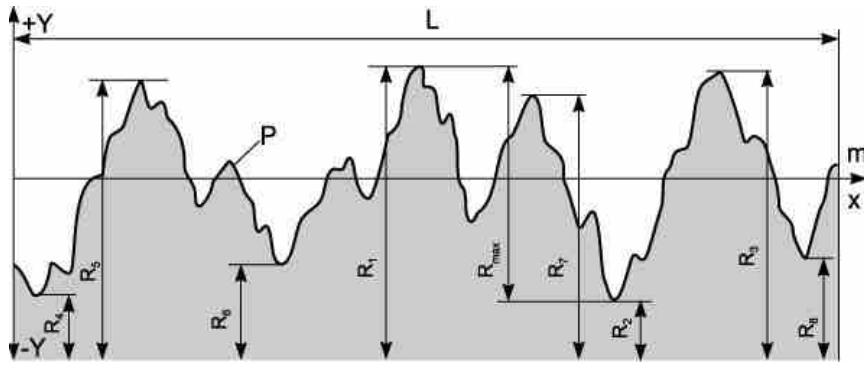
Leveling can be performed in different ways which depends on the required accuracy of the grinding process:

- *with abrasive sticks*
- *with segments*
- *with chilled cast iron wheels*
- *with single-point and multi-point diamond dressing tools.*

Grinding machines for accurate grinding have dressing-devices originally installed.

HRAPAVOST POVRŠINE

SURFACE ROUGHNESS



$$R_a = \frac{1}{L} \int_0^L |y| dx = \frac{(R_1 + R_3 + \dots + R_9) - (R_3 + R_5 + \dots + R_{10})}{5}$$

$$R_t = R_{\max} = R_1 - R_2$$

Hrapavost površine određena je vrednostima R_a i R_t

Surface roughness is determined by values R_a and R_t

p - profil površine m - srednja linija profila
 p - surface profile m - overage profile line

Hrapavost površine, dobijene u procesu brušenja, najviše zavisi od izbora veličine abrazivnih zrna (zrnoće). Tocila sa grubljim zrnima imaju veći kapacitet brušenja materijala - veći učinak, ali sa njima dobijamo hrapavije površine. Kod finog brušenja hrapavost površine zavisi još od poravnavanja tocila, njegove tvrdoće, vrste materijala, načina brušenja, oblika tocila i stanja mašine za brušenje.

Ako želimo da odstranimo veće količine materijala i dobijemo visok kvalitet površine, ekonomičnija je upotreba dva tocila, prvog za grubo, a drugog za fino brušenje.

Roughness of the surface, achieved by the grinding process depends on the choice of the grain size. Wheels with coarser grain sizes are more efficient, but give a coarser surface, at a fine grinding, surface roughness depends on dressing of the wheel, its hardness, type of the material, way of grinding, wheel shape and condition of the grinding machine.

When very efficient grinding and high quality surface should be achieved, it is more economic to use two wheels: first one for rough and second one for fine grinding.

R_a mm	R_t mm	stepen hrapavosti class of finish	zrnoća - grain size							
			36	46	60	80	120	180	320	500
5,0	1,60	N7								
4,5	1,50									
3,5	1,10									
2,50	0,80	N6								
2,1	0,67									
1,7	0,54									
1,3	0,40	N5								
1,1	0,34									
0,88	0,27									
0,65	0,20	N4								
0,55	0,17									
0,45	0,14									
0,35	0,10	N3								
0,29	0,08									
0,24	0,07									
0,175	0,05	N2								
0,14	0,04									
0,11	0,03									
0,08	0,025	N1								
0,068	0,017									
0,053	0,014									
0,04	0,010									

Tabela prikazuje zavisnost R_a i R_t kod prolaznog spoljašnjeg kružnog brušenja

Review of dependence R_a and R_t at traverse external cylindrical grinding

Hlađenje

RASHLADNO SREDSTVO

Rashladno sredstvo prvenstveno odvodi toplotu sa predmeta obrade i tocila, a ujedno smanjuje trenje između tocila i predmeta obrade. Zbog korozije čistu vodu ne upotrebljavamo kao rashladno sredstvo.

Ali, upotrebljavamo njene emulzije sa mineralnim uljima. Mašine za brušenje su snabdevene uređajima za hlađenje, koji redovno i u dovoljnoj količini dovode rashladno sredstvo. Ovi uređaji ujedno i prečišćavaju - filtriraju rashladno sredstvo. Dobre rezultate možemo dobiti samo kvalitetnim rashladnim sredstvom.

DOVOD RASHLADNOG SREDSTVA

Ako se rashladno sredstvo ne dovodi pravilno, ono ne vrši funkciju hlađenja i čišćenja. Preporučujemo vođenje računa o sledećim načelima:

- celokupnu količinu rashladnog sredstva treba dovesti do mesta brušenja preko dobro postavljenih mlaznica, što bliže mestu brušenja
- ako nam je rashladno sredstvo potrebno samo za čišćenje tocila, svu količinu rashladnog sredstva moramo usmeriti na odod tocila
- dobro hlađenje predmeta obrade i čišćenje tocila postizemo postavljanjem specijalnih mlaznica i odvodnih limova.

Mašine za brušenje često imaju loše postavljene zaštitnike zato radnika koji pravilno postavi protok rashladnog sredstva može ovo da ga prska i da bi to izbegao, on smanjuje protok, što može da prouzrokuje oštećenje predmeta obrade. Bolje je brusiti suvo nego sa premalom količinom dovedenog rashladnog sredstva.

Posle završenog rada tocilo ne sme ostati potopljeno u rashladnom sredstvu jer se prilikom ponovnog stavljanja u pokret može razleteti zbog prevelikog debalansa. Posle završetka rada tocilo treba još neko vreme da se okreće bez dovoda rashladnog sredstva kako bi se iscedilo.

Skladištenje tocila

Odgovarajuće skladištenje tocila neobhodno je zbog bezbednosti u radu sa njima, kako bi se očuvao njihov kvalitet i manipulacijom ne oštete.

Preporučljivo je tocila skladištiti u specijalno za to konstruisanim regalima i što bliže mestu upotrebe. Moramo izbegavati mesta u blizini transportnih puteva i drugih mesta gde su velike vibracije.

Konstrukcija regala je takva da se na njih mogu stavljati lako i sigurno svi oblici tocila, da uzimanje tocila bude lako i pristupačno sa minimalnom manipulacijom i da preuzimanje jednog ne utiče na stabilnost ostalih.

KERAMIČKA TOCILA

Tocila sa keramičkim vezivom nisu osetljiva na atmosferske uticaje, ali su zbog svoje krтости vrlo osetljiva na udarce. Ovi mogu da prouzrokuju pukotine često nevidljive običnim okom.

Cooling

COOLING AGENT

The cooling agent neutralizes the heat of the processed object and the grinding wheel and at the same time reduces their friction.

Plain water must be avoided as it tends to rust metal parts. Usually water emulsions with mineral oils are used. Grinding machines are equipped with cooling devices which regularly and sufficiently supply the coolant. These devices also serve as filters for the coolant. Good grinding results can only be achieved through high quality cooling agent.

CONDUIT OF COOLING AGENT

The cooling agent ought to be directed correctly to cool and clean efficiently. Following instructions are suggested:

- *the coolant ought to be directed to the point of grinding by sprayers which should be located as near as possible to the grinding point;*

- *when the coolant is applied only for cleaning of the grinding wheel, the flow of the coolant is to be directed to the periphery of the grinding wheel;*

- *good cooling and cleaning effects can also be achieved by special sprayers and outflow thin plates.*

Guardings of the grinding machines are usually located unsuitably. Therefore the worker may be splashed y the coolant. To avoid this, the worker usually reduces the quantity of the coolant, which can damage the processed object. It is better to grind dry than with insufficient quantity of the coolant.

After the grinding process has been finished, the grinding wheel should not slaty in the coolant, because it can become unbalanced. After finishing, the grinding wheel should run for a short time without the coolant, to get dry.

Storage of Grinding

Wheels

Grinding wheels require careful handling and proper storage.

Wheels should be stored on shelves, near to place of their application if possible. Places near to transport ways should be avoided because of harmful vibrations.

Construction of wooden racks for storing should enable simple and safety handing with grinding wheels, so that taking away of one wheel does not effect other wheels.

VITRIFIED BONDED GRINDING WHEELS

Vitrified bonded grinding wheels are not sensitive to atmospheric influences, but they are very fragile and sensitive to strokes. Strokes can cause very small, for human eye invisible cracks. They are usually stored onshelves with longitudinal laths which prevent wheels from rolling.

BAKELITNA TOCILA

Tocila u bakleitnom vezivu i ostala tocila koja sadrže veštačke smole vremenom gube svoje kvalitetne karakteristike. Taj proces je brži ukoliko su uslovi skladištenja nepogodni. Prostorija gde su uskladištena tocila treba da bude suva, provetrena. Štetne su nagle promene temperature, bliskost izvora toplote i niske temperature (ispod 0° C).

Preporučljivi uslovi skladištenja:

- temperatura između 10-30° C
- relativna vlažnost ne veća od 70 %.

U ovim uslovima tocila od bakleitnog veziva mogu se skladištiti do dve godine bez znatnih promena fizičkih osobina. Duže skladištenje povećava krtošću veziva, a time se smanjuje njihova mehanička čvrstoća.

RESINOID BONDED GRINDING WHEELS

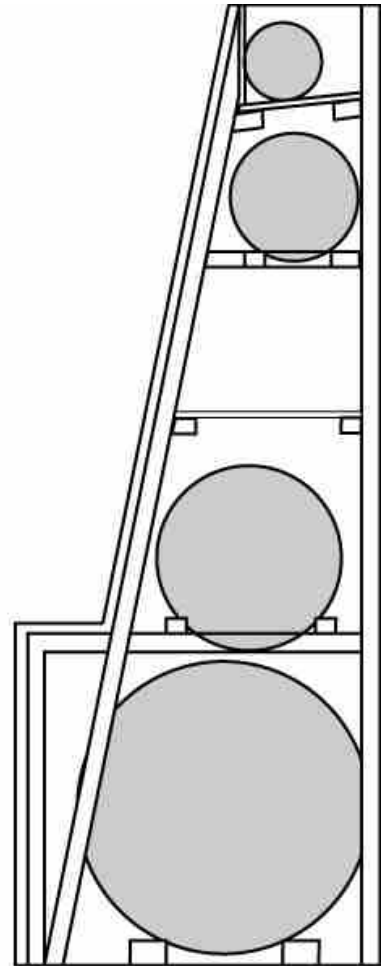
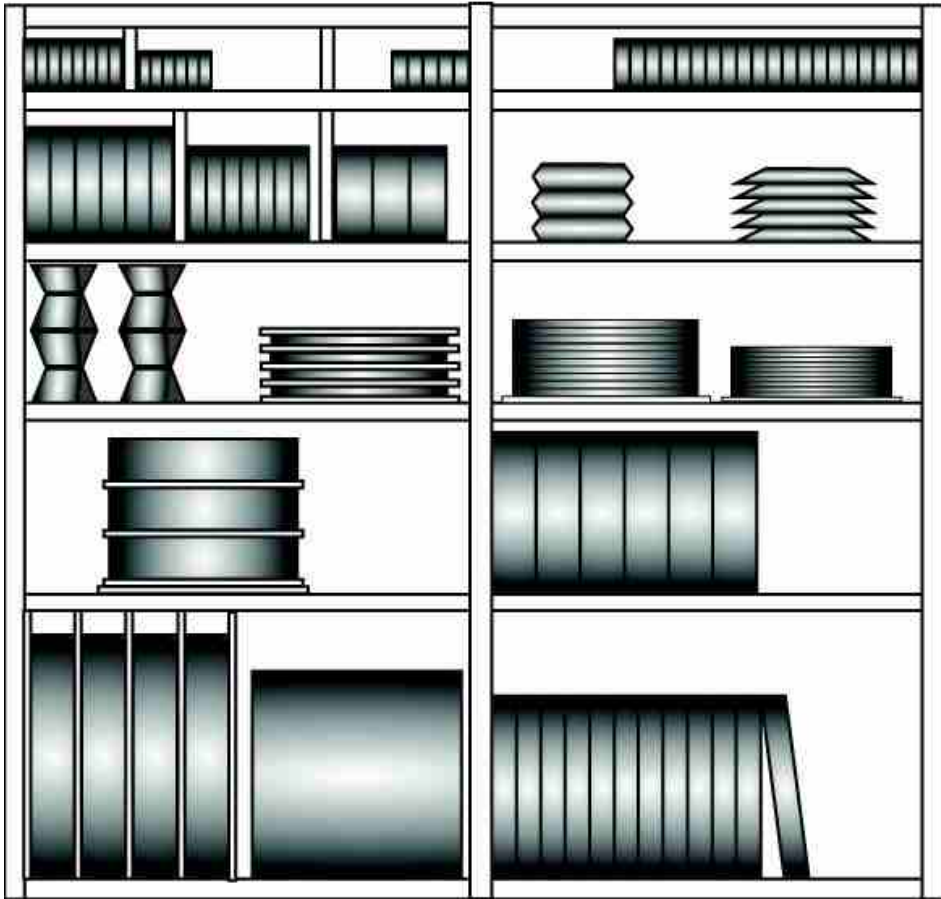
Resinoid bonded grinding wheels and other wheels which contain artificial resins, gradually loose their qualities. This process is accelerated by unsuitable storage conditions. The store room must be dry, airy and without sudden temperature changes. Grinding wheels must not get frozen.

Suggested storage conditions:

- temperature between 10° C and 30° C
- humidity not over 70 %.

Under these conditions resinoid bonded grinding Under these conditions resinoid bonded grinding wheels can be stored two years without changes of their physical properties.

Longer storage increases brittleness of the bond and decreases mechanical solidness of grinding wheels.



Težine brusnih ploča

Za brzo približno izračunavanje težine tocila nezavisno od njihove specifične težine možemo upotrebiti sledeću formulu

$$G=D^2 \times T$$

gde je:

G - težina tocila u kg

D - prečnik tocila u dm

T - Debljina tocila u dm

Weights of Grinding Wheels

For fast and approximate calculating of grinding wheels weights, independently of specific weights, following formula can be used:

$$G=D^2 \times T$$

where:

G = grinding wheel weight in kg

D = grinding wheel diameter in dm

T = grinding wheel thickness in dm

Približne težine ravnih brusnih ploča u kg

Approximate weights of plane grinding wheels

D mm	visina tocila (T) u mm - Grinding wheel height (T) in mm												D mm
	3	6	10	13	16	20	25	32	40	50	60	100	
10	0,0005	0,0011	0,0018	0,0023	0,0029	0,0036	0,0045	0,0058	0,0072	0,009			10
20	0,0022	0,0043	0,0072	0,0094	0,012	0,014	0,023	0,023	0,029	0,036			20
30	0,0049	0,0098	0,0163	0,021	0,026	0,033	0,041	0,052	0,065	0,081	0,102	0,163	30
40	0,0087	0,0173	0,0289	0,038	0,046	0,058	0,072	0,092	0,116	0,144	0,182	0,289	40
50	0,014	0,027	0,045	0,059	0,072	0,090	0,113	0,144	0,184	0,266	0,284	0,451	50
65	0,023	0,046	0,076	0,099	0,122	0,153	0,191	0,244	0,305	0,381	0,480	0,763	65
75	0,0336	0,0672	0,112	0,1456	0,1792	0,225	0,281	0,3584	0,450	0,560	0,7036	1,120	75
80	0,043	0,086	0,143	0,186	0,229	0,286	0,358	0,458	0,572	0,715	0,901	1,43	80
100	0,05	0,110	0,180	0,230	0,290	0,360	0,450	0,580	0,720	0,900	1,14	1,81	100
125	0,08	0,17	0,28	0,37	0,45	0,56	0,71	0,90	1,13	1,41	1,78	2,82	125
150		0,24	0,41	0,53	0,65	0,81	1,02	1,30	1,62	2,03	2,56	4,06	150
175		0,33	0,55	0,72	0,88	1,11	1,38	1,77	2,21	2,76	3,48	5,53	175
200		0,43	0,72	0,94	1,16	1,44	1,81	2,31	2,89	3,61	4,55	7,22	200
225			0,91	1,19	1,46	1,83	2,29	2,92	3,66	4,57	5,76	9,14	225
250			1,13	1,47	1,80	2,26	2,82	3,61	4,56	5,64	7,11	11,28	250
300			1,63	2,11	2,60	3,25	4,06	5,20	6,50	8,13	10,24	16,25	300
350			2,21	2,87	3,54	4,42	5,53	7,08	8,84	11,06	13,93	22,11	350
400			2,89	3,76	4,62	5,78	7,22	9,24	11,56	14,45	18,20	28,89	400
450			3,66	4,75	5,85	7,31	9,14	11,70	14,62	18,28	23,03	36,56	450
500				5,87	7,22	9,03	11,29	14,44	18,06	22,57	28,44	45,14	500
600						13,00	16,25	20,80	26,00	32,50	40,95	65,00	600

Težine u tabeli važe za brusne ploče od korunda u keramičkom vezivu. Za tocila od silicijum karbida težina je za 10% manja od težine iz tabele. Za tocila u bakelitnom vezivu težina je za 15% veća.

Weights in the table are valid for vitrified bonded grinding wheels. Weights for resinoid bonded grinding wheels are higher for 15% Weights for grinding wheels of silicon carbide lower for 10%.

Broj obrtaja tocila

Rotational speeds

Broj obrtaja tocila (min^{-1}) u zavisnosti od precnika tocila i obodne brzine (m/sek)

Rotational speed (min^{-1}) in dependence on wheel diameter (D) and peripheral speed (m/sec)

D mm	obodna brzina (m/sek) - Peripheral speed (m/sec)												
	12	16	20	25	32	35	40	45	50	63	80	100	125
3	76390	101860	127320	195160	203720	222810							
6	38200	50390	63660	79580	101860	111410	127320	143240	159160	200540	554650		
8	28650	38200	47750	59680	76390	83560	95490	107430	119370	150400	190990	238730	
10	22920	30560	38200	47750	61120	66850	76390	85940	95490	120320	152790	190990	238730
13	17630	23510	29380	36730	47010	51420	58770	66110	73460	92560	117530	146910	183640
16	14320	19100	23870	29840	38200	41780	47750	53710	59680	75200	95490	119340	149210
20	11460	15270	19100	23870	30560	33420	38200	42970	47750	60160	76390	95490	119340
25	9170	12220	15280	19100	24450	26740	30560	34380	38200	48130	61120	76390	95490
32	7160	9550	11940	14920	19100	20890	23870	26860	29840	37600	47750	59680	74600
40	5730	7640	9550	11940	15280	16710	19100	21490	23870	30080	38200	47750	59680
50	4780	6110	7640	9550	12220	13370	15280	17190	19100	24060	30560	38200	47750
63	3640	4850	6060	7580	9700	10610	12130	13640	15160	19100	24250	30320	37890
80	2870	3820	4780	5970	7640	8360	9550	10740	11940	15040	19100	23870	29840
100	2290	3060	3820	4780	6110	6680	7640	8590	9550	12030	15280	19100	23870
125	1830	2440	3060	3820	4890	5350	6110	6875	7640	9630	12220	15280	19100
150	1530	2040	2550	3180	4070	4460	5090	5730	6370	8020	10190	12730	15920
175	1310	1750	2180	2730	3490	3820	4370	4910	5460	6880	80730	10910	13640
180	1270	1700	2120	2650	3400	3710	4240	4775	5310	6680	8490	16010	13260
200	1150	1530	1910	2390	3060	3340	3820	4230	4780	6020	7640	9550	11940
230	1000	1330	1660	2080	2660	2910	3320	3740	4150	5230	6640	8300	10380
250	920	1230	1570	1910	2440	2670	3060	3440	3820	4810	6110	7640	9550
300	765	1020	1270	1590	2040	2230	2550	2865	3180	4010	5090	6370	7960
350	655	875	1090	1365	1745	1910	2180	2455	2730	3440	4370	5460	6820
400	575	765	955	1195	1530	1670	1910	2150	2390	3010	3820	4780	5970
450	510	680	850	1060	1360	1485	1700	1910	2120	2670	3400	4240	5300
500	460	610	765	955	1220	1335	1530	1720	1910	2410	3060	3820	4780
600	380	510	640	795	1020	1115	1270	1430	1590	2000	2550	3180	3980