SETTING REGIMES AND PROCESSING POSSIBILITIES OF MATERIALS SUBMITTED BY UNCONVENTIONAL PROCESSES AT RECONSTRUCTING REFERENCES

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Abstract. *This paper presents methods of processing layers deposited on different parts by thermal arc metalizing process; establish procedures for processing, working parameters of the various operations to achieve a uniform coating on dimensions and to obtain the required physical and mechanical properties.*
Keywords: *coatings, processing methods, working parameters*

1. INTRODUCTION

Since thermal spray arc cannot provide smooth and uniform application of metallic layers to provide additional thickness for machining, ie the addition of processing. Size of processing's addition depends on feature and characteristic of processing and processed surface dimensions. Processing margins are presented in Table 1 depending on the diameter and length of machined part.

Table 1

Work piece diameter (mm)	Processing length l (mm)					
	<100	101-250	251-500	501-800	801-1200	1200-2000
10	0.8 0.2	0.9 0.2	1 0.3	-	-	-
11-18	0.9 0.25	0.9 0.3	1 0.3	1.1 0.4	-	-
19-30	0.9 0.4	1.0 0.4	1.1 0.45	1.3 0.5	1.4 0.5	-
31-50	1.0 0.5	1.0 0.5	1.1 0.55	1.3 0.6	1.5 0.65	1.7 0.65
51-80	1.1 0.5	1.1 0.5	1.2 0.55	1.4 0.6	1.6 0.7	1.8 0.75
81-120	1.1 0.55	1.2 0.55	1.2 0.6	1.4 0.7	1.6 0.75	1.9 0.8
121-180	1.2 0.55	1.2 0.6	1.3 0.65	1.5 0.7	1.7 0.75	2.0 0.8
181-260	1.3 0.55	1.3 0.6	1.4 0.7	1.6 0.75	1.8 0.8	2.0 0.85
261-360	1.3 0.55	1.4 0.6	1.5 0.7	1.7 0.75	1.9 0.8	2.1 0.8
361-500	1.4 0.6	1.5 0.7	1.5 0.75	1.7 0.85	1.9 0.85	2.2 1

2. PROCESSING METALLIC LAYER

Current machining which are metallic layer are turning and grinding, and in special cases (when only one can apply the two operations) may be applied to milling, but only with the agreement of the technologist that has developed technology for refurbishment of the play.Metallic layer processing involves two operations:

- Debarring or cleaning the metallic surface (and nearby)
- Process it.

a) Debarring. This operation is done usually by filing or grinding (manually) and if possible, by turning. The operation consists in removal of material deposited on the metalized surface adjacent areas that were protected with metal masks or paint but a sprayed material joined them. Always, if this operation, meaning the filing, grinding or turning should be only to base material, otherwise it may cause separation of the metalized surface layer.

b) Processing itself. Is the operation to bring the final share of metallic piece. As a general rule to start the final processing operation of metallic layers (whatever the processing procedure adopted) is that it always starts up where higher layer is deposited and processing purposes will be the purpose of pushing layer to anchor areas. Also, top of the metalized layer will be given below by some moves easily executed with manual feed. Due to mechanical, physical and technological properties of the deposited layer by metallization, the most common processing methods used are: turning and grinding.

2.1. Turning

The process is best used for processing deposited layer due to the wide range of parts surfaces of revolution which is reconditioning and due to characteristics of processing that allow a system working continuously, without sudden changes.

Turning use is limited only by the hardness of the metallization layer, the layers hard working hard only through amendment. In this scheme for turning choice must take into account physicochemical and technological characteristics of deposited layer, low resistance to shocks, high fragility, chip breaking, high resistance to compression. Given all this, were established the elements of cutting regime on the following criteria:

- Tool materials are made for working hard iron (usually carbides of Group K);
- Rake angle of the blade is usually taken as negative for purpose that the horizontal component of cutting force (P_{y}) is directed to layer and not to pull it;

- Advance work and depth of cut should be chosen so that processing effort is not too large and not appear MPS system vibration.
- Feed rate is determined also to have a system not working too hard and not appear vibration;
- Ray peak and advance work are chosen based on the quality required for surface processing.

Beyond these few criteria, very important are the modes of clamping tool a, work piece clamping module, gauge track, etc. Following research, it was established cutting processing speed by turning the metallic layers, for various materials, speed shown in Table 2

Table 2

Material deposited	Cutting speed (m / min.)
Ferrous (Al alloys)	42
Ferrous (Cu alloy)	35
Pseudo alloys	30-35
Steel (HB<200)	25-30
Steel (300<HB<400)	18-22

a) - recommended cutting speed for processing metallic layer by outer turning must take into account a range of parameters listed below.

Cutting regime parameters:

- K10 Carbide Cutter
- Sustainability T = 90 min.
- Angles γ= -6^0 ; α= 8^0 $(x = x_s\ ) = 45^0$
- Ray peak = 1mm
- 20x20-section
- Advance-s = 0.2 mm / rev.
- Depth of cut = 1 mm

b) For other cutting conditions it will correct cutting speed with a coefficient k whose value is: K= $K_1.K_2.K_3\ldots\ldots\ldots K_9$. Coefficients k_1 - k_9, are chosen according to actual cutting conditions in Tables 3-11.

Table 3. K_1 - coefficient depending on the blade section and the nature of processing

Processed material / section	Ferrous and pseudo alloys	Steels
10x10	0.93	0.87
12x12	0.95	0.89
16x16	0.97	0.94
20x20	1	1
25x25	1.04	1.02
40x40	1.08	1.04

Table 4. K_2 coefficient depending mainly angle

χ	30 ^{0}	45 ^{0}	60 ^{0}	75 ^{0}	90 ^{0}
K_2	1.3	1	0.9	0.85	0.8

Table 5. K 3-factor based on secondary angle and cutting tool material

χ_S	Cutting tool material	
	HSS	Carbide
5 ^{0}	1.22	1.22
10 ^{0}	1.15	1.14
15 ^{0}	1	1.1
30 ^{0}	0.91	1.04
45 ^{0}	0.87	1

Table 6. K_4 - coefficient depending on the range and nature of the knife edge of the processed material

Radius (mm)	Processed material	
	Ferrous and pseudo alloys	Steels
0.5	0.96	0.81
0.8	0.99	0.89
1	1	1
1.5	1.04	1.01
2	1.07	1.07

Table 7. K 5-coefficient according to the cutting tool material

Tool material	HSS	Plate P_{10}	Plate P_{20}	Plate P_{30}	K-20 plate
K_5	.76	0.76	0.65	0.6	0.85

Table 8. K_6 - advance coefficient based on the knife and the nature of processing

Processed material	Advance (mm / rev)	K_6
Ferrous (aluminum alloy)	0.1	1.2
	0.2	1
	0.4	0.9
	0.6	0.8
Ferrous (copper alloys)	0.1	1.2
	0.2	1
	0.4	0.85
	0.6	0.75
pseudo alloys	0.1	1.2
	0.2	1
	0.4	0.85
	0.6	0.75
Steel HB < 200	0.1	1.2
	0.2	1
	0.4	0.9
	0.6	0.8
Steels 200 < HB < 400	0.1	1.2
	0.2	1
	0.4	0.8
	0.6	0.7

Table 9. K-7 - coefficient depending on the nature and type of processing blade

Processing type		K_7
Exterior		1
Indoor	Dg = 50	0.7
	Dg = 70 ... 100	0.75
	Dg = 150	0.8
	Dg = 250	0.85
	Dg> 250	0.9
Front	Normal knife $\chi=45^o$, $\chi_S= 10^o$	1.2
	Normal knife $\chi = \chi_{S=}45^o$	1
	Knife hovered $\chi = 10^o$, $\chi_{S=}100^o$	1.5
	Knife hovered $\chi = 100^o$, $\chi_{S=}10^o$	0.9

Table 10. K-8 - depending on the form factor machines surface

Continuous Surfaces	$K_8 = 1$
Interrupted surfaces	$K_8 = 0.7$ to 0.8

Table 11. K-9 - depending on the cooling coefficient for the material used

Processed material	Cooling from processing	
	Cooled	Without cooling
Ferrous + pseudo alloys	1	0.9
Steels	1	0.8

2.2. Rectification

This method of processing metallic layer is used in two cases:

- the metallization layer deposited has an excessive hardness and other processes processing is uneconomic or impractical;
- when seeking a better quality of surface, which cannot be obtained by other machining processes.

Correcting operation is executed with wheels. The choice of grinding wheels characteristics depends largely on the success of the operation, especially in the processing layers of composite material made by grinding wheels deposited by metallization.

In selecting grinding wheels their parameters and cutting conditions must be such inter conditioned that grinding wheels work in self sharpening, ie cutting waste particles of abrasive wheels to break or become detached from the binder because the cutting forces. With greater capacity for self sharpening disc, his durability will be even greater, higher productivity and less abrasive consumption. Must take into account that besides cutting bluntness granules, clogged appears (even if the abrasive particles are unused) which occurs due to penetration into the pores of grinding wheel chip. Cutting regime to rectify design and choice of grinding wheel must be made taking into account the physical and mechanical features and characteristics of the deposited layer by metallization.

Choice of abrasive wheel used in processing characteristics stripping metal layers deposited by metallization. An abrasive disc is characterized by abrasive material, binder, grain, hardness and structure.

- *Choice of abrasive material* is based on nature and hardness deposited metallic layer. Thus, for bronze layers and pseudo alloys with high hardness recommended electro Corydon (s). For layers of steel and pseudo alloys is recommended soft green silicon carbide (VC).

- *Choice of binder.* The binder is the one how ensure abrasive grain cohesion. The most used is the ceramic binder (binder has the disadvantage that the ceramic discs are more fragile). For finish machining using Bakelite binder which is resistant and elastic, but destroys the action of cutting fluids alkaline. For polishing operation is used rubber-based glue, under subject that it clogged very quickly.

- *Choice of grain.* For coatings deposited by metallization it's used low grit abrasive particles (60-80) for working with small chips and small local overheating, good processing characteristics for metallic layers to be processed without local overheating as overheating or low.

- *Choice of body abrasive hardness.* Metallic layers to rectify the same rule is applied to the processing of conventional materials: high hardness discs for pseudo alloys processing and low hardness steels (30 HRC) and record low hardness (H, J, K) for layers with high hardness.

- *Abrasive body structure*

- the grinding and internal grinding wheels are used with open structure: 8 to 12
- the outer grinding wheels used in structure 5-6
- to correct soft materials - structure 6-8
- correction to hard materials - structure 7-9

For special correction cases in which adjustment cannot use cutting fluids are used super porous wheels.

Operation parameters of rectification.

For proper selection of cutting parameters to rectify must take into account the shape and dimensions of the work piece to be adjusted, how its grip on the grinding machine, grinding wheels characteristics, working conditions, especially , material that is corrected. Cutting regime parameters in grinding are:

- Main cutting speed (V_d in m / sec)
- feed rate of work piece (circular advance, v_p m/min)
- longitudinal advance (s_l was, mm / rev)
- Advance cross ($s_{t,}$ mm / double race).

2.2.1. Outside Round Correction.

Main cutting speed is chosen according to the hardness of the processed material and cement grinding wheel that is working.

Table 12. Grinding wheel peripheral speed v_d

Processed material	Cement grinding wheel	$V_{d,}$ m / sec.
Mild steel	Ceramic	25 to 30
Hardened steel and tough composite material	Ceramic	25 to 30
Composite materials soft and soft metals	Ceramic	15 to 20

Other parameters will be set according to the kind and nature of processing, material deposited by metallization and is correct size pieces.

a). Correction round the outer crossing

Table 13. Work piece rotational speed v_p (n / min)

Nature of processing and material submitted		Work piece diameter (mm)						
		<25	25-50	50-75	75-100	100-160	160-250	> 250
Roughing		10-20	13-27	16-33	20-36	22-44	27-54	35-65
Finishing	Steel HB<200	10-20	17-44	22-55	26-65	28-74	33-88	40-110
	Steel HB>200	23-34	29-44	37-55	42-65	51-74	60-88	70-110
	Soft pseudo alloys	25-40	30-45	40-65	50-80	60-100	80-120	90-150

Note: *when seeking an area with better quality, we work with the lower rotational speed of the play, but with careful not to cause excessive local overheating.*

<u>*The longitudinally advance*</u> S_l <u>*(mm / rev).*</u> Calculate the fraction of the width of grinding wheel.

- $S_l = \beta * B$ (mm/rot)
  - for roughing, β is chosen according to the size of the work piece:
  - for $d_p \leq 20$, $\beta = 0{,}5$
  - for $d_p > 20$, $\beta = 0{,}63 - 0{,}8$
- finishing, is chosen according to the quality of seeking to obtain the processed surface:
  - for $R_a = 3{,}2 - 1{,}6$ $\beta = 0{,}75 - 0{,}5$
  - for $R_a = 0{,}8$ $\beta = 0{,}5 - 0{,}25$

<u>*Fifth Cross*</u> (penetration) s_t (mm / double trap). Advance of entry will be determined by the designer cutting regime for each case, depending on conditions of performance required. Guideline values are:

- 0.02 to 0.01 mm / c.d. for roughing processing
- 0.003 to 0.008 mm / c.d. for finishing processing

b). Correction round the outer penetration. Table 14 shows the rotation of the work piece.

Table 14. Work piece rotational speed v_p(m / min)

Nature of processing and material processing		Work piece diameter (mm)					
		<25	25-50	50-75	75-100	100-125	125-160
Roughing		9,5-24	12-26	14-28,5	15-29	15,5-31	16-31
Finishing	Steel HB<300	15,3-36	15,7-47	17-56,5	18,5-60	19-65	20-73
	Steel HB>300	24,5-36	26,7-47	29-56,5	33-60	33-65	33-73
	Pseudo alloys	25-50	30-55	35-62	40-68	40-75	45-85

<u>*Transverse feed rate s_t (mm / min).*</u> Set the designer of cutting regime for metallic parts, depending on each case for the concrete conditions of work piece and its surface quality operating conditions. It recommends the following:

- for roughing s_t = 0.4 to 1.75 mm / min
- for finishing s_t = 0.2 to 0.7 mm / min

2.2.2. Correction inner round.

Cutting regime parameters to rectify the inner round are the same as those from outside round grinding, but their values differ, since working conditions are different for the two types of corrections (Tables 15-16).

Table 15. Grinding wheel speed Vd

Processed material	Piece diameter, Φ mm			
	<17	17 to 30	30 to 65	> 65
Steel	15	20	25	30
Pseudo alloys	12	15	18	20

Table 16. Rotational speed of work piece

Nature of processing and material processing		Machined inner diameter, mm				
		50 to 75	75-100	100-150	150-250	250-400
Roughing		16 to 35	18 to 38	22 to 44	27 to 54	From 33 to 65
Finish	Steel HB<300	20 to 55	25 to 62	28 to 75	33 to 88	70-110
	Steel HB>300	36 to 55	45 to 60	51-73	60 to 88	90-110
	Pseudo alloys	32 to 48	37 to 54	44 to 65	48 to 72	54 to 80

Advance longitudinally is calculated as the ratio between the diameter and length of the song.

$$s_t = \beta \cdot B$$

where: β is a factor chosen according to the ratio of the diameter and length processed in compliance with Table 17.

B - width of grinding wheel, mm .

Table 17. Coefficient values β processed according to the material nature and report processing L / D

Processed material	Nature of processing	Coefficient β				
		Ratio L / D				
		4: 1	2: 1	1: 1	1: 2	1: 4
Steel	Roughing	0,75-0,6	0,7-0,6	0, .6-0,5	0,5-0,45	0.4
	Finishing	0,25-0,4	0,25-0,4	0.3	0,2-0,3	0,2-0,3
Pseudo alloys	Roughing	0,8-0,7	0,7-0,65	0,6-0,5	0.5	0,5-0,45
	Finishing	0,45-0,3	0,45-0,3	0,4-0,3	0,4-0,3	0,4-0,3

Advance across s_t (mm / c.d) .Sets for each case, the actual working conditions funcţion. It recommends the following:

- for roughing = 0.002 to 0.02 mm /c.d
- finishing = 0.001 to 0.01 mm / c.d

2.2.3. Grinding

Cutting regime parameters in grinding are: grinding wheel speed v_d (m / sec), penetration advance to s_t (mm / c.d) and the main advance speed v_p (m / min). Experiments have demonstrated that metallic layer deposited on flat surfaces have special processing features to the layers deposited on outer cylindrical surfaces. Experiments have demonstrated that valid principle of operation processing will begin in the middle of metallic surface into its edges, in purpose of pushing towards the edge layer, ie towards the anchorage areas. Processing will begin with filing tops, and after coating uniformity (after their tops removed) will continue processing after conventional processing methods used to process flat surfaces - ie it will start working from one end toward the other. Processing ends flat metallic surfaces starts with debarring neighboring areas that have been accidentally deposited metal particles during metallization. Processing will begin in the middle towards the ends or metallic surface, where the surface has only one hand at the end surface, the peak processing will be pushing for the purpose of submission towards the end of the inside surface (the bed was made anchor).

Table 18. Grinding wheel speed v_d

Processed material	Processing type	v_d (m / sec)
Steels	Roughing	18 to 20
	Finishing	20 to 25
Pseudo alloys	Roughing	15 to 18
	Finishing	18 to 20

Advance of entry to s_t (mm / c.d) will be established for each case depending on track conditions of service requests. Values are recommended:

- for roughing = 0.05 to 0.002 mm / c.d
- for finishing = 0.01 to 0.001 mm / c.d

The main advance speed v_p (m/min) recommended:

- for roughing = 6.3 to 1.6 m / min
- for finishing = 12.5 to 32 m / min.

Unlike the processing of surface preparation for metallization to be done without coolant, final processing is made with liquid cooling system that reduces heat processing.

3. CONCLUSIONS

From experiments conducted it was found that processing should not be made by the method of sample chips because metallic layer does not behave like a solid material and does not spark, so the worker processor tends to increase the penetration of advance causing local overheating which may lead to detach layer. Processing will be on wheels with high capacity embed chips for processing materials that resemble metallic gray cast iron processing chips resulting from short and fragile to be embedded in mass grinding wheel.

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