Fourth School Year

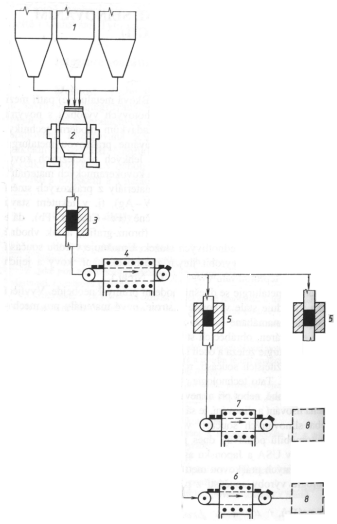
POWDER METALLURGY

Powder metallurgy is technology which leads to the production of ***semi-products*** using *sintering* that is the ***sintering*** of pressed powders. Powder metallurgy enables the production of materials, which are not possible to produce using classical metallurgy, or their production is too technologically or economically ***demanding***.

The most known products produced by powder metallurgy:

a) Cutting materials (alloyed carbides, ***high-speed steels***, cutting ceramics….)
b) Alloys with a very precise chemical ***composition***
c) Metal alloys, which have different ***melting*** temperatures or ***densities***
d) Metal alloys with non-metals
e) Super alloys
f) Filters
g) ***Friction*** and ***sliding*** materials

Powder metallurgy procedures



Block diagram of technological procedures

1. Powder and lubricant ***tanks***
2. Mixing powder
3. ***Pressing*** powder
4. ***Sintering***
5. Calibrating, ***pressing***
6. ***Sintering***, ***soaking*** the surface with lubricants
7. ***Thermal treatment***
8. Other procedures

1. Powder production

a) mechanical production – milling

- „wet ***milling*** method“

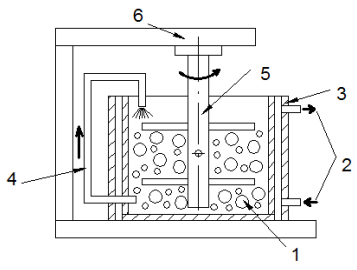


Diagram of an atritor (= dryer pulverizer)

1. ***Milling ball*** with ***grist*** and liquid
2. Circulation of ***cooling*** water
3. ***Tank***
4. Pumping system
5. Shaft with ***blades***
6. Stand with shaft drive

- „dry ***milling*** method“

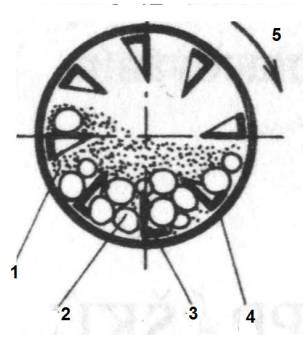


Diagram of a round mill

1. ***Grist***
2. ***Milling ball***
3. ***Drum blades***
4. ***Drum*** cylinder
5. Rotating ***drum***

b) chemical production

It consists of chemical reactions leading to the ***acquisition*** of a chemically pure metal or ***compound***. An example of a chemical reaction can be **$FeO + H_2 \rightarrow Fe + H_2O$**

c) electrical-chemical production

It is used for the production of copper, silver and iron powder (of ***aqueous solutions***) and highly ***meltable*** metals from melted salts (of tantalum, niobium and similar elements).

d) ***physical production***

An example is the ***spatter*** of the stream of liquid alloys in gas, the steam condensation of metals on cold plates and similar phenomena.

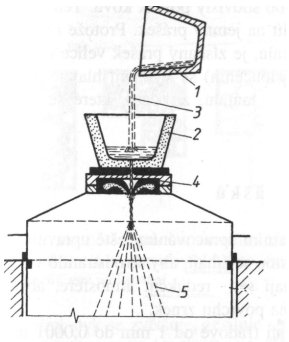


Diagram of the blowing of a stream of liquid alloys by an inert gas

1. Melted metal
2. Ceramic ***vessel***
3. Stream of liquid alloys
4. ***Nozzle*** with gas
5. Sprayed metal

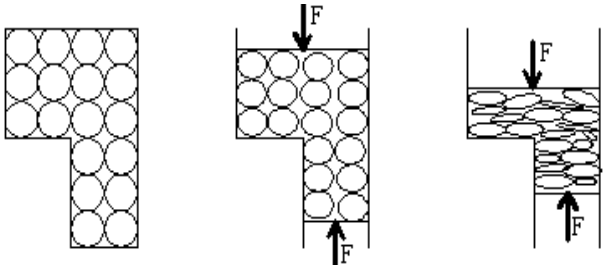
2. Powder *treatment*

It is necessary to treat the powder before ***pressing*** so that the final product is without ***defects***. Basic ***treatments*** include ***drying***, ***annealing*** for removing internal tension in powder grains, ***in-seaming*** for homogeneous ***granularity***, mixing with a lubricant and other ***treatments***.

3. Powder *pressing*

Pressing reduces the original volume to about 1/7. This causes us to achieve a ***preliminary*** shape of a future product, without the required strength. ***Pressing*** can be done using the cold method or at increased temperatures. Pressing leads to the ***relocation*** of ***grains*** in volume and to their elastic deformation.

Pressing pressures are very high (400 – 1 000 MPa) and it is necessary to ***adjust*** the shape of a ***pressing***, because the pressure in the powder does not expand in all directions in the same way. That is why a ***pressing*** does not have the same properties in all directions.



Procedures of *pressing* powder in a *mould*

1. ***Grains*** of powder after ***filling*** a ***mould*** 2. Relocating ***grains*** in volume 3. ***Grain*** deformation

4. *Sintering* powder

Sintering leads to the ***sintering*** of individual ***compounds*** without ***melting***. The ***sintering*** temperature is given by the ***melting*** temperature of individual components. This leads to the ***melting*** of ***binding agents***. Their diffusion connects the components of a future product.

Sintering is usually carried out in a protective atmosphere, which prevents the formation of chemical corrosion. It is necessary to sinter some pressings in a vacuum to avoid oxidation or their reduction.

5. *Further* product *treatments*

We ***improve*** the resultant properties of a product by ***further treatment***. For example by repeated ***sintering*** it is possible to increase the strength of ***cutting tips***, by calibrating to increase dimension accuracy, by coating to extend the ***durability*** of a tool, by ***soaking*** with a lubricant to reduce ***friction*** and other similar ***treatments***.

Literature and sources used: M. Hluchý a kolektiv „ Strojírenská technologie 2, SNTL, M Hluchý, J. Kolouch, R. Paňák „Strojírenská technologie 2, Scientia, Internet, Odborné texty SPŠ

VOCABULARY

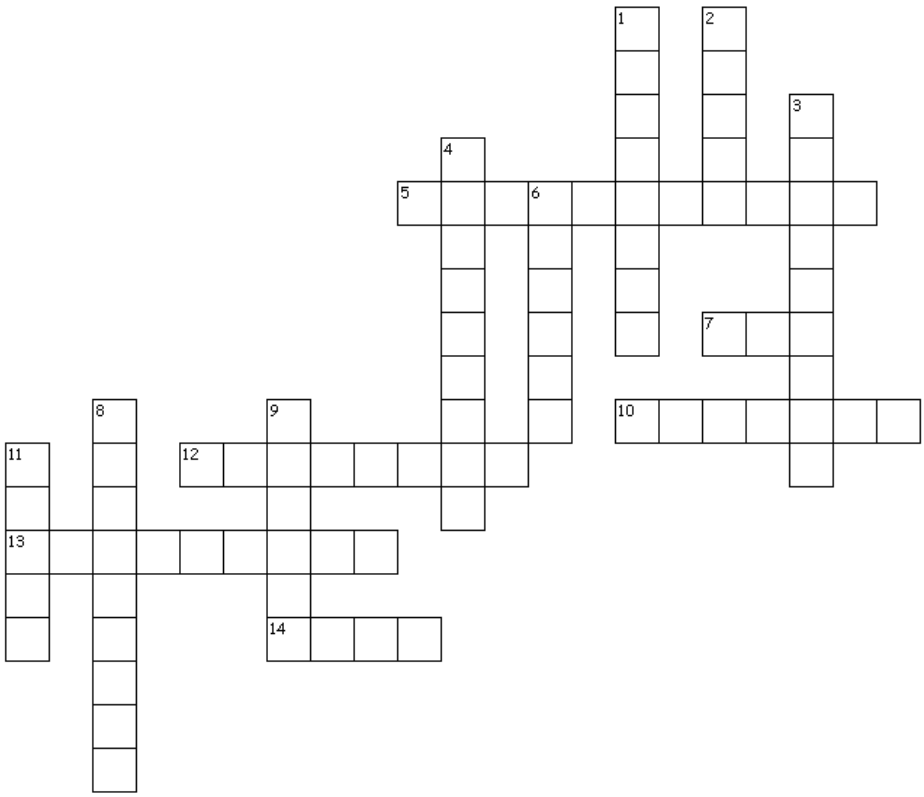
acquisition	získání	**high-speed steel**	rychlořezná ocel
adjust	nastavovat	**improve**	zlepšovat
annealing	žíhání	**inert**	inertní
aqueous	vodný	**in-seaming**	osívání
binding agent	pojivo, tmel	**meltable**	tavitelný
blade	lopatka	**melting**	tavení
blowing	foukání, vhánění vzduchu	**milling**	mletí
		milling ball	mlecí koule
composition	složení	**mould**	forma
compound	sloučenina	**nozzle**	dýza, tryska
cooling	chladící	**preliminary**	předběžný
cutting tip	břitová destička	**pressing**	lisování
defect	vada	**relocation**	přemisťování
demanding	náročný	**semi-product**	polotovar
density	hustota	**sintering**	slinování, spékání
drum	buben	**sliding**	kluzký
drying	vysoušení	**soaking**	napouštění
durability	trvanlivost, odolnost	**solution**	roztok
filling	náplň, plnění	**spatter**	rozstřik, postřik
friction	tření	**tank**	zásobník
further	další	**tension**	pnutí
grain	zrno	**thermal treatment**	tepelné zpracování
granularity	zrnitost	**treatment**	zpracování, úprava
grist	melivo	**vessel**	nádoba

COMPREHENSION QUESTIONS

1. What do you know about powder metallurgy?
2. What products produced by powder metallurgy do you know?
3. Can you name the main parts of the powder metallurgy procedure?
4. How do we produce a powder?

EXERCISES

1. Criss Cross Puzzle - 14 words were placed into the puzzle.



Across
5. teplota
7. plyn
10. zlepšit
12. lisování
13. úprava
14. nádrž

Down
1. přesnost
2. hřídel
3. koroze
4. náročný
6. prášek
8. žíhání
9. vada
11. kov

2. Translate the verbs and add corresponding nouns:

	VERBS	NOUNS
1	improve	
2	rotate	
3	adjust	
4	connect	
5	press	
6	relocate	
7	lead	
8	treat	

EXERCISES – key for teachers

1. Criss Cross Puzzle

Across

5. teplota - temperature
7. plyn - gas
10. zlepšit - improve
12. lisování - pressing
13. úprava - treatment
14. nádrž - tank

Down

1. přesnost - accuracy
2. hřídel - shaft
3. koroze - corrosion
4. náročný - demanding
6. prášek - powder
8. žíhání - annealing
9. vada - defect
11. kov - metal

2. Translate the verbs and add corresponding nouns:

	VERBS		NOUNS
1	improve	***zlepšovat***	**improvement**
2	rotate	***otáčet (se)***	**rotation**
3	adjust	***nastavovat***	**adjustment**
4	connect	***spojit***	**connection**
5	press	***stisknout, stlačit***	**pressure**
6	relocate	***přemístit***	**relocation**
7	lead	***vest, řídit***	**leader**
8	treat	***upravit, zacházet, nakládat***	**treatment**