Sintered Brass Chip Micro-porosity and Mass loss Analysis for Industrial Filters

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Abstract. Product development in the metal industry generates a huge quantity of solid waste by the year, this waste is recycled by using different methods, being chemical or melting. The biggest challenge for the industry is finding ways to utilize this material with the least utilization of energy possible. As such using the chips generated by mechanical metal processes as dust for metallurgy is an option, giving the material a new purpose without melting. The dust metallurgy consists in using the material in a particulate state and applying different pressure for the wished material. The experiment consist in utilizing brass chips (70Cu-30Zn) as a substitute for the dust metallurgy process. After selection of the material in two different granularity (# -25 and # -14/+25) the brass chips were compacted in three different pressures (100 MPa, 150 MPa and 200 MPa) and sintered in an oven at 800 ºC with $2x10^{-2}$ mbar. After the dust metallurgy processes were applied to the analyzed material. The final product showed that it is possible to develop sintered filters through dust metallurgy processes by using brass chips, being a viable alternative to industrial processes that involve less mechanical strength. The final results show different amounts of mass and therefore density loss in the sintering process.

Keywords. Microporosity, Micrography, Qualitative analysis, Porosity, Sintered material.

1. Introduction

A common issue of the metal industry is the generation of solid waste, those are hard to process without chemical products or going through melting. [1] Utilizing powder metallurgy can be an alternative for recycling the waste without a loss and chemical process. [2]

The way powder metallurgy distinct from common methods of processing metallic elements is the primitive material, which is the metal powder, allowing the production of different product, bringing better formats, more precision and more complexity to pieces developed through processing the material with the method. [3]

The processing is divided by two main steps, using a press to compact the material to get as close as it can to the final wished material (compacting) and getting it into an oven, so it can melt the metal creating solid particles in between the powder (sintering). [4]

The principal objective of developing products using this technique is the reduction of unused solid waste in the metal mechanic industry. It being a reliable and low cost processing of the elements analyzed.

The objective of this study is evaluating the developed products by body porosity and micro-porosity, using different equipment and technique. The equipment and parameters applied through the research and development were provided by BRATS – Sintered filters.

2. Methodology

2.1 Sample development

The samples were developed using approximately 4,5 kg of diverse brass chips as shown in Fig. 1(a) of brass (70Cu-30Zn). The chips were washed with detergent and water and dried in an oven at 150ºC.

(a) (b)

Fig. 1 - (a) Brass chips of different sizes. (b) Vibrating sieve used for size determination.

Different mesh were separated using different vibration sieves (Fig 1.(b)) for choosing the granularity, after that step the sieves # -25 and # -14/+25 were chosen by following industry standard.

After the separation, the density were analyzed, the more dense is the material the better the physical properties of the material. [5] For the categorization a metallic recipient was measured by the difference of the material, the average value can be seen on Tab. 1, the density of both material have apparent density of 5,2 g/cm^3. [6]

Tab. 1 - Apparent density of the brass chips.

Sieve size (mesh)	Chip size (µm)	Apparent density (g/cm^3)
#-14/+25	1410 – 707	1,98 ± 0,03
#-25	707	2,19 ± 0,06

For compacting the samples, both sizes were mixed with 0,25% in mass and mixed for 20 minutes utilizing a V mixer, which consist in a mixer with two tubes aligned in between 45º and 90º rotating on a single axis. Allowing the material a better mixing.

The powder was filled in a 24,4 mm in diameter metallic matrix with around 5 g each, after adding the powder 6 discs (Fig. 2) were compacted using 100 MPa, 150 MPa and 200 MPa for each mesh by using an EMIC press.

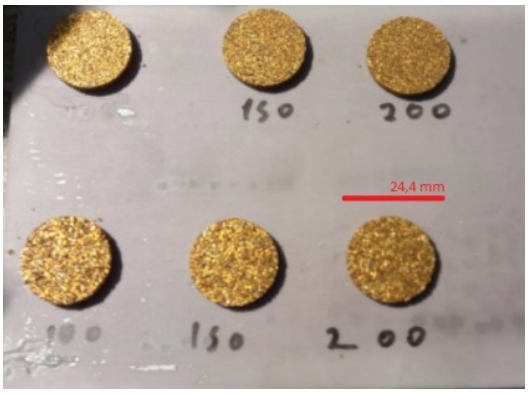


Fig. 2 - Sintered discs developed for comparsion.

The sintering was produced using a vacuum oven with 2x10^{-2} mbar (Thermal Technology Inc.). The processing took 90 minutes in total, being 60 minutes with the temperature of 800º C. The final material was cold slowly inside the oven itself (Fig.3(a)).

(a) (b)

Fig. 3 - (a) Oven. (b) Industrial sintered filter.

For the analysis of the sample porosity a microscopy was utilized for generating different amplification and visual imaging of the developed material, allowing a comparison of the. All the samples utilized were polished with sandpapers of 1 µm. The same was done with an industrial sintered filter of the same material (Fig. 3(b)).

The porosity was analyzed by the Arquimedes method, utilizing a precision scale, the density of the sample underwater could be compared to the sample outside the water, allowing the acquisition of the density of the porous material.

The following equation was used (1) [7]:

$$d^p = \left(\frac{m^d}{m^u - m^{ap}} \right) \cdot d^1 \quad (1)$$

Where: D^p is the density of the sample, m^d is the density of the sample out of the water, m^u is the density of the sample underwater, m^{ap} is the apparent density and d^1 is the fluid density.

After acquisition of the density, the following equation is applied (2) [8]:

$$p = 1 - \left(\frac{d^{vol}}{d^p} \right) \quad (2)$$

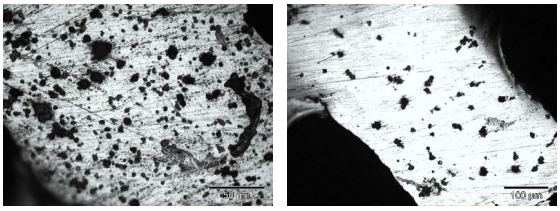
Where: d^{vol} is the volumetric density of the sample without water and d^p is the density of the material (1).

3. Results and discussions

Both experimental data and micrography, were acquired from the experiments, allowing a general analysis of the results for different states, as the general purpose of the experiment.

3.1 Micro-porosity

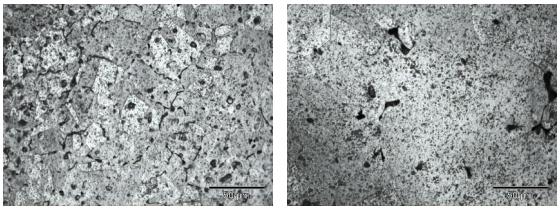
The micrography allows to analyze the micro-porosity, as it can be seen in Fig.4(a) and Fig.4(b) there is an extensive amount of porosity on each grain of the raw brass.



(a) (b)

Fig. 4 - (a) Micrography of the raw brass chips (50x). (b) Micrography of the raw brass chips (20x).

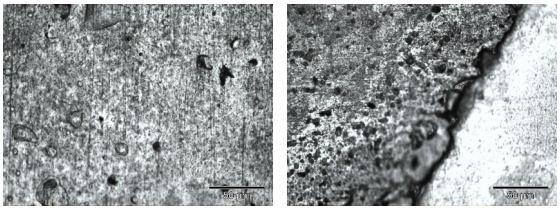
Compacting brass chips showed smaller micro-porosity in general, as it can be seen in Fig.5(a) and Fig.5(b) the concentration of the porosity increased but as a result decreased in size for # -14/+25. This can be given by the fact that the transitioning state of the matter as it isn't melting nor staying completely solid, reduces the porosity size.



(a) (b)

Fig. 5 - (a) Micrography of the # -14/+25 sintered filter (50x). (b) Micrography of the # -14/+25 sintered filter (50x).

Compacting with smaller grain shows even greater porosity reduction as the affect area grows and space for micro-porosity actually reduces. (Fig.6(a) and Fig.6(b))



(a) (b)

Fig. 6 - (a) Micrography of the # -25 sintered filter (50x). (b) Micrography of the # -25 sintered filter (50x).

Atomized sintered brass chips for the purpose of developing sintered filters have high porosity by each sphere. (Fig.7)

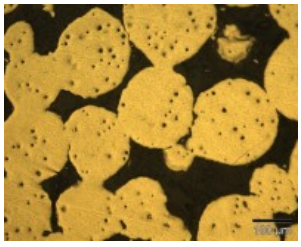


Fig. 7 - Atomized sintered brass chip (20x).

3.2 Data acquired

The density of the sintered material fell after the heating processes (Fig.8), in general this is given by the fact that the material oxidize inside the oven.

Samples with bigger grain (Fig. 8 - # -14/+25) showed a smaller density reduction, this can be given by the fact that the amount of area for oxidation is smaller the bigger the grain is, allowing the final product to be denser.

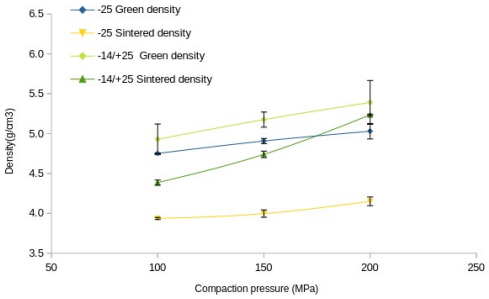


Fig. 8 - Density x Compaction pressure of the samples

Mass loss increases together with both the compacting pressure and grain size (Fig.9).

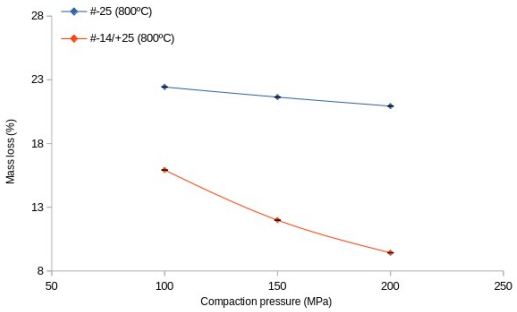


Fig. 9 - Mass loss x Compaction pressure of the samples

4. Conclusions

Elevated amount of porosity on both the raw brass and sintered brass can be a problem for products aiming resistance, but for the sintered filters developed through the processes of dust metallurgy it helps increasing the general flow of the fluid passing through the material.

General porosity of the filters reduces as the amount of pressure rises, becoming a problem for flow to go through.

Sintered filters developed by using brass chips is an alternative for using common dust metallurgy dust development processes. Allowing a cheaper and recycled way of developing those kind of products.

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6. References

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