Fabrication of Low Density Sintered Stainless Steel Filter

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Abstract

In a manufacturing technique of the sintered filter, pressureless sintering method has good permeability, it is not need the binder and lubricant used on compacting process, so it has little contamination and it is easy to control the pore size and shape but the mechanical strength is low relatively *and it is difficult that parts of complicate form are manufactured. In the case of manufacturing the filter by press and sintering method, in order to be satisfactory characteristic of un-pressed filter, in this study sintered metal filter fabricated by using 30-40mesh stainless steel 316L powder and additive agents. Porosity and structure of pores, permeability and mechanical strength of the sintered filter were investigated with the variation sintering conditions. Porosity was nearly constant about 60~70%, density, permeability and mechanical strength were changed markedly with quantity of additive materials and sintering conditions.*

Keywords : sintered metal filter, STS316L, low density, porosity, permeability

1. Introduction

Filter is necessary for filtration and purification of harmful and various matters which are required in the area of environment [1-2)] and hygiene and various engineering parts, we are manufacturing many filters for wide application using metal, ceramic, high polymer materials and fiber.

In the case of porous metal, the requirement of filter have higher mechanical strength and permeability according to the uniform pore size and distribution and is properly used as mechanical advanced parts preventing the damage of machine in the weak environment with heat-impact and in the case of vibration impact or filtering matters which is strongly corrosive. The research about porous material development and advanced product are required

Compressive pressure and sintering temperature is very important to control pore size and permeability of the sintered filter. Generally, metal filter was manufactured by the process of pressureless sintering, press sintering and hot isostatic pressing (HIP).

Recently, the metal filter are also manufactured by the process of powder injection molding (PIM) and self-propagated high temperature sintering (SHS). The generally porosity of PM filter is 30~40%, mesh filter is 30~60%, and fiber filter is 60~90%.

In this study, low-density sintered metal filters were fabricated by press and sintering method. Density, pore shape and permeability and mechanical strength of the filters were investigated with the variation of compressive pressure and sintering conditions.

2. Experimental and Results

The raw material is stainless steel powder (380~570 ㎛) which is made by the high pressure water atomization (Fig 1(a)). This stainless steel powder was mixed with other additives for improving sinterability and pore formation.[3)] The mixed powder was pressed with relatively low pressure (100~300kgf/cm^2) and sintered at 1300℃ for 1hr ~2hrs to form low density material. However, it is difficult to keep the formed shape due to low forming pressure. So that organic binder was treated to increase forming strength as shown at fig 1(b).[4)] Organic binder was coated uniformly on the particle surface.

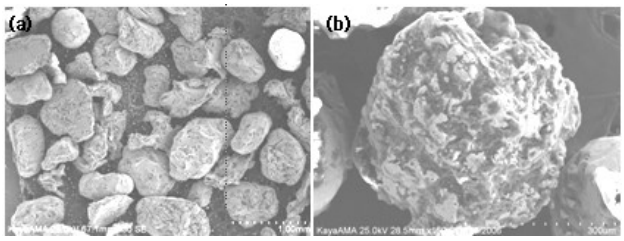

Fig. 1. SEM images of (a) mixed powder in this study and (b) binder treated powder

The density, radial crushing load (using UTM) and pore shape of sintering filter were investigated. And permeability of sintering filter was also evaluated with permeability tester like fig. 2. The permeability was evaluated with the differential pressure between input pressure (100bar) and output pressure as followed in the table 1.[5-6)]

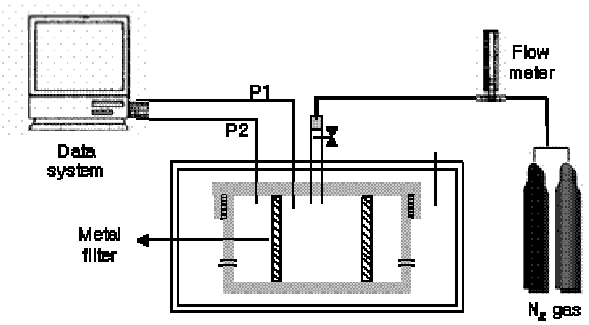

Fig.2. Schematic diagram of permeability tester

The sintered density was changed between 2.8 and 3.4 g/cm^3 depending on forming pressure. Namely, porosity of sintered filter was higher between 60% ~ 70% than general PM filter, Table 1.

It was difficult to keep the forming shape during sintering due to the low forming density and decomposed organic binder. So that sintering mold was demanded to prevent the change of sintering shape.

Table.1 Properties of sintered filter with sintering conditions.

SPL	Temp. (℃)	Time (hr)	Campaction pressure (kgf/㎠)	Additive Material (%)	Radial Crushing Load (kgf)	Permeability (Δbar)	Density (g/㎤)
a	1300	2	100	2.0	198	1.9	2.94
b			200	2.0	219	1.98	3.21
c			300	2.0	243	2.19	3.45
d		1	100	2.0	201	1.97	2.78
e			200	2.0	224	2.15	3.24
f			300	2.0	239	2.36	3.43
g		1	200	2.0	224	2.15	3.24
h			200	1.0	345	2.34	3.19
i			200	0.5	420	2.56	3.04

The radial crushing load was increased in as increasing sintered density because of increasing the sintered neck area between particles.

In the case of adding sintering additive, it represented higher radial crushing load in addition of 0.5% than 2.0%. It is not clear that the radial crushing load decrease in spite of more adding the improving sinterability agents.

And large pores formed in the sintered filter due to adding the pore forming agent to improve the permeability as shown in fig 3. The permeability represented the lowest differential pressure at the low forming pressure, decreased to 2.5bar. in 0.5% additive.

Fig. 3 is the result of pore shape by stereoscopic microscope, the pore size at 100kgf/cm^2 pressure as shown in fig 3 (a)(d) was more larger than 300kgf/cm^2 pressure as shown in fig 3 (c)(f). This correspond to permeability result. Partially, large pore was formed by pore forming material.

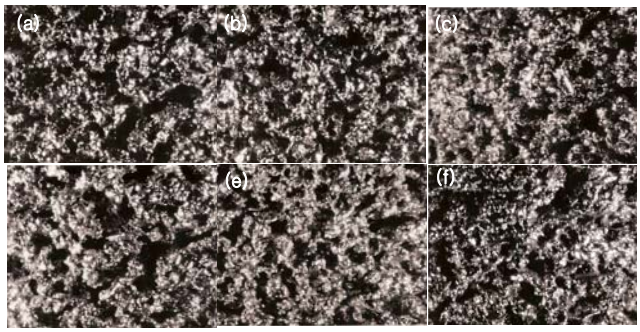

Fig.3. Pore shape of sintered filter as the forming pressure and sintering time.

3. Summary

Low density sintered filter was manufactured by using stainless steel powder, additive agents and press-sintering method. The result is as followed

1. Permeability and density decrease relatively as increasing forming pressure. So that pore forming agents was utilized to manufacturing of low density sintered metal filter.
2. Porosity of sintered filter was higher between 60% ~ 70% than general PM filter.
3. The radial crushing load was increased in as increasing sintered density because of increasing the sintered neck area between particles.
4. The permeability represented the lowest differential pressure(ΔP=1.9bar) at the low forming pressure (100kgf/cm^2), decreased to 2.5bar. in the 0.5% additive.

4. References

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