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SINTERED METAL FILTERS FOR HOT AND CORROSIVE LIQUID AND GAS APPLICATIONS

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ABSTRACT

Sintered metal filters are used for their high strength, corrosion resistance and high temperature capability in a variety of industries. The immediate advantages of sintered metal filters over other (polymeric and ceramic) filter materials are their ability to withstand higher pressures and temperatures, and their ductility and toughness to withstand process shocks and upset conditions. Sintered metal filters are routinely used, and are finding additional applications in refineries, petrochemical, chemical, power, pharmaceutical and semiconductor industries. Sintered porous metal filters have recently been developed in highly corrosion resistant Hastelloy[®] C-276 alloy. A high permeability, Hiflow[™] media has also been developed in nickel. Hastelloy C-276 is a popular alloy used in the chemical process, power, paper and food processing industry for its excellent corrosion resistance. Mott Corporation produces rolled and welded Hastelloy C-276 filter elements in liquid filtration ratings from 0.5 to 10 µm. The availability of all-welded Hastelloy C-276 filters has provided successful alternative for ceramic filters that often break in service due to their brittle nature. The Hiflow[™] Nickel filter media has been developed in 0.1 and 0.2 µm liquid filtration ratings. Hiflow[™] Nickel filters have porosity ranging from 40 to 60%, providing high permeability and high blowback efficiency. This paper will describe the microstructures, permeability, and corrosive and high temperature liquid and gas applications of new sintered metal filters.

Key Words: Metal filters, Sintered Metal, Corrosive fluid filtration, Hastelloy filters, gas filters, high pressure filters, and porous metal

[®] Hastelloy is a registered trademark of Haynes Corporation.

INTRODUCTION

Sintered metal filters have been used for a variety of applications in the industry, ranging from clarifying polymer melts to 9 LRV (log reduction value) filtration of high purity gases used in the semiconductor industry. The sintered metal filters are long lasting, can be cleaned for re-use, and can be completely recycled, depending on the nature of the contaminant. The disposable plastic filters often become a hazardous or non-biodegradable waste material.

Sintered metal filters are typically manufactured by selecting metal powder of specific particle size distribution, molding them into the required shape and high temperature sintering in hydrogen to obtain a strong porous structure. Sintered metal filters are available in liquid filtration ratings from 0.1 μm to 100 μm , and have been used for 9 LRV filtration of gases. This paper describes the properties of newly developed highly corrosion resistant filters and highly porous microfiltration media.

CORROSION RESISTANT SINTERED POROUS MATERIALS

Sintered metal filters are used where resistance to high pressures and high temperatures are required. The most popular material for sintered metal filters is 316L Stainless Steel, which is a widely accepted alloy throughout the industry. However in the chemical processing and petrochemical industries, there are many instances where 316L SS does not have sufficient corrosion resistance and corrosion resistant materials such as Hastelloy C-276 are used. This necessitated the development of rolled and welded Hastelloy C-276 filter elements. The Hastelloy C-276 elements replace ceramic elements used in the chemical process industry, and bring the advantages of a metal filter element. The advantages of Hastelloy C-276 elements include high strength and toughness to survive repeated blow back pressures cycles, and ability to withstand thermal shocks.

Hastelloy C-276 elements have traditionally been available as isostatically pressed elements in diameters ranging from 0.5" to 2.0" or larger. The isostatically pressed media has a high surface roughness. Rolled and welded media has a smooth surface due to the rolling process. In slurry filtration, where a cake is developed on the filter element wall, cake release to regenerate the filter is key to filter operation. Cake release has been demonstrated to be superior from the smooth surface of the rolled and welded element.

Figures 1a and 1b show the air and water permeability of 0.5 and 2 μm grade Hastelloy C-276 and 316 L Stainless Steel media. The Hastelloy C-276 media has been developed to closely follow the physical characteristics of the standard 316L Stainless Steel media, so that industrial filters can be readily sized. Also, if there are corrosion concerns, the 316L Stainless Steel media, can be readily replaced with the more corrosion resistant Hastelloy C-276 media.

Typical applications of Hastelloy C-276 filtration media will be found in the following applications, where highly corrosive fluids are usually present:

- ❖ Bleach plants in pulp and paper industry
- ❖ Flue-gas desulfurization
- ❖ Organic chloride production
- ❖ Processes using halide or acid catalysts
- ❖ Food processing equipment
- ❖ Components exposed to sour gas
- ❖ Sulfuric acid environment
- ❖ Certain areas in petrochemical plants
- ❖ Sea water and brine solution
- ❖ Pharmaceutical equipment

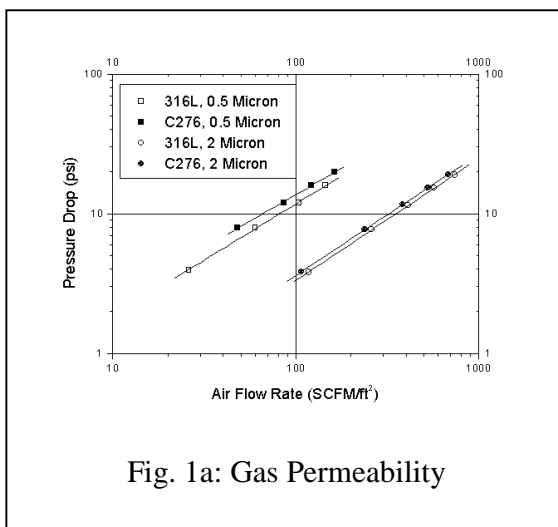


Fig. 1a: Gas Permeability

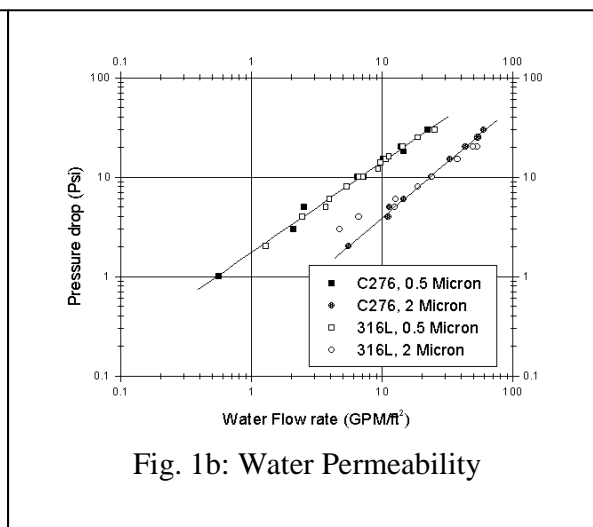


Fig. 1b: Water Permeability

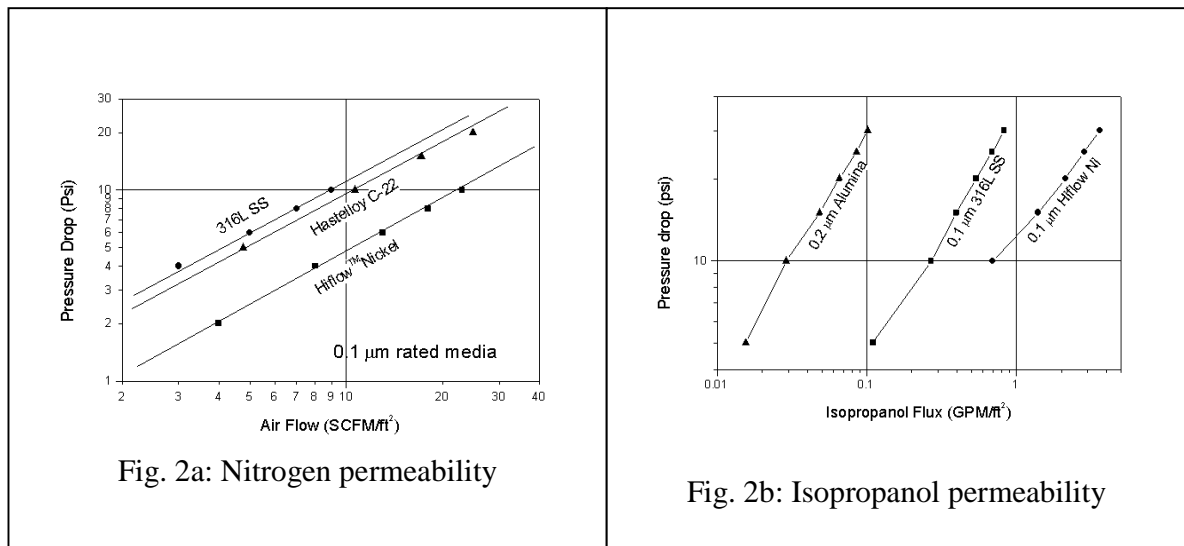
SINTERED METAL MICROFILTRATION MEDIA

Media for microfiltration, i.e., for filtration of 0.1 to 2 μm size particles in liquids are available commercially in polymers, ceramics and metals. Sintered metal microfiltration media can be welded, and therefore do not require polymeric seals. Sintered metal microfiltration media are used where high corrosion resistance, long life, high temperature and high-pressure capability are desired. The strength and toughness of the sintered metal microfiltration media provides resistance to thermal shock as well as pressure shocks during blowback. Table 1 shows porosity and tensile strength of microfiltration media in Nickel, 316L Stainless Steel and Hastelloy C-22.

Table 1: Physical Properties of Sintered Metal Microfiltration Media					
Mott Grade	Material	Tube Inner Diameter (Inches)	Wall Thickness (Inches)	Porosity %	Tensile Strength (psi)
0.1 μm	Hiflow™ Ni	0.35	0.090	40	12,000
0.1 μm	316L SS	0.35	0.055	25	27,000
0.1 μm	Hastelloy C-22	0.36	0.085	20	35,000

Higher porosity in the microfiltration media provides better back washability, since the blowback pressure is readily transmitted through the media wall to the cake structure to be dislodged. The high porosity media therefore provides higher throughput. Depending on the nature of the slurry, higher porosity media will in general provide higher permeability during filtration.

Figures 2a and 2b show the air and liquid permeability of the 0.1 μm grade microfiltration media. The permeability of Hiflow™ Nickel media is higher due to its higher porosity. The three media in different alloys have varying degrees of corrosion resistance. Nickel is a corrosion resistant material and suitable for ambient conditions, or alkaline solutions. Nickel is not suitable where oxidizing acids or high chlorides are present. For such conditions, 316L Stainless Steel may be used. Hastelloy media is for corrosion situations where 316L Stainless Steel is not applicable. These three materials cover a large range of commercial applications.



The sintered metal microfiltration media are designed to be used in cross flow filters when filtering liquids. The Hiflow™ Nickel in slightly modified form is also used for semiconductor gas filtration with an efficiency of 9 LRV (log reduction value).

SUMMARY

Recent developments in manufacturing sintered metal media have led to the development of corrosion resistant sintered metal filters that can be used in applications where 316L stainless steel will not survive. Corrosion resistant Hastelloy C-276 filters will provide excellent service and value in chemical, food and pharmaceutical plants.

High permeability sintered metal microfiltration media have also been developed. Their uses include operation as cross flow filters in separating 0.1 to 2 μm size particles from liquid

streams. Similar media are used for filtering gases used in semiconductor plants with 9 LRV filtration efficiency. Additional industrial gas filtration applications are being developed with the Hiflow™ Nickel media.