

Primer on Metal Filtration Media

by

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Description:

Metal filtration media comes in many alloys and forms functioning in a wide range of applications. Some of the more popular alloys are stainless steel, nickel, brass, copper, aluminum, epoxy coated carbon steel and high-alloys such as Monel and Hastalloy. Media forms include wire cloth, wedge wire, perforated plate, fiber metal felt, knitted cloth, powdered metal, expanded metal and more. To review each of these individual metals and/or media justice would require an entire article, because of the unique properties and performance each provides. However, it is safe to say that metal, regardless of its alloy, material form or use, has unique attributes making it the most versatile of all filter media and material of choice in a wide number of filter applications. Unique properties include high-temperature capability, chemical and corrosion resistance (alloy dependent), rigidity (stiffness), toughness and strength. Because metal is adaptable in so many configurations, metal can be incorporated in virtually any filter application; the one exception being as an alternative for polymeric and ceramic membranes, because of the fine pore size capability of these materials. However, with recent advances in the manufacture of fine metal fibers and powdered metal technology, metal may present a challenge at the fringes of certain pore size microporous membranes in the next several years.

The marketplace for wire cloth in the United States is \$90-100 million, mostly market grade. Epoxy coated carbon steel is not counted in this total. Because such a large percentage of the market grade is imported, this volume can vary depending upon exchange rates. The vast percentage of this wire is stainless steel, which range as low as \$0.50/sf to levels of over \$60/sf. However, the majority is priced in the \$1-3/sf range. The majority of the wire cloth comes from the Far East, such as China South Korea and Japan to a lesser degree. Precision woven for high-end applications typically comes from Europe with Germany, France and Switzerland as the most important centers. Although there is wire weaving in the United States, the industry the volume is relatively small and typically consists of epoxy coated carbon steel, although there are weavers of specialty high-alloy wire that produce custom runs to fill niche applications.

Fiber Metal Felt is used found widely as filtration media for use in polymer filters in the films and synthetic textile fibers industry. Fibers of 4-12 micron in diameter are common. They are airlaid and sintered to form a rigid filter media with filtration capabilities in the 10-40 micron range. An 8 ounce per square yard airlaid un-sintered media will sell in the \$65-80 per square yard, but the price is volatile. This media is primarily imported from Europe, but its use has diminished greatly in the United States over the last twenty years as much of the synthetic textile industry, especially for fine diameter polyester and nylon.

History:

Man has been forming metal since the Bronze Age, 3,500 B.C., when copper and tin were combined to create the first alloy for use in cups, urns and weapons. Only history knows when the first metal filter was made. However, a significant advance was made, once the drawing of wire was developed in England in the late 1800's and when enterprising individuals began weaving wire cloth. This new wire cloth technology quickly spread throughout Europe and other parts of the world, particularly the United States where metal filters and sieve screens became a practical reality. Thus, filtration media woven metal mesh having openings (pores) became generally comparable with woven fabrics of the day. Because fabrics were made only from natural fibers at the time (synthetic fibers were still 50-60 years in the future), metal mesh was a boon to many industries because of its formability and depending upon the alloy, its chemical and corrosion resistance, across a broad pH range. Metal cloth rapidly grew in popularity and use as a practical filtration media in diverse markets and applications.

Material(s) of Construction:

Metal media is available in many popular alloys ranging from epoxy coated carbon steel to stainless steel, copper, nickel, titanium and Hastalloy. Each metal has many versions or alloys. For example, stainless steel, universally the most popular alloy in filtration, can be obtained in many grades. With slight variations of component metals, such as chrome, nickel and manganese, stainless steel filtration media will possess different physical and exhibit different performance properties. One example would be the difference between makeup between 316 and 316L stainless steel with a fractional difference (0.05%) carbon content, enough to permit sintering of the 316L stainless steel. In turn, each alloy yields different cost and performance characteristics. Other alloys are available with magnetic properties, an important and obvious asset when metal particle removal is important.

Media Forms:

Metal media, seemingly, is available in an endless array of forms. Some of the most popular are (1) Wire cloth, woven in many styles, such as plain weave, Dutch twill etc. (2) Wedge wire, wedges with flat sides laid in parallel. Spacing between the wedges creates slots, which serve as the fluid flow path. (3) Perforated plate, usually round holes or slots which have been mechanically stamped (4) Metal Fiber, fibers, made in wire drawing processes, are formed into webs typically through air or wet laid technologies (5) Knitted, similar to woven wire but knitted, usually into three dimensional structures (6) Powdered metal, as the name implies are fine powders which are generally packed into a mold and sintered to form a porous shape. (7) Expanded metal created when metal foil or sheet is slit in small repeated patterns and then subsequently stretched opening the slits. There are other popular metal forms such as magnetic, charged plates and composites of metal, such as fine metal fibers and wire cloth. Also, very heavy woven wire is used as screens to classify gravel and rock to size for use in construction, such as roadbeds.

Special Characteristics:

Metal has a number of special properties and characteristics each with distinguishing attributes. The most notable is one that few people would put at the head of the list. Specifically, metal can be formed into almost an endless configurations from a long list of alloys. In turn, the filter media and/or element manufacturers are able to tailor filtration media and filtration products to satisfy almost every users requirement. The one common characteristic that all metals have is that of high temperature resistance in comparison to other media such as synthetic woven and nonwoven fabrics, membranes, porous plastics and paper. Only specialty filtration media such as ceramics come close in matching metal for high temperature. However, they cannot match the versatility of metal. Most specialty metals used in filtration, excluding plain carbon steel, have a high degree of chemical and corrosion resistance and many instances will match-up with fluoropolymers, an attribute often over-looked. Many performance alloys can be sintered to provide shape and structural integrity. Other factors, which differentiate metal, are its strength, toughness and stiffness compared to other media. These factors allow metal to be formed into rigid structures and contribute to metal's ability to withstand the high temperature, pressure and strong chemical attack seen in many chemical processing and other performance applications.

Manufacturing Methods:

Metal media is one of the most versatile of all filtration media as alluded to earlier. Only nonwoven fabrics in all their available forms and configurations may present a possible challenge. Metal's versatility permits an array manufacturing methods. The most common being woven wire cloth followed by knitted wire, which is produced on equipment similar to synthetic knitted textiles. Other common forms of metal media include wedge wire. Perforated plate is made from flat sheet and perforated with circular holes and sometimes slots. Powdered metal and metal fibers are self-descriptive and require sintering to form a useable part either in a flat sheet or shaped part. Expanded metal consists of strategically slit or punched metal, which is stretched to open the cuts to form a prescribed opening.

Filter Configurations and Function:

In general terms, there likely isn't a single filter media or finished filter element or application that can not be made from metal with the exception of membranes consisting of sub-micron mean flow pore size. Although advances in powder metal and new developments in fine metal fiber media may challenge this pore size barrier in the near future. Metal media is not limited to stationary forms. Endless belts of metal links are found in a number of filtration and dewatering applications. Woven metal, wedge wire and perforated plate are common in circular or pleated filter elements and as flat screens, leafs, sieves, support screens and separators on rotating drums. Metal in the form of knitted wire yields a very high void volume and is configured as pads. With support grids these self-supporting devices, sometimes called pads, are used as mist eliminators to scrub toxic gasses from air streams. These devices have air high-flow properties and fine aerosol particle capture efficiency. Powdered metal and fine metal fibers are sintered as flat stock and

frequently pleated or formed into shapes. Wire cloth is typically used in circular or pleated filter elements, as flat screens for sifting, such as for flour or abrasives or as a support screen for weaker media.

Market/Applications:

Markets vary widely depending upon the type of metal media. Although more than one metal media format can compete for the same application, cost and functionality of the filter often dictate the preferred choice. For example, 20 micron woven wire cloth is less expensive than a sintered metal fiber mat. However, a 20 micron metal fiber mat has far higher dirt holding capacity for use in polymer filters for film extrusion and textile fiber spinning. Other media applications, include leafs and septums for filter aid cake formation, support screens and pleated filter elements to the media itself, as well as in sifting and dewatering applications. In coalescers, PTFE coated wire cloth insures no free-water carry-over. Metal is used widely in filter candles and back-pulse configurations in addition to magnetic metal plates to capture metal fines and chips. Other metal uses include, electrostatic precipitator plates, centrifuge disks and vanes. Also, metal used in gas filters in semiconductor manufacture, strainers for process industry prefiltration and general particulate removal and edge filters for water purification in the pulp and paper, coal and coke, sewage treatment and sugar industry. Applications are extensive and far broader than described here.

Advantages:

The most important advantage of metal is it's versatility, reusability and the many forms into which it can be configured, its inherent strength and stiffness and depending upon the alloy, its temperature capability over most other filter media as well as it's corrosion resistance over a wide pH range as mentioned earlier. The advantage of sintering, allows metal media to be fused into a rigid structure and into many forms including metal fibers elements, which present a minimal risk of fibers breaking-off into the effluent. Filters and filtration systems containing sintered components often use a single alloy of construction, a significant manufacturing and compatibility asset. A number of alloys have magnetic properties and charged metal plate can provide additional benefits for enhanced filtration efficiency. Metal is not apt to wear out rapidly, its abrasion resistance is generally excellent. UV, weathering and ozone resistance, depending upon the alloy, is superior to most other media. Electro-polished metal in filter housings provide very smooth surfaces and special coatings can provide unique protective properties for less resistant metal alloys. Many metal filters can be cleaned with aggressive chemical and/or heat, a significant advantage in an increasingly environmentally conscious world.

Disadvantages:

High performance metal media from stainless steel and many of its alloys and metal cousins can be expensive relative to other media in constructions such as textile fibers, nonwoven and monofilament woven fabrics, porous plastics, paper, certain membrane and similar media. Metal

media also is often sintered to end caps and support structures, which a slow and less flexible process than melt processing as is the case with thermoplastic media filters and separators. Metal media is not generally available in mean flow pore ratings less than 5 micron. Metal cannot be incinerated for easy disposal. However, it can be reclaimed. These disadvantages simply point out that no single filter media can meet all the industries needs and never will. However, in spite of any disadvantages, the selection of metal media is growing in usage and remains the media of choice in many applications.

Market Penetration and Trends:

Metal Media is one of the principal filtration media in our industry and arguably found across the widest market and number of applications. Metal will continue to occupy a special place and is not likely to be displaced or relegate it's position of eminence as the most versatile media, in spite of a potential case that could be made by nonwoven fabrics. There are future opportunities for penetration of metal media into baghouse applications where higher temperatures are stressing the limits of synthetic and PTFE products and the chemical resistance of glass. Reusable metal media, which is either back-pulsed or cleaned by thermo, acoustic or chemical means in both air and liquid will surely grow in the future. The only question is how much will it gain relative to other media? A good bet would be that metal will be one of the leading growth media for years to come, because of larger demands for specialized media having versatile capabilities in a world that is environmentally conscious and increasingly puts a premium on re-usable filters.

The foregoing description does not represent all specialty metal filtration media forms and variations. They are simply too numerous to include in this brief primer.

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