Filtration Housing Basics

Filtration vessels are an integral part of the filtration process. There are a wide array of vessels in the market, with price ranges and quality standards even more varied. Stainless steel is the preferred material for product contact in the healthcare market, while application with microelectronics may require the compatibility of a fluoropolymer. A refinery will require an ASME code stamp on the vessel, however a plating operation may settle for plastic or fiberglass. The choice of vessel will depend on numerous factors including the application, chemical or thermal compatibility, price and even insurance requirements.

MATERIALS OF CONSTRUCTION

While filtration vessels can be made from a wide variety of materials including plastic, fiberglass, and fluoropolymer, the most common materials are carbon steel, 304 and 316 stainless steel. The choice of material is dictated by a number of factors, including cost and compatibility. Certain applications may require more exotic metals such as Hastelloy or Inconel.

Carbon steel is the most widely used engineering material and accounts for approximately eighty five percent, of the annual steel production worldwide. It is a metal alloy that contains at least 95% iron with up to 2.1% carbon. Carbon and other elements within iron act as hardening agents, thus the higher the carbon content, the stronger the steel, but this also reduces the steel's weldability and ductility, making the steel more brittle. It is the lower cost of the steel materials used in vessel fabrication, but due to their nature of limited alloy content, the material is prone to general corrosion behavior, most common rusting in aqueous environments and perforations from acid exposure.

To overcome the corrosion limitations of carbon steel, common practice is to use stainless steel, which is group of iron based alloys containing a minimum of 10.5% chromium with carbon content usually less than 0.08%. This forms a protective self-healing oxide film, which is the reason why this group of steels has their characteristic "stainlessness" or corrosion resistance. The ability of the oxide layer to heal itself means that the steel is corrosion resistant, no matter how much of the surface is removed. Other elements are added, such as molybdenum, to further improve corrosion resistance and other properties. There are over 50 stainless steel grades that were originally recognized by the American Iron and Steel Institute (AISI). 304 and 316 are the typical choices and referred to as austenitic stainless steel, a group containing at least 16% chromium and 6% nickel. The most frequently used stainless steel in use is Grade 304 (UNS 30400), the basic "18-8" alloy (18% chromium, 8% nickel). Grade 316 (UNS 31600), has an addition of at least 2% molybdenum, which significantly increases the metal's resistance to "salt" corrosion. There is no visible difference between the two materials, so a material test report (MTR) of the actual material would be required to validate it as being 304 or 316. A reduction of the carbon content from the 0.08% to 0.03%, further classifies the material from 304 or 316 to 304L or 316L, for low carbon stainless.

SURFACE FINISHES

In order to protect vessel from the environment, provide for a higher level of chemical compatibility or meet certain cleanliness standards, vessels general receive some further surface finish, depending upon the material used in construction of the vessel as well as the application. Low cost alternative may involve pain, bead blasting or mechanical polishing, while further corrosion resistance can be achieved on stainless steel by the use of chemical treatment processes. In some applications, particular those involving sanitary vessels, a surface roughness value is define, referred to as Ra µm, or roughness average. The Ra is determined using a sensitive instrument called a profilometer which employs a diamond tipped stylus to measure peaks and valleys in a relatively smooth surface. Cost are associated with the addition of any surface finish, with the decreasing the roughness of a surface usually resulting in the most significant increase in manufacturing costs.

Paint: The most common treatment for carbon steel is to apply paint to the exterior surface. The type may vary by application and is often called out in the specification at the time of quote. These paints are typically epoxy or polymer based to prevent atmospheric corrosion.

Bead Blast: A form of high pressure cleaning commonly used to mechanically clean parts, removing oxides, contaminants, paint, and other coatings on the surface. One of the most common materials used in bead blasting are small spherical particles of glass that are shot with air pressure at a surface, but other types of bead materials are also used in the process, such as silicon carbide and stainless steel beads.

Mechanical Polishing: The mechanical smoothing and removal of contaminates. Involving grinding, polishing and buffing of the surface. This process is used to smooth out welds and may be used to provide a surface with a specified roughness. Or prepare metal surfaces for electropolishing.

Passivation: Process involves immersing stainless steel components in a solution of nitric or citric acid without oxidizing salts to improve the surface condition of stainless steel. Passivation treatments dissolve the imbedded iron that has been imbedded in the surface during forming or machining, and restore the original corrosion-resistant surface by forming a thin, transparent oxide film. If allowed to remain, the iron can corrode and give the appearance of rust spots on the stainless steel.

Electropolishing: An electrochemical process that is a "super passivator" process, cleaning and polishing metal in a special electrochemical solution. An electrical current is passed through a chemical bath, dissolving a small amount of metal from the surface, leaving a smooth, shiny finish. The current is greatest on the outside edges and corners of parts, which are left especially smooth. Increasing the process time will remove more amount of metal. Holes can be enlarged, threads can be rounded and sharp edges or burrs can be reduced. Electropolishing is the best choice when contamination cannot be tolerated.

VESSEL STANDARDS

ASME Code Standards

Vessels may have certain certifications specified, the most common of which is ASME (American Society of Mechanical Engineers). The ASME Boiler and Pressure Vessel Code (BPVC) establishes rules of safety governing the design, fabrication, and inspection of boilers and pressure vessels, in order to provide for a margin for deterioration in service and applies to vessels vessels having an internal or external pressure which exceeds 15 psi and inside diameter to be larger than 152 mm. Parameters such as wall thicknesses, materials, flange ratings, welding details, and extent of nondestructive examination are determined by design conditions such as pressure, temperature, corrosion allowance, The acceptance and certification is symbolized by the "U Stamp" for pressure vessels and "UM Stamp" for miniature pressure vessels (under 35 gallons).

CE Mark

Vessels sold within the European Economic Area (EEA) that have pressure ratings over 0.5 bar may require the CE mark (formerly EC mark). The CE mark may also be found on products sold outside the EEA that are manufactured in or designed to be sold in the EEA. In conjunction with the Pressure Equipment Directive (PED), the intent is to harmonize the design and safety requirements for all types of pressure vessels, which would include filter housings.

3A Sanitary Standards

One of the primary food equipment organizations is 3-A Sanitary Standards, Inc. This organization has defined standards for equipment used for processing and handling food products in order to ensure safe food and adequate sanitation program. These standards involve the design, fabrication, construction, and installation that ensures the equipment can be adequately cleaned and sanitized, and that surfaces are resistant to daily exposure to corrosive food products and cleaning/sanitizing chemicals. While these standards are written with the food industry in mind, the healthcare industry has adopted many of these principles for sanitary vessels. A number of critical areas are defined:

Product Contact Surfaces—All contact surfaces should be smooth; free of cracks and crevices; nonporous; nonabsorbent; non-contaminating; nonreactive; corrosion resistant; durable and maintenance free; nontoxic; and cleanable.

Surface Texture and/or Finish—If any surface is ground, polished, or textured in any way, it must be done so that the final surface is smooth, durable and free of cracks and crevices. Typical minimum finish for sanitary applications is 32 Ra, with some pharmaceutical requirements at 25 Ra or less.

Construction and Fabrication—Equipment should be designed and fabricated in such a way that all contact surfaces are free of sharp corners and crevices. All mating surfaces must also be continuous (e.g., substantially flush). Construction of all processing equipment should allow for easy disassembly for cleaning and inspection. Where appropriate (e.g., vessels, chambers, tanks), equipment should be self-draining and pitched to a drainable port with no potential hold up of food materials or solutions. Internal angles should be coved or rounded. All connections, attachments, and ancillary Equipment should not create a dead end or an area where product can accumulate and is not accessible to cleaning solutions. Product contact is to be avoided with threaded equipment.