# PT 102
# Single melt 316L stainless steel considerations compared to double melt

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## Overview

There are two basic types of 316L stainless steel (SS) used in UHP gas systems – single melt and double melt (also referred to as remelt). The melt processes to produce 316L SS commonly include: AOD (argon oxygen decarburization), VIM (vacuum induction melt) and VAR (vacuum arc remelt). AOD and VIM are each utilized as a single melting process and as the first melt process prior to VAR (VAR will be used rather than secondary remelt). 316L SS stated alone without VAR is assumed to be single melt. 316L SS followed by VIM/VAR, AOD/VAR or VAR all signify double melt materials.

VAR has lower impurities and is more homogenous compared to single melt. This comes with a higher cost for the material. The following is intended to help users understand the differences and benefits of the two melt processes.

## Single melt material

316L SS material has impurities of random non-metallic and sulfide inclusions which concentrate in clusters. As the material is hot rolled into a bar form, the clusters are stretched along the axis of the bar. The stretching elongates the inclusion clusters to form thread like formations, called appropriately stringers. Stringers are problematic if they cross through a thin wall section machined perpendicular to the axis of the bar. A gas that reacts with the stringer, such as a corrosive, can cause a leak to atmosphere.

Background history: when weld fittings transitioned from forged to machined from bar stock, termed micro-fit, in the early 90's, outboard leaks started occurring with corrosive gas service. The leaks were caused by stringers through thin wall sections, such as a micro-fit elbow, where one leg is machined along the axis of the bar and the other leg perpendicular where a stringer would cross the thin wall. The solution was VAR material.

## VAR material

VAR material has lower impurities compared to single melt and the impurities are evenly dispersed rather than clustered. The material is more homogeneous

than single melt and is free of stringers caused by grouping of inclusions, clusters, as a result. Thin wall sections are, therefore, not a concern.

The Sulphur percentage in VAR is less than single melt. Sulphur acts as a cutting tool lubricant which leads to VAR being more difficult and time consuming to machine compared to single melt. The fewer parts machined per hour along with higher cost of the VAR material itself, makes a product with VAR material more expensive compared to the same with single melt.

Homogenous material has another advantage, surface appearance. VAR material polishes and electro-polishes very well compared to single melt. Mirror like surfaces are common today with VAR whereas single melt will have a more cloudy and non-uniform appearance. The single melt clusters of impurities also lead to pitting when located near the surface. VAR does not suffer from such pitting due to material uniformity.

**Pros and cons**

Both materials have their advantages and disadvantages. There are appropriate applications for both materials.

VAR has the advantages of being stringer free with better surface chemistry and finish. The finer finish enhances purge ability and moisture dry down in theory. The disadvantage is only cost, as it is more expensive due to material and machining costs.

The advantage of single melt is primarily lower cost.

**Material flaws**

The drawing process to create a round or square shape can induce flaws. Hairline voids can be created which mimic stringers. The voids can lead to leaks through the material itself depending upon where they occur in the final machined part. Unlike stringers, however, these voids can occur with both single melt and VAR materials and will leak in any gas service (not require corrosive gas to create a leak path).

It must be noted that though such flaws can occur, they are extremely rare. However, it must also be noted that if a bar has such a flaw and it is cut up to make many parts, the odds are several parts will have a leak making all parts from that heat lot suspect.

## Conclusion

Today, single melt is commonly used for N2 and inert applications, whereas VAR is used for specialty gas delivery. The use of VAR for corrosive and reactive gases. VAR can be used for all gases, but single melt is recommended only for inert gases.