Why Material Performance Can Be Different

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Differences in material machining performance is probably the number one issue that skilled operators face on the job. Jobs that were "gravy" or "easy to run" the last time they were performed suddenly become "jobs from Hell," or "no longer run at rate."

It is easy to say, "The material batch changed, so it must be the material." However, that kind of logic does not help your team members understand the problem. Nor does it help them create a solution that reduces the problem in the future and get you back to full production sooner. Let's look at what might be involved when material performance is markedly different.

Understanding Variation. Variation is the real issue when performance of a batch doesn't meet expectations based on a prior run. In most cases, the material certification shows identical material that conforms to specification. Yet, the machinist finds that his or her best use of time is to contact Engineering or Purchasing to find out what is wrong with the material.

It's not the material itself that is "wrong." It is the fact that it has been provided differently than the other batch, which also met the same specification and standard. How can two batches of steel meet the specification and still be different? Here are a few things to consider:

Melt Process and Supplier. Are the two lots of material from the same company and melt process of origin? Are they both electric furnace melt and, if so, from the same melt shop?

IN THIS ISSUE

Different melt shops may have different practices, policies, process aims and other standards that result in subtle (or not-so-subtle) material differences, even when producing the same nominal grade.

Is one basic oxygen melt? The electric furnace process uses a high percentage of scrap for feedstock and melts in atmospheric air. Basic oxygen shops rely on limited scrap additions to virgin melt, blast furnace iron. The reaction vessel is saturated with oxygen, not atmospheric air, so nitrogen tends to run lower than electric furnace steel.

Material certifications seldom report nitrogen. In addition, the initial solidification of the steel into blooms (sections greater than 8"x 8") or billets (sections less than 8"x 8") is a determinant of the amount of reduction in area by hot rolling. This can affect the performance of the material in both the machining process and end use.

Variation of sourcing and source processes is more responsible for performance differences than the chemical make-up shown on the test report.

Cold-Finish Process and Supplier. Exactly what does your immediate supplier mean when it says the bars are cold-finished? Is that different than what your previous supplier meant when it identified the bars as cold-finished?

CONTINUES ON PAGE X

CONTINUED FROM PAGE X

MATERIAL PERFORMANCE

"Cold-finishing" means that the final production operations take place at ambient (not elevated) temperatures. Turning-and-polishing is one cold-finishing process that does not change the mechanical properties of the bars.

On the other hand, "cold-drawing," by imparting cold-working strain to the steel, increases tensile, yield strength and hardness, while reducing ductility. These changes substantially improve the steel's machinability.

Even if both suppliers apply cold-drawing to the steel, they may have different methods, practices, policies and techniques, resulting in differences in the performance of the material provided. In the case of shapes, was the shape produced from a hot roll of the same shape or was it drawn from a round into the final shape? Differences, differences.

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Recipe. On non-free machining steels, such as plain carbon grades 1018 or 1045, or various alloy grades, there are still intentional recipe ingredients that can measurably affect the machining performance of the steel in your process. Sulfur, in particular, is such an addition.

While many melt shops try to hold the level of sulfur down for quality and process reasons, it has been proved throughout my career that whenever sulfur was above 0.020 weight percent, there were no complaints concerning machinability.

If it was much below that level—say, in the range of 0.015 to 0.018 weight percent—I would receive complaints and failed tooling to check. Below 0.015 weight percent, the material was generally held to be "unmachinable," requiring additional steps to assure acceptable surface finish and tool life.

Solutions for Your Shop. Here is one approach to reducing, if not eliminating, the variability in supply that creates production difficulties in your shop: 5-S your supply process (Sort, Straighten, Sweep, Standardize and Sustain).

Sort your material requirements into categories by material size and grade. Minimize the number of sizes by making do. Accept the higher-than-expected yield loss because you are gaining fewer variations in material supplied. Try to limit each material category to a single supplier/melt shop cold-finishing process combination.

Straighten your existing materials inventory and orders to get a better view of what you have and what is on order. Are any known troublemakers in-house or on order? If you know you always have difficulties with a particular supply path, why keep material from it in-house or on order?

Sweep your inventory and order book of unneeded or troublemaking materials. Just because they don't machine well for you doesn't mean they will give others difficulty.

It might be exactly what someone else's process is used to. So, if you don't have time to learn how to make these challenging "outliers" perform, why not sell them and better use the cash someplace else?

Standardize your material order procedures and policies to maximize your chances of success. If your analysis of job performance versus material supply process shows you that a particular combination of melt shop or cold-finisher always beats rate, *why aren't you already standardized to reward those suppliers with the business?*

If your answer is "price-per-pound," you need to recognize that those cents-per-pound are costing you dollars-per-hour in the shop.

Sustain the process. This means discussing with your customers the importance of adequate lead times and firm commitments. That way, you can get the material that performs best for your process on their parts.

Show them how their "demand time" compares to the time needed to get material on lead time. Get them on your side regarding reduced variability and improved delivery with shorter lead times.

The material test reports/certifications are an important place to start to identify the differences between steel provided by different suppliers. It is critical to note that what is not shown on the cert may, in fact, be a more important determinant of machining performance variability than what is shown.

We realize that with today's short notice on the demand side and longer lead times on the supply side, variation in material supply is a greater problem than ever before. That's why you need to 5S your raw material procurement and inventory. It will allow you to reduce and eliminate as many potential causes of variability as possible.