Filtration Efficiency's Impact on Compressor Health

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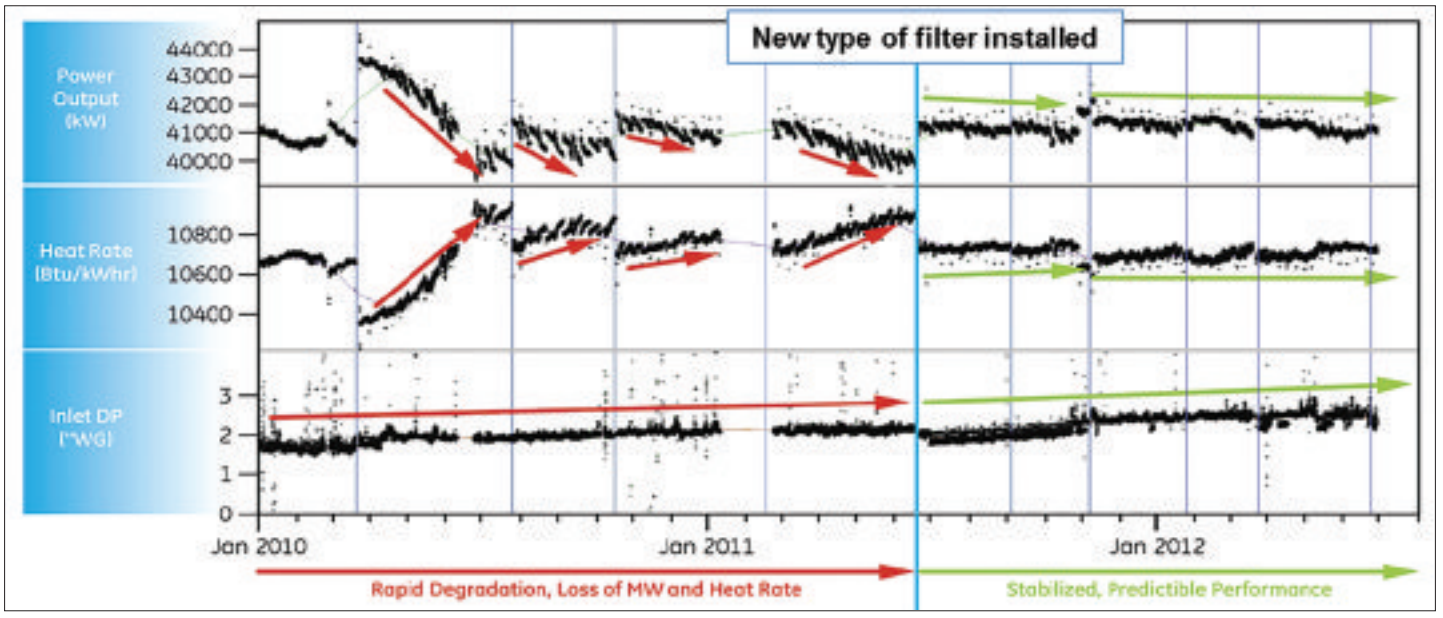

Fig. 1: This chart is one example of performance indicators to evaluate in place of filtration efficiency. This represents turbine performance, starting with, from top to bottom: MW output, heat rate, and differential pressure.

If one were to ask a plant manager to name the critical factors for proper gas turbine performance, it's likely the inlet system would show up far down the list. However, it is often the overlooked aspects of plant maintenance that can have the most impact. Nowhere is that more true than in relation to the gas turbine inlet system. With the amount of air consumed by a gas turbine, the choice of inlet filters is one of the most critical.

To that end, operators now have more choices than ever when it comes to filters for their inlet systems. Multiple manufacturers, media choices, metal options and efficiency ratings lead to a dizzying array to choose from. And with the ramifications of getting the choice wrong looming ominously, operators want to be sure they're selecting the right filter.

But how does one compare one filter to another? And most importantly, what is that filter's effect on compressor health?

TRADITIONAL FILTRATION STANDARDS

Filters can be evaluated in numerous ways, all meant to provide comparisons for one filter to another.

Perhaps the most common – and first evaluated – standard is filtration efficiency. Depending on where one is in the world, a filter company may use the European standard (European Norm, or EN) or the ASHRAE standard. Often, you'll find a filter with both ratings. While the ratings don't correspond 1:1, they are similar. For the purposes of this article, we will focus on the European standard ratings, better known as the EN779 test.

This is what is known as a laboratory rating: A filter is sent to a test lab, run through a filtration efficiency test and depending on how much dust particles it filters, it is assigned a rating. Today's standard final stage filters often run from an F8 rating to E12, better known as EPA, and previously, the HEPA class of filtration.

Note that filters in the EPA/HEPA class are evaluated using a different European standard test, known as EN1822. This test evaluates the initial clean efficiency of the filter only and does not take into account the effect of loading dust and the dust-

holding capacity of the filter, whereas the EN779 test (and it's equivalent ASHRAE 52.2), used for filters rated F9 and below, is called a through-life test, and takes the effect of dust loading into account.

Filters have been evaluated this way for many years. It's easy to understand why. A rating simplifies things and makes comparisons possible. And since all filters are tested to the same standard, the comparison should, in theory, hold up.

However, while lab testing is an accepted way to measure and compare filters, is it truly the best standard of filtration efficiency? After all, gas turbines don't run in labs. They run in harsh conditions, from severe heat and dust storms, through smog filled skies to icy arctic conditions. To that effect, one must actually evaluate a filter's true performance.

FACTORS FOR FILTER SELECTION

It's time to also consider the evaluation of other factors when selecting a filter for an air inlet system. Filtration efficiencies measure how much of a specific dust and other particles a filter removes during a specified test, and is designed to give an estimate of filter life and effectiveness. But that devalues the impact that other factors of the filter play on the performance of your plant.

In addition, it's now possible to demonstrate that other factors play just as much a role in compressor health and filter effectiveness as the efficiency of the filter does.

Here's a short checklist of things to consider:

Size of inlet house – How much air and moisture passes through?

Depending on how large the inlet is, user may need to look at how the airflow can be treated along with what they are selecting.

Metals or plastics used for filter casings – Is there a benefit from stainless steel vs. galvanized? Do certain types of plastics hold up better?

Metals can be affected by corrosion from surrounding site conditions that can affect filter performance. Stainless steel provides a benefit in corrosive and coastal environments because the metal housing won't degrade as quickly. If a filter has plastic housing, the selection there is also important. Some plastics will become brittle and crack over time and some can creep, which morphs the shape of the frame.

Filter construction – What is the general quality and robustness of the final assembly?

Construction is also an important factor to consider. Self-cleaning filters typically have a spiral bead of glue that bonds the inner and outer mesh to the filter media. If this glue is improperly applied, it runs the risk of detaching from the filter and being ingested into the clean air path of

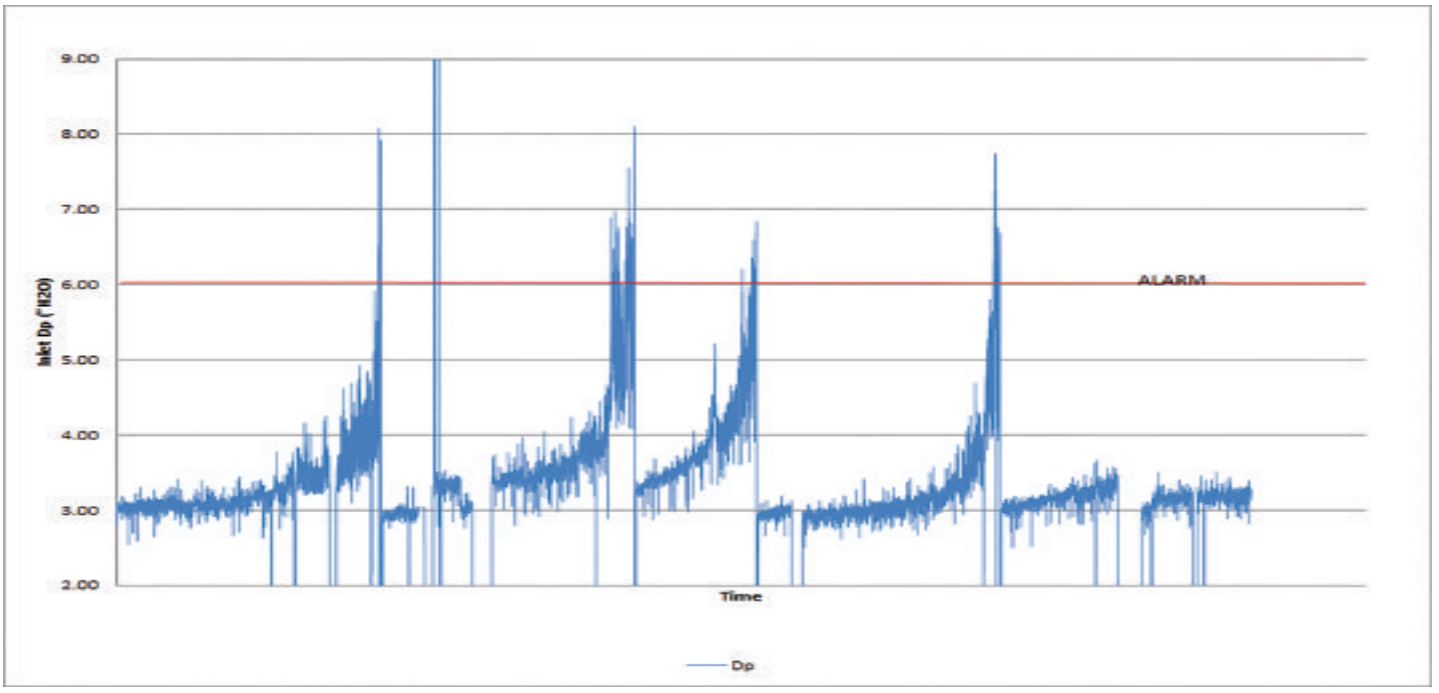

Fig. 2: The rapid dP spikes from EPA filters can trip turbine alarms and lead to unplanned outages. This side effect wouldn't be known by evaluating on filtration efficiency alone.

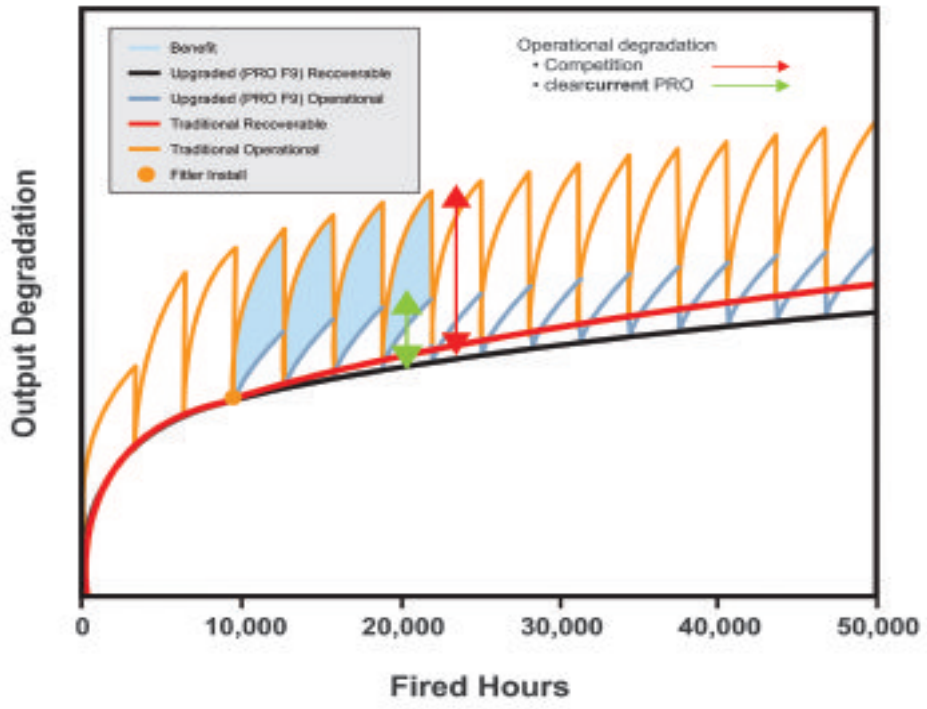

Fig. 3: The shaded blue areas indicate performance improvement by upgrading from one F9-rated filter to another, showing that all similarly rated filters are not equal in performance.

the gas turbine. No matter what efficiency rating a filter has, if there is poor sealing either of the media within the frame of the filter, or of the filter frame to the filter house, it won't function as advertised.

Media selection – Just because a filter achieves a higher rating doesn't make it effective for all environments. As with tires on a car, certain types are made for certain conditions.

It's important to understand what the filter is made of. Some filters are tested only when dry. Burst strength when wet isn't disclosed, meaning the media may not hold up as well. Glass fiber media requires a chemical binder to keep it together. Some filters use water-soluble binders, which break up over time when wet and cause filter failure. Again, the filter rating won't tell any of this critical information that is crucial to maintaining a healthy compressor.

This is just a small checklist. And it merely demonstrates that the amount of dust a filter can remove is only one part of a larger parcel of things to consider when selecting filters. And it doesn't even contain some of the most important factors to consider: plant performance.

Compressor degradation, plant output, heat rate, differential pressure (dP): all key performance indicators for a power plant, and all factors that should be at the forefront when evaluating filters. What one gets on paper is not necessarily what one gets in the real world. A filter's true rating is what one get when evaluating plant performance vs. filter selection.

These are the factors that are important. And these are the factors that make up compressor health.

IMPORTANCE OF COMPRESSOR HEALTH

While traditional filtration efficiencies still have their place when evaluating filters, it is becoming increasingly clear that operators should be focusing on what the filter is actually designed to do – protect the compressor. Compressor health starts with the inlet system.

In a recent experiment, CLARCOR Industrial Air analyzed more than 50 sites globally to determine what factors play a role in compressor health. Using CLARCOR Industrial Air's unique position as a gas turbine filter supplier who also was part of a major gas turbine OEM, the company was able to not only monitor performance, but also gain access to a wide variety of compressors.

Engineers analyzed and scraped compressor blades, categorized contaminants that stuck to blades, and examined those filters and factors that led to compromised compressor health. The study consisted of F8-rated filters, F9-rated filters and EPA (HEPA) filters ranging from E10-E12.

The results were quite interesting, and, if one is focusing on compressor health, very eye-opening. The EPA (HEPA) filters helped maintain the long-term health of the compressor blades by providing a clean blade almost every time. However, if focus is on performance factors, the EPA (HEPA) filters suffered many issues. EPA (HEPA) filters suffered from increased operational degradation, higher dP spikes and a very unpredictable end of life that led to unplanned outages and filter switch outs.

And as mentioned above, the experiment also showed there are many differences just going from one F9-rated filter to another. On paper, both filters are rated the same. But if focus is on MW performance, heat rate and dP, as shown in figure 3, it's quite clear that one filter provides a significant improvement over the other. And this wouldn't have been known if the filter evaluation was made solely on efficiency.

CONCLUSION

Filter evaluation has evolved in recent years and operators can now see how filters directly affect compressor health and plant performance. Traditional filter evaluation methods maintain their place in a checklist of factors for inlet filter selection, but no longer should a filter purchase be based solely on filtration efficiency.

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