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Do your homework before ordering replacement inlet air filters

"Ask four powerplant O&M managers how they determine when to replace the air filters in their gas-turbine (GT) inlet systems and the chances are good that you'll get at least two different answers," observes Jim Benson, an aftermarket filtration specialist for Donaldson Company Inc, Minneapolis (benson@mail.donaldson.com, 952-887-3719). Determining the optimal time to replace turbine inlet air filters is not a simple matter and can vary significantly from one plant to another.

Ideally, says Benson, who advises GT owners on filtration matters, inlet air filters should be replaced when one of the following conditions occurs:

- Filters have surpassed their usable life, as indicated by physical damage, degradation of media, corrosion of metal components, etc.
- The annualized operating cost of leaving dirty filters in service—that is, lost turbine output attributed to pressure drop—is greater than the cost of replacing the filters.

Unfortunately, it is difficult to match exactly the end of filter life with a scheduled outage that can accommodate replacement. This can result in less than optimal filter replacement cycles.

Evaluating filter condition

It's not very difficult to recognize when a filter is damaged or if there's a hole in the filter media, continues Benson. Similarly, corrosion of metal components can be easily identified, although there's no reason for concern unless this corrosion occurs on the clean side of the filter media.

It also is relatively easy to recognize when filters are "dirty," but that alone is not a good reason for replacing them. Dirty filters are good; they prove that the filtration media is

doing its job. In fact, dirty filters—unless damaged—have much higher filtration efficiency than new filters, so it's usually better not to replace them unless the pressure drop across the filters is high.

Benson notes, however, that filters—especially those in peaking operations—may show no visible signs of problems but still require replacement because the filter media has lost its physical strength. The cause: media degradation because of age and/or exposure to contaminants contained in the inlet air.

Media degradation is not something that's visible, but the possibility of it occurring should be recognized, especially in pulse-cleaned air filter systems. Therefore, O&M managers should consider having the physical properties of the media tested to confirm acceptability for continued use after two years of service—and every year thereafter. Such testing is available from most filter manufacturers either free of charge or for a nominal fee.

Optimizing filter life and turbine operation

Inlet air system maintenance and filter replacement are important for assuring turbine protection and for maximizing turbine output. Replacing filters too often can be costly and inefficient, but not replacing them when necessary can be even more costly.

Benson recommends a thorough analysis of site environmental conditions and turbine operating parameters before specifying replacement filters. He suggests soliciting recom-

mendations from filter manufacturers and evaluating and comparing ASHRAE filter test reports for candidate replacements.

The cost of replacement filters for large turbine inlet-air systems can be significant, but Benson urges that purchasing decisions not be based solely on price. While filter cost certainly is a major factor in every decision, don't forget to consider the operating penalties associated with high pressure drop and low fractional efficiency for alternative offerings before signing a purchase order.

Recall that as filters become fouled, the pressure drop across them increases. This higher delta p requires more energy to draw air into the turbine, which lowers efficiency. It also reduces the density of the air going to the turbine, decreasing turbine output.

Generally speaking, says Benson, each 1 in. H_2O of pressure drop at the inlet of a turbine will decrease its output by at least 0.25% while increasing heat rate by at least 0.10%. These may not look like significant numbers, but they are when you consider that a difference of only 0.1 in. H_2O between the average pressure drop of two filter options for a 150-MW turbine system operating at base load can be worth thousands of dollars in increased revenue and lower fuel costs over the life of the filter elements.

By recognizing the impact of pressure drop on operating costs, the O&M manager can do a quick cost/benefit analysis of alternative filter offerings and calculate the pressure drop above which continued operation with dirty filters justifies scheduling a replacement.

Finally, Benson laments that the importance of filtration efficiency to turbine performance is often all but ignored when replacement filters are purchased. Although most filters are very efficient on particles larger than 5 microns (thereby meeting the turbine manufacturer's specifications for erosion prevention), the fractional efficiencies on particles smaller than 3 microns, which impact compressor fouling, can vary significantly among filter options.

The effects of compressor fouling are not as easy to quantify as those for pressure drop, but fouling also can have a significant impact on both turbine output and heat rate. This is most apparent to plant personnel who compare turbine output and heat rate before and after off-line compressor water washes. Failure to consider the differences in initial filtration efficiency among filter options can lead to a bad purchasing decision—one that adversely impacts turbine performance.

ASHRAE 52.1-1992 test reports provide the best data for comparing pressure-drop performance among filter options, while ASHRAE 52.2-1999 test reports provide efficiency data that will allow for comparing differences in initial fractional efficiencies among filter options.

Helpful hints

There are no simple rules for determining when to replace filters in a GT inlet air system, but here are two simple guidelines to remember:

- Don't wait until there's a problem before scheduling a filter replacement. Inspect filter elements on a regular basis and monitor pressure drop across the filters. If your filters are more than two years old, have the condition of the filter media evaluated.
- For base-load units, schedule filter replacement during a planned outage of sufficient duration. This usually results in replacing filters earlier than necessary, but maintaining continuity of GT operation is far more important. By comparison, peaking units generally allow more optimal filter replacement.

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