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Heat Transfer in the Boiler: Impact on Air Pollution Control Equipment

Jon Cavote, President and Chief Operating Officer at United Dynamics Corp. (UDC), speaks with Mae Kowalke, Neundorfer's Manager of Stories, about heat transfer and boiler reliability, and how these factors impact downstream air pollution control equipment. Get more episodes and join the conversation on iTunes or at www.neundorfer.com/podcast.

Mae: So, Jon, let's start by having you give our listeners a little background on United Dynamics Corporation.

Jon: United Dynamics Corp. is a boiler inspection firm that was developed in the mid 1970s. We specialize in boiler inspections and overall power plant reliability and safety improvements. UDC also offers educational services and metallurgical engineering services—boiler tube failures and deposit weight density evaluations, and chemical analysis. We're in the business to reduce downtime and improve overall efficiency of power plants.

Mae: People who listen to this podcast spend a lot of time thinking about how to capture hazardous air pollutants. Why should they care about what happens in the boiler, and why should boiler maintenance people care about what happens with pollution capture?

Jon: There are interconnections between different areas of an overall power plant system. A lot of facilities experience a breakdown between these interconnects. For example, a common boiler maintenance issue, particularly on the waterwalls, is *fireside corrosion*. When operating under low-NOx conditions, if oxygen is at sub-stoichiometric levels (below one percent), fireside corrosion can occur. It literally chews away tube surfaces.

Fireside corrosion poses a maintenance challenge because tubes must maintain a certain thickness to withstand the hoop stress pressures from inside. Also, temperature is a concern. Coal fineness and other factors also come into play. Once fouling or slagging starts on waterwalls, plants run into a heat efficiency issue where energy is transferred from the intended locations and into the pendants and platens. On the back end with the precipitator, a lot of times the result, directly or indirectly, is opacity issues.

As our inspectors go through the boiler, we notice if there is air in-leakage, particularly on negative or balanced-draft units—holes in the penthouse floor, holes in the casing breached from the extended sidewalls, things like that. This has an impact on the overall efficiency of combustion, which can cause increased levels of CO, increased levels of slagging and fouling (depending on the ash fusion temperatures of the fuel), and can also cause opacity issues on the back end, especially if the plant is doing extensive soot-blowing.

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Historically, UDC inspectors would write up instances of air in-leakage as a Priority 2 or Priority 3 issue. Over the last few years, seeing the level of impact tramp air has caused on some of these systems, we've instructed our crews, depending on the scenario, to bump air in-leakage to Priority 1 if it can be justified.

Mae: You talked about some of the main issues on the boiler reliability side. Can you talk a bit more about that, and how those issues impact downstream equipment?

Jon: Sure. Here's how it works: by unit design, you've got x amount of energy to be absorbed in the waterwalls. There is radiant energy being exposed to the waterwall tubes themselves. Whenever slagging starts building an insulating layer on the surface of the waterwall tubes, it removes the ability for that energy to be absorbed at that location.

If the plant is burning a lower BTU or PRB fuel, not only will there be the ash or slag layer on the tube itself, but also an ash layer that's lighter in color, which deflects more radiant energy from the tube surface. The energy not absorbed by design in the waterwall circuits will naturally go downstream and there will be more energy absorption in the pendants and platens above.

Customers call us from time to time with problems maintaining reheat temperature. Even with spray flows wide open, they can’t keep superheat temperatures down below 1,005 degrees. The issue, ninety percent of the time, comes down to slagging and fouling, and the effects of not being able to absorb energy where it's designed to be absorbed.

On the other side of that, we have had a few customers with issues actually *reaching* re-heat temperature. It's a similar effect. It all comes down to the amount of slagging and ash built up on the tubes, and the thickness of the ash layer—obviously, the thicker the layer, more insulating factor it's going to be. That goes all the way back to the ash fusion temperatures of the fuel and oxygen levels during combustion.

When we talk about downstream equipment, it absolutely has an effect. In the event there is slagging and fouling on superheats and reheat pendants up above, we've seen situations where utilities have opacity issues such that they have to monitor their soot blowing practices; if they don't, it causes problems on the back end in the precipitators and baghouses.

Mae: Is there a takeaway you'd like people to think about in relation to how different systems relate to one another?

Jon: I would look at minimizing opacity, minimizing air in-leakage/tramp air, trying to improve the efficiency and effectiveness of low NOx equipment (burners, SCRs, SNCRs) and doing everything possible to clean up on the back end using scrubbing systems and what not.

At the end of the day, everybody operates. But, very few utilities actually operate as efficiently and reliably as they possibly can. When it comes right down to it, minimizing the damage or negative effect on back-end equipment has a lot to do with what we're finding on inspections as far as air in-leakage. It has an extremely large amount to do with what's happening in combustion on the front side: coal fineness and fuel type—not just what that is, but also what it is in comparison to what the unit was designed to burn and its BTU release rating.

It's just a matter of putting it all together and not isolating yourself to your one specific profession. It's a good thing to open up your mind a little bit and be concerned with what's happening on the front end.

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