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The Cost Impact of Poor Airheater Performance

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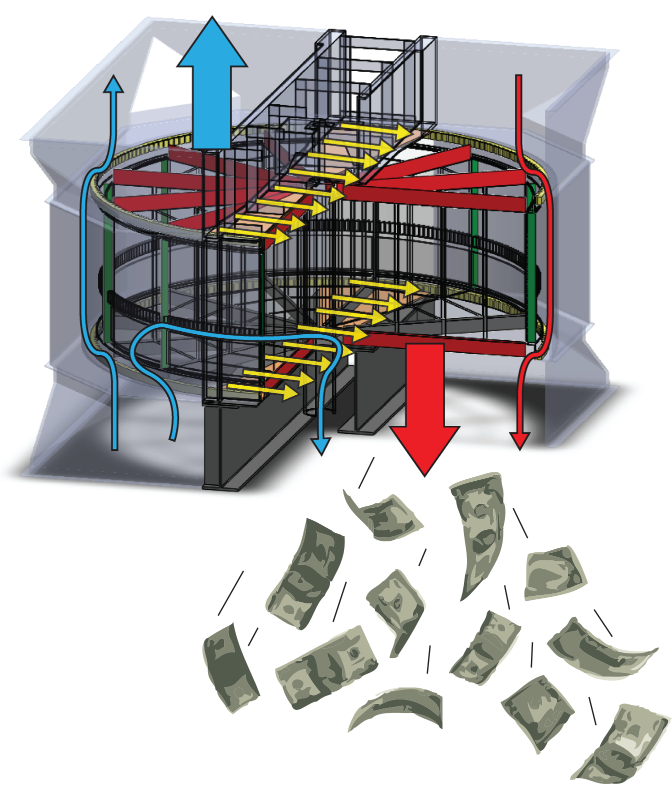
Many plants are complacent with their air heater leakage. It is common knowledge that air heater leakage is detrimental to performance, but the extent and severity as well as the impact on the bottom line are often overlooked. When you begin to look at the complete picture, the more important maintaining minimal air heater leakage becomes.

Leakage through a regenerative Ljungstrom style air heater occurs in several ways. With all of the moving parts, there are plenty of ways for air to go where it is not supposed to go. Air can escape through the radial seals on both the cold and hot side of the rotor. It can also bypass the rotor completely and go into the furnace unheated. Similarly the gas can bypass the rotor and go into the backend equipment uncooled. While less common, Rothemuhle air heaters have similar leakage paths. In addition, air is carried into the gas stream by the baskets directly. Basket cleanliness plays a role in air heater leakage. As the baskets become plugged, the basket differential increases. The gas will then take the path of least resistance and will increasingly pass around the basket instead of through it. In addition, since the fans have to pull harder on the gas to get it to pass through the air heater, the air on the other side of the seals is pulled harder as well. Therefore, it is important to make sure the air heater soot blowers are working properly and as often as required. All seals should be set to the proper clearance to minimize the amount of air in-leakage and gas bypass.



Tubular air heaters are often assumed to have zero leakage because of the design. However, as small holes begin to develop, they rapidly increase in size. Design leakage on a tubular air heater is 0%, but 7-8% is not uncommon. Therefore regardless of type, air heater leakage is a problem shared by all three. Tubes need to be plugged as they develop holes. However, if too many tubes are plugged, the differential across the air heater begins to increase. This will exacerbate the leakage through the remaining tubes. If this is the case, there are few options to correcting the leakage beyond re-tubing the affected circuits. This high maintenance cost is one of the reasons regenerative air heaters are more common than recuperative tubular style air heaters.

Air leakage negatively impacts flow rate and temperature. The air leaking into the gas flow adds to the flow going through the air heater and subsequent downstream equipment. In addition, the air temperature is lower than that of the gas stream and thus reduces the gas temperature. Sometimes poor air heater performance goes unnoticed because the gas outlet temperatures are so low; the thinking is "Because the gas outlet temperatures are low, my air heater must be working well." However, if you were to evaluate the air heater performance on the true gas outlet temperature, the temperature of the gas without any diluting air, then the performance would not look quite as impressive. Since the gas is heating air that never reaches the furnace, this heat is more or less thrown away. In this respect, air heater leakage is a net heat rate penalty.

Perhaps the biggest impact poor air heater leakage has is not on the air heater itself, but on the FD and ID fans. As the air in-leakage increases, the FD and ID fans have to work harder to maintain the desired drafts and flows into and out of the furnace. Not only do the fans have to push/pull more flow, but even more costly, they have to operate at a pressure higher than design. In the summer months when the ambient air has a greater volume, it is possible that the fans can no longer keep up with the increased demands placed on the system. If the unit cannot make full load during the hours when the price of energy is at its greatest, the financial impact of air heater leakage is quite large.

As important as air heater leakage is, it is rarely measured properly. If oxygen probes are present at the air heater gas inlet and outlet then the leakage can be calculated. However, just a few probes do not get a good quality representation of the entire duct. A proper test grid with test points distributed evenly across the duct is required to capture the stratifications in the flue gas. A proper test grid can sometimes even help determine the source of the leakage. Typically higher oxygen concentrations are found closer to the sector plates on a Ljungstrom-style air heater. Depending on where the test grid is, it could also help determine which tube circuits are leaking on a tubular air heater. For highly stratified flows, a weighted average should be used based on a gas velocity. Leakage testing does have its limitations. It cannot measure air or gas bypass around the baskets. Therefore, true leakage is higher than “air in-leakage.”

When evaluating air heater leakage it is important to look at the other performance factors as well. These include air and gas side efficiency, x-ratio, and total thermal efficiency. A thermal efficiency of an air heater is required to fully understand the true performance of an air heater. However, the testing required for that is even more demanding than a PTC test. Multipoint probes can dramatically decrease the testing time and personnel required for a PTC or thermal style test. Weekly monitoring is a good diagnostic tool and with the right equipment, not a huge time investment.

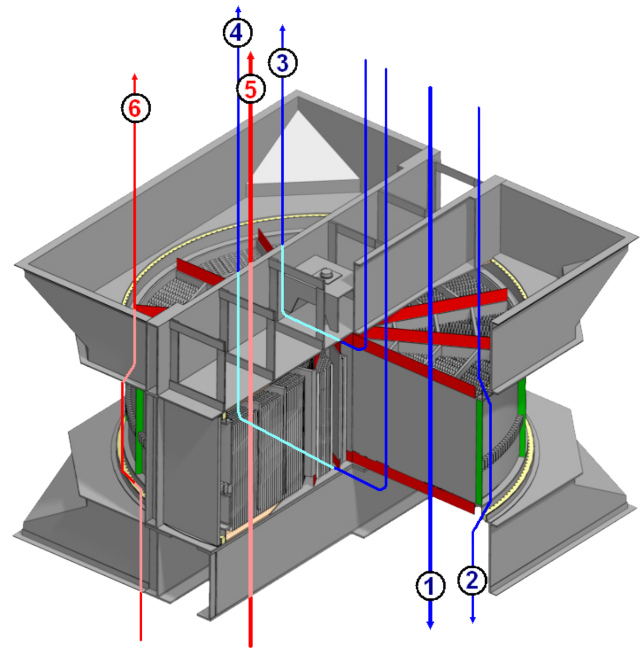
Air in-leakage also effects downstream equipment like scrubbers, precipitators, and baghouses. ESPs are particularly sensitive to temperatures and velocities. Air in-leakage negatively affects both. The higher velocity will also increase the erosion rates due to flyash.

Leakage testing only identifies problem areas. However, knowing where to concentrate your work during the next outage will make your time and money more productive. Expansion joints, casing, and air heater seals are common places for air in-leakage. Storm Technologies has extensive experience in measuring air heater leakage and helping customers understand the impact it has on both performance and heat rate.

A more detailed illustration of the Air Heater leakage paths on a Ljungstrom style air heater is illustrated as follows:

Consequences of each flow path (leakage):

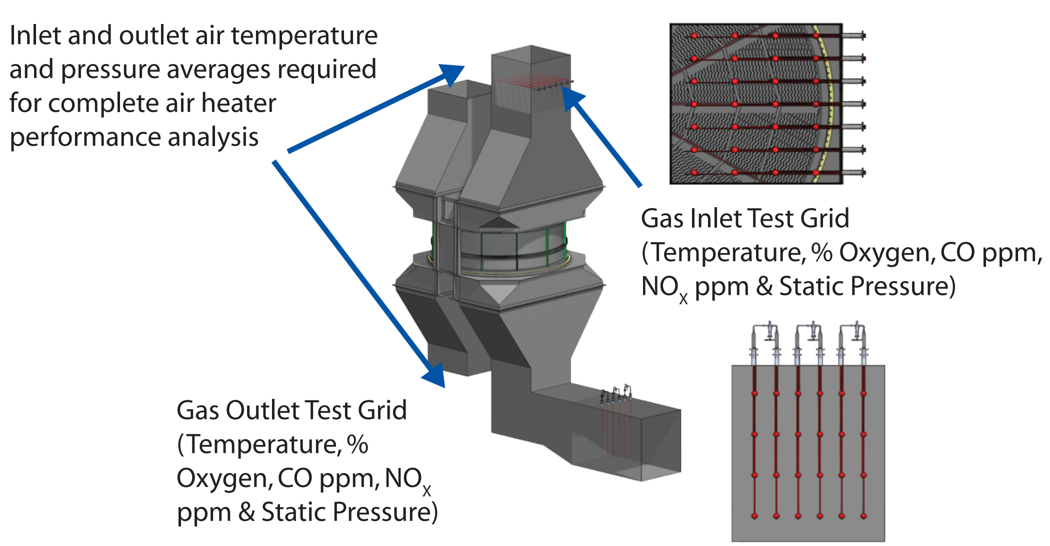
1. No penalty with intended flow path
2. This air never gets heated and thus lowers the air heater outlet temperature lowering heat rate
3. This air is waste volume. It makes the FD fan and the ID fan work harder increasing auxiliary horsepower.



4. The most damaging leakage because it steals heat from the gas and increases the workload on the FD and ID fans: a heat penalty and an auxiliary horsepower penalty
5. No penalty with intended flow path
6. This heat is wasted and directly increases the dry gas loss which is a heat rate / boiler efficiency penalty

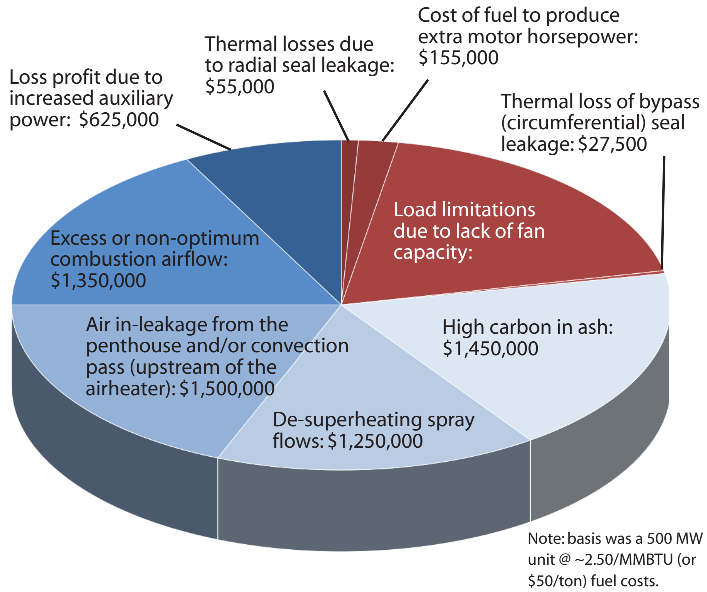
In our experience, utilization of high performance seals and/or incorporating a performance testing program as part of an airheater overhaul and/or refurbishment is necessary to evaluate the design parameters and/or challenges upfront that can be evaluated prior to installation of new design baskets and/or high performance seals. Performance factors typically measured in a complete air heater test by Storm Technologies include:

1. Air In-Leakage
2. Corrected Gas Outlet Temperature
3. X-Ratio
4. Gas Side Efficiency



In addition to test factors, we also recommend comprehensive diagnostic testing programs be implemented as well to evaluate the firing system, total system efficiency, air in-leakage and/or plant heat rate opportunities. Typical, average cost impacts, based on a median average of utility plant performance opportunities with air heater and the inter-related stealth losses related to non-optimum airflow management and/or air in-leakage upstream of the APH are illustrated in the chart to the right.

Storm Technologies primary focus is to provide cost effective and value added solutions to its customers in the power generating industry. Storm's engineering services include combustion and boiler performance improvements, heat rate programs, pulverizer optimization programs, specialized testing programs and airflow measurement, control and improvement. Storm fabricates its products in house and is accredited by American Society of Mechanical Engineers (ASME) and National Board in accordance with the applicable rules of the National Board and ASME Boiler and Pressure Vessel Code.



Measurable losses associated with air heaters (Total): **$1,737,500 (Red)**

Measurable losses related to boiler air in-leakage and/or poor combustion airflow management (Total): **$6,175,000 (Blue)**

Paragon Airheater Technologies specializes in the manufacturing of high-performance seals, basketed elements, and replacement parts for rotary, regenerative airheaters. Paragon provides trained technical personnel to perform routine inspection services, condition assessments, outage planning, diagnostic services or emergency maintenance and repair. Paragon's exclusive and patented design for both radial/axial and circumferential/ bypass seals are specifically designed to provide maximum efficiency while withstanding the harsh operating conditions normally encountered in the air heater.

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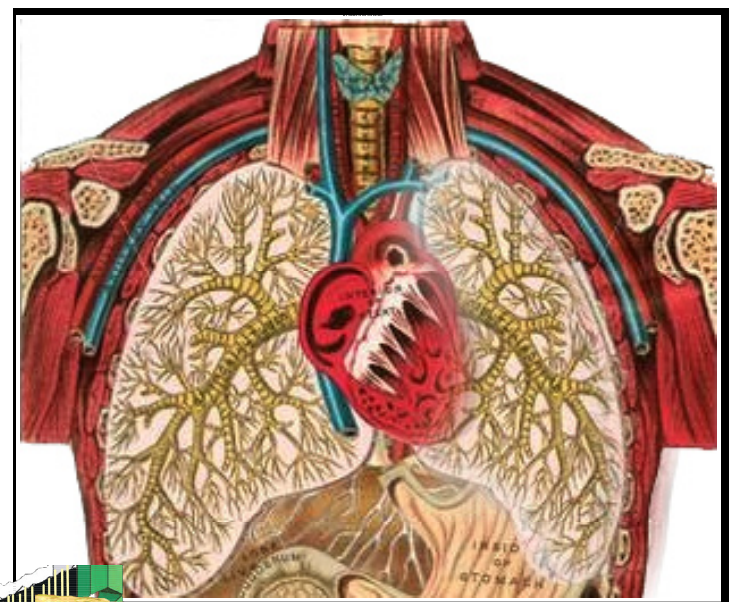

With that said, we ask the question, "Have you had your Pulmonary fit test?" Contact Storm Technologies today if you are interested in learning more about optimizing combustion and/or airheater performance.

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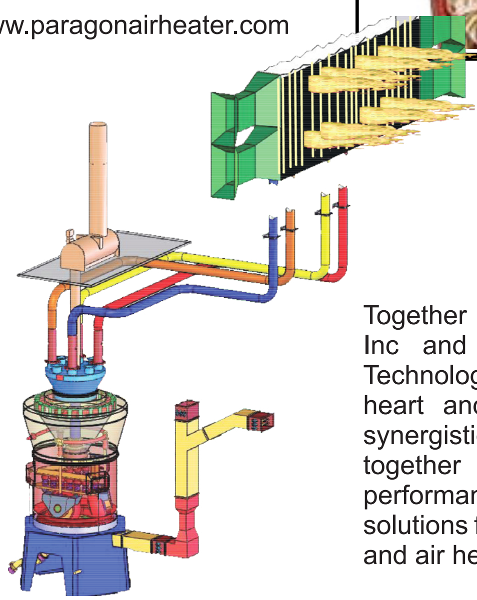
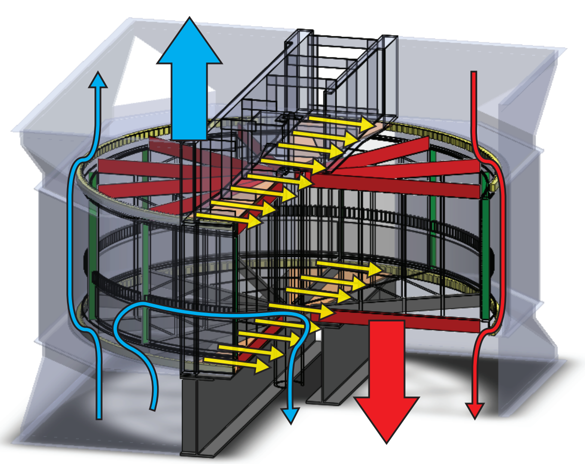


"The Heart"

Together Storm Technologies, Inc and Paragon Air Heater Technologies represent the heart and breathing power of synergistic solutions working together by offering high performance equipment and solutions for combustion systems and air heaters.



"The Lungs"