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Bypass losses squander big bucks

Many fossil plant engineers are unaware of the extent of their air heater performance problems or the revenues Lost by failing to eliminate excessive gas bypass. Air heater Leakage of 20% is not uncommon, and in some extreme cases a level of 40% has been measured. The impact on plant operations of air heater Leakage is often grossly underestimated. It adversely affects the performance of the boiler and pollution control equipment, increases plant heat rate, and can constrain plant output during peak Loads. These effects increase maintenance and fuel costs, put the plant owner at risk of paying noncompliance fees, and reduce revenue from power sales.

The biggest adverse impact of air heater Leakage is on boiler fans. Fan motors are one of the largest electricity users in the plant, and air heater seal Leakage can account for as much as 25% of total fan horsepower. Any plant engineer would jump at the chance to reduce fan power consumption by 25%. Surprisingly, that can be accomplished simply and inexpensively, by installing new air heater seals.

Seal the deal

Regenerative air heaters capture the heat in boiler exhaust gases by passing those gases through heat-absorblng metallic elements. The elements slowly rotate and alternately contact the hot gases and the cool inlet air from boiler fans. The captured waste heat is released into the inlet air, preheating it just before it enters the boiler (Figure 2).

Sealing these types of heaters is extremely difficult due to their Large diameter (up to 60 feet) and the Large temperature difference between the hot and cold sides (about 400F), which produces dynamic thermal distortion of the rotor. The outer edge of a Large hot air heater typically distorts by 2 inches or more (compared with the cold condition), providing a large gap through which plenty of air can escape.

Figure 2 shows common Leakage paths for typical air heaters. Paths A and B illustrated radial leakage between the sector plates and the basketed element on the cold and hot sides, respectively. Radial Leakage raises required boiler fan horsepower because it does not contribute to combustion, yet it still must be moved. Paths C and D show circumferential leakage, in which air Leaks past the outside of the rotor and thus either fails to be preheated (path C) or fails to transfer its heat to the air heater (path D). Circumferential Leakage does not increase fan horsepower because it still makes its way to the boiler. However, circumferential Leakage does adversely impact heat transfer and boiler heat rate.

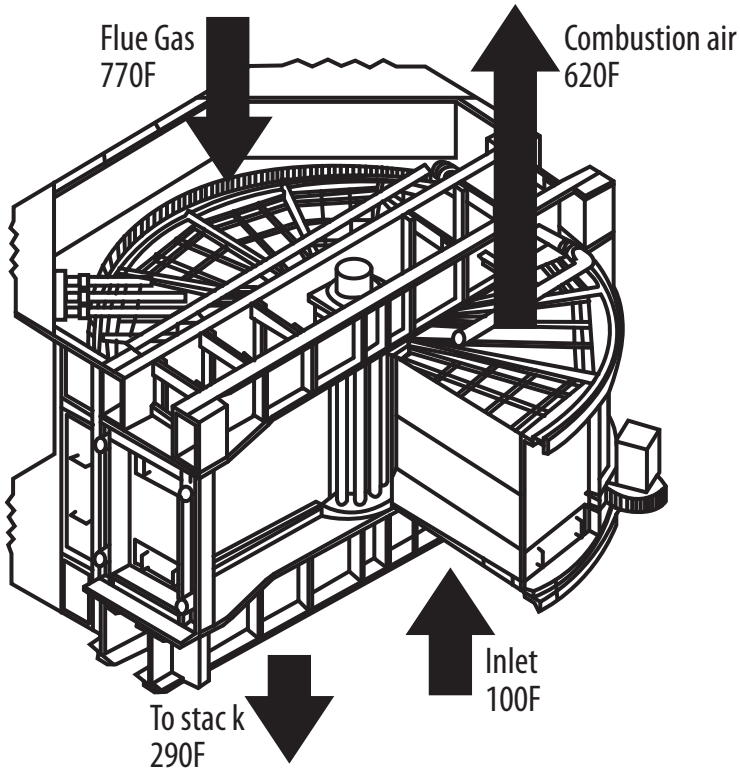
Quantify the losses

The amount by which radial Leakage (paths A and B) can be reduced is directly temperature to avoided fan horsepower and, hence, reduced electricity consumption. Because fans primarily move a volume of air, the horsepower/volume relationship for the boiler fan is relevant. temperature the slope of this fan curve is typically about 1.0 at the fan's design operating point, the slope can easily increase to 2.5 or more as the fan's operating point approaches maximum volume. This means that for every I% reduction in radial air Leakage, 1% Less air must be moved by the boiler's forced-draft or induced-draft fans. This, in turn, translates into a I% to 2.5% reduction in required fan horsepower (Figure 3).

A real-world example illustrates the magnitude of electricity (and cost) savings possible. It assumes the following:

- Initial radial Leakage rate: 16% of airflow.
- Radial Leakage rate after installation of more-effective air heater seals: 9%.
- Net reduction of radial seal leakage: 7%
- Plant out put: 500 MW
- Plant heat rate : 10,500 Btu/kWh (net)
- Total installed fan hp: 16,000 hp.
- Fuel cost (coal): $2/mmBtu

1. Around the edges. Typical temperature in a regenerative air heater.
Source: Paragon Airheater Technologies



Assuming a fan curve slope of 1.5, a 7% reduction in air volume translates into a fan horsepower reduction of :1,680 hp, or :1,253 kW. At the assumed heat rate of :10,500 Btu/kWh, the reduction in air leakage would produce a fuel savings of :13.2 mmBtu/hr. At the assumed fuel cost of $2/mmBtu, the fuel cost savings would be $26.40/hr. If its capacity factor were 75%, a plant would reduce its annual fuel bill by $:173,500. In other words, $:173,500 Less fuel would be needed to power the fans simply by reducing radial leakage in the air heater.

Capacity enhancement

The previous example describes only one type of benefit of reducing air heater Leakage. The North American ELectric ReLiabiLity Eouncil (HERE) and others continue to project generating capacity shortfaLLs in some parts of North America. Each capacity shortfaLL increases the value of incremental generating capacity during peak periods, such as on hot summer days.

However, many fossiL-fired power plants are capacity-constrained during these periods. The reason is that air expands and becomes Less dense in warm weather. As a result, fans must move a greater volume of air in warm weather to provide the same amount of air mass as in cooler weather. Lack of fan capacity is the reason why many generating units are capacity-Limited during warm weather. This problem becomes more evident when plants add or upgrade poLlution control equipment such as a selective cataLytic reduction system, eLectrostatic precipitator, and/or baghouse, each of which increases loads on the fans.

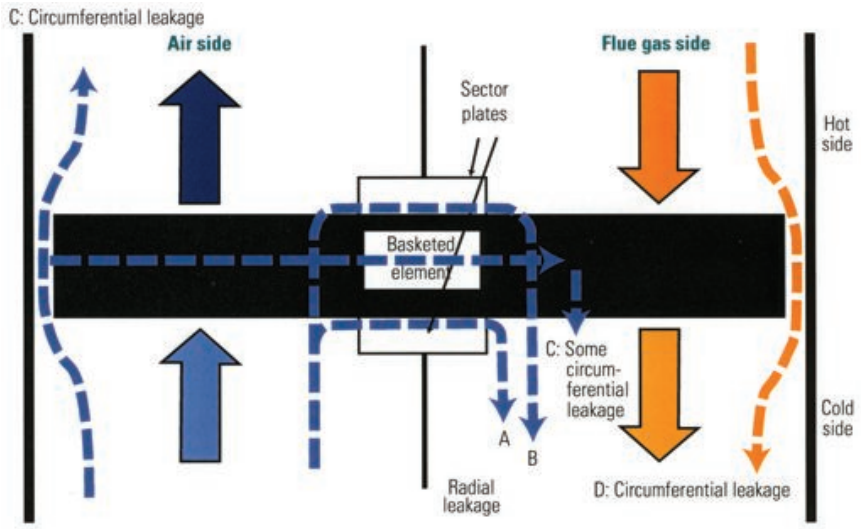
Because the price of power tracks demand, revenue forfeited from Lost or reduced power sales due to fan capacity limitations can be significant. In some cases, when power producers sell power on the spot market, the power sold during peak periods over two months of the year can represent a Large percentage of total annual revenue. If a power producer is committed to a fixed contract and is unable to generate promised fulfill its contractuaL obligation.

In many cases, hot weather capacity Losses can be eliminated by reducing air heater Leakage. Assuming 250 hours per year of fan [imitations, an average toad reduction of :10 MW, and a sate price for power during the [imitation of $250/MWh, the potential revenue Loss is $625,000 per year.

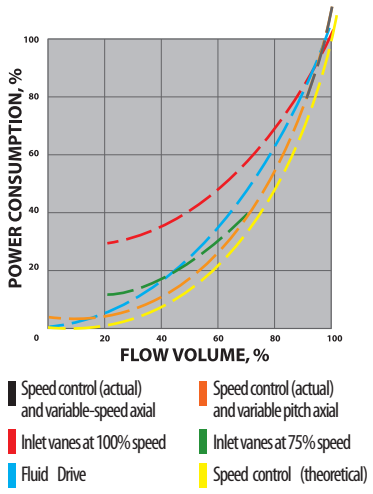
Despite these adverse effects and Lost opportunities, most power producers continue to use air heater seal technoLogy that has not appreciably changed for decades. Traditional air heater seaLs are tittle more than strips of thin-gauge steel which cannot sea[tightly and are offen blown open or damaged by high differential pressures. In contrast, today's high-performance air heater seaLs have proven capable of reducing air heater Leakage by 50% or more, compared with standard seals.

Some newer seals use a be[tows to produce a spring force that keeps the seal in contact with its mating surface (the sector plate) over a wide range of differential pressures and rotor turndowns. Others, catted interlocking circumferentia[seats, are used on the perimeter of the air heater's rotor. They reduce bypass Leakage, and their structure is designed to resist the type of damage suffered by standard seats during rotor turndown.

2. Down the drain. The sum of radial and circumferential leakage in air heaters typically exceeds 25%. Radial leakage can reach up to 350 feet/second. Source: Paragon Airheater Technologies



2. Power hog.
Power consumption of different classes of power plant fans as a percentage of air flow. *Source: Paragon Airheater Technologies*



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