Ekström & Son
since 1896

Low-Fouling, High Temperature Air Preheaters for the Carbon Black Industry

White Paper By:
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Summary:
Fouling of tubular heat exchangers means that particles clog up the tubes and compromise the functionality. Sticky high-grade Carbon Blacks are especially prone to clog. Fouling reduces productivity, offsets the quality of the product, creates mechanical strain, and risk of corrosion on the tubes of the heat exchanger. Ekström & Son's experience is built on supplying air preheaters to most leading carbon black manufacturers worldwide since 1993. Ekström air preheaters come in 800ºC and 900ºC versions addressing economic preheating for the carbon black industry.

Introduction:

The combustion air preheater [APH] is key equipment for economical operation of a modern carbon black plant. Air preheating up to 900ºC and above is today obtained, giving substantial cost savings due to the recovery of heat in the carbon black reactor flue gas. It is essential with a reliable and robust design of the air preheater. Ekström & Son has addressed the different challenges by adopting new materials of construction and by innovative design.

Figure 1: Assembly of air preheater in the Ekstrom workshop, south Sweden

High-grade blacks offer market growth, but with fouling and production challenges

High-grade carbon blacks (larger particle size) offer the greatest market growth potential, but from a much smaller base, and provide the highest pricing per kilogram of all carbon blacks (CEH, 2008). Higher grade blacks also offer producers some protection from the cyclicality of the rubber and automotive industries. Demand for specialty blacks is primarily concentrated in the plastics, ink and paint industries; use as conductive fillers for batteries is also a growth market in Asia. However, the larger particle size makes these blacks prone to stickiness and therefore fouling. It thereby increase the need for mechanical cleaning, demanding more production stops. The end result is increasing production costs when using standard air preheating.

Ekström 800ºC APH – Double Shell Design

For those manufacturers preferring lower preheat temperature Ekström & Son's double shell 800ºC APH builds on proven technology from other process industries and reduces the tendency to fouling. For many carbon black producers the preferred preheat temperature is still 800ºC, especially in demanding operation environments with regular power cuts or other challenges. There were two reasons behind the development of the second generation air preheater in the mid-1990s: Firstly, to bring down the metal temperature in the hot parts of the shell to levels that would allow the use of thinner shell sections and at the same time eliminate the risk of mechanical instability of the shell. Secondly, attempts at innovative design that would decrease the amount of fouling when producing high grade (sticky) and larger carbon black particles with a higher tendency to clog up the tubes.

Double shell APH:s are well known from other industrial heat recovery applications and are frequently used e.g. in the glass industry. By combining the double shell with the first generation tube bundle, an innovative solution has been used that proved to meet the two design requirements. The design has the following specific characteristics: A jacket is built around the bundle through which the main air stream is forced. In this way the outer load-carrying shell is cooled efficiently, thus improving its strength considerably. At the same time the air stream is lifted to about 300ºC before it touches the heat exchanger tubes. This reduces considerably the temperature differential between the tube and gas, and is held uniformly at around 100ºC along the whole tube length. The beneficial effect on fouling has been proven on multiple industrial installations.

Below, the graph shows the temperature differential between CB gas and heat exchanger tube wall for a conventional single shell design and Ekström & Son's double shell design. The benefit of the reduced temperature differential for the latter is a reduced tendency to fouling.

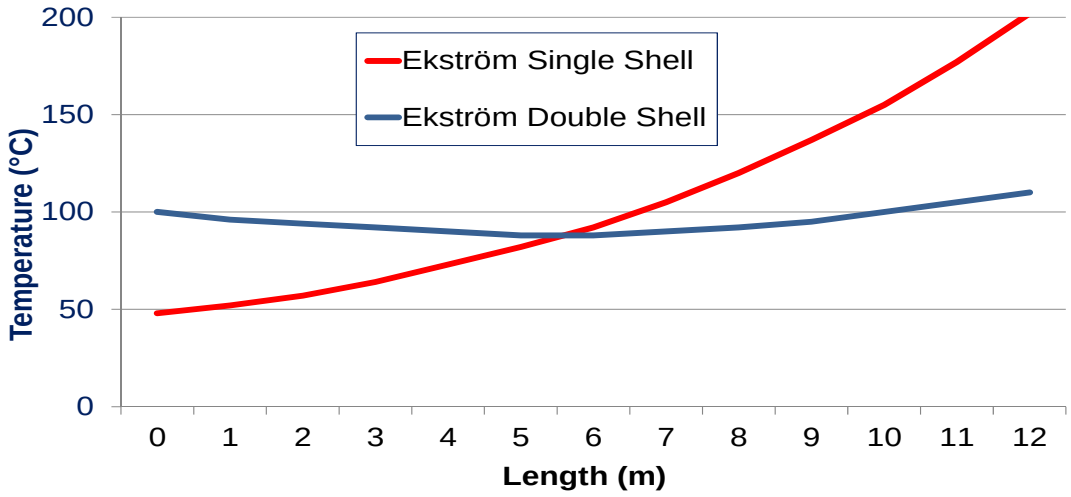

Figure 2: Temperature difference between tube and carbon black gas at 800ºC

Ekström 900ºC APH – Single Shell Design

Ekström & Son's 900ºC APH answers to the industry's demand for high combustion temperatures for economical operation. Procurement managers are increasingly considering short-term savings when investing in new equipment against long-term savings from reliable operation with low fouling and longer lifetime, decreasing the need for costly maintenance. The latter choice dominates among leading manufacturers.

Fouling of heat exchangers is a phenomenon that has a series of negative impacts on the operation. Thus, it reduces productivity, it offsets the quality of the product and it induces increased mechanical strain and risk of corrosion of heat exchanger tubes. The general experience by carbon black producers is that fouling starts predominantly at the top of the heat exchanger. This is where the cold air enters, and the temperature differential between CB gas and tube is the highest. A benefit, apart from higher fuel economy, for 900ºC usage seems to be less fouling compared to lower preheat temperatures. The Ekström patented design has an extended fire tube surface enabling the same height on our 800 and 900 degree models, simplifying for customers who install into existing support structures. However, installing a new 900ºC air preheater also means that connecting equipment needs to be upgraded, adding to the initial investment compared to standard 800ºC or 650ºC preheating.

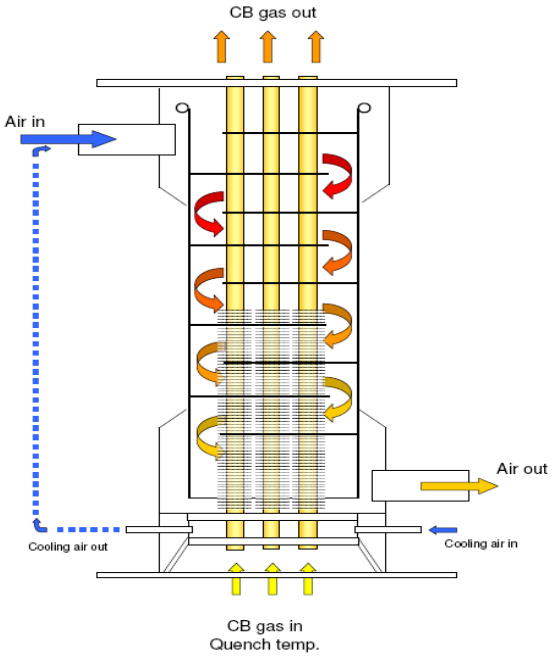

Figure 2: Ekström Single Shell 900ºC Carbon Black Air Preheater

Ekström & Son, a supplier to the process industry since 1896 has delivered air preheaters for the Carbon Black industry since 1993. We are committed to continuously developing new solutions for our customers. Please do not hesitate to contact us for questions or to set up a meeting!

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