

Meltshop Baghouse Fan Blade Upgrade Project

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Nucor Steel–Texas (NS-TX) replaced its meltshop baghouse fan blades with higher-efficiency, backward-inclined blades in March 2012, and resulted in significant operating cost savings, along with increased flow, decreased fan wear, minimal housing modifications, reduced power consumption and less maintenance.

Operational Overview

The meltshop and baghouse at NS-TX was designed, constructed and installed between 2002 and 2004. The meltshop was designed for a single 100-ton, AC power and eccentric bottom tap (EBT) electric arc furnace (EAF) with a twin ladle metallurgical station (LMS). The LMS contains a single set of rotating electrodes with dual stirring and alloy handling capability. Originally, the meltshop was installed with a 4-strand billet caster, but was designed to house a fifth strand, which was installed several years later. The exhaust system from the meltshop consists of a direct shell evacuation from the EAF, a canopy hood from the EAF building, ductwork from each LMS station hood and a small canopy hood for the caster. This

exhaust system flows through one positive-pressure, reverse-air-style baghouse. The design airflow of the baghouse is 1.6 million actual cubic feet/minute (acfm). Figure 1 shows the arrangement of the fans and baghouse.

The Original Fans

The baghouse was built with five forward-curved, radial-tipped centrifugal main air fans rated at 330,000 acfm and connected with 1,750-hp motors. It was designed with four operating fans and one in-line spare. There are two LMS fans connected with 1,250-hp motors. Additionally, a reverse air fan connected with a 500-hp motor provides negative pressure to clean the baghouse bags. The baghouse is a positive-pressure, reverse-air-style baghouse. The air flowrates are controlled by dampers at the inlet of each fan. To maintain minimum air flow, these dampers were set between 95% and 98% of the motors' full load amperes (FLA). Due to their design, the fans were prone to dust impact at steep angles, causing erosion of the blades. Figure 2 shows the original fan blades, and Figure 3 shows the

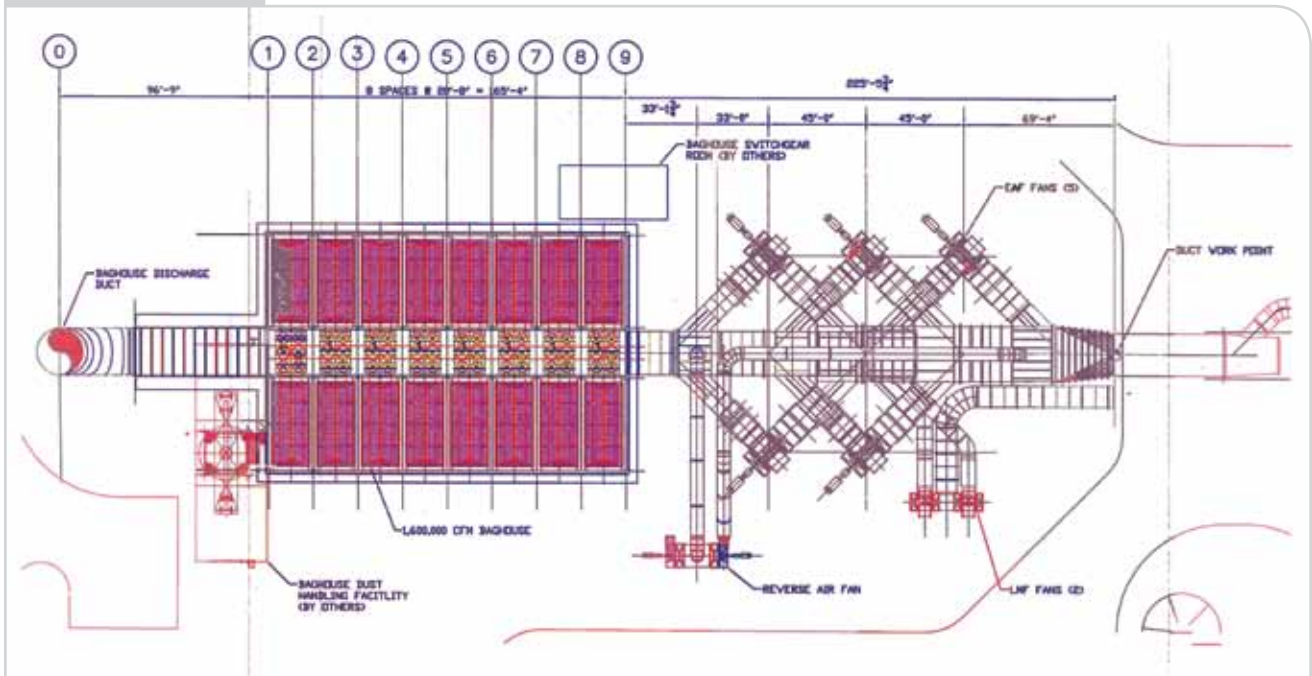
Nucor Steel–Texas completed a meltshop baghouse fan blade project using Airstream's backward-inclined, high-efficiency fan blades. The new fan blades were installed and operational in late March 2012. The fan blade replacement resulted in significant operating cost savings, along with increased flow, decreased fan wear, minimal housing modifications, reduced power consumption and less maintenance.

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Figure 1



Baghouse arrangement — plan view.

Figure 2



Original forward-curved, radial-tipped fans.

original fan curve and testing conditions conducted on fan blades in November 2011.

The Project

Nucor Steel-Texas was faced with the decision of either conducting major fan blade maintenance and repair or performing a complete fan blade replacement. NS-TX conducted a benchmarking trip prior to implementing the project and visited Nucor

Steel-Kankakee, where a newer design of AirStream fan blades was installed. A number of meetings, discussions, testing, emails and phone conversations took place over a two-year period with two fan blade manufacturers prior to choosing the manufacturer. Ultimately, NS-TX chose to replace the existing fan blades with highly efficient, backward-inclined blades. NS-TX chose AirStream for a turnkey service because of its previous successful experience.

AirStream's first step was to carry out original fan performance tests to establish a project baseline. The results are summarized in Table 1 and shown on the original fan curve in Figure 3.

The next step was to conduct computer modeling. The flow of gas and dust was modeled using AirStream impellers in the original fan housings using proprietary iFlow technology. This allowed AirStream to guarantee the performance and efficiency of the upgraded fans at Nucor's site without the need for laboratory tests. Specifically, the results were:

- Using AirStream high-efficiency impellers, power use could be reduced by 2.0 MW at the tested flows.
- No modifications to the original fan housings were necessary. Only new impellers, shafts and inlet cones would be needed. The existing housings, bearings, coupling and motors would be reused.

- Wear life would be increased by a factor of three to five times. Most dust would pass through the impeller without impinging on any surfaces.

Based on the modeling results, AirStream presented NS-TX with pricing, delivery and installation timeframes. The total cost of the fan blade replacement project was just over US\$1.2 million to install four new fan blades and inlet cones in the existing fan housings. In addition, this project was eligible for an energy efficiency incentive with NS-TX's energy provider by removing energy demand from the electrical grid during peak summer hours. Upon completion of a successful performance period, the energy provider was permitted to reimburse US\$880,000. Overall, the project cost was less than US\$350,000. Based on existing operating conditions and electrical costs, this would be paid back within one year.

The New Fan Blades

Backward-inclined fans operate much more efficiently than forward-curved fans and have a more favorable characteristic power curve (Figure 4). The measure is related to a strictly industrial process, which proceeds at a constant rate throughout the year. The measure has no seasonal dependence, since each fan provides constant mass flow (scfm) year round. The backward-inclined fans also reduce fan blade erosion by minimizing dust impact at steep angles that is seen in the forward-curved fans. The fans were installed with minimal changes made to the existing fan housing and use the same motor, couplings and bearings as the original fans. The inlet dampers are now set for motor loading of 77–80% FLA. At this loading, the inlet dampers are almost fully open. Figures 5 and 6 show the backward-inclined fan blades being installed.

Conclusions

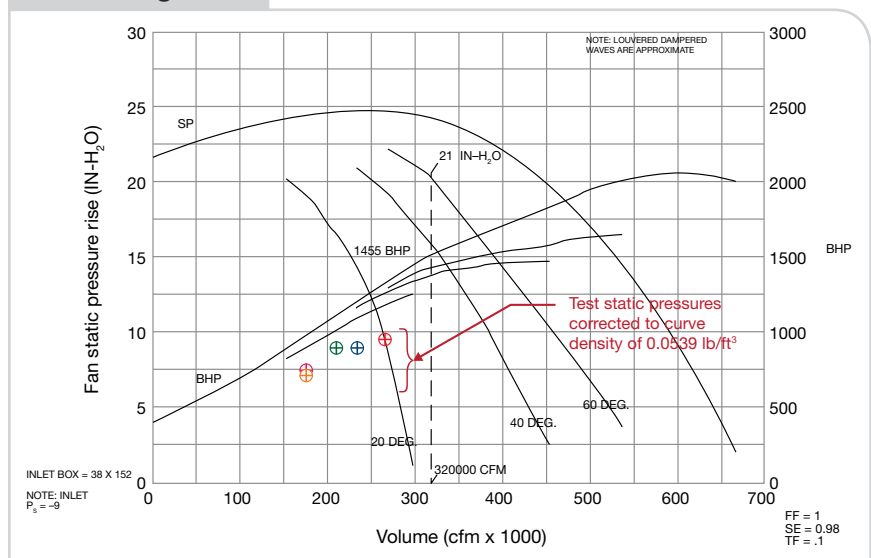
The project allowed for the operation to run only three fans rather than the original four to achieve

Table 1

AirStream Tests of Original Fans on 3 November 2011			
	Motor input power, kW	Mass flow, scfm	Fan total efficiency, %
Fan No. 1	1,344.7	291,470	44.85
Fan No. 2	1,344.7	272,000	38.32
Fan No. 3	1,340.9	282,762	41.85
Fan No. 4	1,344.7	261,860	31.14
Fan No. 5	1,310.6	241,685	31.26
Average four-fan total	5,348	1,079,820	37.48

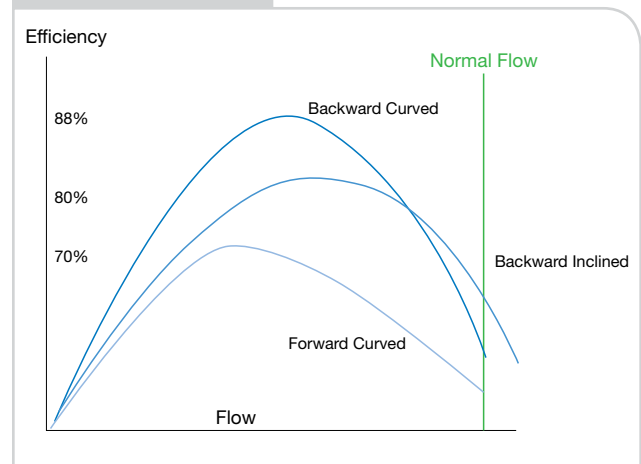
Note: Motor rating of 1,750 hp = 1,305 kW fan input = 1,373 kW motor input.

Figure 3



Original fan curve and test conditions.

Figure 4



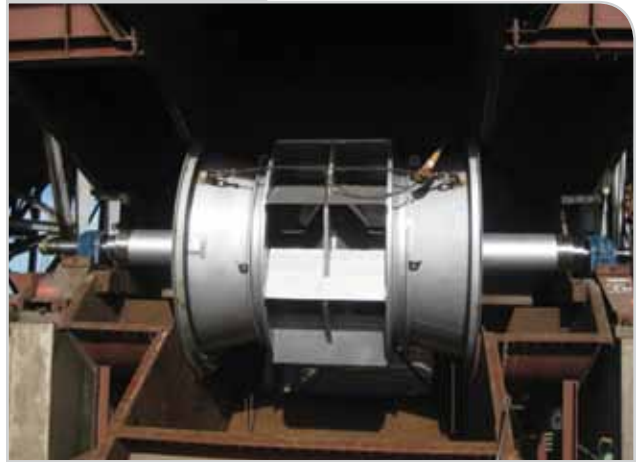
Fan blade style comparison.

Figure 5



New backward-inclined-style fan blade.

Figure 6



New blade in housing.

Table 2

Fan Data With Original and New Fan Blades

Fan blade	Running days	Total fan kW average	Total tons	kWh/ton	Average stack flow (scfm)
Original	32	5,081	2,395	49.36	1,290,409
New	34	3,217	3,461	21.66	1,359,103

the same airflow. Additionally, running three fans used less electricity per fan than when four fans were required. This is because the new fan blades increased the efficiency from just over 39% to 68% efficiency. Each fan is connected to an existing 1,750-hp motor and is designed to provide from 380,000 to 410,000 scfm. Operation of only three fan blades resulted in an energy demand savings of 2,000 kW during operation. The performance data is shown in Table 2.

The U.S. Department of Energy states that the average annual energy use for a household is approximately 14,000 kWh. This means that the operation of these new fan blades based on 8,000 hours of annual operation at 3,000 kW total demand rather than the

5,000 kW demand would save enough energy to power more than 1,100 homes for an entire year.

The project was a huge success, and NS-TX is currently working with AirStream on projects that will continue to improve the efficiency of its baghouse. The project has saved enough in electrical costs alone to pay back the US\$350,000 investment.

Acknowledgments

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