For Immediate Release

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Petroleum Industry Recognizing Importance of Damper Drive Performance to Help Meet NOx Reduction Requirements of Clean Air Act

Repeatable and accurate positioning of damper improves thermal efficiency of furnaces, helping to lower NOx emissions as much as 80% and increasing profit margin by 2-8% from fuel savings.

Because of the 1990 Amendments to the Federal Clean Air Act, petroleum refineries and other industries throughout the country are now forced to examine every aspect of their process-heating operations in order to reduce cumulative nitrogen oxides (NOx) emissions from their plants. While aging furnace burners are already rapidly being replaced with newer low NOx burners, attention is now being directed toward the furnace and heater stack damper drives.

Changing the final damper control elements to more reliable and accurate damper drives greatly improves the combustion of air and flue gases and reduces tramp air from entering furnaces. The resulting efficiency - depending on the type of low NOx burner selected and on how "tight" the furnace is for leaks – can lower emissions as much as 55-80% when used in combination with other low NOx strategies; while potentially increasing profit margins from 2-8% per furnace from fuel savings alone.

An industry-wide issue with inescapable deadlines

In 1998, the U.S. Environmental Protection Agency (EPA) refined the Act's amendments into the National Emission Standards for Hazardous Air Pollutants from Petroleum Refinery Vents (referred to as Refinery MACT II), which cover emissions from catalytic cracker, catalytic reformer and sulfur plants. These rules were promulgated in late 2000 and have now officially impacted the majority of refineries throughout the country. Some areas of the country have until 2008 to fully meet emissions targets, but the EPA has already teamed up with the U.S. Department of Justice to force multi- million dollar emission-reduction deals with major oil producers throughout the country.

At the state and local level, deadlines loom even closer. California's Rule 1109 dictates that refinery-wide emissions not exceed 0.3 pound (0.14 kilogram) of NO_x per million BTUs of heat input when operated on liquid fuel. In the San Francisco area of the state, this target must be met by July 1, 2002.

Don Nelson - a NO_x Project Engineer for ConneXsys Engineering with 30 years experience in the petroleum refining and production industry - is currently doing contract work for a major refinery near San Francisco Bay. "The consequences of these deadlines are severe," says Nelson. "You either comply or you shut the high NO_x producing furnaces down. You cannot count on deviations or variances."

Strategies for reducing emissions

Thermal NO_x results from the thermal fixation of molecular nitrogen and oxygen present in the combustion air increase rapidly at peak flame temperatures exceeding 1540°C (2800°F) and with the increasing duration of time that reactants remain within the area of peak flame.

"The more oxygen in the eye of the flame, the more NO_x you make," observes Nelson. The industry norm is to burn with a residual 3% oxygen going out the stack. More than that and you increase emissions. Plus, your burn becomes less efficient."

One of the more common methods to lower NO_x emissions is a combination of low NO_x burners (LNB) and flue gas recirculation (FGR). According to EPA technical document number 453/R-93-034 – which identifies alternative controls for NO_x emitters - FGR combined with LNBs can lead to total NO_x reductions of 55% over uncontrolled emissions.

State of the art burners spin the flame and induce recirculation of nearby flue gases inside the firebox thereby cooling the peak flame temperature. Nelson has worked closely with burner vendors to perfect this technique, while still allowing the burner parts to be manufactured economically.

FGR operates to reduce O_2 usage by forcing the return of flue gas to the burners. By recycling 15 to 30% of the inert products of combustion to the primary combustion zone, the reactants are diluted. This reduces the peak flame temperature, reduces local oxygen concentrations to levels below 3% and inhibits thermal NO_x formation.

"For this technique to work optimally, you need precise damper control to maintain a slight negative draft inside the firebox," says Nelson. "For this reason, every time you put in a new burner, you should consider installation of precision damper drives, linkages, damper blades, bearings, etc. to effect smooth control of the draft. Even with selective catalytic reduction (SCR) techniques, controlling the flue gas environment is essential. Accurate damper drives permit this control."

The increasing importance of precise damper drives

More than the damper itself, damper control and linkage is proving increasingly important to NO_x reduction efforts. Installing a new distributed control system (DCS) at grade and a new oxygen analyzer in the stack, without installing a new final control element, equates with putting a Cadillac dashboard on a Model T.

"Sometimes excess oxygen gets into the burner because many older furnaces have cracks and leaks from overuse, rust and damage from past explosions," observes Nelson. "Cold O_2 leaks in, falls to the bottom of the furnace, heats up the flame and creates excess NO_x. Because you can never get all the leaks out, you must manipulate the flue environment with very fine damper control. Typically, at the top of the radiant section of the furnace you want a negative 0.1" of vacuum, as measured by a water gauge. In order to achieve that at both the high and low firing range, you must have precise damper movements."

Refineries located in regions of the country that experience sudden weather changes need to pay particular attention to damper positioning, as the outside temperature can significantly affect the furnace temperature and the resultant furnace draft. In order to maintain a steady state at the burner, a furnace damper might move 600-2000 times a day to accommodate temperature swings. The damper drive should be capable of very small movements. In order to provide accurate control of the damper blade, it is imperative that damper drives respond to ¼% and ½% demand signal changes. The drive and connecting rod linkage movement must be totally free of any unnecessary backlash and deadband.

Another compelling reason for precise damper movement involves the bottom line.

"In the San Francisco area, everyone is burning refinery fuel gas for environmental reasons," Nelson points out. "But this relatively expensive gas is usually a mixed bag of hydrocarbons ranging from methane, ethanes, up to butanes and heavier. Because the fuel composition can change minute to minute, you need more or less air at any given moment. With tight damper control and a tightly sealed furnace, a clever operator could maintain his oxygen levels as low as possible, maybe down to 1.5 or 2 % residual O_2. That lowers the NO_x levels even further and less fuel is consumed."

Challenges in effecting good damper control

While the need for modern, high performance damper drives remains clear, fixing the problem involves much more than drafting a technical document.

"Half of the difficulty in retrofitting a new damper drive is the project management," says Nelson. "Dropping the floor out of a furnace and putting in a new burner is a major job. It can take months of work: writing specs; picking vendors; getting them to understand what's going on; getting it to the sub-vendors; then the sub, sub-vendors; and then giving it to the construction contractor. Finally comes the task of installing it correctly per the drawings, which can be confusing at times."

Given that plant operation managers now must often do the same amount of work that previously took two or three individuals, the need for turnkey solutions has clearly increased. The easiest damper drive installations usually involve vendors who will supply up-front engineering, auto-cad installation drawings, electrical interface drawings, and even field supervision and start-up assistance for unbolting the existing drive and installing the new one.

"In the first phase of our work, we retrofitted approximately 20 furnaces with new burners and a new SCR system at two related refineries," says Nelson. "Many of the furnaces were retrofitted with new dampers and new or relocated damper drives. During the initial process, the importance of precise damper control, and the dramatic effect that draft can have on the NO_x performance and overall efficiency, was not immediately recognized. We have subsequently made adjustments. In our last phase we have standardized on the TYPE K damper drives."

"With the TYPE K guys, they designed- in just about everything we asked for," continues Nelson. "It all arrived pre-assembled so you can just bolt it into the ground; hook up the air supply lines, electric instrument connections, then the linkage; and walk away from it knowing it will work. This makes it easier for specifiers like me because I just tell them what I want and they do all the engineering and shop assembly. This is especially helpful when you want to avoid a lot of on-site labor. You want to have as much assembly-work as possible to be done at the factory. This simplifies field labor and field supervision."

Robust, turnkey damper drives meet the challenge

TYPE K Damper Drives, a division of Controls International Inc., is the leader in the manufacture of final control drives that thrive in environments of extreme temperatures (between -40°F and 300°F), heavy vibration and fly ash, while providing continuous duty service (more than 3600 starts per hour) with smooth, accurate and repeatable damper positioning (an overall linearity of <0.5% and a hysteresis of <0.3%). TYPE K earned its reputation for reliability (warranted for three years or 4,000,000 operations) by eliminating the linear-to-rotary conversion of pneumatic cylinder drives and the grinding gears and backlash of electric drives - the pneumatic true rotary actuator has only one moving part. Seven different sizes are available to handle torque output ratings ranging from 90 ft. lbs. to 10,416 ft. lbs. (based on 100 PSI supply air).

Of significance to specifying engineers, TYPE K retrofit drives are custom designed for each application, requiring no additional engineering or field fabrication. The process begins with a field survey, coordinated with plant personnel, to determine dimensions and details. For ease of installation, pedestal mounts are designed to match the existing drive footprint dimensions and output shaft location (X-Y-Z axis). Existing connecting rod linkage and clevis or spherical rod ends are carefully inspected and replaced by TYPE K, if found in poor condition. In many cases a direct mount retrofit to the damper is preferred. After the drive is fully assembled, calibrated, cycle tested, it is then shipped ready for "drop in" installation and operation.

A Canadian damper control success story

For some consolation, U.S. refineries can consider the plight of Canadian petrochemical operators, where air quality regulations are even more stringent.

The province of Ontario is committed to reducing NO_x emissions by 50% as of 2006, according to Ian McLellan, a mechanical engineer for SNC-Lavalin Group - one of the leading engineering and construction firms in the world with offices across Canada and 30 other countries. McLellan has worked with dampers since 1973.

"I'd say 90% of the drives in North America will need to be replaced because none of the old systems were designed with precise control in mind," comments McLellan. "But now we're talking about fractions of a percent control, so you can't use the old stuff."

Currently working on projects at oil refineries in Ontario, McLellan explains why damper control became an important element at one site.

"Plant management did an upgrade on a large furnace, but the furnace was never able to demonstrate a stable O_2 level, partly because they didn't have good repeatability control over the furnace air," states McLellan. "Yet, we couldn't manually fool around with the original system because it was controlled by some "old unreliable" actuators. They're large and they have a bit of play in them. Repeatability was probably on the order of 1.5% - hardly enough to qualify for precise control."

"The other problem was that all three traditional actuators were jamming when the towers would heat up," continues McLellan. " The refractory was falling out, hitting the damper and stopping it. The old arm-connected pneumatic actuators couldn't stand up to this. The damper shaft actuator arms were actually bending."

The chief stationary engineer at the plant was already familiar with the TYPE K damper drives and asked McLellan to specify them for this project.

"Since I don't do this stuff all the time, the turnkey aspect of the TYPE K damper controls made it simple," says McLellan. "They promised to obtain the damper, put their drive on it, test it, verify it and then ship it up to us."

Installation at this plant posed a particularly difficult challenge, as a special coupling was required.

"The damper drive had to attach to a duct that got up to 1500°F," says McLellan. "We needed a special drive coupling that would reach out into our existing damper coupling and not unduly end load the damper shaft as it expanded from the heat. So the engineers at TYPE K designed a customized bracket and coupling that would allow for significant axial shaft expansion. They came up with a sliding coupling utilizing a square key-way and a heat sink. This allows the shaft to expand sideways about one inch on each side as the air stream heats and cools. Pillow block bearings were also installed to maintain support while still permitting the sliding action inside the shaft coupling. This also helped prevent the refractory from getting in the works and jamming the damper blade."

Installation of the first two damper drives was completed by the middle of December 2001. McLellan and his staff immediately noticed an improvement in damper control.

"With the TYPE K damper drives, the stability of NO_x emission reductions improved tremendously," reports McLellan. "Before, the process used to wander around a lot. Essentially, we run at approximately 7% excess air, so plus or minus 1.5% meant you could swing from 5.5 to 8.5%. But now, repeatability is on the order of 0.1 to 0.25%; a big improvement."

"I also expect the TYPE K to perform well for a long time," McLellan continues. "They've got a lot of robust features. For instance, it has an energized seal with stainless steel backing fingers and a low-friction coated interior, so there will be very low wear on the actuator. Additionally, air pressure is applied to both sides of the vane, so there is no backlash. The positioner basically holds the damper at desired set point without drifting."

McLellan expects to install the new TYPE K damper drives on the next planned job over in Michigan.

"We are going to recommend TYPE Ks to our clients based on our positive experience with the hardware and with the sales and engineering support," says McLellan. "From what I've seen so far, they are the best damper drive for the job. That's important,

because a retrofit job has to work the first time. Once the process starts up, there's no going back. You can't change your mind and say, 'Oh gee, let's shut down again.'"

Improved damper drive performance enables a bright future for refineries

The successes realized at isolated plants across North America mean that other refineries can meet their emission targets by improving their damper drive elements. More important, the retrofitting of other NO_x control strategies doesn't necessarily have to be a financial drain on petrochemical operations.

"I see companies saving large amounts of money by improving their control systems, both with improved final control elements, like the TYPE K damper drives, and with improved attention to the control algorithms" says McLellan. "The hard-dollar savings come in the form of conserving on fuel, because you are precisely controlling your outlet flue gas conditions. You don't get as wide fuel swings, even with variable fuel compositions and calorific values. You also don't tend to get large product swings because you are getting consistent temperatures applied to your tubes. The product coming out the end of the cracking furnace, for example, seems to be of a slightly more consistent quality on its way to the 'frac' towers. I predict that most operators will experience some increase in profitability, possibly as high as 2% for some individual units.

While the NO_x reduction deadlines of the Clean Air Act and similar legislation draw ever closer, operators of refineries and petrochemical plants can derive some benefit from their efforts to reduce emissions. The installation of modern damper control can actually improve product quality and safety levels, while lowering maintenance expenses and on-site man-hours, even for those plants located outside of non-attainment zones. This type of "payback" casts the whole issue of emissions reduction into a much better light.

For more information regarding precise, turnkey damper control systems, contact TYPE K Damper Drives, a division of Controls International, Inc., at 10410 Vista Park Road; Dallas, TX 75238; (214) 343-9980; fax (214) 343-2658; or visit www.typek.com.

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