Air Products' Oxy-fuel Integrated Solution Addresses New Environmental Regulations in Glass Manufacturing . . .

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Gill Hu, General Manager and Chief Engineer, CS Fiberglass

Bird's eye view of Chung Shun Century's plant

In just 6 months, a leading fiberglass manufacturer in China successfully reduced NOx emissions by 80% in its production process to meet the government's environmental regulations for Asian Games 2010 as well as contributing to building a greener community by converting from air-fuel to Air Products' integrated oxy-fuel solution. The conversion brought no interruption to daily operations but delivered long-term economic and production benefits.

Alkali-free fiberglass produced by Chung Shun Century's Oxy-fuel furnaces

China ranks first in the world for glass both in terms of production and consumption. According to some statistics, the number of glass manufacturers in the China market had already exceeded 20,000. Traditionally labeled as a high energy consumption industry, glass production also produces nitrogen oxide (NOx) emissions—a contributor to smog and acid rain.

The industry has been facing an unprecedented environmental and regulatory requirement from the government. China's 12th Five-Year Plan, launched in early 2011, sets out more stringent environmental targets for the Chinese economy and stipulates that by the end of 2015, the nation's energy consumption be reduced by 16% for each unit of GDP, and NOx emissions must be lowered by 10% compared with the 2010 level in specific regions and industries.

Glass manufacturers are under pressure to implement measures to meet the targets set by the government while improving their productivity and operational performance for growing market demands.

Guangzhou Chung Shun Century Fiberglass (CS) is a leading fiberglass producer in China. Its mother company, Kingboard Chemical Holdings, is a Hong Kong listed corporation which operates more than 60 manufacturing plants with business activities ranging from laminates to printed circuit boards, chemicals to property developments in China. CS was facing an urgent and pressing need to convert to a new, NOx emission reducing process.

NOx emissions—a burning issue

Established in 2001, CS manufactures alkali-free fiberglass for its mother company's printed circuit board production. Like many domestic glass manufacturers, CS had been using traditional air-fuel combustion for glass melting in its fiberglass production process.

Host city to the 2010 Asian Games, the Guangzhou government began to enforce environmental regulations in 2009 to early 2010 with a mission to improve the city's environment and green image for this major international event occurring in October and November 2010. CS was among many manufacturers who were requested to reduce NOx emissions. For CS, the reduction target was 80% and the deadline was no later than September of 2010.

"Improving our energy efficiency and reducing emissions had been our key priorities. We were honored to play a role in contributing to a successful green Asian Games in our city but the aggressive target and deadline presented a significant challenge to our operation," said Gill Hu, General Manager and Chief Engineer of CS. "We needed to quickly find the right supplier and right solution to help us accomplish these goals, and it had to be implemented smoothly without disrupting our normal production. "We had already heard of oxy-fuel technology before 2000, and had been aware of and following the industry trends and applications. Like other glass manufacturers, we were very cautious about converting to this new technology as air-fuel met our production needs and there was no pressing need to change. The need to cut NOx by 80% for the Asian Games deadline changed all that, however, and brought a strong sense of urgency to the matter."

The performance of many air-fuel combustion processes can be improved by enriching the combustion air with oxygen. When the oxygen concentration is raised above the 20.9% present in air, the air is said to be oxygen-enriched. Oxygen enrichment of combustion air increases both the flame temperature and the thermal efficiency of the furnace. It can also reduce the amount of inert nitrogen gas flowing through the combustion process in industrial heating applications, making the process more thermally efficient, since less energy is wasted to heat the nitrogen, which is emitted through the stack. The reduction in nitrogen flow also has environmental benefits: lower NOx emissions and lower particulate emissions.

The cost of using high purity oxygen for enrichment can be offset by gains in productivity from enhanced combustion. Although oxygen must be purchased (while air is available for the cost of running a blower), its proven benefits can result in immediate cost savings. Oxygen enrichment can increase production rates without the costly addition of another furnace, thanks to increased thermal efficiency.

CS knew oxy-fuel technology was the best solution to meet the aggressive emission reduction targets, but replacing air-fuel combustion with oxy-fuel technology was no easy decision to make. They talked to a number of suppliers, including both multinational and local ones, and quickly came to the conclusion that partnering with Air Products was the right choice for them.

Air Products has been at the vanguard of oxy-fuel technology since it was first introduced and has over 50 years of global experience developing and improving oxy-fuel technologies for the glass industry, underlined with a proven track record of over 200 successful oxygen-fuel applications worldwide.

“Air Products approached us as early as 2003 to explain the process and benefits of oxy-fuel technology, and it was clear to us they were a leader in the technology. With their deep knowledge and proven experience, Air Products convinced us that we could trust them to help us engineer the conversion on time and meet our targets,” said Gill of CS.

“We had known CS since 2003. Their people are professional and technically savvy, and we were deeply honored to win their trust on this important project. We understood their challenges, technical requirements and

time pressure," said Richard Huang, Air Products Asia Industry Manager for Glass and Primary Metals & Minerals. "As we had for some time anticipated that NOx emission cuts would open up a greater need in China for oxy-fuel technology, our glass experts in China and around the world have been geared up to respond to this. So when CS needed a reliable supplier, Air Products was ready to team up with them."

Integrated oxy-fuel solution

From the onset, a core requirement for CS was working with a partner who was able to understand the full spectrum of their needs and deliver a complete, turnkey solution. Air Products' ability to tailor a comprehensive and fully integrated oxy-fuel solution—from gas management to furnace equipment, and on-site technical support and management—was a key factor in winning the trust and the contract from CS. "We were impressed by their comprehensive integrated solutions approach comprising equipment, training and technical expertise to solve our immediate and long-term challenges," said Gill of CS.

Air Products is a leader in proprietary oxygen enrichment and oxy-fuel technologies that, with minimal capital investment, can help increase production, lower fuel costs, reduce emissions, and improve operations.

The integrated solution designed for CS from the Air Products Glass team included Air Products' Cleanfire® burners, oxygen supply and on-site gas generation system, gas flow control skid, system design and engineering,

procurement, installation, and start-up assistance. On-site training and ongoing technical support were provided throughout the process.

"The entire project was backed by Air Products' global resources working together with the local project team, bringing extensive technical know-how and long-standing industry experience to the challenge," said Richard of Air Products. "Our integrated solution approach and technical expertise gave CS the reassurance and peace of mind that we could solve their challenge."

Fuelling for success—far beyond emission reductions

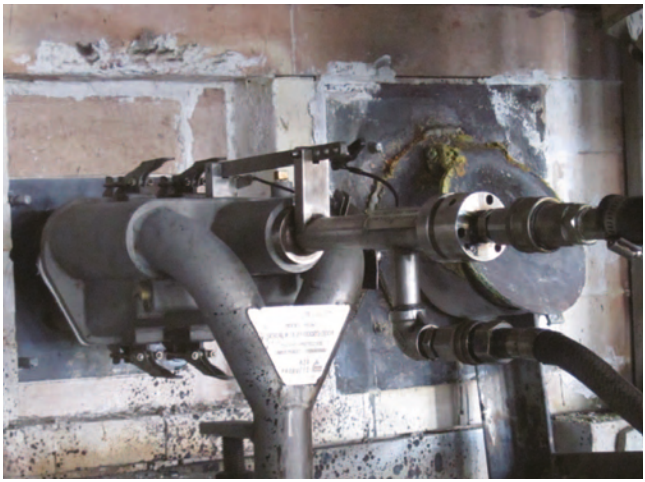
The two companies started the cooperative effort in March 2010. Some months of preparation and trials then followed to fine-tune and test the proposed system design and installation. The implementation process then began in earnest in August.

"We noted a number of emission and productivity gains within the first two months. Critically, NOx emissions, as validated by the local environmental department, were reduced by more than the targeted 80%, and even below the required 400mg/m^3 industry level stipulated by the authorities," said Carlos Huang, CS Research and Development Manager.

Adjustable oxygen flow control skid

"Further efficiency gains included a 35% reduction in fuel consumption, lower electricity consumption, and increased productivity as well as improved quality of glass and easier operations."

In addition to major reductions in NOx emissions of over 80%, Air Products' oxy-fuel solution can deliver up to 25% increase in productivity and 60% energy savings. It can also improve quality, such as reducing bubbles, in glassware.



Cleanfire® burners — easy installation and maintenance

At this stage it had become clear to CS that Air Products' equipment was genuinely world-class: "We realized the quality of Air Products' Cleanfire® burners and equipment was far superior to other alternatives we had looked at previously," said Carlos of CS.

"We have seen major improvements compared to the old air-fuel burners in meeting emission targets as well as in improving efficiency and control. Air-fuel burners required one man on-site continuously to check the flame and relay information to the control center by walkie-talkie," Gill of CS added. "The Cleanfire® burners installed by Air Products are controlled entirely by remote computer control, and each burner can be managed independently."

Air Products' Cleanfire® burners have been proven to out-perform other burners by more than 5% in fuel efficiency and productivity. They have better heat transfer to glass, easy maintenance, and wider flow rate.

The Cleanfire® HR™ and HR$_i$™ series has several benefits, including lower maintenance costs, high flame radiation, more uniform heating, larger flame covered area, and minimized pollutant emissions. This oxy-fuel burner has been successfully implemented in several high production reverb furnaces. Air Products has installed more than 1,500 Cleanfire® burners around the world.

"Our Cleanfire® oxy-fuel burners are designed to achieve high combustion efficiency and are much easier to clean and maintain. There is no other comparable product in the market," added Richard of Air Products. "We were delighted with the initial results and to be able to repay CS's trust and confidence in us by meeting their emission cuts on schedule and on target."

"The transition from air-fuel to oxy-fuel was easier than we had thought," said Carlos of CS. "We initially focused on converting one of our air-fuel furnaces to oxy-fuel. The conversion was completed in about one week. This was conducted while the furnace was still in operation and without any major disruption to normal production. And it has reduced the number of burners active in the furnace by half."

Following the successful conversion of the first furnace in late 2010, CS and Air Products then completed the conversion of CS's second furnace in April 2011, which has delivered similar results in NOx emissions and efficiency gains.

Air Products' VSA systems provide reliable and cost effective oxygen supply to customers

VSA—long term economic benefits

To reap long-term economic benefits through fuel savings, an integral component of the oxy-fuel conversion project was installing on-site oxygen generation through Air Products' PRISM® VSA (Vacuum Swing Adsorption) systems. Utilizing proprietary state-of-the-art oxygen production technology, the PRISM® VSA generators are a flexible and highly reliable oxygen supply source with low capital and operating costs. The combination of advanced process technology, low specific power, optimal supply chain sourcing, compact footprint, packaged modular design for ease of installation, and fast project execution strategy have established Air Products as a global leader in VSA oxygen. The VSA generators due to come on-stream in late 2011 will provide CS with a long-term economical, reliable and uninterrupted oxygen supply.

Mr. Gill Hu, GM and Chief Engineer of Chung Shun Century (left), and Richard Huang, Air Products Asia Industry Manager for Glass and Primary Metals & Minerals (right)

Working together as one team

"Apart from technology and products, it was clear we were on the same wavelength with the Air Products technical team from the start," commented Gill of CS. "They listened closely and designed a complete solution for us. Of course, we encountered some issues and teething problems during the early stage of the conversion process, but they were always able to respond quickly to these challenges."

During the project, the two companies worked as one team, sharing knowledge and expertise. One example is that the initial Cleanfire® burners that were installed required frequent cleaning due to the use of heavy oil as fuel. By working closely together, different alternatives were explored to resolve this issue, and in December 2010 upgraded burners were installed that delivered higher combustion efficiency and were easier to clean and maintain.

Gill said: "Reducing NOx emissions by 80% in just six months without disrupting our production operations was a major challenge for us. But our decision to trust in Air Products has proven to be a major success. If I were to name something that I like most about Air Products, it is their people. Air Products provided us with a team of true glass industry experts who listened, understood and were responsive to our needs. We really worked together as one team."

A challenging yet promising market

Clearly, the future years will see increasingly stringent environmental controls enforced by the Chinese government as the country's social and economic development continues to thrive. The industrial sector will face growing pressure to shift to less energy-intensive and more sustainable processes. The impact is especially huge on the glass making industry as the production process emits NOx and requires high energy consumption. According to the "2011 China Glass Industry Development Prospect and Investment Analyst Report", China's heavy oil consumption is currently 35% higher than the global level,

while furnace efficiency is generally 5%–10% lower than overseas levels.

At the same time, environmental pressure is paired with high-speed development of China's glass industry, which benefitted from robust economic growth, vigorous investment and increased demand in sectors like construction, automobiles, semiconductors, electronic appliances, and new energy, etc. Taking fiberglass as an example, by 2015 China's domestic demand is expected to reach 2.52 million tons, or 43% of global capacity. It is therefore equally important for glass makers not to sacrifice productivity, product quality, cost and operational efficiency in order to build and maintain a competitive edge.

Oxy-fuel is a proven technology that can significantly cut NOx emissions while delivering further production and efficiency benefits and is an effective solution to help Chinese glass makers succeed in the challenging marketplace. A leader in oxy-fuel technology with over 50 years of experience and a proven track record, Air Products offers an integrated oxy-fuel solution comprising gas supply to oxy-fuel burners and technology, a customized control system, technical and design expertise, commissioning service, safety and site training, maintenance contracts and project management. It also allows flexibility and enhanced security through equipment purchase or lease options and multiple gas supply modes. At the heart of this integrated solution are Air Products' glass experts and their vast experience and technical know-how.

Glass fiber is being produced at a furnace product line powered by oxy-fuel

Richard of Air Products concluded: "Oxy-fuel combustion isn't a new concept for most industry players in the China market but it has not been adopted as widely as it has been in Europe or the United States. With the new regulatory requirements coming into force, we can see a growing need for oxy-fuel technology in the flourishing Chinese glass market. As an integrated solutions provider with the best-in-class team and technologies, we are geared up to respond to this need."

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