

Efficient Firing Solution

Kromschröder burners and controls are meeting the expanded needs of a fused silica crucible manufacturer

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A division of Ceradyne, Inc. Ceradyne Thermo Materials, located in Clarkston, GA, is a world-wide leader in providing fused silica products for high-tech industries. A recent facility expansion was undertaken in response to the solar energy industry's demand for photovoltaic silicon solar cells, which represent an important energy source for the future. The facility manufactures fused silica crucibles used in the photovoltaics process.

Kromschröder UK provided high-velocity BIC burners and combustion controls used to create the fused silica casting crucibles. The kiln was designed by Drayton Beaumont, Staffordshire, England, and the combustion solution includes a complete feature set of components manufactured by Elster/Kromschröder of Osnabrück, Germany. (Kromschröder products are represented in North America by Hauck Manufacturing Co., Lebanon, PA.)

During the manufacturing process, the silicon is first melted in a crucible and induction heating is used to melt the silicon in the crucible, transforming it into silicon crystals. The unique properties and the ultra-high



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purity of the fused silica crucibles eliminate the possibility of silicon contamination inside the crucible. Once the process is complete, the crucible is destroyed and the silicon ingot is removed.

High quality fused silica is essential to the manufacture of the crucibles. The silica is processed and mixed into a slip/slurry. The crucibles are slip-cast into molds, which are also manufactured by Ceradyne, and the green crucibles are then dried, fired and cooled in periodic kilns.

Firing Details

The kilns are equipped with Kromschröder high performance burners and control components. High cycle duty valves and regulators and burners with high turndown capability are essential in providing a fuel efficient pulse fired combustion

system – particularly one which is required to perform multiple functions. Extremely accurate temperature control, +/- 1 degree C, and superior temperature uniformity allow the kilns to be used for firing cycles including drying, firing and cooling.

Each kiln is equipped with 24 high velocity Kromschroder BIC burners arranged in 12 two-burner zones. The burners are pulse fired in pairs. Pulse fire control utilizes the high velocity burner at its maximum velocity by operating the individual burners on/off. The timing between each burner cycle is determined by the temperature demand and pulse algorithm in the PLC. The burners are fired in a random pattern to increase the circulation within the kiln. Pulse firing provides the highest fuel efficiency and greatest degree of temperature uniformity, and is the ideal type of control system for many industrial heating applications.

Features incorporated in the Kromschroder components provide operational advantages not available from other combustion equipment and ensure an economical solution for the crucible firing process. Each burner features a continuous internal pilot with a spark and sense electrode which serves the dual purpose of spark ignition and flame sensing of the pilot flame. The pilot air and gas are regulated to provide accurate flows and allow high burner turndown. An ionization rod is included with the burner and used to detect the main flame.

A Kromschroder air butterfly valve with a direct coupled electronic IC40 actuator at each burner is cycled on and off during the firing cycle. The butterfly valve design, in conjunction with the actuator, provides a very low leakage rate and almost zero hysteresis.



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Operating settings were programmed into the actuator via BCSOFT, a package developed by Kromschroder that allows a PC interface to be used to initialize and exchange settings data between components. Via BCSOFT, the settings were duplicated and loaded into the other actuators which shortened commissioning time and eliminated the possibility of error or tampering with linkage and desired control settings.

The Drayton Beaumont kiln control system is PLC based. The touch screens allow kiln operators to closely monitor the combustion system. Start-up screens, kiln overview screens with burner and pulse status, temperature loop tuning screens, first out annunciation and other operator screens provide a user friendly operating system.

Burner Control

Kromschroder's VAG combination shutoff valve and ratio regulator control the gas flow to each burner. The ratio regulator is cross connected downstream of the air butterfly valve. As the air increases with the opening of the butterfly valve to the high position, the gas increases in proportion. A built in limiting orifice

in the burner is used to set high fire gas flow for optimum fuel air ratio. Low fire gas flow is adjustable on the front of the regulator housing. The VAG's high life, high cycle duty solenoid is controlled by the PLC once the pilot flame is established.

Burner control is provided via a Kromschroder BCU 480 Burner Control Unit supplied for each burner. The unit has a built in ignition transformer and two flame amplifiers. The BCU controls the ignition process and continuously monitors the pilot and main burner flames. A digital input signal from the PLC is provided to the BCU which controls the IC40 for the on/off pulse firing of the main burner flame.

The closing of the gas valve is delayed until the air valve has reached its low position assuring complete combustion. The BCUs are mounted at each burner to reduce installation costs and simplify installation, commissioning and troubleshooting efforts. A second pneumatic actuated main air valve is located at each burner to provide additional air during the cooling cycle.

Gas Delivery and Safety

The main gas fuel train is a complete Kromschroder system consisting of components for gas filtration, gas regulation with overpressure protection, as well as modular safeguard controls and fuel metering. A JSAV Overpressure Shutoff Valve, also known as a Slam Shut Valve, is piped upstream of the VGBF Pressure Reducing Regulator for protection against high gas pressure to the downstream components.

The main gas train includes Kromschroder's latest modular safeguard control unit, the Valvario. The FM and CSA approved double shut-off valve, VCS, is equipped with tightness control in lieu of proof of closure switch. Also known as valve proving controls, the TC module, upon startup of the gas train, verifies if the two solenoid safety shutoff valves have an acceptable leakage rate as determined by the appropriate approving authority.

If an unacceptable leakage rate is detected by the valve proving controls, the TC activates an alarm and locks out the combustion system until the problem is resolved. Low and high gas pressure switches are flange mounted to the side of the valve body to complete the safeguard control package. A relief valve is located directly downstream to vent trapped gas between leak tests.

Continued Expansion

Worldwide customers choose Ceradyne Thermo Materials' crucibles over those of other manufacturers for their high reliability, fully traceable production and purity data availability, and outstanding customer service. The quality workmanship of the new kiln and combustion system, along with expedient installation and



A modular safeguard control unit



The main gas fuel train system consists of components for gas filtration and regulation with overpressure protection, as well as modular safeguard controls and fuel monitoring.

trouble-free commissioning, allowed Ceradyne Thermo Materials to bring this kiln online one week after complete installation and start-up commissioning.

The increasing demand for crucibles has required Ceradyne Thermo Materials to procure more kilns. The performance of the first kiln resulted in a contract for two more Dayton Beaumont kilns equipped with Kromschroder burners and controls to meet ever rising production demand.

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