Oxy-Fuel Glass Melting – A Path to Sustainability and Lower CO2 Emissions

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Over 300 commercial glass melting furnaces have been successfully converted to oxy-fuel firing worldwide since 1991 when the first full oxy-fuel conversion of a large container glass furnace took place. The main benefits for oxy-fuel conversion are fuel reduction, glass quality improvement, emissions reduction (NOx, SO_2, particulates), and productivity improvements. However, despite the demonstrated benefits of oxy-fuel use in glass furnaces and significant penetration of oxy-fuel in the specialty glass furnaces, only about 60 container and float glass furnaces have been converted to oxy-fuel firing, while most of large soda-lime glass furnaces are still fired with air using large regenerators to recover waste heat in the flue gas. The primary reason has been economic – with the prevailing environment of low natural gas prices in North America and Europe, the nominal 10% savings in fuel from switching to oxy-fuel is more than offset by the additional cost of using oxygen.

More recently though, there has been an increased emphasis on sustainability and lowering CO_2 emissions. As a result, process industries – refineries, steel mills, cement kilns and glass furnaces are looking for ways to substantially reduce CO_2 emissions from their operations. More specifically, several glass companies (container, float and fiberglass) have made definitive commitments for CO_2 reduction as part of the Science Based Targets Initiative.

This emerging trend could substantially strengthen the case for oxy-fuel glass melting. Flue gas typically exits the oxy-fuel glass furnace at 1450 – 1500^{o}C. With full flue gas heat recovery, fuel consumption is estimated to decrease by 20 – 30% with a corresponding reduction in CO_2 emissions, thereby enabling glass companies to meet their 2030 CO_2 reduction milestones.

Linde offers multiple waste heat recovery technologies for the glass market under the OPTIMELT™ trademark:

- Thermo-chemical Regenerator Systems
- Batch and/or Cullet Preheating (through an exclusive arrangement with Johansson Industries)

This webinar provides an update on the OPTIMELT TCR technology, including results from the operating system at Libbey Leerdam, the unique "self-cleaning" mechanism that minimizes the tendency for build-up in the regenerators, continued technology development (Gen II TCR) and preliminary economics for large container glass furnaces.

Raw material preheating is another way to significantly reduce furnace energy input requirements by recovering heat directly from the flue gas. Batch and cullet preheating systems for air-fired regenerative furnaces typically achieve preheat temperatures of about 250^{o}C-300^{o}C. Johansson Industries has developed batch preheating (BPH) and cullet preheating (CPH) systems uniquely adapted to oxy-fuel fired glass furnaces. Since batch and cullet are physically quite different materials, they are preheated in separate vessels. Direct contact with the flue gas results in high heat transfer rates and high material preheat temperatures in the range of 400 – 450^{o}C.

Flue gas exiting each of the above heat recovery systems (TCR, CPH, BPH) is still at a temperature high enough to allow for further heat recovery. Combining these technologies results in final flue gas temperatures in the range of 200 – 350^{o}C, indicative of full heat recovery. The optimal combination will depend on the project and site specifics, e.g. fuel prices, cullet rate, internal vs post-consumer recycled cullet, available space, CO_2 avoidance costs and capital constraints.

Taking the step of converting to oxy-fuel with full heat recovery should position glass companies to achieve the near-term goal of 20 – 30% reduction in CO_2 emissions. This also makes the glass furnace future-ready to achieve carbon neutrality when low / zero carbon fuels like green H_2 become more economically viable. Finally, the flue gas from an oxy-fuel glass furnaces is much richer in CO_2 relative to air-fuel furnaces. In principle, the flue gas could be CO_2 capture ready with minimal flue gas processing.