Collage of Engineering

Materials Department

Third Class

Lecture (4)

GLASS

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4.2 Glass melt

In Previous lectures, the preparation of the batch has been described, from the selection of the raw materials and their structures to the charging of the batch in the furnace. The modern glass container factories are three-part operations: **the batch house**, **the hot end**, and **the cold end**. The batch house handles the raw materials; the hot end handles the manufacture proper, annealing ovens, and forming machines; and the cold end handles the product-inspection and packaging equipment.

4.2.1 Furnace types

Different furnace types and designs exist, depending on the quantity of glass to be produced, the type of glass production, plus economic (and logistic) factors

The main types of furnaces include:

1- Pot furnaces (discontinuous).

2- Day tanks (semi-continuous).

3- Recuperative / unit type melters.

4- Cross-fired regenerative furnaces.

5- End-port fired regenerative furnaces.

6- Oxygen-fired unit melters.

7- Special (segmented) melter.

8- All-electric furnaces.

1- Discontinuous furnace (day tanks and pot furnaces)

The following actions take place (generally in a one-day cycle) within discontinuous melting furnaces:

Melting tank or pot is charged with mixed raw material batch. This batch is heated to the desired temperature. The glass is melted, fined, homogenized and subsequently cooled down to the working temperature to allow forming by the craftsman or semi-automatic machines taking portions (gobs) of glass from the glass melt pot.

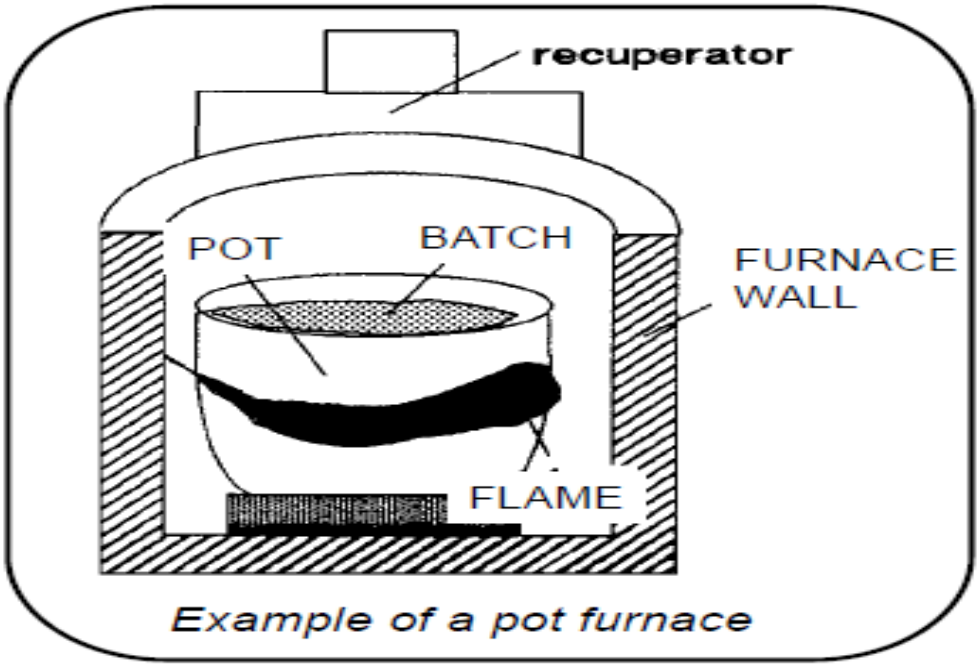


Figure (4-1) Pot furnace

2- Continuous glass furnaces

Usual synonyms for a continuous furnace are **glass-melting tank** or **tank furnace**.

These furnaces are applied for

1- Container glass production
2- Flat glass (Float & Rolled) production
3- Most tableware glass production
4- Fiber & glass wool production
5- Most specialty glass production (tubes, display glass, glass-ceramics, lighting bulbs, . .).

These furnaces not applied for*:*

1- *Most hand-made glass*
2- *Vitreous silica*
3- *Optical glass fibers*

Continuous glass furnaces characteristics

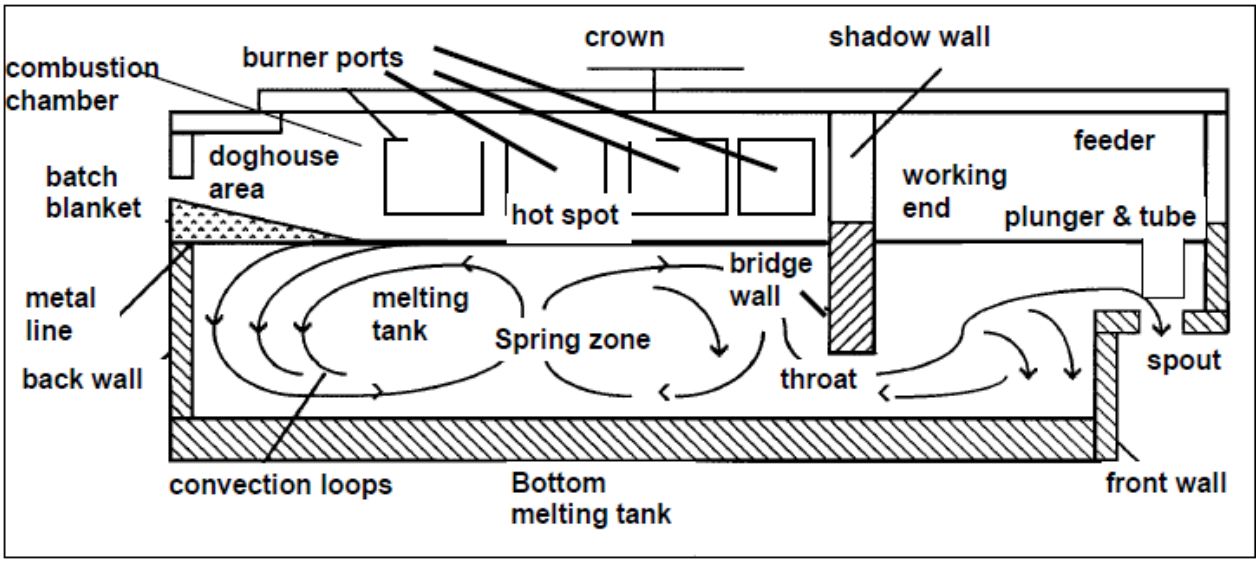
1- Tank of refractory material, **continuously charged** with mixed batch
2- All basis process steps in **different zones** or sections of furnace

3- These furnace types are suitable for the **mass production** of glass
4- The furnace melting capacity (**glass pull**) usually is expressed in the number of (metric) tons of glass melted per day (24 hours). Depending on the furnace and type of glass produced, the pull can vary from ~ 20 tons per day (TPD) up to > 700 TPD
5- Extra mixing by the application of **bubbling or electrodes**
6- Possibility to **boost** energy input using **electrodes**

A melting furnace consists of:

a- **Melting tank** (glass melt bath)
b- **Superstructur**e (combustion chamber)
c- **Throat** as connection between the melting end and the riser that brings the molten glass in the **refiner, working end or distributor**
d- **Neck** in case of float glass production, between the melting end and working end
e- **Working chamber** (working end, gathering end, nose, refiner)
f- **Heat exchangers**: regenerators or recuperators

Designations of glass furnace components (tank furnace, cross fired, dimension scale is not meant to be correctly presented).



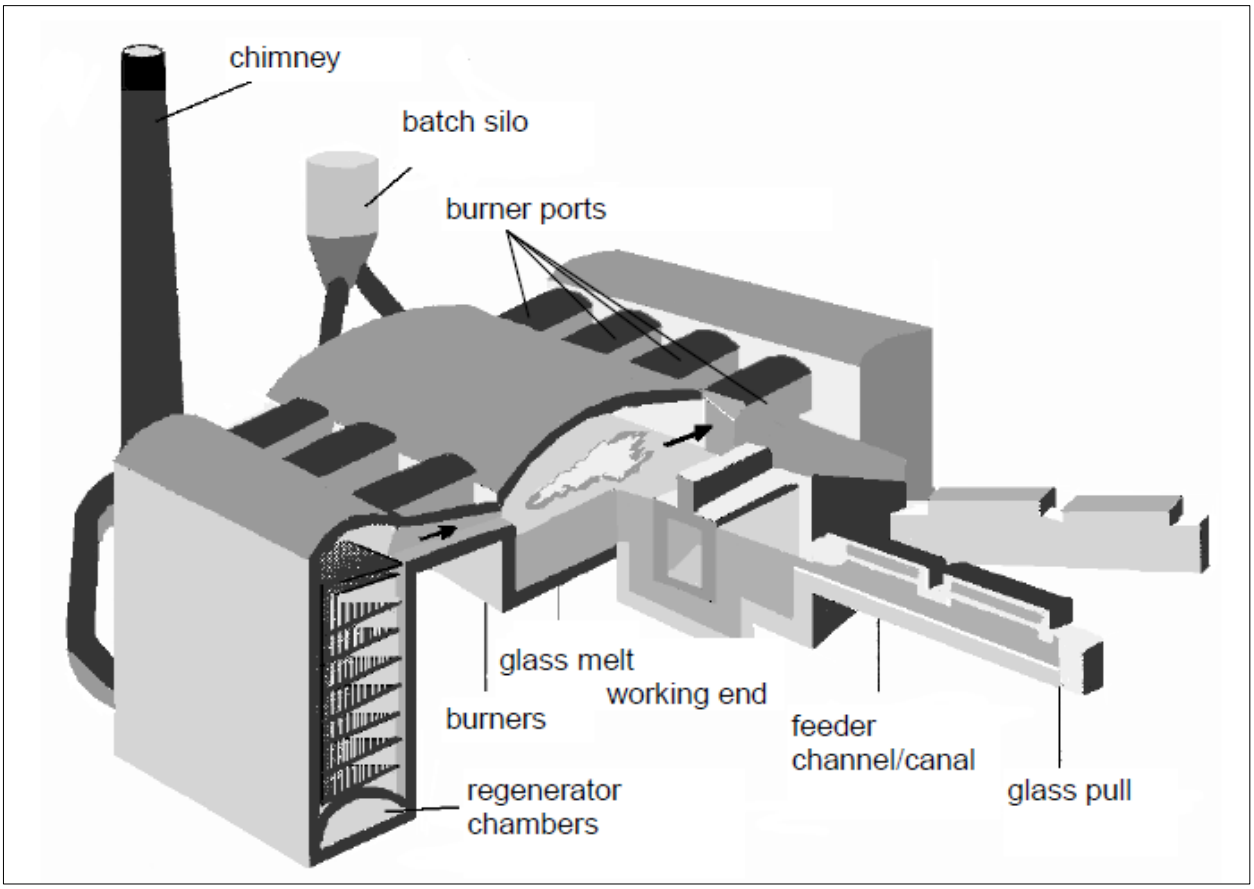


Figure (4-2) Continuous glass furnaces

3- Regenerative furnaces

A regenerator consists of a **regenerator chamber** in which a **checkerwork** (or just **checkers**) of **refractory bricks** has been stacked. In one cycle the checker is heated up by flue gases, subsequently in the following stage (20-30 minutes) the heat is transferred to combustion air. These furnaces are provided with 2 or more (an even number) regenerators.

In principle the optimum **half-cycle time** depends on the pull of the melting tank (**thermal load**). During the **burner reversal**, lasting about 30 - 60 seconds, there are no flames within the furnace. The reversal period (no-firing interval) should be as short as possible to avoid too much cooling down of the furnace.

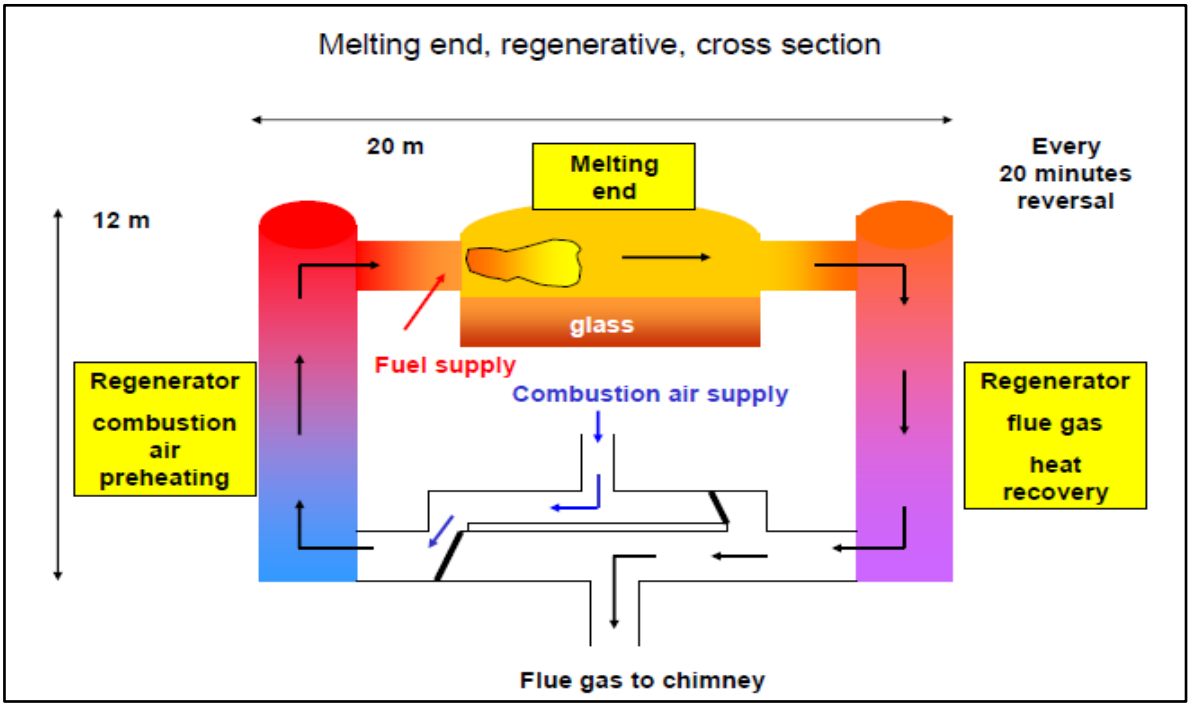


Figure (4-3) Regenerative furnaces

4- Cross-fired regenerative furnaces

The regenerators are placed on the **side of the furnace.** The furnace can be equipped on both sides with **4 up to 8 burner ports (per side)** depending on furnace size.

The **profile of heating** (fuel distribution among the burners located along the sidewalls) determines location and size of the hot spot area (primary fining zone) in the glass melt.

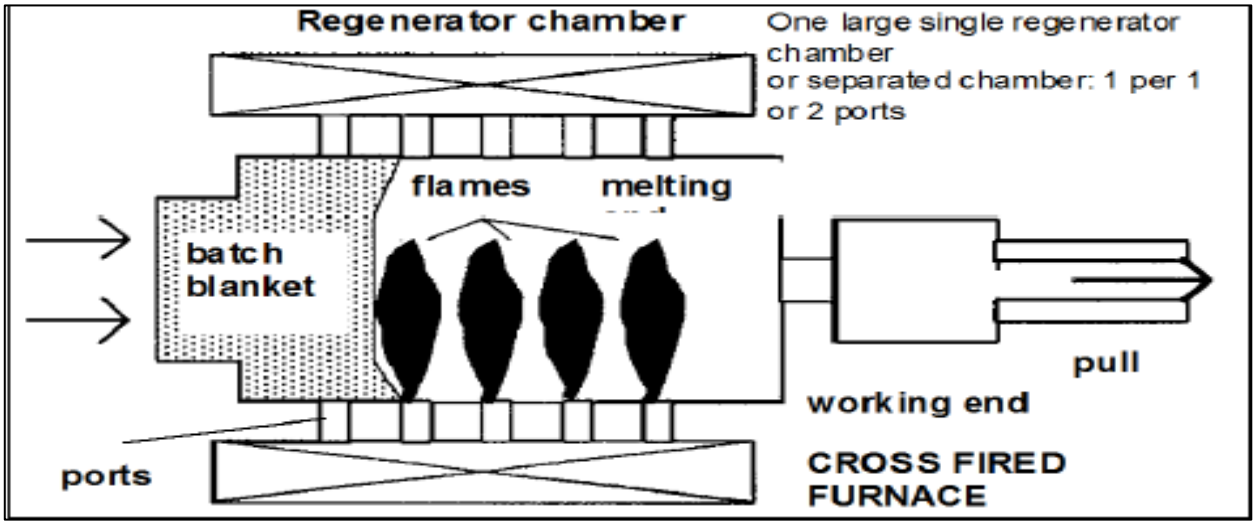


Figure (4-4) Cross-fired regenerative furnaces

5- End port-fired (or U-flame) regenerative furnaces

Burners (2 to 4 burners at each port) and the regenerator chambers are connected **at the back wall side** of the superstructure. The combustion of fuel & preheated air from one regenerator chamber takes place: flames starting from the burner

nozzles and extending almost over the length of the furnace. Less structural heat losses compared to cross fired regenerative furnaces (combustion gases have longer residence time)

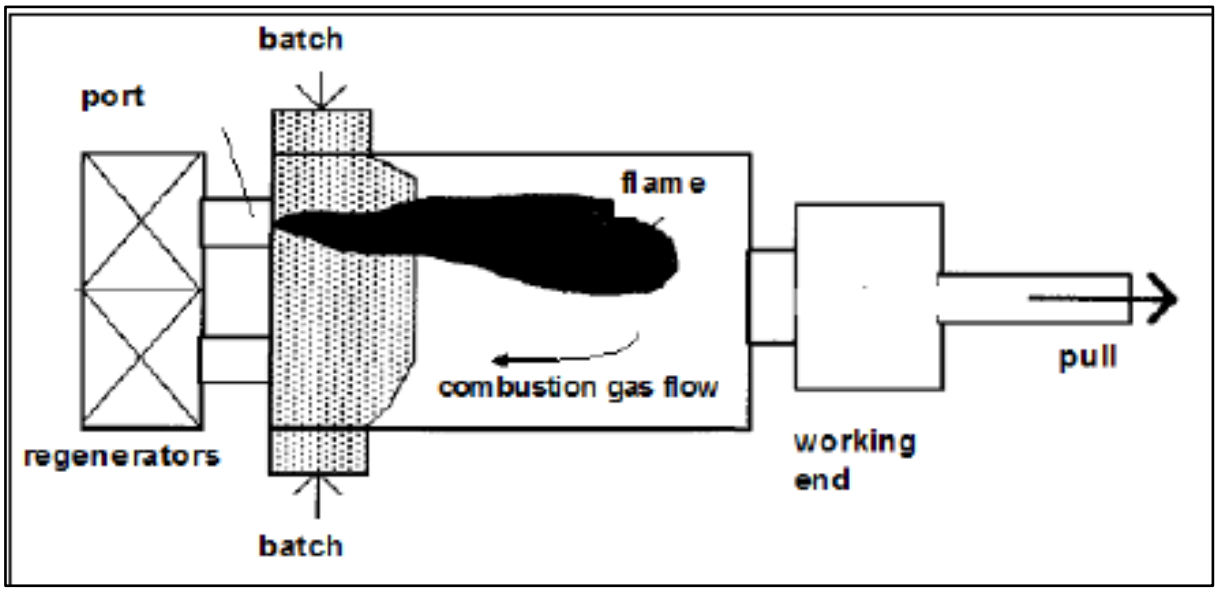


Figure (4-5) End port-fired

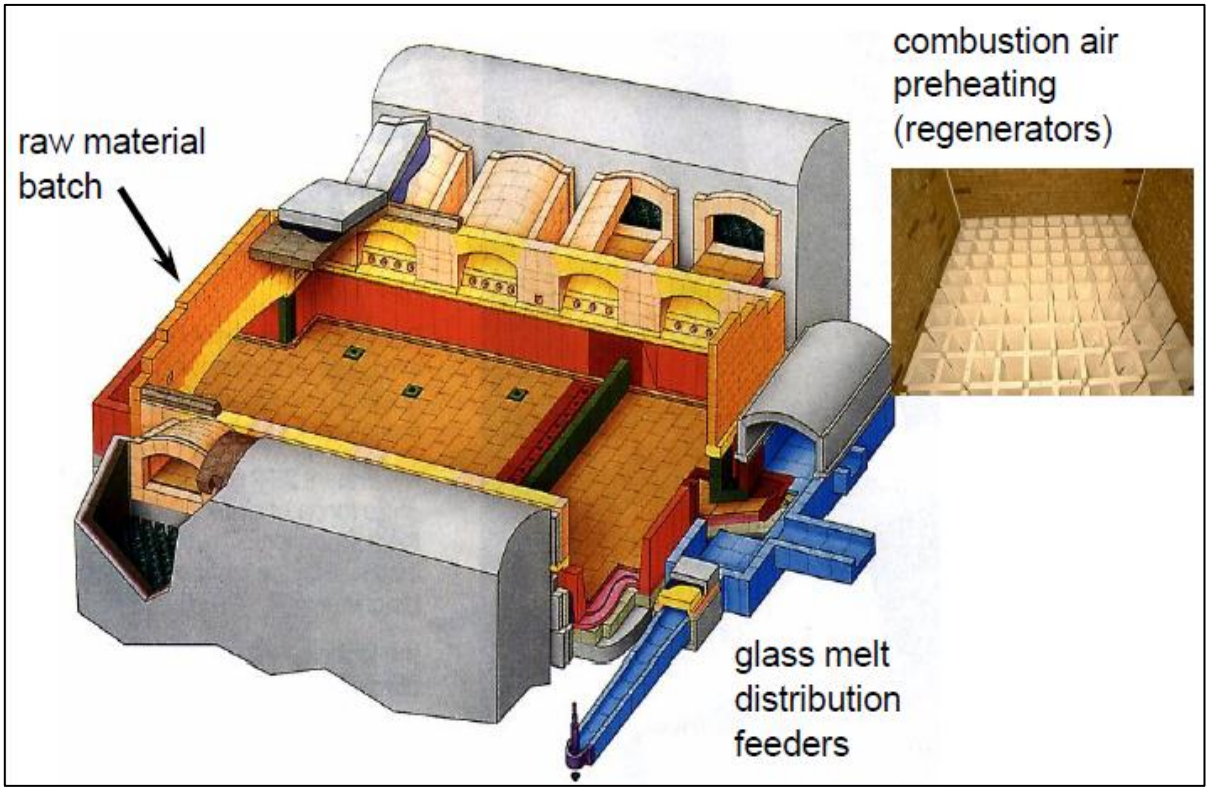


Figure (4-6) Typical air-fired container furnace

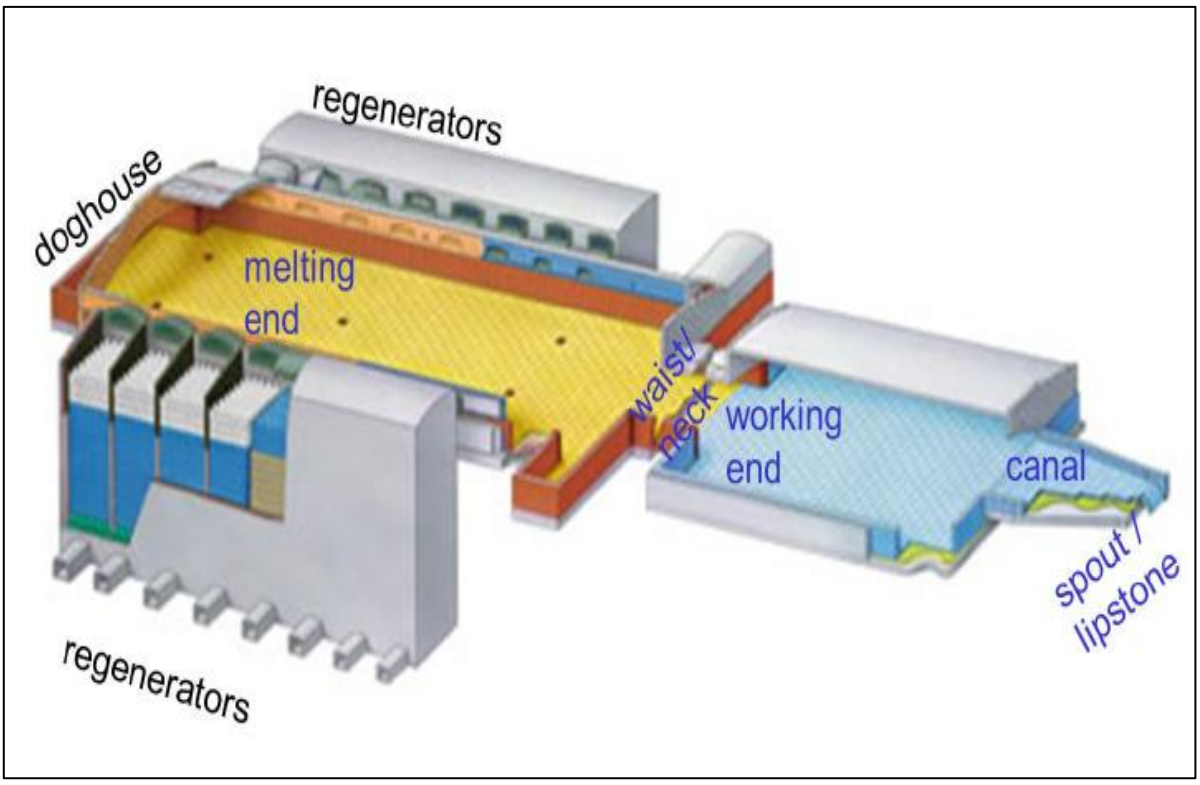


Figure (4-7) flat glass furnace

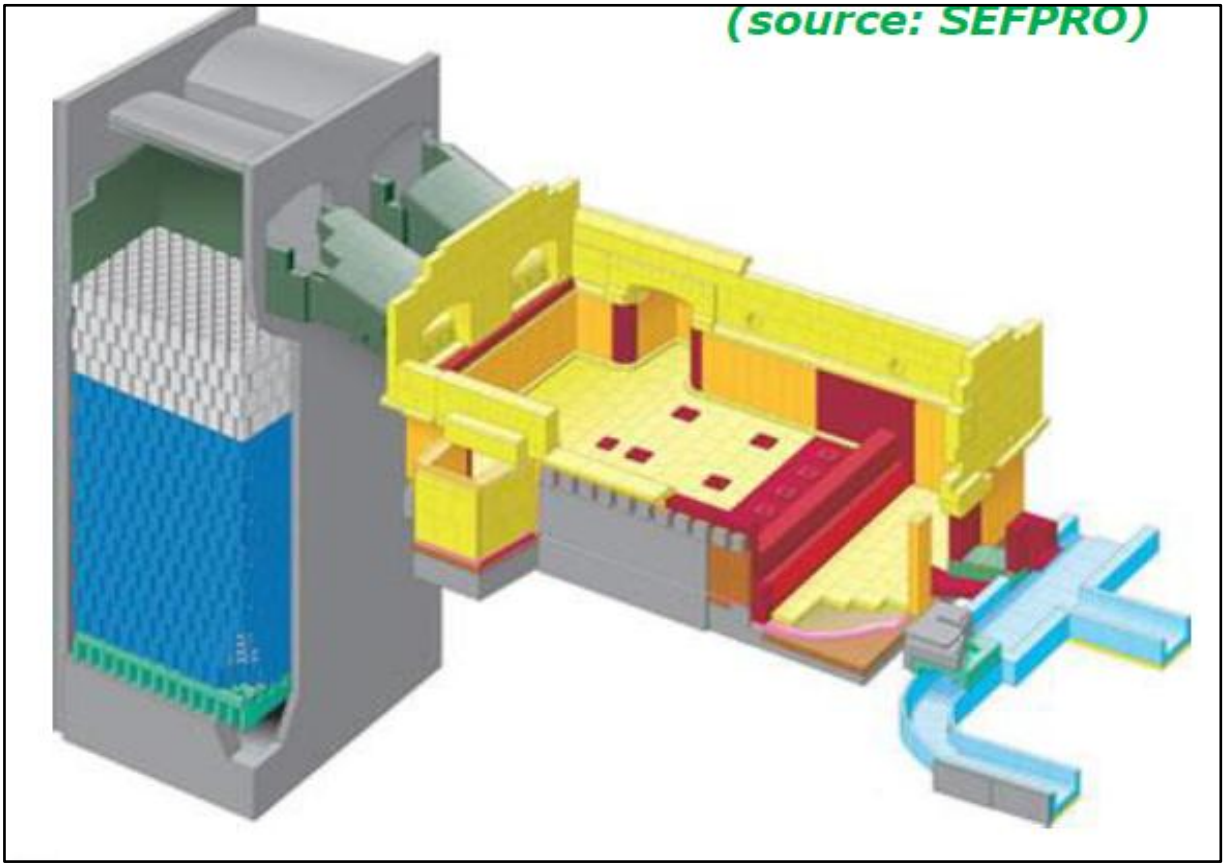


Figure (4-8) Example end-port regenerative furnace