Fluid bed furnace

Rev. 0, 06/2010 *(C. Bittner)*

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Fluid bed annealing furnace

- What is a fluidized bed annealing furnace?
- Comparison between furnace lengths
- Advantages of a fluidized bed annealing furnace
- Fluidized bed general description
  - Operation
  - Anatomy of Automat's fluidized bed annealing furnace
  - Retort design
  - Advantages of the double-tube design
  - Temperature control
  - Aluminum oxide return system
  - Motorized threading aid for wires
- Fluidized bed furnace heat balance

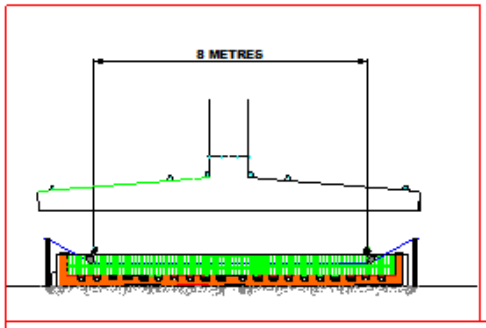
What is a fluidized bed furnace?

- **Automat fluidized bed furnace is the most advanced design available today. It encompasses the benefits of:**
  - Environmental harmless as opposed to lead.
  - Fast heat exchange rate between wire and fluid media ➔ high product quality, short furnace.
  - Accurate control of temperature and high temperature stability ➔ higher quality of the annealing process and the product.
  - Extremely high of the tensile results obtained across the wire field (on all wires).

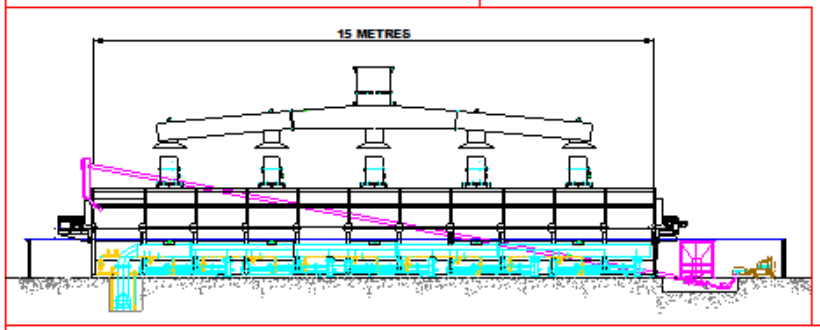
What is a fluidized bed furnace?

- **Benefits (cont'd):**
  - 45% higher fuel efficiency compared to lead or open fire furnace.
  - 75% less installation cost ➔ one short, compact unit to connect to gas feeding line.
  - Delivered completely assembled ➔ faster commissioning, less cost.
  - No capital expensive investment in lead

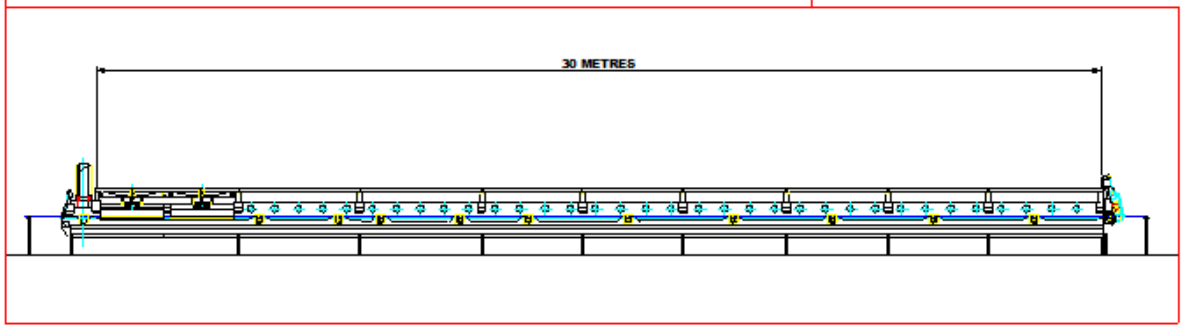
Comparison between furnace lengths



- Molten lead bath at 700 deg C: 8 meter immersion length



- Fluidized bed at 750 deg C: 15 meter immersion length

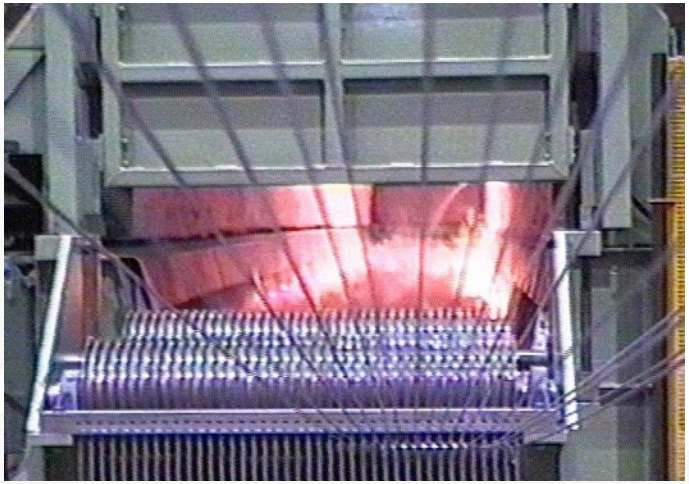


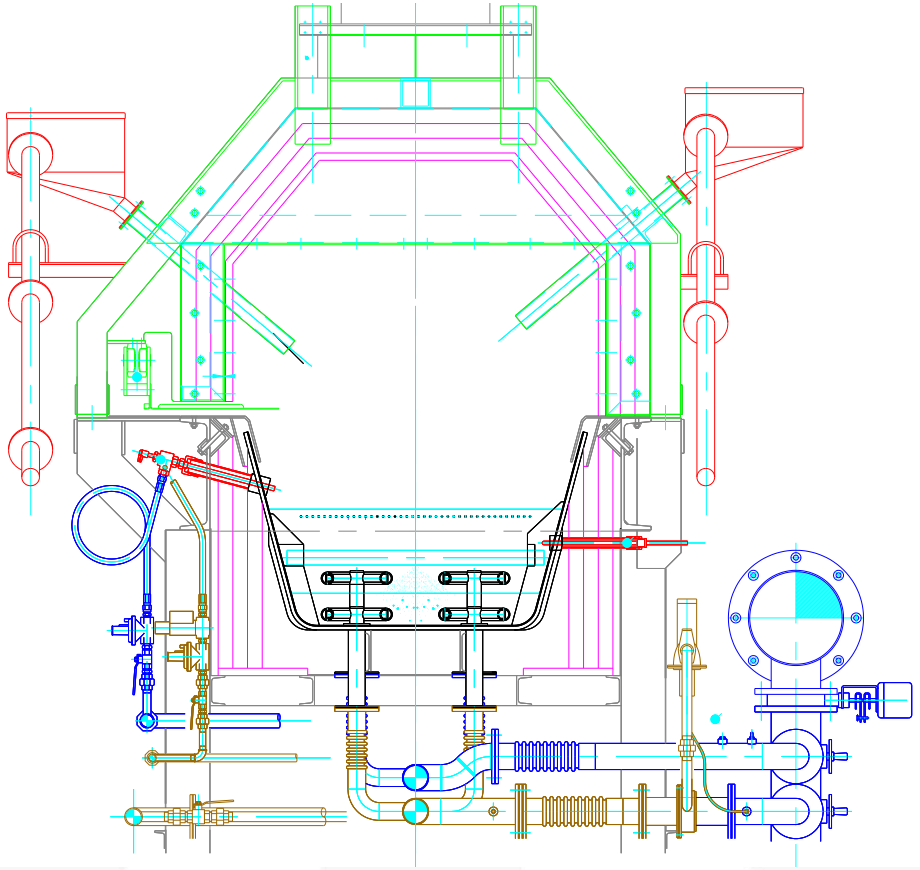
- Hot air oven at 900 deg C: 30 meter heating length

Fluidized bed general description

- Wire strands pass horizontally through the fluidized bed of aluminum oxide particles.
- The bed may be heated up to operating temperature say for annealing 680 – 720 deg C.
- In the case of heating, this is by means of internal gas firing using Natural, Propane, Butane or producer gasses. The fluidizing of the bed by the gas stream, as in the Double Tube design, is achieved through special injection tubes submerged within the aluminum oxide. The oxide itself is contained in a retort manufactured in nickel-chrome heat resistant alloy.
- The retort is filled to the correct height by two grades of aluminum oxide particles. A non fluidizing course grade, acting as a diffusion layer, at the bottom of the retort and a finer grade towards the top - The firing takes place with in the fluidizing top layer of fine grit.

Fluidized bed general description





Anatomy of Automat's fluidized bed annealing furnace

- Featuring :
  - The Double Tube system.
  - Aluminum oxide fluidizing medium.
  - Fluidizing layer 60 grit for maximum heat transfer.
  - Diffusion layer 12 grit for complete mixing.
  - One piece build.
  - Motorized shuttle.
  - Twin sand return fans.

Retort design

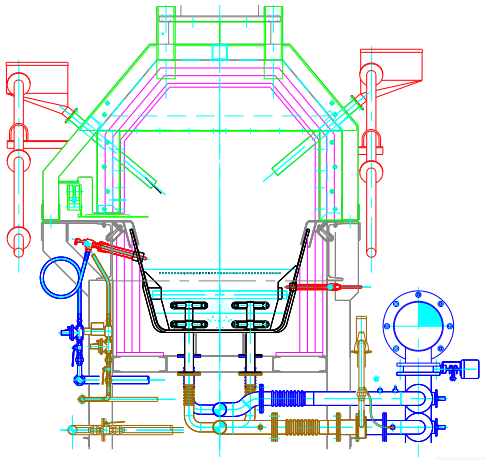
- The retort design forms a solid homogeneous container for the aluminum oxide, and so any expansion or contraction over the top and bottom of the bed will be taking place within the same material (nickel-chrome alloy). There are no tiles underneath the aluminum oxide to fail, which may cause repair problems at the base of the bed.

- Furthermore, the retort is located within the insulated lower furnace casing in such a way that it is free to move while expanding or contracting.

- The injection tubes are similarly installed to the retort, so they are free to move as the retort moves. After extensive use, should it become necessary, tubes can readily be replaced within the retort.

Advantages of the double-tube design

- The advantage of the injection tube design over other designs, such as ceramic tiles, for distribution of gases, are as follows:
  - Through one set of tubes half amount air and total amount gas mixture is injected into the furnace bed. This mixture is non-combustible, because it is not within the limits of flammability.
  - Additional air is injected through the second set of tubes, at a controlled rate for desired fluidization, and a combustible mixture is then achieved which ignites within the fine grit section.
  - Rate of fluidization and fluidization levels are readily controlled using this design. Additionally, the configuration of the tubes within retort gives rise to uniform fluidization (hence heating) throughout the fluid bed.
  - Expected temperature uniformity within the bed would be ± 5 deg C.

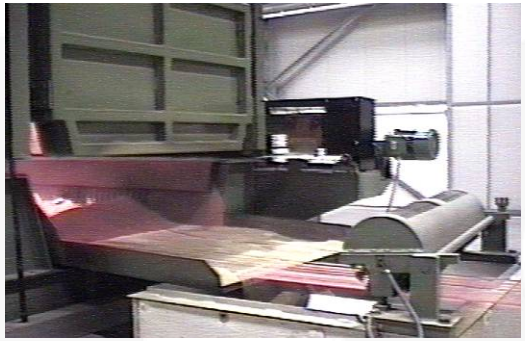


Temperature control

- The fluid bed furnace is controlled in 3 m (10 ft) zones.
- The fluid bed temperature in each zone is regulated by a temperature controller. Additionally, each zone is supplied with its own high limit controller, which is situated above the bed. Its function is to protect the flue from excessive temperatures.
- A simple on/off system is used to control the gas and thereby heat input (the air flow remaining substantially constant). Therefore, the heat requirement inside the bed very quickly responds to suit throughput conditions, if, for example, the furnace has an initial production throughput of 30 wires, requiring maximum heat within the furnace bed, but during operation the number of wires is reduced to say 20, the furnace control system will automatically reduce the thermal input to the bed to suit the new throughput conditions.
- When 30 wire production is restored, then the furnace returns to its original thermal conditions.

Aluminium oxide return system

- The oxide return system is well proven. This is a simple pneumatic transport system which utilizes a small fan. The oxide is collected continuously in a hopper at the exit end of the furnace and fed back into the furnace continually.
- The oxide is generally free from any contaminants, so it is usually not necessary to have any filter system. The oxide is returned to the furnace at the entry point of the fluid bed furnace.



Power assisted threading of wires

- A motorized shuttle is provided to thread the wire through the furnace. A stainless steel blade is driven via a motorized reduction gearbox along a slot in the side of the furnace which is created by raising the top section of the hood.
- The shuttle is chain driven, fitted with a pneumatic tensioning device, and parked at either end of the furnace when not in use.

Fluidized bed furnace heat balance