High-temperature – Conveyor Belt Furnace

Ingo Cremer, Dipl.-Ing. CREMER Thermoprozessanlagen GmbH Auf dem Flabig D-52355Dueren, Germany
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Preface

Conveyor Belt Sintering Furnaces are the backbone of the PM industry since the early days. Ever since engineers are trying to push the limits of the Conveyor Belt Furnace towards high-temperature, a lot of different approaches have been made to increase the maximum sintering temperature from 1.150°C towards 1.200°C. Especially the development of new parts are requiring higher densities and higher sintering temperature, but in parallel also the costs has to be reduced by cheaper raw materials and less production steps. The recent developments in powder alloys require as well higher temperature. Sintering a chromium-alloyed material at 1.180°C gives so much better mechanical properties than sintering at 1.120°C.
Regular high-temperature equipment is on the market since many years and is nowadays also equipped with sinter-hardening and annealing processes. But this equipment is fairly complex and is usually operated up to 1.280°C. A Conveyor Belt Furnace is less complex and if it can be operated at 1.180°C, it is sufficient for a lot of applications. The following essay describes a Conveyor Belt Furnace that meets the above mentioned demands.

General state of technology

Conveyor Belt Furnaces are widely applied in the industry. The product is put on a conveyor belt which is pulled through the furnace. The belt is running in strokes or continuously.
The furnaces are operating with an inert or reducing atmosphere. The plants are subdivided in several sections:

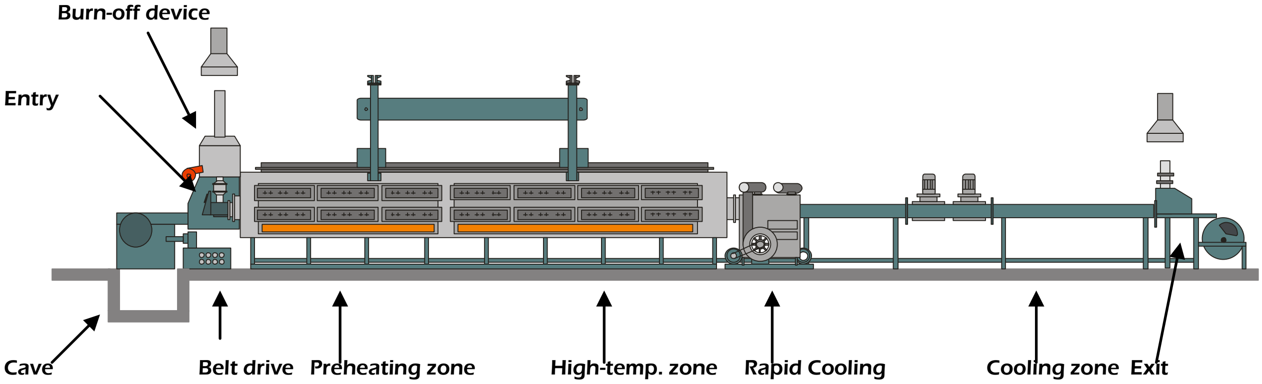
- Furnace entry
- Heat-up section (Dewaxing)
- High-temperature zone
- Cooling zone
- Furnace exit

Furthermore, special modules may be incorporated whereby the features of the P/M part can be improved (for example: Carburizing zone, Rapid cooling, Annealing zone).
Usually, a wire mesh belt of heat-resistant stainless steel is installed as conveyor belt, for example: DIN1.4841. But these belts are the reason for the restriction in max. sintering temperature. Usually at a belt load of approx. 65kg/m² and a temperature of 1.120°C in the high-temperature zone, a belt life of 6 months will achieved. Here, the length of the high-temperature zone and the total load of the belt is playing an important roll.

State of technology

Here, we would like to refer to our Conveyor Belt Furnaces which are on duty already more than 100 times. Relevant national and international furnace manufacturer are selling such furnaces since decades.

Here, you can see a side view of a Conveyor Belt Furnace of type: CBS-300-115/e, equipped with a belt of 600 mm width, made by CREMER for Sintering P/M-products under protective gas atmosphere.



Technical disadvantages

Furnaces as shown have their limitation in the max. operating temperature of the high-temperature zone (practicable at 1.120-1.150°C). The conveyor belt is losing exponentially strength with increasing temperature. Following, the belt load should not exceed approx. 70 kg/m² to reach economical endurances (3-6 months).

As described in the preface, many processes are applied in this temperature range. But for the most operators, a little bit more temperature would have an advantage to improve the quality and characteristics of the P/M parts. But the improved process conditions cannot be reached economical by usual Conveyor Belt Furnaces.

Previous solution ideas

To avoid the temperature limitation of the Conveyor Belt Furnace, several approaches have been acquired and tested in the past. But they all are going into the direction of improving the belt and his quality (ceramic, graphite, molybdenum, Super-Alloys…).

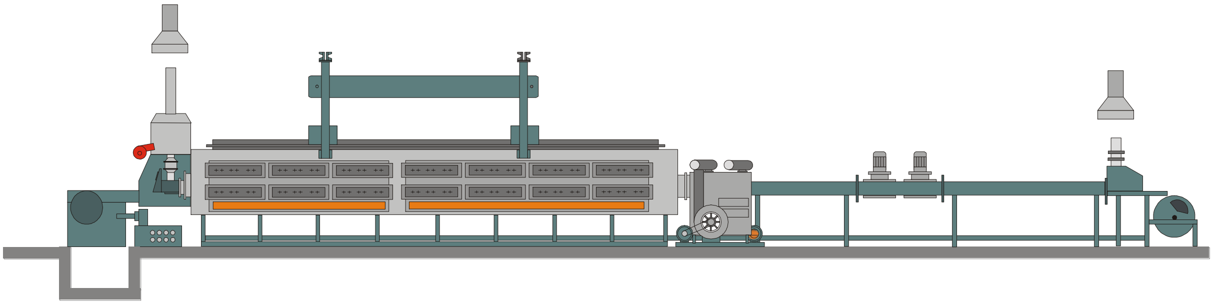
Hereby, partial successes have been reached, but mostly not used. Beneath technical reasons, mostly the economic efficiency is not given.

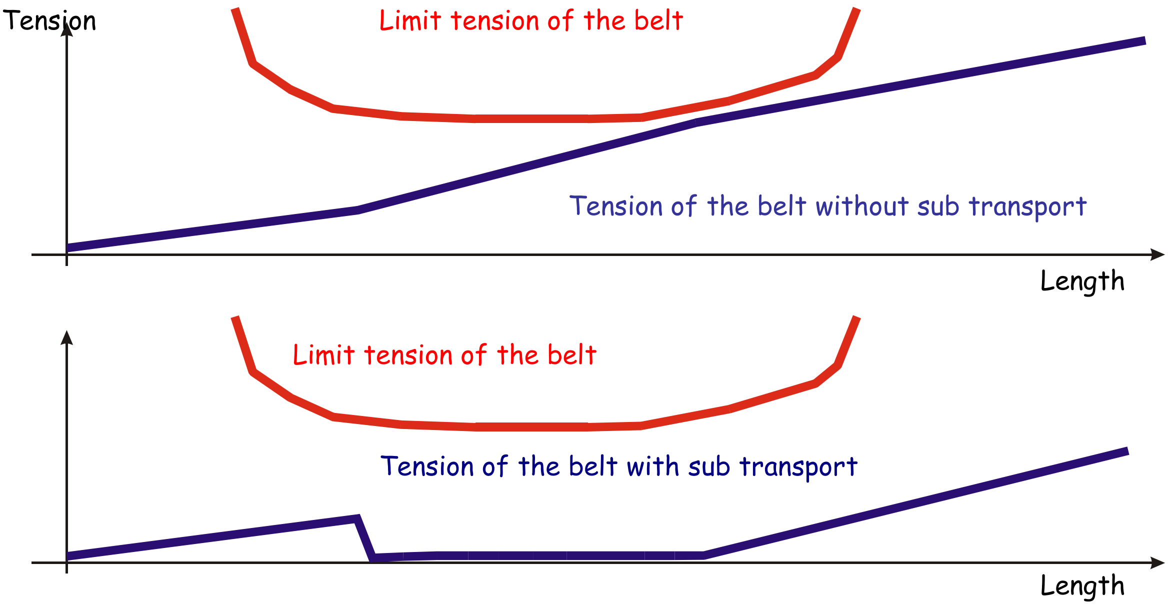
Parallel developments

At Walking Beam Furnaces, it is known that even at process temperature of up to 1.280°C pure iron trays can be used. Hereby, the tray is carrying only its own weight and the product. Assuming that, the consideration is arisen to support the conveyor belt in the high-temperature zone by a suitable transport mechanism.

General presentation of the invention, principle and effect

In the high-temperature area of a Conveyor Belt Furnace, a mechanism is installed below the conveyor belt to support the belt during the forward movement and following to cancel the friction between belt rest (muffle) and the belt. This way, the tension on the belt will be minimized in this area. A lower tension means a higher limit temperature or a longer life of the belt.



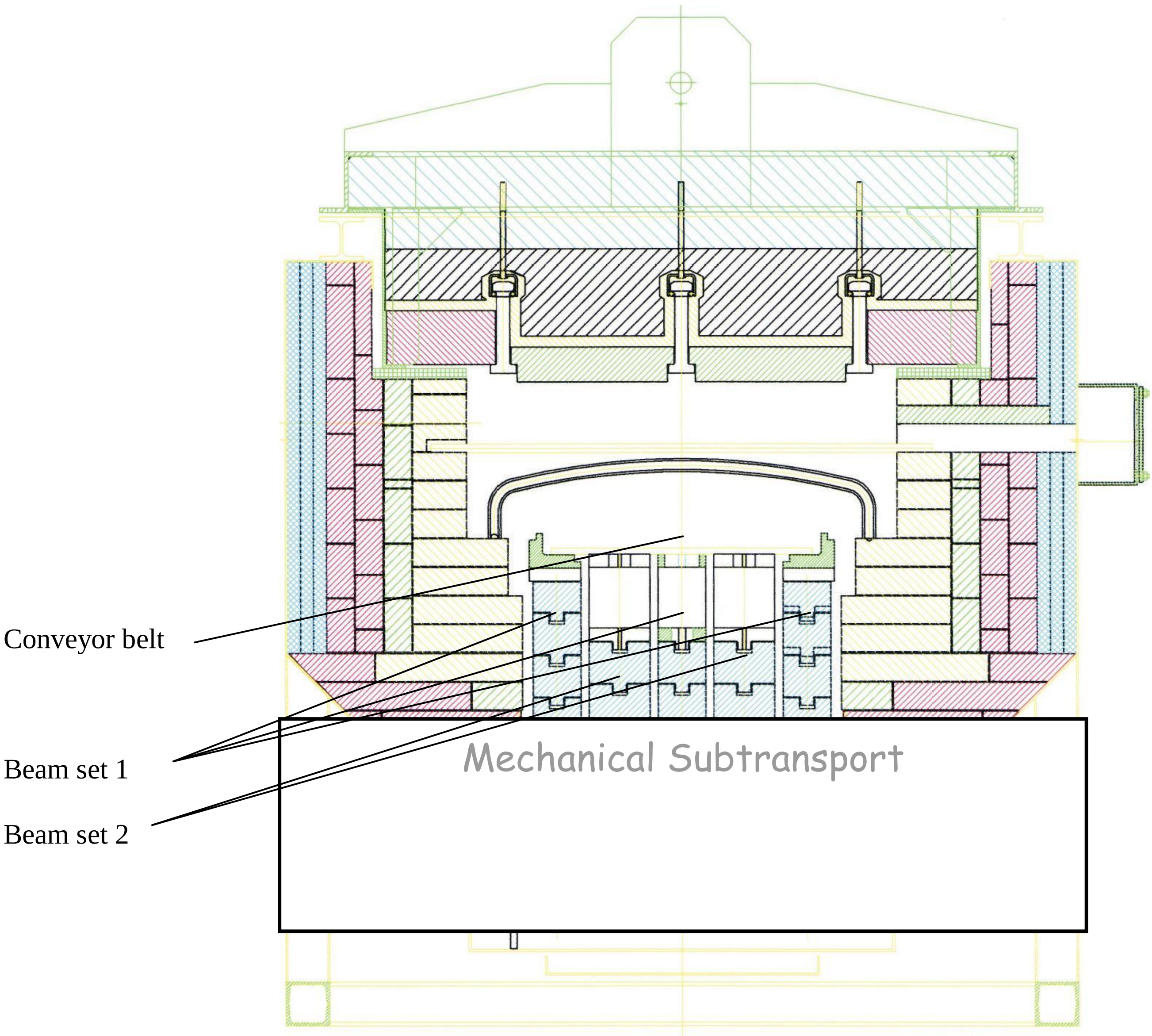


Schematic Diagram of the belt tension analogous to the measuring series

The first diagram shows the tension course in conventional furnaces. It shows that the belt tension is reaching nearly the limit.

In the second diagram, the belt tension in the high-temperature is taking over largely by the sub transport and the belt tension is clearly below the max. belt tension.

The mechanism consists of several support beams. Some are moving forward simultaneously with the belt in flow direction. Then, the belt and the first beam set stop. The belt is lifted up now by a second beam set and the first beam set is running back without the belt in flow direction. The second beam set is diving under the level of the belt and first beam set is driving forward again with the belt in flow direction. Additionally, the belt is driven externally with a conventional belt drive.



Advantages of the invention

By application of a mechanical sub transport, following advantages arise:

- Higher process temperature at identical belt life time and belt load
- Higher belt life at usual process temperature and identical charging
- Higher charging of the belt at usual process temperature and identical charging
- Simple plant technology can be applied at high-temperature processes
- More favorable plant investigation costs
- Simple automation by periphery aggregates

Achieved facts

This type of equipment is on the market since summer 2004 and has produced P/M pieces up to 1.200°C. The belt last 14 months and was producing 2.000t of parts. (Approx. 400kg/h) An other application is operating at 1.180°C for 8month with one belt and produces 500t of P/M parts. It can be said, that this new generation of furnaces offers at three times the lifetime of a belt at 1.120°C or 40% more lifetime at 1.180°C as conventional furnaces. In the future it will be investigated to use even cheaper belts.