OTTO JUNKER

Publication

SLE Pusher Furnace ®
Side **L**oaded **E**nergy
Saving Pusher Furnace ®

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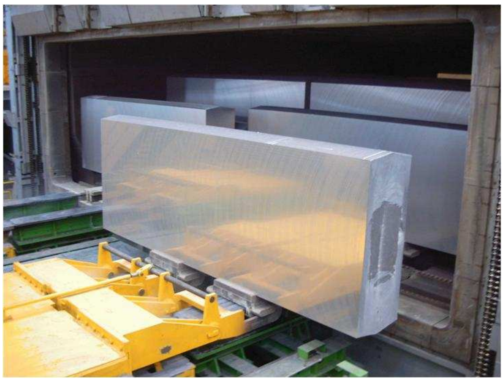
SLE Pusher Furnace ®
Side Loaded Energy Saving Pusher Furnace ®

A new generation pusher furnace for pre-heating and homogenizing aluminium slabs prior to hot rolling

1. Introduction

In aluminium hot-rolling, the slabs to be rolled are preheated to a 400 – 550 °C rolling temperature or else homogenized over a prolonged soak period at around 600 °C and then cooled down to this rolling temperature before entering the mill.

This process is carried out mainly with the aid of pusher furnaces, pit furnaces or - in rare cases –, bogie hearth or chamber-type furnaces. For new facility projects, the pit furnace plays a lesser role than its pusher-type counterpart today since new pit furnaces are erected mainly alongside existing ones or where a broad range of diverse slab formats needs to be rolled.

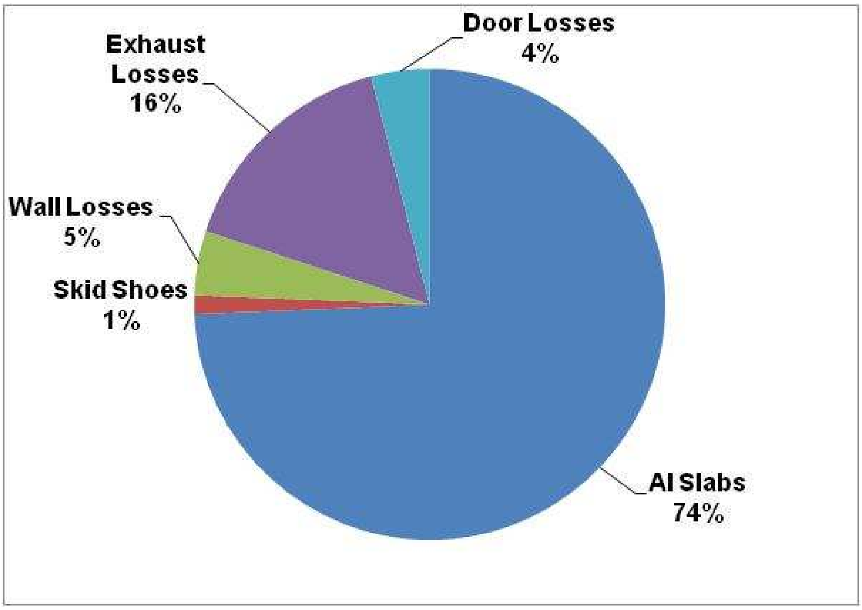


Example: Pusher furnace for 32-tonne slabs.

The equipment type most commonly employed nowadays for pre-heating and homogenizing slabs for hot rolling is the pusher furnace, which offers a number of design-inherent benefits such as fully automatic operation, high heating and cooling rates even at high throughput levels, and the lowest technical energy consumption of all furnace types mentioned above. Its low specific gas consumption is due to the high-convection heat transfer taking place at the maximum charge density, which is considerably greater than what can be achieved in a chamber or pit-type furnace.

The main part of the energy expended on the processes comes from the combustion of natural gas, LPG or other energy carriers. The amount of electric power consumed in the above processes is vastly lower, at around 6 – 8%, than the energy derived from the gaseous fuel (92 – 94 %) and shall therefore not be further considered herein.

The specific consumption of natural gas (Nm³ per tonne of aluminium) varies greatly with furnace size, slab dimensions and process-related parameters such as the target temperature and (if applicable) required soak time. In percentage terms, the portion of specific energy actually fed into the charge per tonne of aluminium may easily vary by as much as 8% in the same installation.



This diagram illustrates the distribution of energy flows associated with heating a medium-sized slab. In our example, the breakdown is as follows: charge (rolling slabs) 74%, dead load (skid shoes) 1%, idle losses (wall and feed-through losses) 5%, off-gas losses 16%, and door losses associated with charging and discharging operations 4%.

In this everyday industrial production application, the specific natural gas consumption amounts to less than 20 Nm³ per tonne of aluminium.

Further reductions in energy input – e.g., at the level of the insulation system, combustion technology and other technologies employed – are achievable only at the expense of significantly increased engineering sophistication that can only be recouped over long operating periods.

Today's state of the art has been attained via numerous progress steps and individual improvements, but without ever sacrificing the fundamental "pusher furnace" principle wherein slabs are charged and discharged via the front and rear furnace faces and travel through the furnace in a transverse orientation.

2. SLE Pusher Furnace ®

Otto Junker, the company's founder, had defined the corporate maxim of **"identifying all problems without bias, finding the solution through joint scientific and practical enterprise, and supplying the result to the customer in the form of quality products."**

True to this mission statement, Otto Junker GmbH has now added an innovative design to the classic pusher furnace concept. In the SLE pusher furnace, additional energy savings are achieved by charging and emptying the furnace via the side walls.

A conventional pusher furnace is charged and emptied via its front and rear faces, and the slabs travel continuously through the furnace in an upright position, standing crosswise on their narrow edges. The furnace door openings are enormous, covering surface areas of as much as 30 sq.m. and more. Since the hot furnace operates at temperatures up to 650 °C, substantial amounts of heat will radiate away through these huge door openings – an issue not to be neglected, among other things, from a safety engineering aspect.

Front view of a conventional-type pusher furnace. The picture is dominated by the large door opening and the massive door.

In the SLE pusher furnace, the slabs enter and exit the furnace longitudinally (instead of transversely), but still in an upright position, through the furnace doors. The furnace is charged and discharged via its side walls. In the following sketches the open door surface is highlighted in white. A comparison between the standard pusher furnace (above) and the SLE unit (below) clearly illustrates the size ratio between the doors of both designs.

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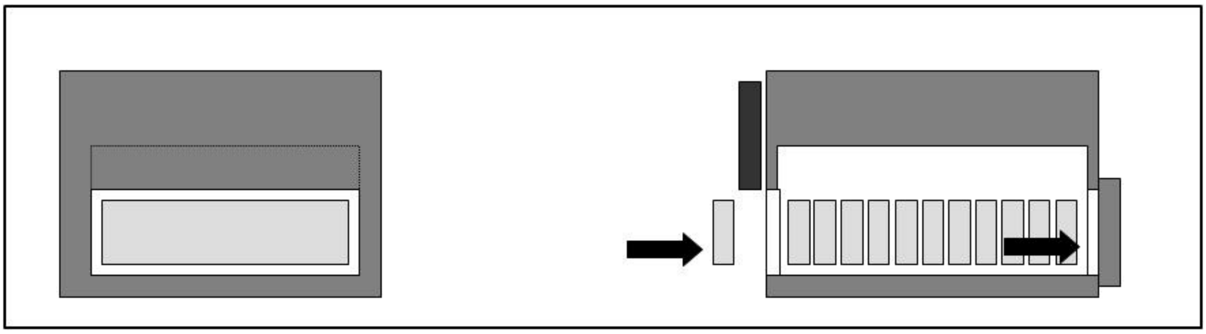
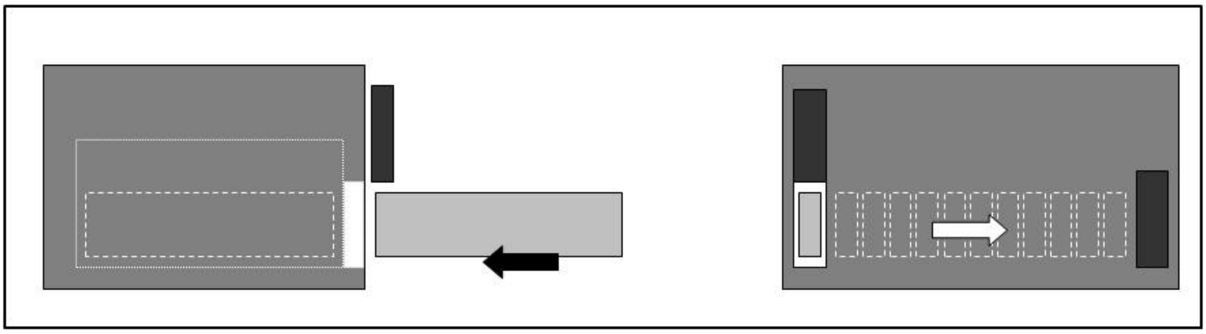


Schematic of a standard furnace. Left: front view showing the door opening and slabs inside the furnace. Right: longitudinal section through the furnace with an open charging door and closed exit door.



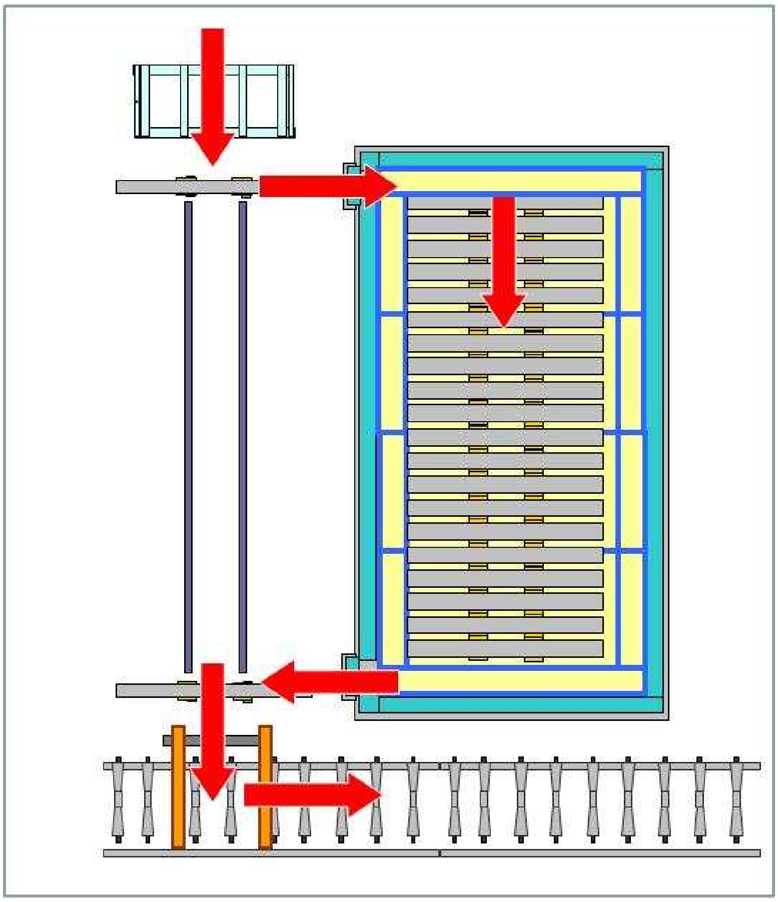
SLE pusher furnace. Left: front view with side door. Right: side view with open charging door and closed exit door.

Depending on the furnace size, which is determined by the slab dimensions and the number of slabs per charge, the door surface area is reduced by a factor of 5 – 10. In addition to their diminished size, the doors are arranged in the side wall and hence, no longer lie in the main airflow direction. Their position in this low-flow region makes for a further reduction in door losses. In pre-heating operation, savings of around 3% - 6 % (depending on load sizes and process) in total energy consumption are thus realized.

The smaller door openings thus provide for (a) a reduction in door losses during charging and discharging, (b) higher zone temperatures during charging and discharging, and (c) slightly reduced heat-up times and somewhat increased throughput rates for an otherwise identically equipped furnace.

3. Structure of the SLE pusher furnace system

The following top view shows an SLE pusher furnace with a charging station for placing and centering the slabs on the skid shoes. The slabs stand upright on their longitudinal edges as they are pushed laterally into the furnace by the charging machines. At the exit station, they are removed from the furnace on the same principle. A centrally arranged up-/ downender places them in the middle of the roller table which conveys them to the mill.



Needless to say, multiple SLE pusher furnaces can be arranged alongside one another. Charging machine solutions have likewise been progressed to production maturity by this time.

For inherent design reasons, the layout of the SLE pusher furnace involves a wider yet shorter footprint, so the overall effect in terms of floorspace needs is a neutral one. Where the equipment is to be arranged transversely in the mill bay, its reduced length requirement will be found particularly convenient. Especially in greenfield site projects the SLE technology is easy to integrate lengthwise, side by side with the long mill roller tables, allowing aluminium manufacturers to benefit effectively from energy savings.

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4. Further energy savings through slab-preheating in combination with an SLE pusher furnace

Heat losses via the off-gas account for a much larger part of the gas consumption than door losses and have remained fairly high despite sophisticated recuperative burner technology. Otto Junker addresses this issue via another development in which the rolling slabs are pre-heated in special preheat chambers using thermal energy recovered from the furnace off-gas. Ideally, the slabs can be heated to a temperature of around 100 ℃ with this technology.

By combining the SLE pusher furnace with preheat chambers adapted to this furnace type, further significant gains in energy efficiency can be realized. The overall reduction in total energy consumption (electric and gas) achievable with this preheating technology lies in the region of up to 14%.

Otto Junker will be glad to present the new SLE Pusher Furnace with or without preheat chamber to you in person while identifying the options for your specific application and discussing implementation potential application routes and ROI scenarios.

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