BLAST FURNACE DESIGN
A PROVEN PHILOSOPHY FOR LONG CAMPAIGNS AT HIGH PRODUCTIVITY FOR LOW COST HOT METAL

DANIELI CORUS

Blast Furnace Design Philosophy

Building or renovating a Blast Furnace plant requires considerable capital expenditure, having obvious consequences for the owner's cost per ton of hot metal. However, many of the performance indicators of the Blast Furnace, such as availability, lifetime and the ability to operate on a wide variety of raw materials, translate into value, eventually reducing hot metal cost.

The furnace's internal dimensions and profile determine its maximum annual production, given the availability of raw materials and maximum levels of coal injection and hence oxygen enrichment.

The Danieli Corus design philosophy for Blast Furnaces is oriented towards maximized performance by securing that throughout the campaign, the internal profile remains as close as possible to the profile as it was at the time of blow–in. The design is optimized based on an analysis of the various thermal, chemical and mechanical attack mechanisms per area. These attack mechanisms can be predicted depending on the chosen mix of raw materials, burdening practice and other process parameters.

In general, the lining design is focused the formation of a solidified layer of slag and burden materials that will reduce the effects of these attack mechanisms considerably. In addition, a number of areas that are critical for achieving the goal of maximized value of the furnace are identified.

Throat Armor
Failure of the throat armor has a significant detrimental effect on burden distribution on the stockline and directly below. Irregular burden descent and compromized process stability are known consequences. The throat armor design should be optimized with respect to resistance to spalling, temperature fluctuations, stress cracking, fatigue and abrasion/erosion.

Bosh, Belly and Stack
The bosh area is severely loaded by the descending burden it carries and the raceway gases in its vicinity. The belly and stack are exposed to heat loads and severe abrasion.
In some cases, the cooling body and lining wear down to critical levels far too soon after blow in, inducing a risk of breakouts. In the bosh area, it also means that the burden is carried by the tuyere noses and jumbo coolers, causing highly frequent unprepared stops.
The Danieli Corus bosh and stack design, consisting of copper plate coolers and high conductivity graphite along with protective silicon carbide in the upper areas, transfers 95% of the heat load onto cooling water, securing that the shell temperature remains under 50°C. It is expected to achieve endless campaigns, given conditions found in furnaces after over 20 years in operation.

Hearth
Given the long life of the furnace's bosh and stack, campaign length is now dictated by hearth life. Liquid flows introduce considerable wear through mechanisms such as erosion and carbon dissolution. Also, structural integrity of the hearth is likely to be compromized since e.g. expansion during heat–up can cause displacement. Through field observations and ceramics research, Danieli Corus has been able to improve hearth design to its current level, allowing for hearth campaigns between 15 and 20 years.

Taphole
The Taphole is exposed to an extremely dynamic environment. Not only are temperatures and pressures high, chemical attack is substantial and frequent drilling and plugging of the taphole make circumstances even more complicated.
At some furnaces, sufficient hot metal for the production of up to 20,000 average passenger cars is removed through relatively small diameter holes every single day. Designing the ultimate taphole, capable of facilitating this operation for periods up to 15 years, is one of the most demanding challenges imposed upon plant builders.
Today, optimum results can be achieved with superior cooling of the shell around the taphole, a redundant lining design and sufficient monitoring capability.

Reference Plants

	JSPL Raigarh No. 2	Corus IJmuiden No. 6	US Steel Gary No. 14	Nucor Steel Louisiana No. 1	SAIL RSP No. 5	Corus IJmuiden No. 7	AMK Alchevsk No. 2
Hearth Diameter (m)	8.4	11	11.74	12	13.2	13.8	13.8
Working Volume (m^3)	1460	2328	3244	2868	3470	3790	3790
Inner Volume (m^3)	1681	2678	3663	3310	4060	4450	4450
Productivity (tHM/m^3WV.d)	2.8	4.0	3.1	3.0	2.3	3.3	2.5
PCI (kg/tHM)	120	255	180	250	150	250	180
	Identical furnaces built for JSW and BSSL						

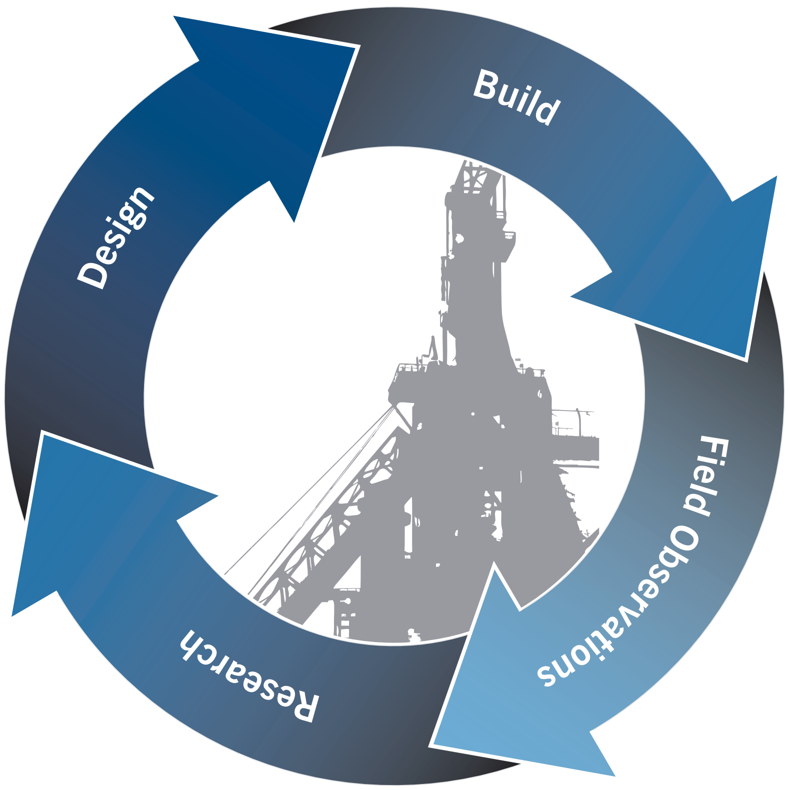
Field Observations in the Development Cycle

In the steel industry, performing the test phase that is part of the development cycle is usually only possible on a lab scale. As an essential replacement, Danieli Corus uses field observations to improve technology. Furnace conditions and process parameters are monitored during operation and analyzed. Also, post mortem analysis is conducted during repairs or outages. These observations are fed back to research models and if these support the observations, existing technology is improved or written off as “proven failure”.

This is how our Blast Furnace designs have become capable of achieving exceptionally long campaigns at high productivity. These achievements are proven by the condition of furnaces that are taken out of operation for hearth repairs (see pictures, taken after 16 and 15 years into their respective campaigns).

This philosophy applies to both construction projects and repairs. In the latter case, the performance of the existing design will be analyzed and details will be used to develop an optimum design for the repair project.

This approach eliminates repeat failure while ensuring that the client is always offered the best solution for the given circumstances instead of off the shelf technology.




Corus IJmuiden No. 6 in 2002 after 16 year campaign
No repairs required in shown area


Corus IJmuiden No. 7 in 2006 after 15 year campaign
No repairs required in shown area

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