The story of the Linz-Donawitz process

A development which has changed the world

voestalpine
ONE STEP AHEAD.

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Introduction

After the Second World War it took some time for a decision to be reached on what should be done with VÖEST AG, the former "Hermann Göring-Werke" plants in Linz. Nobody could have imagined then the breakthrough would take place here: an innovation that would revolutionize the production of steel.

Even on June 25, 1949, when Austrian engineers from VÖEST in Linz achieved this breakthrough following lengthy preparatory work on the LD process both at home and abroad, there was no evidence of the international success that would be achieved within a relatively short period of time.

"No single event in the brief history of VOEST has defined its corporate image and its ongoing development to such a degree."[1] The early post-war years, in fact the entire period until the commissioning of the world's first LD steel plant in Linz in 1952, were difficult. Uncertainties arose and there were massive differences of opinion, but a pioneering spirit prevailed and courageous decisions were taken. The mood could be summed up briefly as "There's no turning back now!" After the commissioning of the world's first two LD steel plants in Linz and Donawitz, the LD process soon gained a foothold elsewhere. The Austrian steel industry, and more specifically the plants in Linz, expected great things from the new steel production process, and a start was also made without delay on marketing it abroad. These hopes were more than fulfilled. Although developed to production maturity, the process naturally had a number of obstacles to overcome, but there was now no stopping its progress throughout the world.

On May 5, 1945 US soldiers seized the "Hermann Göring-Werke" plants in Linz, declaring it to be "German property". They were renamed and split off from Alpine Montan. On July 16, 1946 VÖEST AG was handed over by the Americans to the Republic of Austria in its capacity as trustee. This corporation and others, notably Österreichisch-Alpine Montangesellschaft (ÖAMG), were nationalized on July 26, 1946.

Work began as soon as the war ended on clearing up damage step by step and provisionally starting up individual plants.

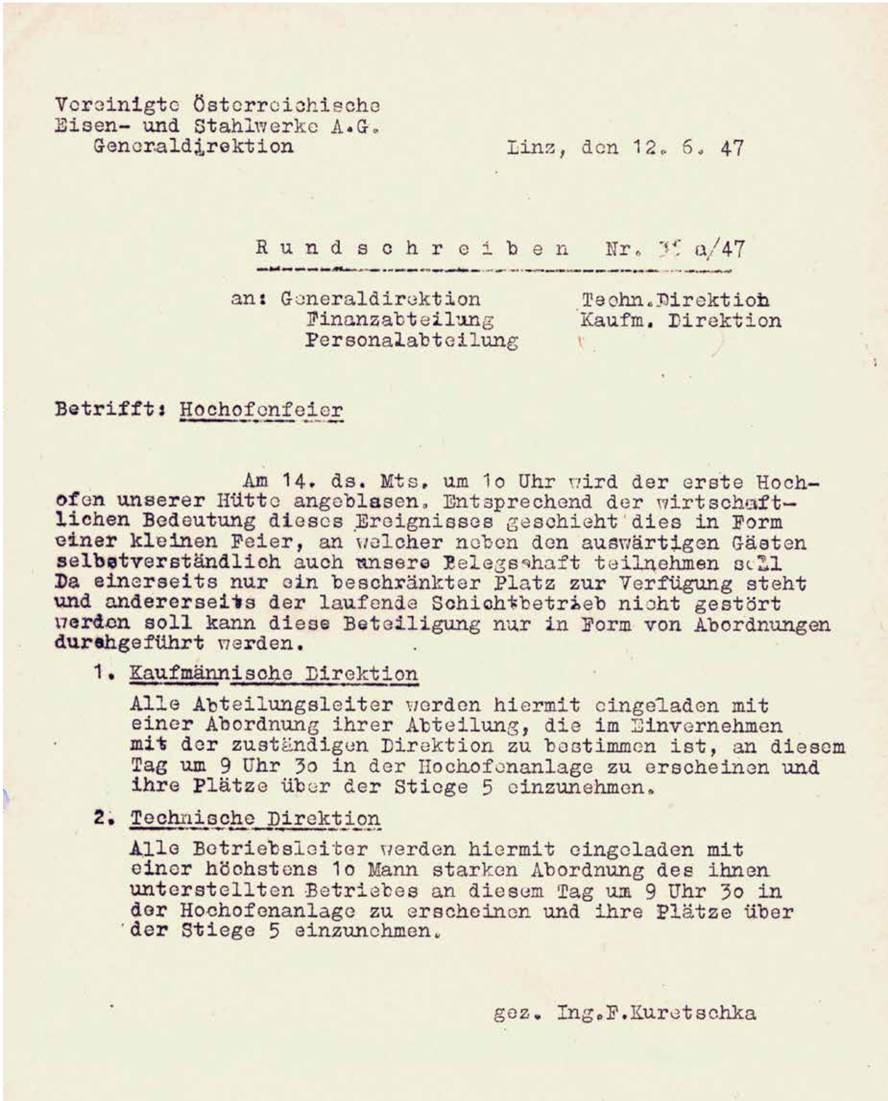
"The transition from production for the armaments industry to production for peaceful purposes, and indeed the whole question of the company's survival, proved to be very complex. There were diverging interests that remained unresolved for some time, including the question of whether the Americans would call for the plant to be disassembled. ... Despite such problems, work began as soon as the war ended on clearing up damage and provisionally starting up individual plants. The plant as a whole was just a torso: although it had six blast furnaces that had survived American bombing raids satisfactorily, the steelmaking plant and rolling mill had been constructed as temporary measures to keep the war economy going. … The decision to keep the Linz plants in operation necessitated a determined investment outlay, since rebuilding alone was not the whole story: extensions were also needed in order to remain competitive."[2]

The US authorities commissioned an expertise by the US metallurgical expert William E. Brewster. This tipped the scales in favor of expanding VÖEST and for the investment project using Marshall Plan funds.[3]

Following the Second World War the situation facing the Austrian iron and steel industry called for the adoption of a new, improved crude steel production method. "For the Linz steelworks, the modern steel plant operated by Eisenwerke Oberdonau was too small, and geared to the production of armaments."[4]

Low-priced iron ore was obtainable from the Erzberg mine in Styria, but there was no energy available in any form, materials to generate it or steel scrap. For these reasons and, as already implied, on account of conflicting interests, some thought was given to shutting down steel production in Linz, although forecasts suggested that the national post-war rebuilding program would stimulate strong demand for steel.[5]

The Austrian Iron and Steel Plan of 1948[6] was "a general plan for the medium-term development of the steel industry".[7] For both Linz and Donawitz it proposed "the introduction of an 'oxygen converter steelmaking process' not previously employed by the Austrian iron and steel industry (…)."[8] What led to this decision? For a start, the amount of scrap available in Austria was not sufficient to achieve the targeted total crude steel volume of 1.07 million metric tons annually by conventional means such as the Siemens-Martin or electric arc furnace.[9] In addition, the intention was to concentrate commercial sheet metal production in Linz, where modern blast furnaces were installed[10] and to construct an American-designed semi-continuous wide strip mill for the production of high-quality sheet. ÖAMG, it was proposed, should concentrate on the production of sectional material. It is also important to remember that for the Austrian special steel industry with its electric arc furnaces, the use of steel scrap was considered "essential".[11]


Vereinigte Österreichische
Eisen- und Stahlwerke A.G.
Generaldirektion

Linz, den 12. 6. 47

Rundschreiben Nr. 36 a/47

an: Generaldirektion
Finanzabteilung
Personalabteilung
Techn. Direktion
Kaufm. Direktion

Betrifft: Hochofenfeier

Am 14. ds. Mts. um 1o Uhr wird der erste Hochofen unserer Hütte angeblasen. Entsprechend der wirtschaftlichen Bedeutung dieses Ereignisses geschieht dies in Form einer kleinen Feier, an welcher neben den auswärtigen Gästen selbstverständlich auch unsere Belegschaft teilnehmen soll. Da einerseits nur ein beschränkter Platz zur Verfügung steht und andererseits der laufende Schichtbetrieb nicht gestört werden soll kann diese Beteiligung nur in Form von Abordnungen durchgeführt werden.

1. Kaufmännische Direktion

Alle Abteilungsleiter werden hiermit eingeladen mit einer Abordnung ihrer Abteilung, die im Einvernehmen mit der zuständigen Direktion zu bestimmen ist, an diesem Tag um 9 Uhr 3o in der Hochofenanlage zu erscheinen und ihre Plätze über der Stiege 5 einzunehmen.

2. Technische Direktion

Alle Betriebsleiter werden hiermit eingeladen mit einer höchstens 1o Mann starken Abordnung des ihnen unterstellten Betriebes an diesem Tag um 9 Uhr 3o in der Hochofenanlage zu erscheinen und ihre Plätze über der Stiege 5 einzunehmen.

gez. Ing. F. Kuretschka

Circular 36a/47 issued by the VÖEST Executive Board for a blast furnace celebration on June 12, 1947.

VÖEST blast furnace.

For the Austrian special steel industry, the use of steel scrap was "essential".

Among the advantages which it was hoped would be achieved with a new steel production process were reducing reliance on imported scrap, the ability to increase the proportion of pig iron, high quality in the "production of sheet, rails and wire", lower investment costs and a competitive position on international markets. It was evident that costs would have to be cut in order to stay competitive. These requirements ruled out the Siemens-Martin and Thomas processes from the outset, but also posed a problem for the electric arc furnace on account of the problematic energy supply situation at that time.[12] Clearly, new approaches would have to be sought. Further expansion was considered desirable in view of the shortages of energy and raw materials all over Europe.[13] In 1948, when it was decided to build a wide strip mill, the steelworks capacity also had to be increased in order to keep it supplied.[14]

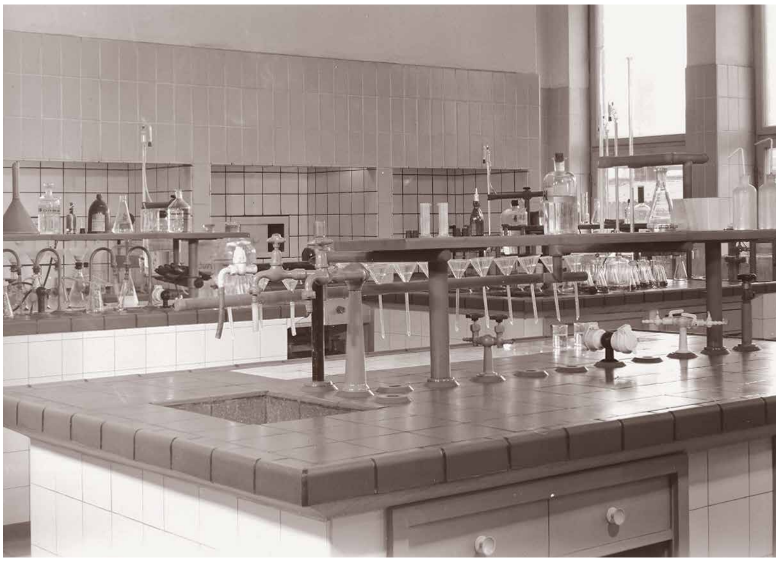
A series of experiments began on June 3, 1949 on the former VÖEST site, using a 2-tonne experimental converter. However, if one goes back as far as the middle of the 19th century, one finds that Henry Bessemer, the Englishman who developed the air refining process, what we now know as the Thomas process, was already considering the use of pure oxygen.[15] At that time no method of making sufficient oxygen available had been found. Such a method did not become practicable until in 1928, when the company Linde succeeded in developing a method (the Linde-Fränkl process) for supplying pure oxygen in large quantities.[16] Oxygen also became very much cheaper, so that both preconditions for introduction of the LD process were fulfilled.[17] In both Europe and the USA, experiments with oxygen were carried out repeatedly. Among those who worked with high-purity oxygen was Otto Lellep, but his concept of "blowing oxygen vertically onto a bath of pig iron" proved unsuccessful.[18] Hubert Hauttmann, who took part in Lellep's experiments between 1936 and 1939 at the Gutehoffnungshütte, where he was employed at that time, commented:

> The intention was to convert pig iron by blowing in pure oxygen through a nozzle in the base of the converter. The steel produced in this way was of miserable quality. [19]

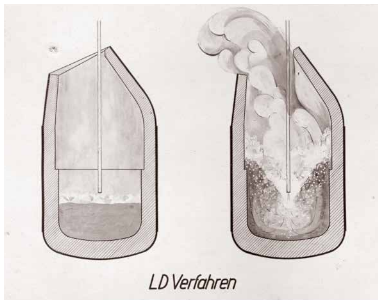
Carl Valerian Schwarz, an employee of the company Hermann A. Brassert, submitted a patent application in 1939 for blowing oxygen into the bath at supersonic speed. But this method too was "not yet capable of producing usable steel".[20] Although the later Linz-Donawitz (LD) process had similarities with Schwarz's patent, its typical features were different (for example "central, vertical blowing").[21] It is surely due to the outbreak of war that the technology described in Schwarz's patent did not lead initially to any practical applications.[22] It was also at the end of the 1930s that the Swiss Professor Robert Durrer began experiments of his own. [23]

A series of trials with a 2-tonne experimental converter began in 1949 on the site of the former VÖEST.

Pictures of the VÖEST 15-tonne experimental LD converter in Linz.


A steelworks laboratory in the 1950s.

After the war a German and a Swiss, Heinrich Hellbrügge and Robert Durrer, began further experiments in the Swiss town of Gerlafingen (where Durrer was Technical Director of the Roll'schen Eisenwerke (Roll AG iron works) from 1946 to 1959). It was Durrer who laid down the basic theoretical principles and "advised VÖEST to blow the oxygen from above in a separate crucible".[24] This was after contact had been established between Gerlafingen and VÖEST with a view to industrial-scale technical cooperation.[25]
A series of experiments was started on June 3, 1949 on the premises of VÖEST, as it was then, using a 2-tonne experimental converter. After the team in Linz had suffered several initial setbacks, a breakthrough took place as early as June 25, 1949, when the oxygen pressure was lowered and the tip of the blowing lance was moved farther away from the bath, so that the oxygen jet could not penetrate so far.[26] "Steel that could be rolled into sheet without problems" was the result[27]. VÖEST's experimental department examined this steel and recorded a thoroughly positive verdict.[28] This was the moment when the LD process was born. The experiments continued until several hundred 2-tonne melts had been produced, after which they were switched to a specially constructed 15-tonne experimental converter erected in the open air. The first batch was produced on October 2, 1949.[29] The new grade of steel was subjected to continuous metallurgical and other tests.



LD crucible before and during oxygen blowing onto the pig iron bath.

In 2003 the former Head of Research and Development at voestalpine, Wilfried Krieger, wrote:

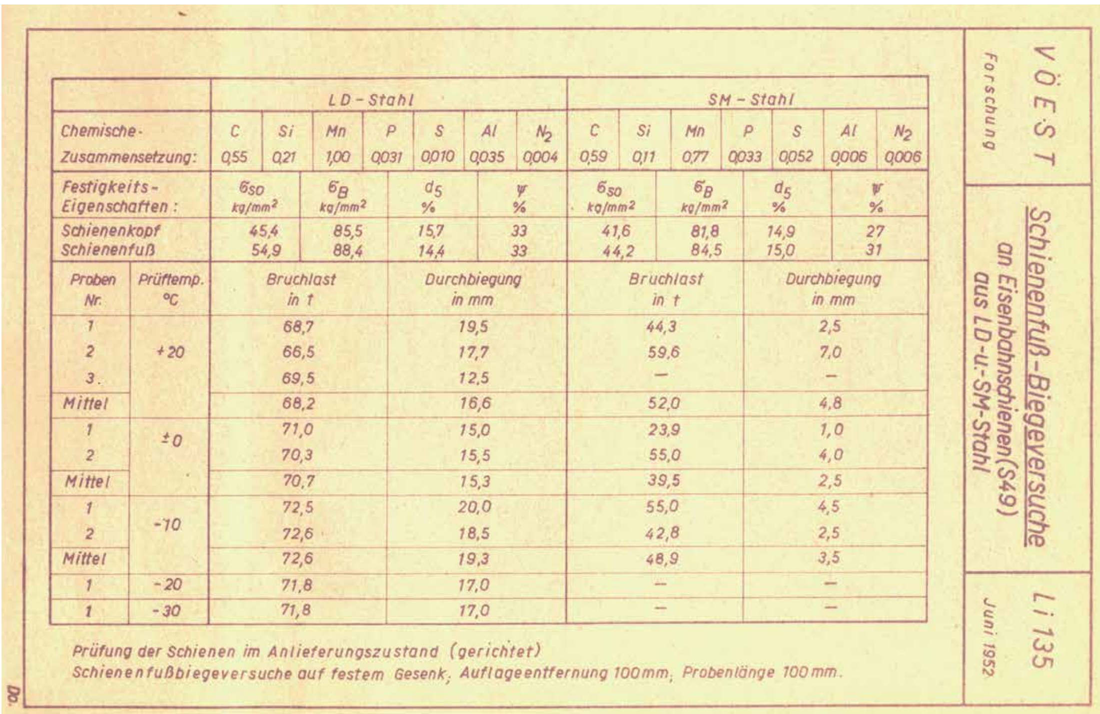
What was the key factor in this innovation? Until then it had been considered impossible to obtain sufficient bath movement without blowing the oxygen in at a greater depth. But this movement was achieved in a highly satisfactory way by the formation of carbon monoxide. The "soft blowing" principle promoted FeO formation and therefore the breakup of scale into the subsidiary elements P and S, which were absorbed by the slag. An excellent new grade of steel was born![30]

In addition to the Roll'schen Eisenwerke in Gerlafingen and VÖEST, Mannesmann AG in Duisburg-Huckingen and ÖAMG (i.e. Donawitz) also expressed interest in May 1949 in "the oxygen blowing process or at least oxygen metallurgy in general". During the experiments in Linz and after a demonstration of the process, a precise division of labor was agreed on June 17. VÖEST was to continue work with crude steel from Linz in a much

larger refining vessel; Mannesmann was to experiment with oxygen blowing of Thomas steel, Roll would investigate the use of oxygen in the electric arc furnace and ÖAMG would conduct tests with oxygen in a low-shaft pig iron furnace.[31]
The agreement obliged everyone concerned with this oxygen metallurgy “not to issue any statement or pass on any information outside their own companies regarding details of oxygen refining that came to their notice or conclusions they may have reached during the discussions in Linz on June 26 and 27, 1949.”[32]

The Donawitz engineers initially named their process “SK”, from the German initials for “Oxygen Converter”.

On the basis of the agreement it soon became evident from experiments in Donawitz that the use of oxygen in shaft furnaces was valueless, whereupon the company began to explore different approaches. The process developed in Donawitz for the recovery of slag with high manganese content by blowing with oxygen led to the awareness that only the use of a blowing process with pure oxygen should be considered


VÖEST
Forschung

Schienenfuß-Biegeversuche an Eisenbahnschienen (S49) aus LD-u.-SM-Stahl

Li 135
Juni 1952

	LD - Stahl							SM - Stahl						
Chemische-Zusammensetzung:	C	Si	Mn	P	S	Al	N_2	C	Si	Mn	P	S	Al	N_2
	0,55	0,21	1,00	0,031	0,010	0,035	0,004	0,59	0,11	0,77	0,033	0,052	0,006	0,006

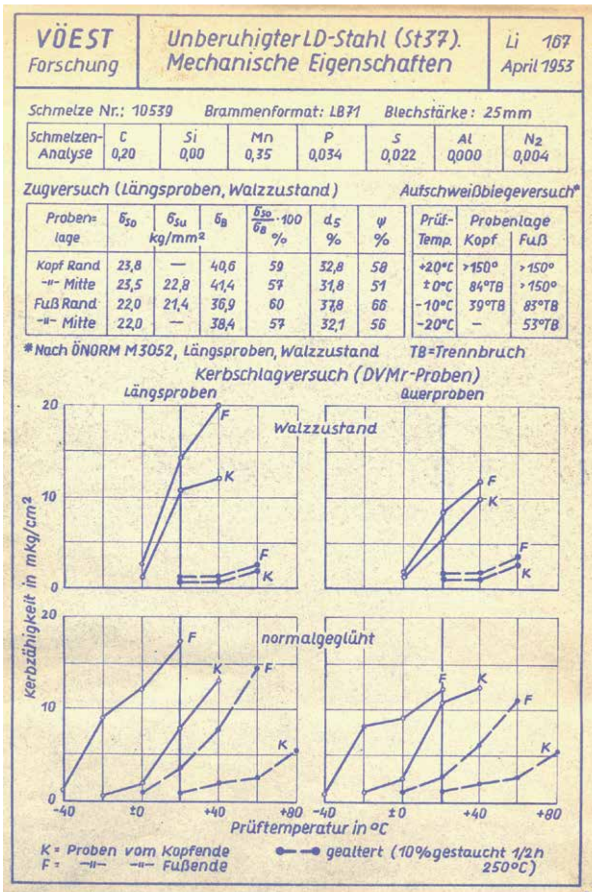
Festigkeits-Eigenschaften:	LD σ_{SO} kg/mm²	LD σ_B kg/mm²	LD d_5 %	LD ψ %	SM σ_{SO} kg/mm²	SM σ_B kg/mm²	SM d_5 %	SM ψ %
Schienenkopf	45,4	85,5	15,7	33	41,6	81,8	14,9	27
Schienenfuß	54,9	88,4	14,4	33	44,2	84,5	15,0	31

Proben Nr.	Prüftemp. °C	LD Bruchlast in t	LD Durchbiegung in mm	SM Bruchlast in t	SM Durchbiegung in mm
1	+20	68,7	19,5	44,3	2,5
2		66,5	17,7	59,6	7,0
3.		69,5	12,5	—	—
Mittel		68,2	16,6	52,0	4,8
1	±0	71,0	15,0	23,9	1,0
2		70,3	15,5	55,0	4,0
Mittel		70,7	15,3	39,5	2,5
1	-10	72,5	20,0	55,0	4,5
2		72,6	18,5	42,8	2,5
Mittel		72,6	19,3	48,9	3,5
1	-20	71,8	17,0	—	—
1	-30	71,8	17,0	—	—

Prüfung der Schienen im Anlieferungszustand (gerichtet)
Schienenfußbiegeversuche auf festem Gesenk; Auflageentfernung 100 mm; Probenlänge 100 mm.

Do.

Rail base bending tests on S49 rails made from LD and OH steel; VÖEST Research, June 1952.[35]



VÖEST Forschung	Unberuhigter LD-Stahl (St37). Mechanische Eigenschaften	Li 167 April 1953

Schmelze Nr.: 10539 Brammenformat: LB71 Blechstärke: 25mm

Schmelzen-Analyse	C	Si	Mn	P	S	Al	N_2
	0,20	0,00	0,35	0,034	0,022	0,000	0,004

Zugversuch (Längsproben, Walzzustand) Aufschweißbiegeversuch*

Probenlage	σ_{so} kg/mm²	σ_{su} kg/mm²	σ_B kg/mm²	$\frac{\sigma_{so}}{\sigma_B}\cdot 100$ %	d_5 %	ψ %	Prüf.-Temp.	Probenlage Kopf	Probenlage Fuß
Kopf Rand	23,8	—	40,6	59	32,8	58	+20°C	>150°	>150°
-"- Mitte	23,5	22,8	41,4	57	31,8	51	±0°C	84°TB	>150°
Fuß Rand	22,0	21,4	36,9	60	37,8	66	-10°C	39°TB	83°TB
-"- Mitte	22,0	—	38,4	57	32,1	56	-20°C	–	53°TB

*Nach ÖNORM M3052, Längsproben, Walzzustand TB=Trennbruch

Mechanical properties of unkilled LD steel (St37); VÖEST Research, April 1953.[36]

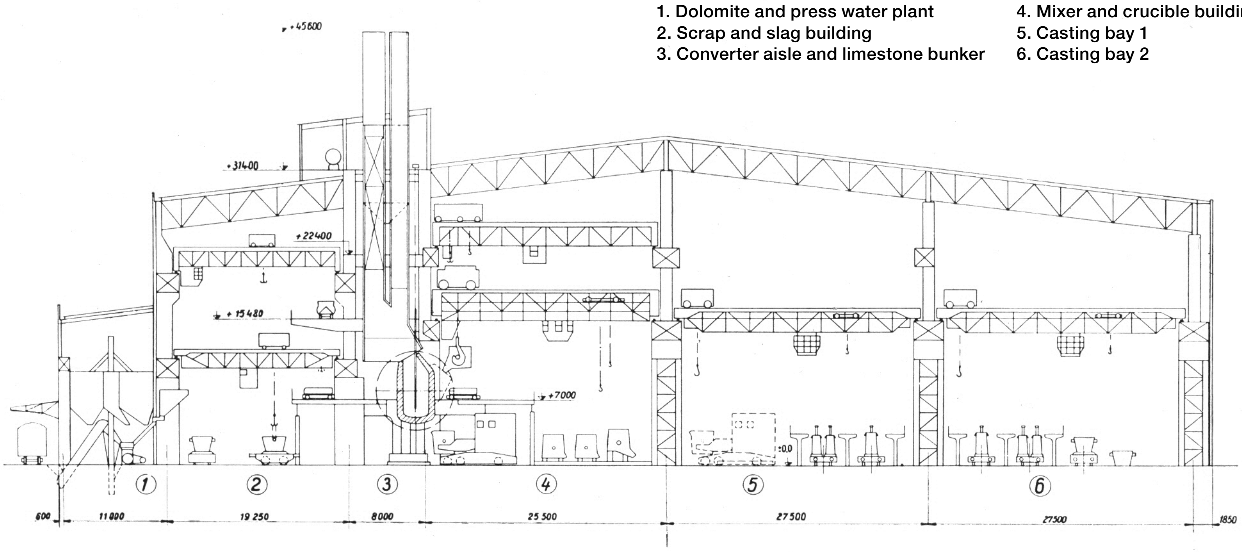
for the steel production expansion and rationalization plans in Donawitz. Following extensive investigation and successful development work on a 5-t or 10-t experimental setup ... with oxygen supplied during the first tests from cylinders arranged in series ... the company management decided to build a new steelworks, which would be ready for operation in two years.[33]

The Donawitz engineers initially named their process "SK", from the German initials for "Oxygen Converter". This term helped distinguish the activities of VÖEST and ÖAMG to a certain extent.[34]

At the eighth international LD workshop in 1977, the former managing director of VÖEST-ALPINE[37], Herbert Koller, remarked:

Pressure to succeed and pursue new paths was combined with a lot of luck or, to use a more modern word, forced us to innovate.[38]

On December 9, 1949 the then managing director Heinrich Richter-Brohm (who was public trustee from August 2, 1947 to August 12, 1950) took a decision not without risk: to build the first LD steelworks.[39] Not long after this, "after clarification of questions concerning production methods for harder grades of steel", it was decided to build an LD plant in Donawitz as well.[40] The first patents were applied for in 1950.

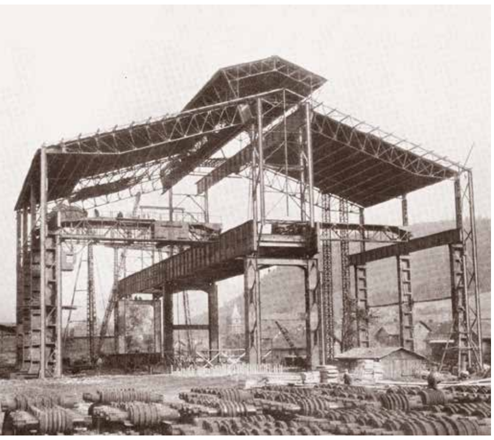


VÖEST LD Steelworks 1; section through crucible building.[41]
1. Dolomite and press water plant
2. Scrap and slag building
3. Converter aisle and limestone bunker
4. Mixer and crucible building
5. Casting bay 1
6. Casting bay 2

VÖEST LD Steelworks 1 under construction.

In the 1951 annual Research and Quality Assurance report, the experimental department is referred to as follows:

> During the review year extensive research work was devoted to the LD steel grades, and a publication was issued. This type of steel is expected to possess great potential in terms of quality, and in particular will permit steel with a high-quality surface combined with good cold formability to be produced. This is especially important for thin sheet metal production, where until now good cold formability was only possible if certain surface flaws were accepted (killed steel grades). But steel with higher yield strength can also be produced extremely advantageously by the oxygen refining process.[42]



Construction work in progress on the LD Steelworks building for the Österreichisch-Alpine Montangesellschaft in Donawitz.

By 1951 it proved possible to "develop the refining of pig iron with pure oxygen in steelmaking into an innovative, operationally reliable process for the production of bulk quality steel" in Linz.[43] Trade and industry experts were informed about the new process for the first time in December 1951, at the Conference of "Eisenhütte Österreich" ("Austrian Society for Metallurgy") in Leoben ("Steel Refining with Pure Oxygen").[44] At the beginning of the discussion at this conference, Robert Durrer stated his point of view: "I am glad that the two metallurgical plants (Linz and Donawitz) have developed the concept of blowing high-purity oxygen onto domestic pig iron into a viable industrial process, and congratulate them on this great success.

On November 27, 1952 the first crucible was commissioned at LD Steelworks 1 in Linz – a milestone in the history of steel production.

Austria will surely be the first nation to produce steel on an industrial scale from pig iron by blowing pure oxygen."[45]

On November 27, 1952 the first crucible was commissioned at LD Steelworks 1 in Linz – a milestone in the history of steel production in general and of the oxygen blowing principle in particular. On January 5, 1953 this LD Steelworks, the first in the world, was officially opened by Austria's Federal President Theodor Körner. By June 17, 1953, LD Steelworks 1 in Linz had already produced 100,000 metric tons of LD steel, and early in December the same year the 250,000th metric ton was tapped.[46] The second LD Steelworks went into operation on May 22, 1953 at the Österreichisch-Alpine Montangesellschaft (ÖAMG) in Donawitz.[47] The process, now developed to full operating maturity, exceeded all expectations in both the quality of the steel it produced and its economic viability.[48] Its inventors also created a "new, positive legend in the post-war years."[49]

A brochure issued by VÖEST in the 1950s declares:

The exceptionally favorable metallurgical conditions in this process yield crude steel so free from oxygen that no deoxidation is needed. This is a low-gas, low-nitrogen steel, free from phosphorus, sulfur and unwanted accompanying elements. In its technical properties, especially cold formability, LD steel is clearly superior to open-hearth (SM) steel. The LD process can also supply structural steel grades of outstanding quality. LD steel has given excellent results in welded structures subject to very severe loads. Wide-strip coils of LD steel are being supplied in large quantities to cold rolling mills abroad.[50]

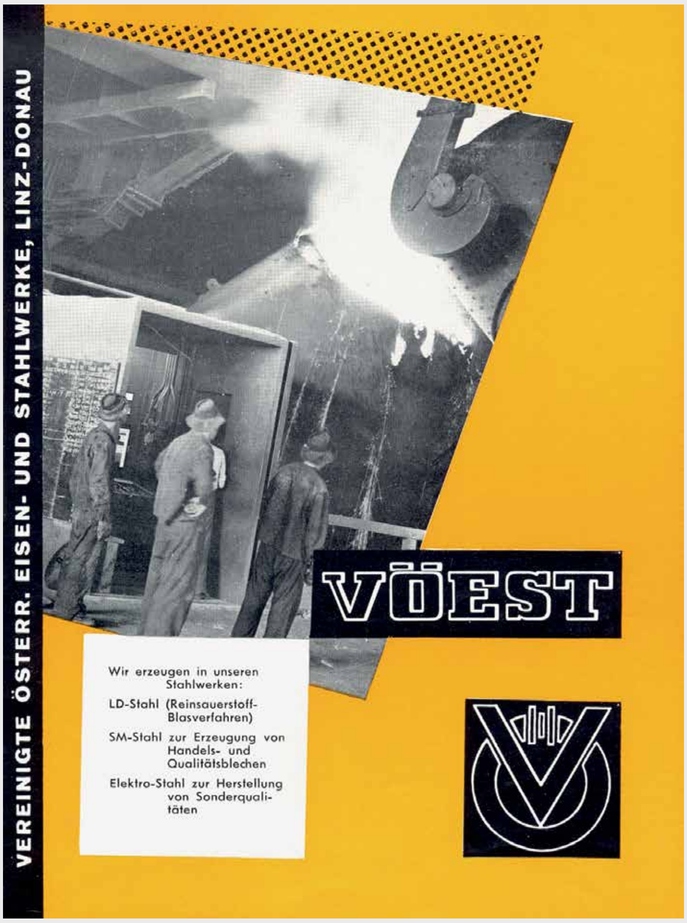
VÖEST's LD Steelworks 1.

Production of screw caps for oil cans from LD steel.

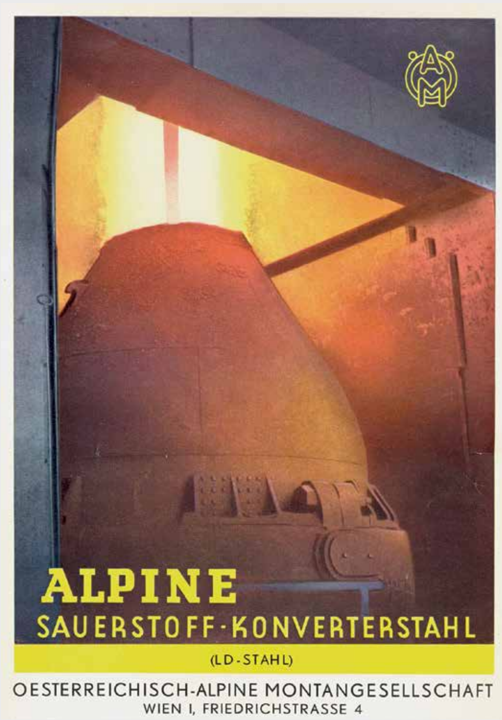
Bending test on a semi-circular tubular element, 1,200 mm diameter, welded from 40-mm gauge LD Aldur 47 structural steel plate (tensile strength 52 kg/mm²) and from St 60 open-hearth sheet steel sensitive to brittle fracture. The sudden fracture occurring during the bending test was absorbed by the LD steel plate close to the weld seam.[51]

The LD name

The abbreviation "LD" stands for "Linz-Donawitz", though as can be seen from a report dated December 9, 1949, "Linz-Durrer" was first suggested.[52] In an article that appeared in 1954, Herbert Trenkler wrote that the new process would be known as the "LD process" for short, and that this would stand (in German) for the "Linz nozzle process).[53] This term was also applied to the steelmaking method in another publication.[54] Hauttmann, on the other hand, held the view that the abbreviation had no specific meaning originally, or possibly stood for "Linz-Danube".[55] In due course the term "Linz-Donawitz process" became established. It first appeared only in 1958, the reason being that the company Donawitz, which "in 1953 had begun to produce oxygen-blown steel by a process similar to that used in Linz"[56], initially referred to "their" steel as ALPINE oxygen-converter steel[57] or SK steel for short. "The abbreviation LD for Linz-Donawitz which is customarily used today was not adopted officially until 1958."[58] Other publications[59] state that the name LD was chosen for the Linz-Donawitz product because VÖEST in Linz and ÖAMG in Donawitz had developed it to industrial-scale maturity.[60] Even today there is some disagreement about the original meaning of the abbreviation LD.



VÖEST advertising for the steelworks' products in 1957,
with pride of place given to "LD steel (pure oxygen-blown process)".



ÖAMG advertising for ALPINE oxygen-converter steel.

The research team

The research team in Linz consisted of Theodor E. Suess, technical director and test coordinator, Hubert Hauttmann, manager of the Experimental Department, Herbert Trenkler, director of the Steelworks, Rudolf Rinesch, who was in charge of the test series, and Fritz Klepp, manager of the steel mill.

Among the many prestigious awards received by the inventors of the LD process was the UNESCO Science Prize in 1972. It was presented to the members of the Linz and Donawitz teams (Otwin Cuscoleca, Wolfgang Kühnelt, Kurt Rösner and Felix Grohs) who played a major part in developing it.

The oxygen plant

Since an industrial-scale oxygen supply plant was needed before the LD process could be introduced, one was built about 500 meters from the LD steelworks. Within a year it became evident that a second oxygen plant of approximately the same capacity was needed. Since it was planned to extend the steelworks by adding a further crucible, a third oxygen plant was built without delay, so that in the future the two LD crucibles being operated by the LD plant could be supplied with oxygen.[61] When the new installations were planned, much attention was devoted to further increases in the purity of the oxygen, this being one of the factors determining the quality of the steel.

"Whereas the first plant supplied oxygen of 98.5 percent purity, the yield from the second plant was increased to 99.5 percent and of the third and largest plant to 99.6 percent."[62]

VÖEST Linz – a meeting of experts.
From left to right: DI Karl Zemsauer, Dr. Hubert Hauttmann, Dr. Theodor E. Suess, Prof. Robert Durrer, DI Heinrich Hellbrügge.

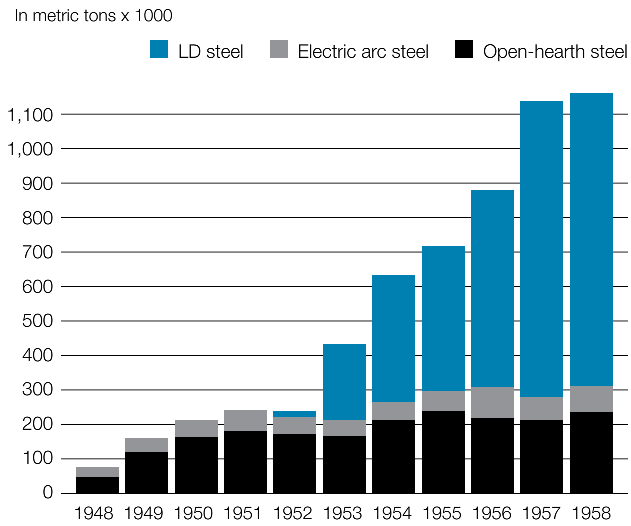
The wide-strip mill

Despite initial criticism of various kinds, the prospects for a wide-strip sheet steel mill to be supplied from the steelworks which were to be built were promising, but problems kept occurring nonetheless, for example approval by the ECA Steel Committee in Paris. The US military authorities also opposed the construction of a wide-strip mill, "since in the event of military confrontation it was not clear whether VÖEST would be taken over by the Soviets."[63]
Manfred Wirth, VÖEST's Commercial Director, received an offer from Peter Krauland, who was then Austria's Federal Minister for state-owned industry, to organize a fact-finding tour of the USA for Austrian steel experts. In the end, he was forced to make the journey alone, since despite intensive intervention on the part of the Austrian government and representations by US High Commissioner General Mark W. Clark, the experts he wished to participate were not granted entry visas for the USA.[64] In that country and in Canada, Wirth visited 18 wide-strip sheet steel production facilities.

The new wide-strip sheet steel line.

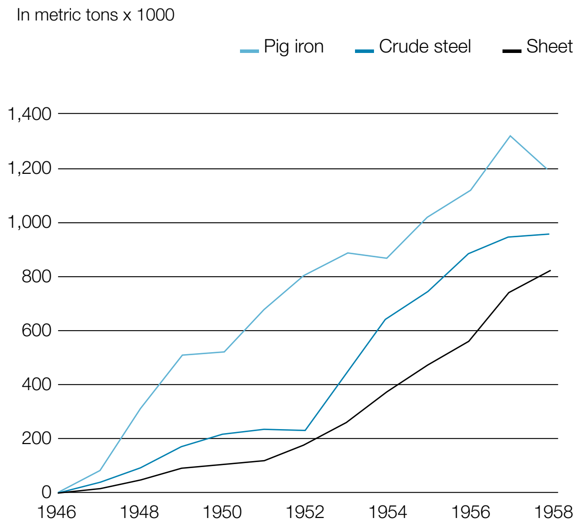
An unscheduled session of the ECA Steel Committee[65] was held in Paris in August 1949, in order to reach a final decision on European ERP wide-strip mill projects. Manfred Wirth, who had been visiting Italy to sell pig iron, traveled to Paris immediately but arrived late. He discovered that the Austrian wide-strip project was regarded as unconvincing and, in view of the ERP's limited budget, had been unanimously voted out of the ERP program, despite the fact that the Austrians already had a legally binding contract with the US company MESTA. According to Wirth, "a deposit had already been paid … this could no longer be canceled, or if it were, would have occasioned immense costs and bankrupted VÖEST, which was surely not the intention of the Marshall Plan." Wirth succeeded in getting the Austrian project put back on the agenda, and argued so persuasively that the majority of the delegates changed their mind and voted in its favor. Even after this, however, doubts were cast on the wisdom of such a major investment, since there was no guarantee that the plant's capacity would be fully utilized.[66] The steelworks using the new basic oxygen technique as projected in December 1949, however, called for a modern wide-strip mill to accept its output, and in view of this its capacity would have to be larger. As it turned out the wide-strip plant went officially on line together with LD Steelworks 1 on January 5, 1953.

VÖEST steel production



VÖEST steel production, 1948–1958.[68]

Pig iron, crude steel and sheet production



Pig iron, crude steel and sheet production, 1946–1958.[69]

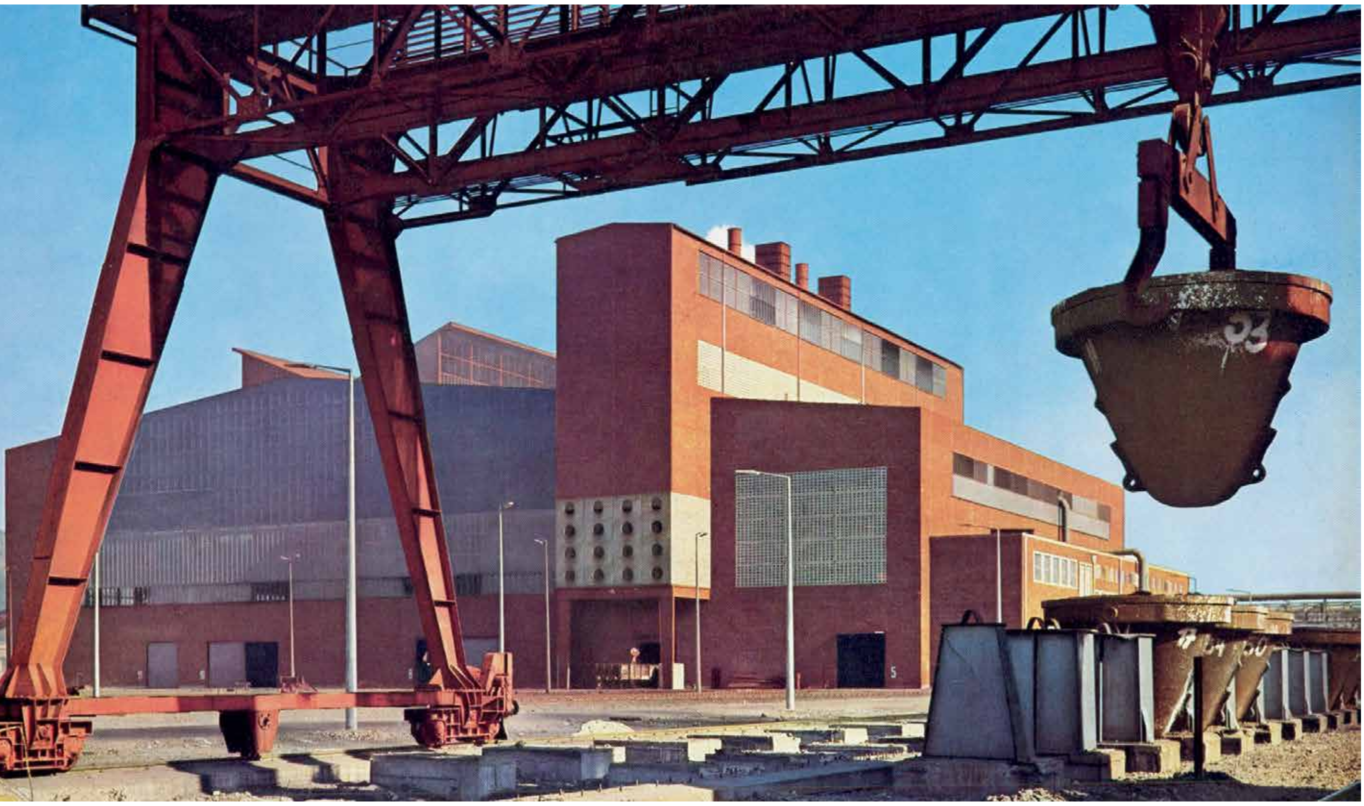
In an article on LD steel, authors Helmut P. Weitzer and Hubert Hauttmann forecast a more than fourfold increase in the volume of crude steel compared with the period between the wars.

Whereas in the period between the First and Second World Wars some 700,000 metric tons of crude steel was produced annually in Austria, output in 1958 will exceed three million metric tons.[67]

Not long elapsed before the Industrial Standards Commission in Austria authorized general approval of the LD steel process.

As early as December 1955 the Austrian Standards Committee decided to give the LD process equal status with the open-hearth and electric arc steelmaking processes for all standardized steel grades (for machinery construction, the building industry, boilermaking, for case hardening and heat-treatable steels and for cast steel), and allow steelworks to decide for themselves which process should be used. A similar situation arose with regard to the Austrian Railroad, for example where welded railroad bridges and rails were concerned. In the meantime the Austrian Technical Inspection Society and the Austrian Waterways Authority also ceased to make a distinction between the above three types of steel when used for steam-raising boilers, pressure vessels, pressure lines, hydro-electric structures and similar applications.[70]

Thanks to its successful innovation management, the Austrian steel industry grew more rapidly than its competitors elsewhere in Western Europe. Its share of total Western European steel production almost doubled.
The LD process is economically superior to the open-hearth process for the following reasons: the speed at which it takes place, the absence of a separate fuel and the lower plant costs. Although large quantities of oxygen are needed, these are produced at the steelworks itself.[71]



VÖEST LD Steelworks 2.

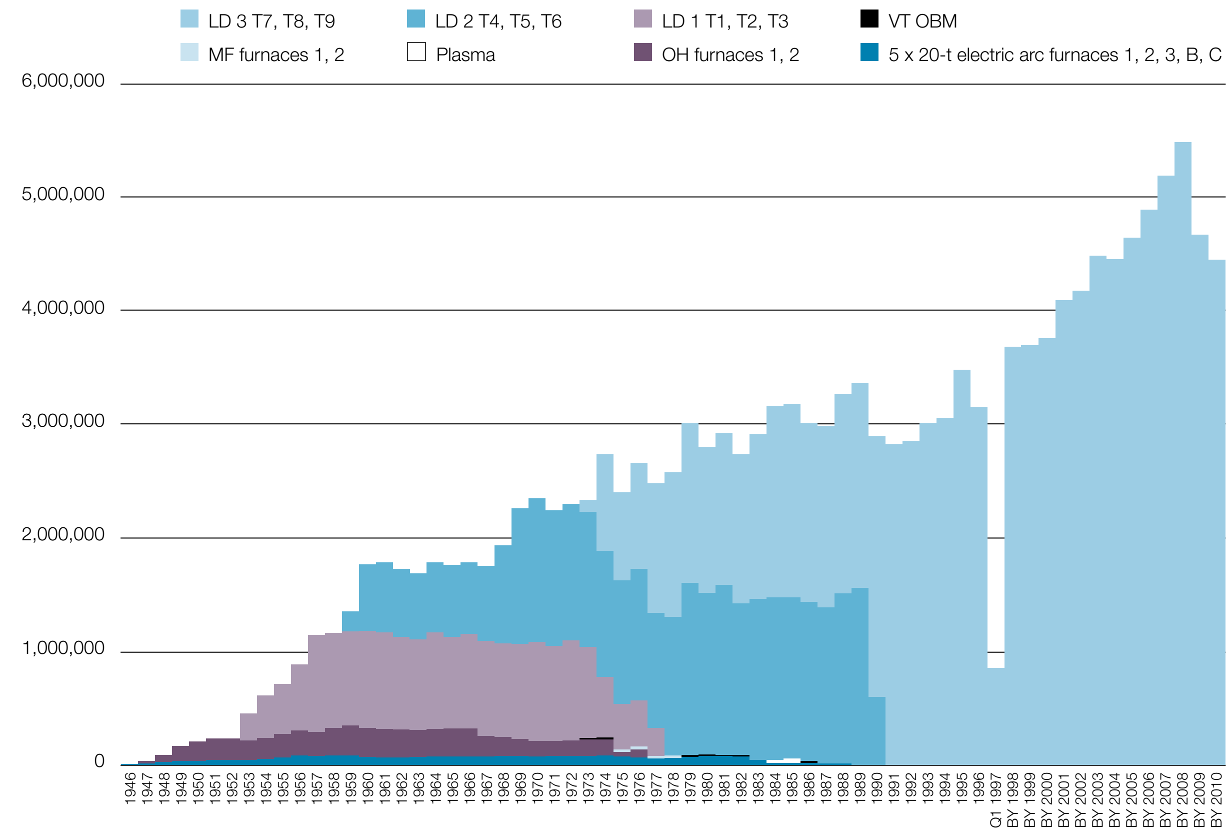
In 1959 LD Steelworks 2 began operation in Linz with two 50-tonne crucibles, to which a third was added in 1968.

Charging a 50-tonne LD crucible at LD Steelworks 2 in Linz.

LD Steelworks 1 had been in operation with two crucibles since 1952/53; a third was added in 1956. Together, these three 30-tonne crucibles had an annual output of 800,000 metric tons of crude steel. Technical improvements were introduced continuously.
The task of the steelworks was to supply steel to the rolling mills, forges and foundry. "Dr. Rinesch was put in charge of the technical management ... of this task, with two assistants acting as plant managers. One of them was responsible for management of the open-hearth and electric furnace areas, the other for LD steel production. To assist these two managers in their respective task areas, each was given a staff comprising one process engineer and an engineer for each of the three working shifts in the entire steelworks. The open-hearth and electric furnace operating area had a staff of one senior foreman, three shift foremen, one casting pit foreman and one foreman for operation of the 5-t electric furnaces (these were installed in the foundry). The LD operating staff consisted of one daytime shift foreman, three shift foremen and one casting pit foreman."[72]

In 1959 the LD Steelworks 2 began operation in Linz, with two 50-tonne crucibles; a third was added in 1968, and was the first to feature computer process control. (By 1990 LD Steelworks 2 had produced about 34.1 million metric tons of crude steel.)[73]

Steel statistics for Linz



In 1970 a special expansion program envisaged an increase in crude steel capacity, which entailed the construction of a new LD steelworks. The first crucible in Steelworks 3 began to operate in 1973. In 1977, after four-shift working had been introduced at this steelworks, LD 1 was shut down. In due course, environmental regulations and rationalization measures led to a project for crude steel production to be concentrated on Steelworks 3. The project was realized between 1987 and 1990, after which LD 2 was also shut down.[74] By January 2010, LD Steelworks 3 had produced 100,000,000 metric tons of crude steel.[75]

"Modernization packages" were introduced that decisively improved the original LD process. Although it remained unaltered in principle, the size of the crucibles changed significantly. Whereas the first crucibles in Linz and Donawitz had a capacity of 30 metric tons, the desire to reduce costs by producing increasingly large batches of steel led to converters of up to 400 metric tons' capacity.[76]

The quality of LD steels for various areas of application was improved all the time, and led in the 1970s to worldwide recognition of the merits of the LD process.[77] As an indication of the international significance of this process: in 1960 4 percent of total crude steel production worldwide used the LD process, but by 1970 the proportion had already reached 40 percent.[78] In 1971 it rose to 42 percent[79] and in 1974 to almost 50 percent.[80] It had reached 60 percent by 1992, and it now accounts for approximately two-thirds of total output.

From the above chart[81] the special significance of the LD process from the start can be seen, together with the increase in LD steel output from Linz. From the second half of the 1980s onward, only LD steelworks were operated, and in 1990, when LD Steelworks 2 was shut down, the whole output came from LD Steelworks 3.

LD Steelworks 3 in Linz, 1990.

Crucible 9 of LD Steelworks 3 in Linz.

LD Steelworks 3 – investments in environmental protection.

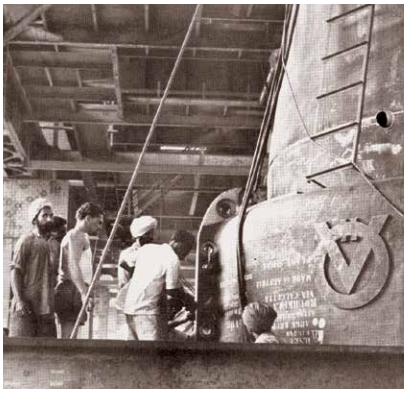
Protection of the environment

Experiments with the LD process gave rise to a major problem: reddish-brown smoke formed over the VÖEST plant site. Even the first experimental melts made it clear that something would have to be done. The smoke contained iron oxide particles that escaped in the course of the process. Flue gas purification was rendered more difficult by the extremely small size of the dust particles, which could only be examined under an electron microscope. There was an obvious need for flue gas purification and heat recovery. Even Crucible 1 had been equipped with a wet cyclone separator as well as other devices. Conversion work was considered the only way of increasing the dust extraction level. After several years of intensive work, trials on two crucibles and the introduction of improvements, a dust extraction plant was completed in 1958 for the entire LD Steelworks 1 (Waagner-Biro-VÖEST system).[82] The same conclusions were applied to LD Steelworks 2, which was still under construction at that time.

Despite higher output in subsequent years and decades, modern technology made it possible to reduce emissions further. LD Steelworks 3, commissioned in 1973, was of a more modern and therefore more environmentally acceptable design. The environmental package of 1987 yielded further decisive improvements.83 The capacity of LD Steelworks 3 was increased and crude steel production concentrated there. This increase in capacity was completed in 1990, after which LD Steelworks 2 was shut down. The same fate had befallen LD Steelworks 1 for cost and environmental protection reasons in 1977. LD Steelworks 3 became one of the most modern, environmentally acceptable steelworks in Europe.

At the Donawitz site too, the importance of environmental protection was recognized; at the end of the 1990s the LD steelworks originally started up in May 1953 was converted into an ultra-modern compact LD plant, which went into operation in 2000.

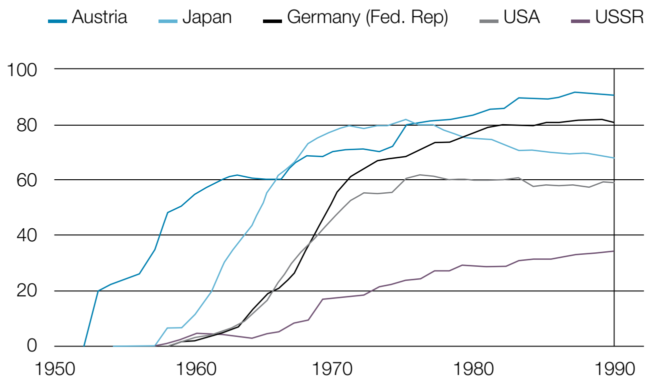
VÖEST's site office in Rourkela, India.


LD crucible assembly in Rourkela, India.

From the start, experts in the industry were divided in their reaction to the LD process. People were skeptical for various reasons. Despite this, the LD process spread rapidly throughout the world. In the experimental phase in particular it was Japanese metallurgists who studied the new process in Linz and Donawitz – and the Japanese were then among the first to acquire a license.[84]
As a means of convincing the skeptics, VÖEST supplied India with 350 locomotive frames made from LD steel plate.[85]
In view of the great international interest that the new process had aroused, VÖEST saw an opportunity to sell it worldwide. In 1957/58 VÖEST itself joined forces with the company Fried. Krupp[86] of Essen to build the first LD steelworks outside Austria. This was in Rourkela, 460 km southwest of Calcutta, and was at the same time VÖEST's first venture into international plant construction, an activity which later became a worthwhile source of business within VÖEST and then VOEST-ALPINE.[87]

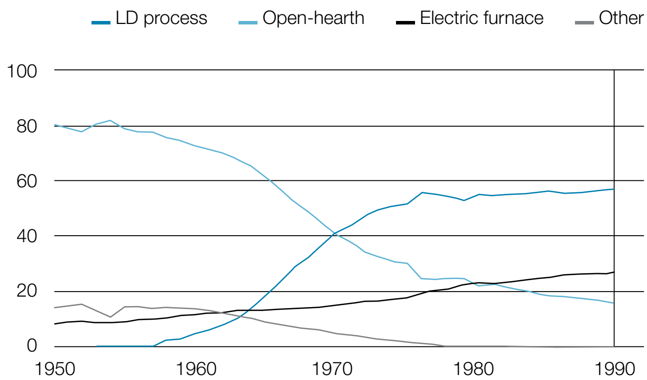
It was not until 1966 that the LD process achieved equal status with the open-hearth and electric arc steel production methods. This was because "severe difficulties had to be overcome before national industrial standards systems would accept LD steel." By the time this problem was solved, LD steel had already secured a 25-percent share of world crude steel production.[88]

LD process shares in %



Progress made by the LD process in various countries, 1950–1990.[89]

Production method shares in %



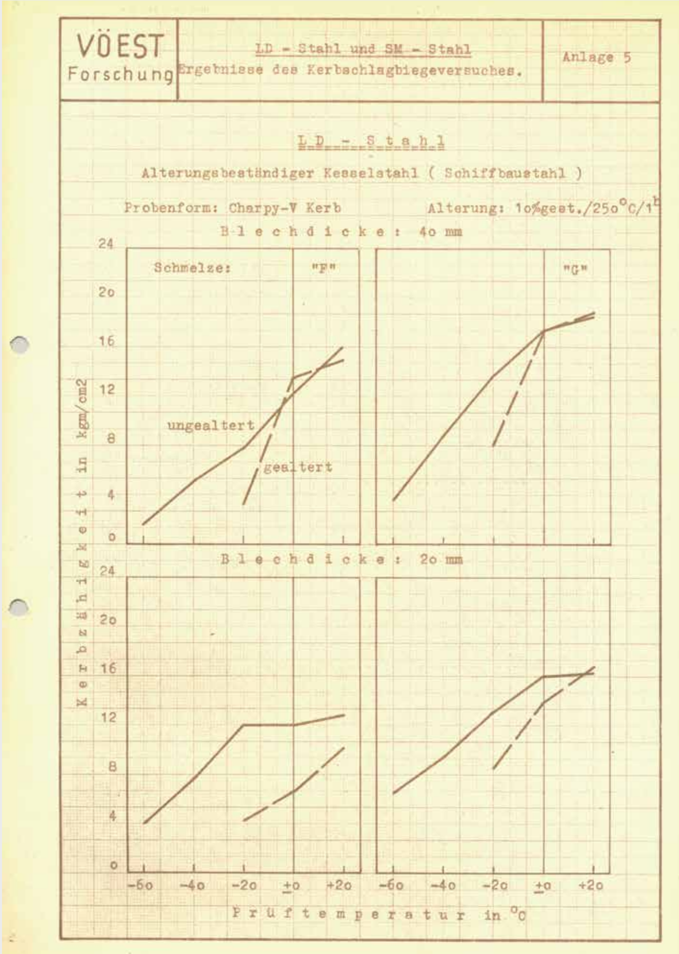
Shares of production methods in world crude steel production, 1950–1990.[90]


The LD steelworks in Rourkela, India during the construction phase (Photo: Steel History Club).

LD steel for oceangoing ships

Approval was sought for all the customary grades of steel plate used in shipbuilding.[92] Shipyards expressed their doubts and were reluctant to take any risks; this applied to an even greater extent to their insurers, who were content to classify steel grades made by the LD method simply as “Bessemer steel”. The British and German Lloyd’s insurers were extremely unwilling to grant approval.[93] However, not long elapsed before LD steel was accepted and approved by the marine classification societies.

In 1957 VÖEST – having established its own shipyard, the Ister Reederei Gesellschaft mbH in Bremen, jointly with the D. Oltmann & Co. of Bremen a year previously – began to design oceangoing ships as practical evidence that LD steel plate was entirely suitable for shipbuilding applications. The first oceangoing freighter was named “Linzertor”.[94] The desire to achieve a degree of stability in freight costs for VÖEST’s extensive raw material requirements may well have played its part in the decision.



LD steel – boiler plate resistant to aging (shipbuilding steel).[91]

“In order to obtain full approval from Germanischer Lloyd, which was hesitant at first, the ‘Linzertor’ was laid down in Flensburg. For the construction of this vessel, which was subject to very close supervision, about 4,000 metric tons of LD steel plate, steel castings and forgings were supplied. The aim of obtaining Germanischer Lloyd’s full approval for all grades and gauges of LD steel was achieved.”[95]

The “Linzertor” oceangoing freighter.

Germanischer Lloyd issued its approval while the “Linzertor” was still under construction.

The MS “Linzertor” was a motor freighter with a load capacity of 14,000 metric tons, a length overall of more than 157 meters, a beam of 19.3 m and a height from keel to uppermost uninterrupted deck of 12.0 m.[96] Only LD steels were used in its construction.

By the end of the 1950s, VÖEST had delivered to shipyards “about 50,000 metric tons of LD Steel, to the total satisfaction of shipping companies and shipbuilders”.[97]

LD steelworks outside Austria before 1959

In August 1954 Dominion Foundries & Steel, Ltd. of Canada became the first foreign corporation to operate an LD steelworks; it had two 60-tonne crucibles. It was followed in the same year by McLouth Steel Corp. in the USA, which started up its LD steelworks with the assistance of VÖEST plant director Rudolf Rinesch.[98] In September 1956 the third foreign company to begin LD operation was the Société des Aciéries de Pompey, France, with a 15-tonne crucible.[99]
In 1957 five LD steelworks were commissioned, in West Germany, Japan, Brazil and the USA. Another five were added to the total in 1958, two in 1959 and eight in 1960.[100]

LD steelworks outside Austria in 1959[101]

- Dominion Foundries and Steel Ltd. (DOFASCO), Hamilton, Ontario (August 1954), holder of the general license for Canada
- Société des Aciéries de Pompey, France (September 1956)
- Gussstahlwerk Witten AG, Witten/Ruhr, West Germany (April 1957)
- Yawata Iron & Steel Co. Ltd., Japan (September 1957)
- Companhia Siderurgica Belgo Mineira, Brazil (October 1957)
- Gussstahlwerk Bochumer Verein AG, Bochum, West Germany (November 1957)
- Jones & Laughlin Steel Corp., Pittsburgh, Pa., USA (November 1957)
- Nippon Kokan Kabushiki Kaisha, Tokyo (January 1958), holder of the general license for Japan
- Koninklijke Nederlandsche Hoogovens en Staalfabrieken N.V., Ijmuiden, Netherlands (January 1958)
- Siderurgia Industrial Compania Iberica S.A. (SICI), Barcelona, Spain (November 1958)
- Kaiser Steel Corp., Nevada, USA (December 1958)
- Algoma Steel Corp., Sault St. Marie, Canada (December 1958)
- Aciéries Réunies de Burbach-Eich-Dudelange, ARBED, Luxembourg (1958)
- ACME Steel Corp., Chicago, USA (June 1959)
- Eisenwerks-Gesellschaft Maximilianshütte AG., Sulzbach-Rosenberg, West Germany (December 1959)

In 1960 more LD steelworks were under construction that had been built until then, in the USA, Japan, Spain, Portugal, Italy (extension of existing plant), West Germany, Brazil, England, Scotland, Norway, Argentina, Australia (1961), and France.[102]

6 Patents[103]

After successful experimental work and technical implementation of the LD process, both Linz and Donawitz applied to the Austrian Patent Office for a number of patents to be granted.[104]

The first patents were applied for in 1950. In Linz, following massive differences of opinion with VÖEST AG, Theodor Suess, who was Technical Director at the time, applied through his private patent attorney for the new process to be patented in his name. In actual fact it was a service invention, and Suess was not involved in direct development work. He forbade his colleagues to "make any statements to the internal patent department regarding knowledge of the new process".[105] VÖEST recommended the other members of the team to submit a follow-up claim to be regarded as "joint inventors". In the end, Suess gave in and declared that Hauttmann was involved to the tune of 40 percent, Trenkler 40 percent and Rinesch 20 percent.[106] The consequence of this dispute was that VÖEST had to wait several years before acquiring the patents.[107] Even then, disputes continued about who was the actual inventor, and the question is in fact still unresolved on an academic level.[108] The LD process was developed further to volume production readiness by engineers at VÖEST and at what was then ÖAMG. In addition the "position of the lance to the bath surface, the oxygen nozzle pattern, the process temperatures and many other details were patented."[109]

The LD process was developed further to volume production readiness by engineers at VÖEST and at what was then ÖAMG.


REPUBLIK ÖSTERREICH

PATENTURKUNDE

AUF GRUND DES PATENTGESETZES IST
der Firma
Vereinigte Österreichische Eisen- und Stahlwerke Aktiengesellschaft in Linz
FÜR DIE IN DER ANGEFÜGTEN PATENTSCHRIFT BESCHRIEBENE ERFINDUNG MIT DER BEZEICHNUNG
Verfahren zur Herstellung von Stahl
EIN PATENT UNTER DER
NR. 174070
ERTEILT WORDEN.

WI DEN 25.Feber 1953.

ÖSTERREICHISCHES PATENTAMT
DER PRÄSIDENT:

DIE JAHRESGEBÜHREN RDEN ALLJÄHRLICH FÄLLIG AM 15.August.

Confirmation by the Austrian Patent Office of the invention in the patent application "Process for the production of steel".

Brassert Oxygen Technik AG

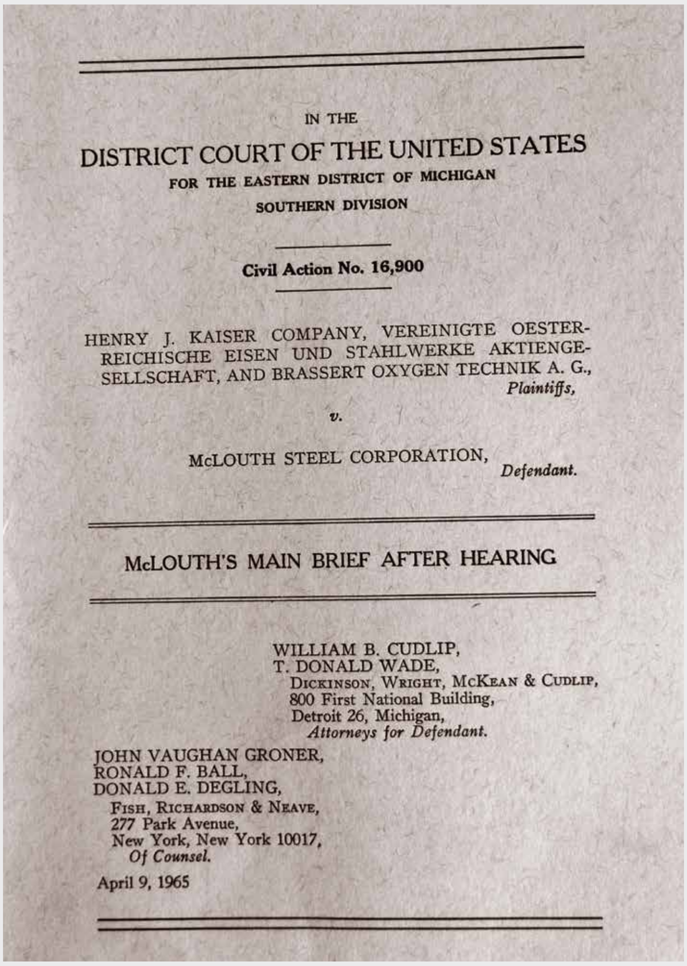
1. International LD conference in Linz – Donawitz – Vienna (1958); presentation by Hubert Hauttmann on sheets produced from LD steel.[110]

In 1952 VÖEST and ÖAMG concluded a contract with Brassert Oxygen Technik AG of Zürich, Switzerland, a company established in that year, assigning world exploitation rights in the LD process to the new company.
This had been preceded by contact between William E. Brassert and VÖEST. Brassert, son of the German-born American citizen and industrial plant constructor Hermann A. Brassert,[111] had learned about the new process and informed VÖEST's managing director Walter Falkenbach – successor to Heinrich Richter-Brohm – that he held the Schwarz patent and that it was being infringed by VÖEST and ÖAMG. In Switzerland, Brassert established a company known as Brassert Oxygen Technik AG (BOT) and assigned the Schwarz patent to it together with another patent granted to John Miles, a former colleague of his father. In turn, the two Austrian companies assigned their Austrian patent applications to the new company.[112]

BOT rapidly notched up successes abroad, but there were evidently weaknesses in the concept of the contract as a whole. Interests differed, since VÖEST began to build or equip steelworks itself. This harbored considerable conflict potential with BOT, which was no longer able to demonstrate the process to its clients. Walter Hitzinger, VÖEST's managing director at the time, prohibited BOT from entering the plant, and the same situation prevailed at ÖAMG in Donawitz.[113] In 1956 VÖEST acquired the entire capital held by BOT, but a year later was "persuaded" by the Austrian government to transfer half of its share of the capital to ÖAMG, which had participated in the development of the process, enabling the dividends to be divided between the two companies.[114] The first BOT LD conference, with 54 participants, was held in 1958 in Vienna, Linz and Donawitz.[115]

BOT had signed a general license agreement in 1954 with the US company Kaiser Engineers, a division of Kaiser Industries Corporation of Oakland, California. This entitled but also obligated the Kaiser to conclude sub-license agreements within its territory. Kaiser also claimed entitlement to take legal proceedings against any US company that used the LD process without having taken out a sub-license.[116] The sub-licensee had to agree to pay 15 US cents per ton of LD steel produced, "until such time as a 'final verdict' was reached by the courts."[117] In the second half of the 1950s, a patent dispute arose with US companies – and lasted until the mid-1970s.

BOT advertising.



IN THE

DISTRICT COURT OF THE UNITED STATES

FOR THE EASTERN DISTRICT OF MICHIGAN

SOUTHERN DIVISION

Civil Action No. 16,900

HENRY J. KAISER COMPANY, VEREINIGTE OESTERREICHISCHE EISEN UND STAHLWERKE AKTIENGESELLSCHAFT, AND BRASSERT OXYGEN TECHNIK A. G.,
Plaintiffs,

v.

McLOUTH STEEL CORPORATION,
Defendant.

McLOUTH'S MAIN BRIEF AFTER HEARING

WILLIAM B. CUDLIP,
T. DONALD WADE,
DICKINSON, WRIGHT, McKEAN & CUDLIP,
800 First National Building,
Detroit 26, Michigan,
Attorneys for Defendant.

JOHN VAUGHAN GRONER,
RONALD F. BALL,
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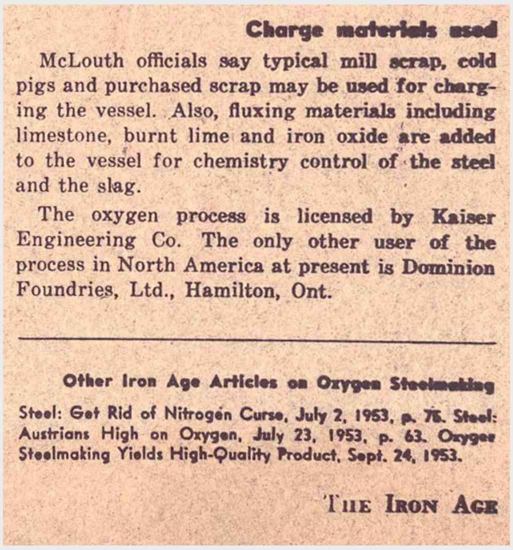
FISH, RICHARDSON & NEAVE,
277 Park Avenue,
New York, New York 10017,
Of Counsel.

April 9, 1965

McLouth's main brief hearing, 1965.



Charge materials used

McLouth officials say typical mill scrap, cold pigs and purchased scrap may be used for charging the vessel. Also, fluxing materials including limestone, burnt lime and iron oxide are added to the vessel for chemistry control of the steel and the slag.

The oxygen process is licensed by Kaiser Engineering Co. The only other user of the process in North America at present is Dominion Foundries, Ltd., Hamilton, Ont.

Other Iron Age Articles on Oxygen Steelmaking

Steel: Get Rid of Nitrogen Curse, July 2, 1953, p. 76. Steel: Austrians High on Oxygen, July 23, 1953, p. 63. Oxygen Steelmaking Yields High-Quality Product, Sept. 24, 1953.

THE IRON AGE

Extract from an article in the specialist journal "The Iron Age".[123]

The patent dispute with US companies

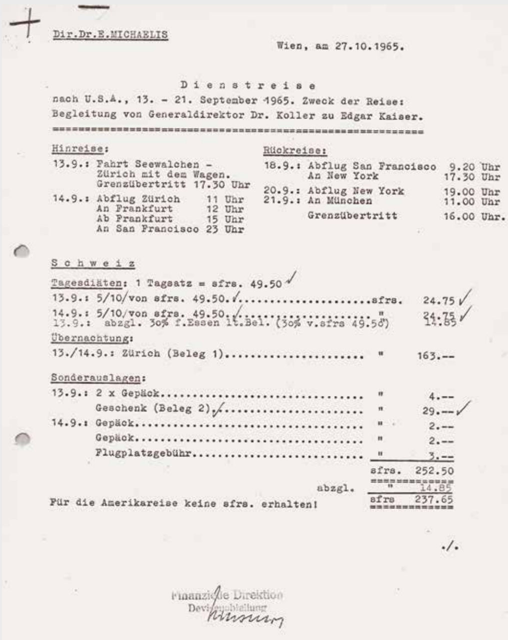
At the end of a patent dispute that lasted many years (from 1957 to 1975) and which concerned "how movement took place in the bath"[118], VÖEST-ALPINE as it was then lost its case and the patents were not recognized – "which amounted to an indirect subsidy for the US steel industry".[119] As early as 1956, McLouth Steel Corporation of Trenton, Michigan, had refused to conclude a license agreement although it had signed an option and know-how agreement in 1954, before one of the patents applied for there had been granted. As a result of this, Kaiser went to court in 1957, with BOT and VÖEST supporting the action. The latter had established its right to ownership of the VÖEST (Suess) patent. McLouth claimed that "it was freely usable with no question of a license payment for this being due."[120] Both Kaiser and BOT assumed initially that this was only a test case undertaken as a means of establishing the patent by law. In actual fact the proceedings dragged on until other steelmaking corporations also had to be proceeded against.[121] The problem lay in the formulation of the patent claim, which did not comply with American patent law because the degree of protection was expressed in a highly formalistic manner. This should be seen against the background of a comment by the President of a large American steelmaking corporation at a general meeting of his company's stockholders: "The LD process is the first genuine step forward on the molten metal side of the steelworks since Henry Bessemer (1856!)."[122]

The McLouth case greatly reduced the prospects of concluding license agreements, since most companies in the iron-producing industry wanted to wait for a verdict to be announced before entering into negotiations. The situation was rendered even more critical when the company Jones & Laughlin of Pittsburgh, Pennsylvania, having signed a sub-license agreement with Kaiser, decided not to adhere to its terms and declared it "invalid because of infringement of anti-trust laws" and also refused to sign a contract for its second LD steelworks, which had gone into operation in Cleveland.[124]

The verdict on the McLouth case, announced on July 6, 1966, stated: "Not only because a patent, once granted, is valid in case of doubt, but also in view of the revolutionary character of the invention, the court has reluctantly reached the conclusion that the patent is invalid."[125] The reason for this invalidity was stated to be that the patent, in its formulation of claims, did not comply with the formal conditions of § 112 of US patent law.[126]

While the claim against Jones & Laughlin was still pending, "a fundamental and far-reaching change occurred in US patent jurisdiction. The verdict reached by the Supreme Court of the United States on May 3, 1971 permitted for the first time the plea of res judicata in patent disputes …
At that time we had proceeded against practically all large American steelmaking corporations, starting with United States Steel, Bethlehem Steel, National Steel, Republic Steel and others, at their legal domiciles, alleging that they had infringed our patent for more than six years. After six years such claims expire according to their volume but not according to their justification. The legal authorities had declared the court in Pittsburgh to be competent for all these claims. When the verdict of May 3, 1971 became known, all the steel corporations against which we were proceeding entered a plea of res judicata and made reference to this significant verdict, which stated however that the court accepting this view must itself decide whether a plea of res judicata should or should not apply.
The Pittsburgh court reached its verdict on January 29, 1974 … and declared that after thorough examination it had reached the conclusion that the plea of res judicata was not applicable, that our patent was valid and could be enforced and that it had been infringed by Jones & Laughlin. The court reached this verdict on the basis of the statements made in the witness stand by the then chief tester of the American Patent Office and those responsible for the patent application. Both these depositions strengthened the view that we had not abandoned the concept of our original invention – as the Detroit verdict had suggested – and replaced it by a different idea, this being the reason why the Michigan courts had declared invalidity on account of formal shortcomings according to § 112 of US patent law. Jones & Laughlin appealed against this verdict before the Third Appeal Senate in Philadelphia.
On April 4, 1975 the appeal court decided that the first-instance verdict of February 19, 1974 was invalid and that the court responsible for it should, having taken the plea of res judicata into account, find in favor of the defendant. In this way the higher court was able to avoid the necessity of examining questions of material law such as validity, enforceability and infringement."[127]

And so VÖEST – which had by then become VÖEST-ALPINE – lost its case in the final instance, although the courts had acknowledged the fundamentally innovative character of the LD process.



Dir.Dr.E.MICHAELIS

Wien, am 27.10.1965.

D i e n s t r e i s e
nach U.S.A., 13. - 21. September 1965. Zweck der Reise:
Begleitung von Generaldirektor Dr. Koller zu Edgar Kaiser.

Hinreise:
13.9.: Fahrt Seewalchen - Zürich mit dem Wagen. Grenzübertritt 17.30 Uhr
14.9.: Abflug Zürich 11 Uhr
An Frankfurt 12 Uhr
Ab Frankfurt 15 Uhr
An San Francisco 23 Uhr

Rückreise:
18.9.: Abflug San Francisco 9.20 Uhr
An New York 17.30 Uhr
20.9.: Abflug New York 19.00 Uhr
21.9.: An München 11.00 Uhr
Grenzübertritt 16.00 Uhr.

S c h w e i z

Tagesdiäten: 1 Tagsatz = sfrs. 49.50

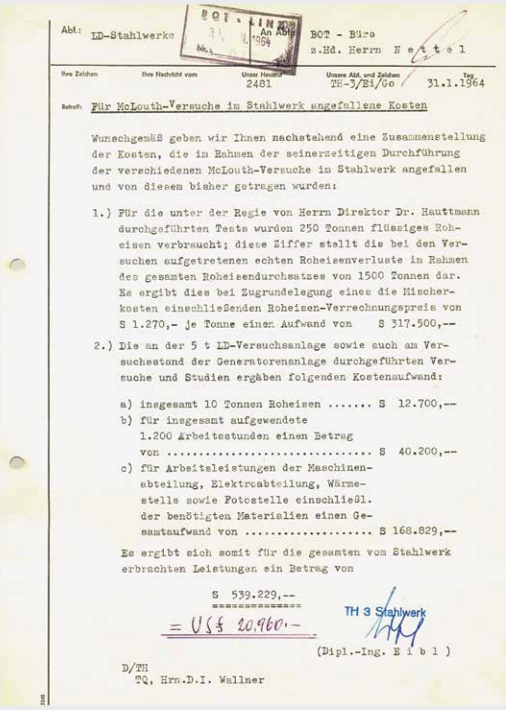
13.9.: 5/10 von sfrs. 49.50	sfrs.	24.75
14.9.: 5/10 von sfrs. 49.50	"	24.75
13.9.: abzgl. 30% f.Essen lt.Bel. (30% v.sfrs 49.50)		14.85
Übernachtung:		
13./14.9.: Zürich (Beleg 1)	"	163.--
Sonderauslagen:		
13.9.: 2 x Gepäck	"	4.--
Geschenk (Beleg 2)	"	29.--
14.9.: Gepäck	"	2.--
Gepäck	"	2.--
Flugplatzgebühr	"	3.--
	sfrs.	252.50
abzgl.	"	14.85
	sfrs	237.65

Für die Amerikareise keine sfrs. erhalten!

./.

Finanzielle Direktion
Devisenabteilung

Business trip to Edgar Kaiser in the USA, undertaken by managing director Dr. Herbert Koller, accompanied by Dr. Eduard Michaelis, from September 13 to 21, 1965.[128]



Abt.: LD-Stahlwerke

BOT - LINZ
An Abt.
1964

BOT - Büro
z.Hd. Herrn N e t t e l

Ihre Zeichen	Ihre Nachricht vom	Unser Hausruf	Unsere Abt. und Zeichen	Tag
		2481	TH-3/Ei/Go	31.1.1964

Betreff: Für McLouth-Versuche im Stahlwerk angefallene Kosten

Wunschgemäß geben wir Ihnen nachstehend eine Zusammenstellung der Kosten, die im Rahmen der seinerzeitigen Durchführung der verschiedenen McLouth-Versuche im Stahlwerk angefallen und von diesem bisher getragen wurden:

1.) Für die unter der Regie von Herrn Direktor Dr. Hauttmann durchgeführten Tests wurden 250 Tonnen flüssiges Roheisen verbraucht; diese Ziffer stellt die bei den Versuchen aufgetretenen echten Roheisenverluste im Rahmen des gesamten Roheisendurchsatzes von 1500 Tonnen dar. Es ergibt dies bei Zugrundelegung eines die Mischerkosten einschließenden Roheisen-Verrechnungspreis von S 1.270,- je Tonne einen Aufwand von S 317.500,--

2.) Die an der 5 t LD-Versuchsanlage sowie auch am Versuchsstand der Generatorenanlage durchgeführten Versuche und Studien ergäben folgenden Kostenaufwand:

a) insgesamt 10 Tonnen Roheisen .... S 12.700,--
b) für insgesamt aufgewendete 1.200 Arbeitsstunden einen Betrag von .... S 40.200,--
c) für Arbeitsleistungen der Maschinenabteilung, Elektroabteilung, Wärmestelle sowie Fotostelle einschließl. der benötigten Materialien einen Gesamtaufwand von .... S 168.829,--

Es ergibt sich somit für die gesamten vom Stahlwerk erbrachten Leistungen ein Betrag von

S 539.229,--

= US$ 20.960.-

TH 3 Stahlwerk

(Dipl.-Ing. E i b l)

D/TH
TQ, Hrn.D.I. Wallner

Costs incurred for McLouth tests at the steelworks, 1964.[129]

Summary

On the basis of known technologies, rebuilding and expanding the Austrian iron and steel industry could only have succeeded to a limited extent. Furthermore, today's worldwide high output of steel would not have been attainable without the highly productive LD process.

Steel production was revolutionized by the LD (basic oxygen) process and the foundation laid for modern steel metallurgy. By 1953, VÖEST was already a strong exporter (pig iron, crude steel and sheet-metal products). "Decisive factors in this strong development were continuous operation of three blast furnaces, full operation of the new basic oxygen steelworks and the effects of extensive investment in the rolling mills. The fundamental decision to give priority to basic materials industries that was taken by the Austrian government even before the Marshall Plan could come into effect was fraught with risk – but correct."[130]

The LD process not only led to worldwide steel production increasing from 200 million metric tons at that time to the present figure of approximately 1.5 billion (thousand million) metric tons, but also made it possible to produce certain steel grades and satisfy certain applications – for example in the automobile industry or in the energy sector – for the first time ever.

In the past 60 years the LD process has of course been continually improved and refined, but it has remained unchanged in principle. LD steel can incidentally be 100-percent recycled, and is the only material that retains its character without loss of quality. In other words, top-quality steel can be produced again from scrap.[131]

Appendix

Brief portraits

Theodor E. SUESS
Theodor E. Suess was born on July 1, 1894 in Weissenbach an der Triesting, Lower Austria. He studied mechanical engineering at the Technical College (now Technical University) in Vienna. Before joining VÖEST as Technical Director (a post he held from December 1947 to the end of June 1951), Suess was a member of the Board of Management of Gutehoffnungshütte AG in Oberhausen, Germany. After his period of employment with VÖEST he joined the Central Authority of the European Coal and Steel Community in Luxembourg. He died tragically in Düsseldorf on March 6, 1956 during an official visit.[132]

Hubert HAUTTMANN
Hubert Hauttmann was born on December 11, 1895 in Kammer am Attersee, Austria. After obtaining his university entrance certificate in Graz he studied at the Technical College (now Technical University) in Vienna and at the Montanistic University Leoben (now University of Leoben, a university for mining, metallurgy, and materials). From 1921 on he worked for Gutehoffnungshütte in Oberhausen, Germany, where he was appointed manager of the Research department in 1933. In 1942 he obtained his doctorate from the Iron and Steel University in Leoben and was granted a lectureship there in 1950. In 1948 he joined what was then VÖEST. Dr. Hauttmann was the recipient of numerous awards. He died on September 19, 1952 in Linz.[133]

Herbert TRENKLER
Herbert Trenkler was born on December 28, 1907 in Königsdorf, Bohemia (now Czech Republic). He studied physics at Munich Technical University for 2 semesters, then metallurgy at the Montanistic University Leoben. In 1933 he was awarded a doctorate. After this, he was a steelworks assistant at Gutehoffnungshütte in Oberhausen, Germany, from 1940 to 1944 director of the steelworks in Hagendingen (Hagondange in Lorraine) and from 1944 to 1945 at the Reichswerke in Salzgitter-Watenstedt, Germany. From 1946 on he was head of Steel Production at VÖEST AG in Linz, and steelworks director from 1948 on. Dr. Trenkler joined the Montanistic University Leoben in 1958 as professor for Ferrous Metallurgy and chairman of the Department of Ferrous Matallurgy, and was rector of the university from 1962 to 1964. In 1972 he was elected a correspondent member of the Austrian Academy of Sciences. He retired with the title of Professor emeritus in 1977 having received a large number of awards. Herbert Trenkler died in Leoben on June 20, 1992.[134]

Rudolf RINESCH
Rudolf Rinesch was born in Bismarckhütte, Upper Silesia, on June 15, 1911. In 1930, after obtaining his university entrance certificate in Knittelfeld, he studied metallurgy at the Montanistic University Leoben. Leoben. From May 1, 1938 to June 1, 1941 he was steelworks assistant at Steirische Gussstahlwerke in Judenburg, then steelworks process manager (1st class) at the special steelworks in Kladno (at that time Protectorate of Bohemia and Moravia). After the Second World War, Germans were evicted from the territory of the former Czechoslovakia.
Rinesch worked from April 8, 1947 to September 12, 1947 for the Köflacher Railroad and Mining Company (loader). In 1948 he was taken on as smelter at the VÖEST steelworks, and from 1949 on was employed at its steelworks as experimental engineer, having satisfied the company's demand for a candidate with "special knowledge of metallurgical and operating matters in a steel-works". This position arose because of the "extension of the steelworks and the associated development work". In 1954 Rinesch received a doctorate from the Montanistic University Leoben for his work on the LD process. He was appointed Steelworks Director and, on May 1, 1958, Plant Director. Rudolf Rinesch died suddenly on November 4, 1976.[135]

Fritz KLEPP
Fritz Klepp was born in Leitendorf near Leoben on April 12, 1909. He studied metallurgy at the Montanistic University Leoben. Until December 1935 he worked at the cellulose plant in Hinterberg (near Leoben), and later, until December 1940, operating assistant/operating engineer at the Österreichisch-Alpine Montangesellschaft and Alpine Montan AG Hermann Göring in Donawitz. Klepp left this company "at his own request" and was employed from January 1, 1941 on as steelworks assistant at Klöckner-Werke AG in Düsseldorf, Germany. On November 1, 1941 he was appointed manager of the Siemens-Martin steelworks with full authority. He left this post at his own request and, from April 1, 1943 on, was steelworks assistant at the Linz steelworks. From April 1, 1945 to April 30, 1955 he was steelworks assistant and steelworks manager. From May 1, 1955 on Klepp was plant director in Liezen, and from July 1, 1968 on VÖEST's technical adviser at BOT (which was absorbed into VÖEST-ALPINE AG on January 1, 1973 after the two companies had merged). Fritz Klepp retired from active business life on July 1, 1974, and died in 1992.[136]

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11 Fiereder (see Note 4), p. 295.
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32 Ibid, p. 253.
33 Ibid, p. 254.
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36 Ibid.
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