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# Iron and Steel in Canada

Fathi Habashi

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# Iron and steel in Canada

*Iron production in Canada started in 1733 under the French Regime in Quebec and developed further during the British occupation. Canada did not contribute greatly to iron production, but it was in Quebec that the bottom-blowing of oxygen in steelmaking was invented, which is now used world wide.* ***By Fathi Habashi****

## Charcoal iron works

In 1733 François Poulin de Francheville (1692-1733), a French merchant from Montreal, built the first furnace in Canada on the bank of the Saint-Maurice River near Trois Rivières located half way between Québec City and Montreal. The furnace was fuelled by charcoal to process local iron ore. Air was blown in the furnace by small bellows operated by a water wheel. The Saint-Maurice River is one of the largest tributaries of the Saint-Lawrence River. The temperature of combustion in the furnace was not enough to melt the iron produced. Thus, a product called 'bloom', which was wrought iron mixed with slag, was obtained. This was removed from the furnace and hammered while hot to squeeze away the slag and thereby obtain a near carbon-free iron. This wrought iron was malleable and could be shaped into different forms. At the conquest of New France in 1760, the Forge passed to the British Government and was operated under military authorities until shut down in 1883.

In the mean time other iron works started operation using charcoal, for example, the Marmora Ironworks, near Peterborough, Ontario, began production in 1823. It consisted of two charcoal-fired blast furnaces and a forge with two sets of water-powered hammers. In 1860 at Radnor, not far from the Saint-Maurice Forge, another furnace was built.

## Coke iron works

All charcoal operated furnaces were shut down when more efficient coke-fired models were erected in Ontario and Nova Scotia. For example, in 1871 the Canadian Titanic Company built two blast furnaces at Saint Urbain, Charlevoix County in Quebec for the utilisation of titaniferous iron ore and using coke.

*Iron production in Canada started in 1733*

## Modern iron ore production

The largest source of iron in Canada was discovered in Labrador in 1892 and started exploitation in the 1950s.

### *Iron Ore of Canada*

The company was founded in 1949 in Montreal and operates a mine, a concentrator, and a pelletising plant in Labrador City, Newfoundland, and Labrador, as well as port facilities in Sept Îles. It also operates a 418 km railroad linking the mine to the port. Iron concentrate is shipped from the mines, such as Wabush, to Sept Îles. In 1970 a beneficiation complex including a pelletising plant in Sept Îles to process Schefferville ore was installed. In 1992 Mitsubishi became shareholder and in 2000 Rio Tinto became the principal shareholder.

### *Quebec Cartier Mining*

Founded in 1957 by US Steel, Quebec Cartier Mining operates from Lac Jeanine to Port Cartier. In 1963 the company built the town of Gagnon to accommodate workers and families. In 1973 Mont Wright mine was started and the town of Fermont was created. In 1981 it extended its operations 112 km north to Fire Lake. Iron ore is

sent from Fermont to Port-Cartier by train on a 400 km railway trip where a pelletising plant was constructed in 1977 by Sidbec-Normines. The falling market forced the company to shut down its Fire Lake and Lac Jeanine plants in the mid-1980s. In 1989, US Steel sold the company to different investors and in 2005 Dofasco became the sole owner. The town of Gagnon was closed and its population moved to Fermont and Port-Cartier. In 2008 it became ArcelorMittal Mines Canada.

### *Wabush Mining*

Wabush is next door to Labrador City. Wabush Iron Company Limited opened in 1967 and closed in 2007.

*Steelmaking underway in Canada*

## Steelmaking

### *Dominion Iron and Steel*

Dominion Iron and Steel was founded in 1899 by the American businessman Henry M. Whitney (1839-1923) at Sydney, NS. He had already formed the Dominion Coal Company in 1893 in Cape Breton and envisioned a local steel plant as the ideal outlet for coal. Limestone was also available in Newfoundland. Sydney harbour provided a shipping outlet to the world. Construction was finished in 1901 and it was the most modern steel plant in the world with a battery of 400 coke ovens capable not only of producing coke, but also of recovering saleable by-products such as tar, benzene, and industrial salt. It had four blast furnaces and 10 open-hearth furnaces. Sydney coalfield supplied more than 44% of Canada's coal production and its iron industry produced more than one-third of the country's pig iron.

Two Bessemer converter furnaces were added in 1907 in an attempt to deal with low-grade iron ore and high-sulphur coal. The company had been a constant money loser, but the situation improved when a domestic rail market developed. Whitney then sold its steel and coal companies to a Canadian consortium in 1909. These two companies merged under the name Dominion Steel Company and was later expanded by adding more blast furnaces and coke ovens. World War I was a major economic boom. In 1920, the British Empire Steel Corporation acquired all of the company's assets.

By now the steel industry was in a recession. The plant was shut down and the massive lay-offs triggered violent strikes. By 1927, the company collapsed into bankruptcy. The plant was operated for two years because of government subsidies, which attracted new investors. In 1929, a British consortium took over and was called the Dominion Steel and Coal Company. The start of World War II in 1939 signalled a boom cycle. In 1942 a 10-ton electric arc furnace was introduced for the manufacture of speciality steel. Oxygen lancing was introduced into the open hearths, which reduced the time needed to produce a heat by half. Also, the Wabana Mines were closed in 1966 and a much higher grade of iron ore was imported from Quebec.

The 1960s were characterised by massive lay-offs and plant closures. By 1967 the plant was losing money. In January 1968, the plant became the property of the Provincial Government of Nova Scotia and became known as the Sydney Steel Corporation.

A continuous caster was commissioned in 1975 as part of the modernisation. By 1982 the plant was in financial difficulty. On 22 May 2000, the lack of a legitimate buyer closed the Sydney Steel Corporation.

### *Algoma Steel*

Founded in 1901 in Sault Sainte Marie, Ontario, on the St. Marys River by the American businessman Francis H. Clergue (1856 –1939). A Bessemer converter was put in operation using pig iron made from the Helen mine in Sault-Saint Marie, but it had to import coal and coke from the

United States. Initially the company specialised in the manufacture of rails for Canadian railways. Algoma is currently the second largest steel producer in Canada. In 2007, it was purchased by India's Essar Group.

### Iron and Steel Company of Canada

Also known as Stelco, it was founded in 1910 in Hamilton, Ontario, by Charles S. Wilcox (1856 to 1938). It was formed by combining several existing smaller steelworks. Coke was produced in retorts, iron pellets were charged into the blast furnace. By 1910 the Bessemer process was no longer in use. Hydrochloric acid was later used as a pickle solution replacing sulphuric acid. Iron and steel production grew slowly until World War II and then rapidly as the post-war economic boom created a tremendous demand for steel. The company filed for bankruptcy in 2007 and was bought by US Steel. The Hamilton plant has not produced steel since 2011, but its coke ovens and cold-rolling finishing works remain in operation. Market conditions led to a permanent shut down on 31 December 2013.

### Dominion Foundries and Steel

Dominion Foundries and Steel, now known as Dofasco, was founded in 1912 by Clifton Sherman (1872-1955) and his brother Frank Sherman (1887-1967) sons of an American blast furnace and steel mill superintendent. It introduced the Basic Oxygen Process (BOP) to North America in 1954 and since then the open-hearth process steadily declined, and none are in use today. Dofasco, the major shareholder of Québec Cartier, was bought by Arcelor Mittal, the world's largest steel producer. This made Québec Cartier one of the leading mining facilities of the world's biggest steel producer. In 1999 Dofasco was the most profitable steel producer in North America.

*Canadian steelworker*

### Atlas Steel

Atlas Steel was founded in 1928 in Welland, Ontario. Originally it was constructed in 1918 by Dillon Crucible Steel Alloy Company to produce high-tensile tool steel. In 1920 the Atlas Crucible Steel Company purchased the business. The facility was acquired by Roy Davis and Daniel Lanthrop in 1928 and operated under the name Atlas Steel Company. Subsequently it was expanded to include a rolling mill plus stainless and other speciality steel production. In 1939 the Canadian government invested heavily in this facility to produce steel for World War II and by 1948 it was regarded as the largest speciality steel company in the British Commonwealth. It developed the first successful continuous casting machine for steel in North America in 1954. Since 2010 it was owned by ASW Steel.

### QIT Fer et Titan

Quebec Iron and Titanium Corporation was founded in 1948 by New Jersey Zinc Company and Kennecott Copper in the USA to exploit an ilmenite deposit at Lac Tio, near Havre-Saint-Pierre in Quebec. An electric furnace process was developed in 1957 in Sorel near Montreal that was the first of its kind in the world to produce titanium dioxide feedstock [Sorelslag], pig iron, and steel from this ore. It was recently purchased by Rio Tinto.

### Quebec Metallic Powders

Next door to QIT Fer et Titan is Quebec Metallic Powders, established in 1968 to produce iron powder by spraying water on a stream of molten iron obtained from QIT.

### Midrex process

Sidbec-Dosco was established by the Quebec Government in 1968 in Contrecoeur near Montreal. It receives iron ore pellets from Sept Iles and reduces them in shaft furnaces where fuel is produced by reforming natural gas. The electric furnaces convert the metallic charge together with scrap into liquid steel. Two continuous casting

machines solidify the liquid steel into slabs and billets. This is the only direct reduction plant in Canada.

## Oxygen for the steel industry

### *LD process*

After World War II intensive research was underway to intensify melting of steel scrap generated during the war. In 1955 researchers at the Vereinigte Österreichische Eisen- und Stahlwerke abbreviated (VÖEST) in Linz in Austria came up with the oxygen lance top blowing technology, the so-called Linzer Düsenverfahren (Linz Lance Technology) or LD process, which had enormous advantages. The plant was built by the Germans before the war and originally named the Hermann Göring Works. After the war, it was considered a German property and was confiscated by the occupying forces. It later became an Austrian nationalised industry. The process developed there was adopted worldwide. As a result, the demand for oxygen increased and oxygen production plants were installed at the steelworks. The process, however, had the disadvantage of being noisy and generating a lot of extremely fine dust.

In spite of all the advantages of top-blowing technology, it was felt that bottom oxygen-blowing was far superior for the following reasons:

- The reaction time is shorter because of the increased volume of oxygen that can be introduced into a batch.
- The slag formed does not hinder the flow of oxygen as in the case of top blowing.
- Less iron evaporates and consequently the amount of brown smoke is minimal, and the iron losses are reduced.
- Reduced iron losses by splashing from the converter because of the reduced volume of gases passing through it. This together with the previous point, are responsible for 1–2 % increased production.

All attempts to use pure oxygen in bottom-blowing were unsuccessful because of the high temperature involved which resulted in the destruction of refractories.

## Research in Canada

In 1939, Air Liquide Canada, member of the Air Liquide Group, headquartered in Paris, hired Guy Savard, a young graduate from the Royal Military College in Kingston, Ontario, as a welding engineer in its Montreal branch. When Nazi troops invaded France, directors of Air Liquide left Paris and settled in Montreal. They expanded the Montreal business and gave it special attention after the war.

In 1947 the company hired Robert Lee, a young graduate from McGill University, as a research assistant in metallurgy. His assignment was to keep Air Liquide in contact with the Canadian iron and steel industry. In 1950, Savard became director of a new department at Air Liquide called Industrial Gas Applications to which Robert Lee was also attached. Armed with the knowledge that nitrogen not only plays no role in oxidation processes, but also decreases the efficiency of combustion, Lee persuaded steel companies to use oxygen instead of air. Oxygen was introduced at the burners in the open-hearth furnaces and into lances to accelerate the refining. This technology was adopted by steel companies and was also extended to other Canadian industries, such as the pulp and paper industry, in rotary kilns in cement manufacture, and in glass-making furnaces.

In 1963, Savard and Lee built an experimental vessel using bottom oxygen blowing where 150 kg of molten iron was used. After months of reflection Lee decided to use a shrouded injector with natural gas as the protecting gas. It was argued that hydrocarbons crack readily at a temperature of about 800°C and, therefore, the heat absorbed for cracking should result in cooling the tip of the nozzle. Contacts were made with many steel companies but nobody was interested.

## Maximilianhütte

In the fall of 1967, Karl Brotzmann, director of research for Eisenwerk-Maximilianshütte in Sulzbach-Rosenberg near Nürnberg in Germany, having learned of these activities in bottom blowing, requested a meeting. This company was facing difficulty in smelting its ores. A metal of high phosphorus and silicon content refined by the Thomas process had the disadvantages of high nitrogen content and a low scrap rate. It was impossible to process this iron by the LD process because lime injection was not possible through the oxygen lance. The meeting took place in Montreal in October, 1967. This led to a license agreement which enabled the company to develop the process to full industrial scale. This process became the major steelmaking process and was known as Q-BOP, i.e., the Quiet Basic Oxygen Process, because the consumption of oxygen takes place quietly during blowing.

SUGGESTED READINGS


- F. Habashi, "One Hundred Years of Liquid Air. Canadian Contribution", *Bull. Can. Inst. Min. & Met.* 96 (1069), 122-125 (2003)
- R. Samson, *The Foges du Saint-Maurice. Beginnings of the Iron and Steel Industry in Canada 1730-1883, Les Presses de l'Université Laval*, 500 pages, Quebec City, Canada 1998. The book is also available in French.
- For Dominion Iron and Steel, see http://www.sydneysteelmuseum.com/history/birth.htm


* *Department of Mining, Metallurgical, and Materials Engineering, Laval University, Quebec City, Canada*