Form 1220-5
(July 1970)

Mailing List 2 T/N 128

Filing Code 3800

Date Issued **August 1971**

TECHNICAL NOTE

U.S. DEPARTMENT OF THE INTERIOR – BUREAU OF LAND MANAGEMENT

Subjects: Iron Ore, Direct Reduction Processes
Steel Ore, Direct Reduction Processes

Reference: Engineering and Mining Journal, October 1969.

Data:

Contains several articles concerning direct reduction processes:

1. Pages 67-73 describes the Mexican HyL process, the only commercially available process. It gives the steel-making economics for a plant capable of producing 250,000 metric tons of steel billets per year (copy attached).

2. Page 98 describes the Standard Oil (N. J.) Fluid Iron Ore Direct Reduction (RIOR) process tested in Nova Scotia. It speculates on location of a commercial facility of about one million tons per year.

3. Page 130 discusses a possible $30 million integrated steel plant using the HyL process to be built by Sovereign Industries in Arizona. Sovereign has an extensive area of black sand deposits located near Black Mountain, Arizona.

Steelmaking economics using HyL direct reduction

An analysis of the cost factors for an integrated facility is presented in the table below by Swindell-Dressler Co., a division of Pullman, Inc. The figures are based on a plant with a capacity of 250,000 mtpy, using natural gas as the prime energy source for all phases of the process from iron ore reduction to electric power generation. The only outside utilities required, according to company spokesmen, would be water and natural gas.

The cost figures are taken from data derived from commercial operation of the HyL plant at Monterrey, Mexico. These statistics provide for all facilities necessary to produce specification steel. The bases used for the calculations include the following:

Ore: 60% Fe, sized ½ to 2-in., with analysis, reducability and physical characteristics comparable to those used at the Monterrey plant. The latter uses Mexican ore of a relatively high 6 to 9% silica content which increases conversion costs in the electric furnaces and also increases the rate of electrode consumption while reducing refractory life. Ores of higher iron content and a lower percentage of silica will reduce gangue problems with benefits in reduced operating costs and greater plant output, reports Swindell-Dressler.

Natural gas: heating value of 935 Btu per cu ft minimum; sulphur, under 5 grains per 1,000 cu ft; and supplied at 150 psig.

Ore reduction: involves 85% metallization; the average charge to electric furnace would be 60% sponge and 40% scrap iron. The figures are based on plant production of 330 days per year.

The costs do not include: spare parts and warehouse supplies; real estate; site clearing; and preparation (site is assumed level and clear); special foundation requirements; all utility main supply lines outside of the site; import duties and inland freight charges.

Cost Factor	Unit Cost ($) (Costs are in U.S. Dollars)	Days/Year	Quantity	$/Year
165,000 tons ▲ Fe/Year HyL Plant Capital Cost: $6,950,000 Basic components are one reformer furnace, four reducing reactors and four heat accumulators. Cost includes all machinery; process equipment and piping; conveyors; steam, water, hydraulic oil, air and gas systems; and electrical distribution system, including a transformer station and 100-kw emergency generator; appropriate buildings and office space; and an automatic control system.				
Natural Gas	0.30/MCF*	330	4,050,000MCF	1,215,000
Water Make-up	0.027/MGal**	330	176,000MGal	4,750
Catalyst and Chemicals		330		20,000
Operating Labor	0.80/Manhour	365 + 10	49,500MHr.	39,600
Supervision	1.25/Manhour	365 + 10	9,000MHr.	11,250
Maintenance	4% Capital Investment	365 + 10		278,000
General Overhead	100% Labor and Supervision			50,850
Miscellaneous Supplies				30,000
Royalty	1.00/Ton Fe			165,000
Net Operating Cost/Yr	$11.00/Ton		165,000 Tons	$1,814,450
Melt Shop and Casting Plant Capital Cost: $8,000,000 These facilities provide all equipment necessary to produce 250,000 metric tons/year of 6" x 6" carbon steel billets by the continuous casting process. Included are three 17-ft. diameter tilting electric furnaces and related electrical equipment; cranes, ladles, buckets and slag pots; instruments; scales; maintenance and ventilation equipment; communication systems; continuous casting machine; observation equipment; all auxiliaries.				
Natural Gas	0.30/MCF	330	61,500MCF	18,450
Water Make-up	0.027/MGal	330	125,000MGal	3,375
Operating Labor	0.80/Manhour	365 + 10	525,000MHr.	420,000
Supervision	1.25/Manhour	365 + 10	9,000MHr.	11,250
Maintenance	4% Capital Investment			320,000
General Overhead	100% Labor and Supervision			431,250
Electrodes	600/Ton		2,000 Tons	1,200,000
Lime	12/Ton		20,500 Tons	246,000
Dolomite	18/Ton		2,625 Tons	47,250
Ferro Alloys	400/Ton		1,450 Tons	580,000
Fluorite	18/Ton		1,450 Tons	26,100
Refractories	145/Ton		2,500 Tons	362,500
Magnesite	46/Ton		1,300 Tons	59,800
Oxygen and Acetylene				88,000
Miscellaneous Supplies				50,000
Net Operating Cost/Yr	$15.46/Ton		250,000 Tons	$3,863,975
50,000kw Power Plant Capital Cost: $7,850,000 The power plant has sufficient capacity to provide electricity to the HyL-ore reduction plant, the melt shop, casting and billet rolling plant, as well as 1,000 kva for general plant use. Equipment includes boilers fired by natural gas; generators of 50,000kw capacity; distribution systems; all auxiliaries.				
Natural Gas	0.30/MCF	365	2,520,000MCF	756,000
Water	0.027/MGal	365	525,000MGal	14,175
Chemicals		365		47,000
Operating Labor	0.80/Manhour	365 + 10	75,000MHr.	60,000
Supervision	1.25/Manhour	365 + 10	16,000MHr.	20,000
Maintenance	1.0% Capital Investment			78,500
General Overhead	70.0% Labor and Supervision			56,000
Net Operating Cost/Yr	$0.0053/KWH		196,000,000KWH	$1,031,675
General Plant Facilities Capital Cost: $6,711,000 These facilities include ore and scrap yards and handling equipment; slag disposal facilities; inplant switching engines, cars and trackage; all other required materials-handling systems; auxiliary and utility systems; lighting and power transmission gear outside the individual plants; sewers and waste disposal; general facility buildings; laboratory and machine shop equipment; mobile equipment.				
Labor	0.80/Manhour		125,000MHr.	100,000
Supervision	1.25/Manhour		9,000MHr.	11,250
Miscellaneous Supplies				50,000
Maintenance	1.6% Capital Investment			107,375
General Overhead	100% Labor and Supervision			111,250
Net Operating Cost/Yr				$379,875

▲ Tons are in Metric Tons *MCF = Thousand Cubic Feet **MGal = Thousand U.S. Gallons