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REFLECTIONS ON THE FUTURE AND ON THE ROLE OF THE FERROALLOYS INDUSTRY IN THE DEVELOPMENT OF NORTH AMERICA

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Talking about our industry and its future on the North American continent is to some extent like giving the weather forecast or giving good advice as a stock market broker. Both of them usually are perfect when it deals with what has happened and what has been the past, but when it goes into the other direction, then, of course, the quality or precision of the information may become much less impressive. So please understand that I also want to start with the more secure information about our industry in the past and at present.

THE FERROALLOYS INDUSTRY IN NORTH AMERICA IN THE 60's AND 70's

Important locations of the North American ferroalloys industry at that time have been areas close to the major rivers like the Ohio-Tennessee-Mississippi river system, the Niagara river and in Canada the St. Lawrence, where hydro electricity could be generated at low costs. As the power requirement of submerged arc furnaces - the standard production unit for ferroalloys - is relatively modest in its demand on stability of the electrical grid, locations close to low megawatt river dam generating plants have been quite an option as evidenced by the location Beauharnois on the St. Lawrence river. Locations relatively close to the market in the U.S. - basically the so-called rust-belt - got the lion's share of ferrosilicon capacity, eventhough a few of those in the states of Ohio, Western Virginia or Iowa were dependent upon coal fired power plants. Cheap coal and almost no investments for emission control in the fossile fuel power plants resulted in competitive power pricing. The major producers are shown on the following map (Figures 1 and 2).

It is of interest to see that almost none of those important producers is still owned by the same company today. In the 60's, the Calvert City plant of then Airco Industries had 120 MW's and was a 6-furnace operation, almost identical in installed MW's and number of furnaces was the Philo, Ohio, plant of OFA, the Ashtabula/Ohio plant of then Union Carbide came pretty close with major production of ferrosilicon and calcium carbide, the Keokuk/Iowa plant of Foote Minerals Company was by far the biggest producer of silvery pig iron and another of their plants at New Haven, West Virginia, had 3 furnaces for ferrosilicon, which altogether on a FeSi 50 basis were good for about 100,000 MTPY.

Up in Canada, there was one location, Beauharnois in the vicinity of Montreal on the St. Lawrence, where Union Carbide had a silicon metal operation with 3 furnaces and a ferromanganese production with one furnace, whereas the neighboring plant in the same town

FIGURE 1

Locations of the North American Ferroalloys Industry

1. Wenatchee, WA
2. Addy, WA +
3. Springfield, OR
4. Keokuk, IO
5. Calvert City, KY
6. Kimball, TN +
7. Bridgeport, AL
8. Lister Hill, AL+
9. Montgomery, AL
10. Selma, AL
11. Philo, OH+
12. Marietta, OH
13. Powhatan Pt, OH+
14. Ashtabula, OH (+)
15. Brilliant, OH +
16. Beverly, OH
17. New Haven, WV
18. Alloy, WV
19. Charleston, SC
20. Niagara Falls, NY
21. Beauharnois, QC +
22. Chicoutimi, QC
23. Bécancour, QC

FIGURE 2

U.S. Center - East Concentration of the Ferroalloys Industry owned by Cromasco had 4 furnaces to produce ferrosilicon of various graded with a capacity of about 50,000 MTPY.

These plants mentioned shall just serve as examples to focus on the changes our industry has gone through since, but are not considered a comprehensive listing of what had been the industry. It is interesting, however, to know that in the mid 70's the total installed capacity of the U.S. ferroalloys industry was about 1,400 MW.

THE NORTH AMERICAN FERROALLOYS INDUSTRY OF TODAY

The presently operating plants as well as their owners and estimated capacities are shown in the following tables (Figures 3 and 4).

It is interesting to note that not only big names of ferroalloy producers disappeared, like Union Carbide, Foote Minerals, Airco/British Oxygen and Ohio Ferroalloy Corp., whereas others came into the scene, in particular European ferroalloy producers like Elkem and SKW. Also newly formed companies like American Alloys or Keokuk Ferrosil have entered into our world, taking over existing plants. Various plants or sections thereof have been abandoned, as for example:

In the United States, starting in the West:

The FeSi and unused silicon metal capacity of Northwest Alloys in Addy, WA

The FeSi operation of the then Hannah Mining Co. in Wenachee, WA

The Reynolds silicon metal capacity in Lister Hill, AL

The FeSi plant of AIMCOR in Timball, TN

The Powhattan Point and the Philo plants of the defunct Ohio Ferroalloys Corporation, OH

The ferrosilicon capacity of the Ashtabula, OH, Ferroalloys and Carbide complex, owned by Elkem Metals

and in Canada:

The location Beauharnois, both with regard to Chromasco's later renamed Timminco's, FeSi operation, as well as Union Carbide's SiMet production and eventually Elkem's facility of FeMn.

This list again does not claim to be comprehensive, but shows important changes, with formerly well-known producers abandoning this business.

Additional capacities were set up mainly for silicon metal. 3 plants built during the 70's give testimony of the growing importance of SiMet in our industry:

The facility in Selma, Alabama, of now Globe Metallurgical Inc.

FIGURE 3

Ferroalloys excluding Silicon Metal Plants in North America, in Operation in 1994

Company Name	Plant Location	# Furnaces	Total MW's	Annual Cap. [MT]
AIMCOR	Bridgeport, AL	1	34	40,000[1)]
American Alloys	New Haven, WV	3	75	95,000[1,2)]
Elkem	Ashtabula, OH	2	90	90,000[1)]
	Chicoutimi, QC	1	28	35,000[1,2)]
	Marietta, OH	3	52	FeMn + Mn
Globe Met.	Beverly, OH	2 + 1	45 ?	?
	Niagara Falls, N.Y.	1	18/24	30,000[1)]
Keokuk Ferrosil	Keokuk IA	2	38	60,000[1,3)]
McAlloy	Charleston, SC	1	28	FeCr
SKW Metals & Alloys	Calvert City, KY	2	68	70,000[1+2)]
SKW Canada	Bécancour, QC	1	30	29,000[2)]

[1)] = FeSi 50
[2)] = FeSi 75
[3)] = FeSi 15 silvery pig iron

FIGURE 4

SiMet Plants in North America, presently in Operation

Company Name	Plant Location	# Furnaces		Total MW's	Annual Cap. [MT]
Silicon Metal Tech	Wenatchee, WA	3		36	19,000
Globe	Springfield, OR	1		16	9,000
	Selma, AL	2		44	32,000
	Beverly, OH	1		18 (?)	11,000 (?)
	Niagara Falls, NY	1		19	12,000
Simcala	Montgomery, AL	3		60	40,000
Elkem	Alloy, WV	5		84 (?)	56,000
American Alloys	New Haven, WV	1		8	6,000
SKW Canada	Bécancour, QC	2		45	31,000
			Total	330	216,000

The SiMet plant of Simcala* in Montgomery, Alabama, and

The SiMet and FeSi plant of SKW Canada Inc. at Bécancour/Québec

The most recent of these investments dates back into 1977, if we ignore furnace conversions or minor modifications which have been done more recently.

Some interesting numbers of the ferroalloys industry in the United States compiled by The Ferroalloys Association TFA shall be shown in the following diagram:

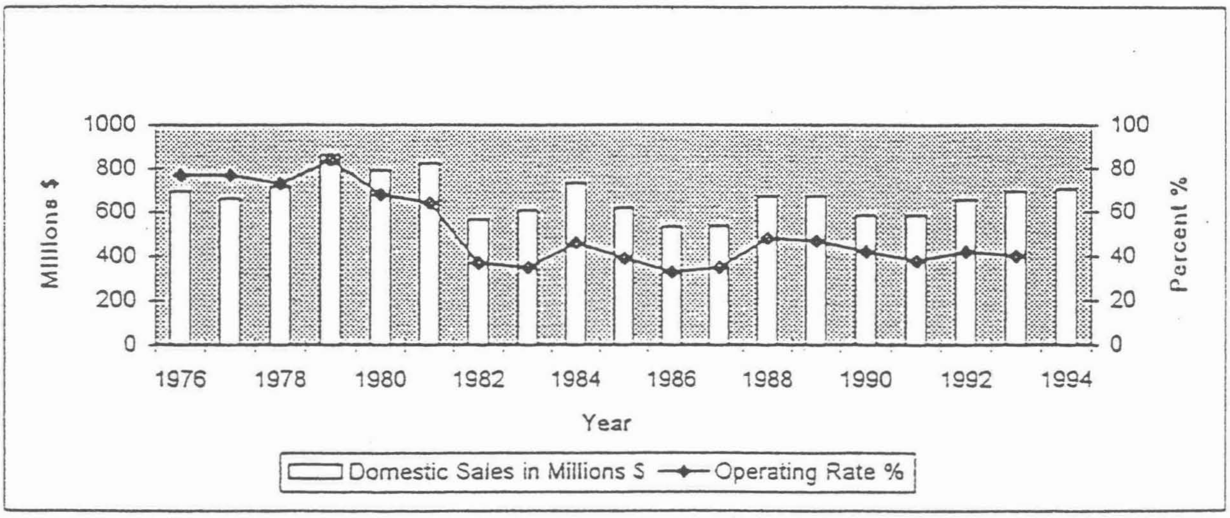

Figure 5. Annual sales and operating rate of the U.S. ferroalloy industry since the mid 70's

Figure 5 displays the total sales in nominal money of this industry into the domestic market over a period of 19 years as well as the operating rate in percent of a defined capacity. This diagram shows very clearly that since the major recession in 1980/81, this industry was forced to shutdown substantial capacity. While some of it occasionally was restarted, the majority of such capacity was eliminated from the market. A rate of about 40% of the once existing capacity shows clearly that a lot of plants or furnaces are now defunct as already pointed out.

STRENGTHS AND WEAKNESSES OF THE NORTH AMERICA FERROALLOYS INDUSTRY IN THE GLOBAL MARKET - AN ATTEMPT TO FOCUS ON IMPORTANT FACTORS OR CHANGES RECENTLY TAKING PLACE

Ferromanganese and Silicomanganese

The fact that for the production of these commodities a relatively smaller amount of electric power is needed makes the unit cost for power somewhat less preponderant and the closeness to raw materials a major asset. In this respect, it appears that the Mexican plants if Minera Autlan should be well positioned.

*the former SiMETCO., after having changed ownership at the beginning of 1995

Economically, the establishment of NAFTA will allow the import of this material into the major market U.S. without duties. A further advantage for them surely will be the recent currency devaluation of the Mexican Peso, which for exporters shall have a substantial advantage, as their costs are almost entirely in Pesos.

Political changes in the world after the collapse of communism and the abolition of apartheid in South Africa trigger certain reconsiderations of strategic material dependence in the U.S. This could eventually affect the long-term existence of Elkem's Marietta/Ohio plant. It appears that previously held strategic stockpiles of Mn- and also Cr-ores by the U.S. government will no longer be a vital issue for vulnerability of the U.S. steel industry producing for war equipment manufacturers. Health and safety aspects, which presently play a major role in the U.S. regarding manganese, however, shall not be overweighted since arguments related to health risks in producing manganese and Mn-alloys should be valid to the same extent for production in other parts of the world. This, however, is a subject which surely in the discussion will need more attention to be paid to. It shall be noted that Elkem has already abandoned the ferromanganese production in Beauharnois, Canada.

Ferrochromium

What was said for ferromanganese is even more valid for ferrochromium. The fact that North America does not own any appreciable Cr-ores and that most of the ferrochromium consumed in the U.S. came from countries considered politically unstable or risky, had caused a government action to build and maintain strategic stockpiles of Cr-ores which were converted into ferrochromium under tolling agreements with the government. It appears that this strategy is now abandoned, so that the only U.S.-ferrochromium producer Macalloy now does business on the same terms as everyone else. I believe that they should be reasonably well located for ore imports and also not too far away from the centers of consumption.

A major increase in the stainless steel production in Canada as a consequence of Korea's Sammi Steel acquisition of Atlas Steel and ambitious capacity expansion may be a stimulus for a ferrochromium project in Quebec, resurfaced os Coloraine. Some reserves of low Cr-bearing ores in the Eastern Townships and not commercially exploited since decades are quoted as a justification of this project as well as favorable power costs. A similar project had been pursued by an international group of companies with experience in this business, but was finally abandoned for economic reasons in the late 80's.

Ferrosilicon

The U.S. steel industry traditionally has been a preferred user of FeSi 50 and this has been produced mostly within their own country. Only in the more recent years, certain imports of FeSi 50 from the former Soviet Union entered this country with known impact upon the market.

Changes in the steel making technology and the overproportionally strong growth of the so called Ministeel plant concept with electric arc furnaces based on scrap, made the demand for FeSi 75 going up strongly, so that the American producers have to have both types for their domestic clientele. Local quartz of acceptable quality for regular FeSi as well as medium grade mineral coal without major processing from the Kentucky/Tennessee coal mines have been the raw materials, whereas Fe almost always came from scrap in form of turnings and borings generated by the manufacturing industry. Therefore, for this industry, the decisive factors for competitiveness are a favorable power rate and production units of substantial size, so that the labor cost per ton of product can be minimized. Obviously, the capital cost factor plays a major role as well, so that relatively old plants with big furnaces and with a reasonable power rate shall have a chance to maintain their position in the business, provided that they are well maintained and the installations for environmental protection are up to standard. This is again a factor where North American producers look critically to the application of similar standards elsewhere in the world in order to not have an unfair disadvantage compared to the offshore competition.

SILICON METAL PRODUCTION

Contrary to past practice, I have separated this material from the silicon alloys for various reasons:

1) Power consumption and power costs are of much higher importance.

2) Quality of and accessability to black materials/reducers is a criterion.

3) The overall transportation costs for raw materials to the SiMet plant can weigh heavily, as there is a ratio of about 7:1 for all raw materials vs one unit of SiMet.

Historically, the most favorable power price has been considered as the criterion for a SiMet location. Compared to all North American SiMet producers already shown, SKW's Bécancour plant surely had been favoured by advantageous power costs through the mid 80's. Those plants who have essentially their own power generating capacity (such as Elkem's Alloy, WV, plant) may still have such an enviable situation. Special power conditions granted to SiMet producers close or related to the aluminum industry enabled them to exist, as the Wenatchee plant, now owned by Silicon Metal Tech, and the now closed Reynolds plant at Lister Hill, AL. Reasonable power conditions at the location Niagara Falls, NY, allowed SKW Alloys in 1986 to go into the silicon metal production as well, and it appears that producers in Alabama could obtain rates which today should be considered the normal level in the industry - maybe from somewhat below 20 to the mid/or even high 20 mills/kWh.

The North American silicon metal industry is based on mineral coal from the Kentucky/Tennessee area, which has to be processed (washed). For those producers being far away from this source, the transportation costs of this coal to the plant as well as a potential degradation by long transportation can be comparatively disadvantageous. In this respect, Silicon Metal Tech's, Wenatchee and Globes' Springfield/Oregon as well as SKW Canada's Bécancour plants may have certain disadvantages vs the others.

Suitable so called HP quartz shall be the basis for silicon metal production for the chemical industry - an application with by far the highest growth rate of all the products considered here. It is my impression that those quartzes out of North Carolina and Alabama give satisfactory performance at reasonable costs based on the quartz delivered plant. In this respect the plants out West seem to have a disadvantage. SKW Canada's Bécancour plant, as the only quasi coastal location of all silicon metal producers in North America, enjoys substantial flexibility if and when quartz cannot be used out of their own quartz mine close by. To me it is THE export location of all North American ferroalloys plants!

WHAT DO I EXPECT FOR THE FUTURE OF THE NORTH AMERICAN FERROALLOYS INDUSTRY?

Because of what was already said for the manganese and chromium alloys, I would like to restrict my evaluation to the chances for the future of the FeSi and SiMet producers.

North America, in particular the United States, have been politically open to worldwide free trade. It is for this reason that substantial volume has been imported and will continue to be imported. The energy policy of the various power producers appears to go towards a certain leveraged power price for such type of consumption, and the times of huge differences between favourable/unfavourable power prices - from below 10 mills to close to 40 mills - seem to have disappeared. From this angle of view, I dare to say that the North American ferroalloys producers may now be at relatively equal terms and no longer disfavoured compared to their competitors elsewhere.

Discussions about further energy taxes, like a CO_2 tax, of course, can threaten the industry. An introduction of such an additional burden, however, shall not take place in any way to disfavour certain locations vs others. In particular one has to request that all political lobbying shall prevent that only one or some few countries undertake such a draconic action and thereby again unbalance the competitive structure of our industry.

Concessions to generate their own power and thereby allowing much lower energy costs than mentioned above, will not be very likely obtainable in the future, so that new greenfield plants are not expected to be set up, even though the deregulation in the electric power industry in North America is an important factor. It is much more by belief that power transportation costs through the interconnected grid across the country will have the effect of a certain protection against price hikes from local, provincial or state suppliers.

Efforts to use existing capacities in the most efficient way by cutting fixed costs have surely been undertaken by each and everyone. This obviously has made the North American industry competitive against any other elsewhere. A consequence thereof may, however, be that in case of economic difficulties, the amount of jobs being threatened fall below a critical threshold, where politicians traditionally give attention to such a situation. This is said in view of support to the industry against unfair competition, but not to encourage or request subsidies for certain plants during times of economic slumps.

A major factor is the environmental aspect, which can or may distort the competitiveness of the industry. Well-functioning pollution abatement systems, which reduce dust emissions to below 30 mg/Nm^3, require not only a substantial initial investment but also considerable operating costs. I would estimate that up to 20% of the silicon metal costs are spent for dust pollution control. I consider it imperative that air pollution control standards in the world should be harmonized so that there be no ferroalloy producer running without such dust pollution abatement system.

Another subject of concern is the issue of silicosis supposedly caused by small amounts of crystalline silica in handling quartz and producing silicon alloys. We are concerned that different standards regarding protection against inhalation of dust will be applied in various countries in the world which we would consider totally unjustified. A similar concern is indeed threatening the North American manganese industry since several years, whereas there seems to be no concern elsewhere in the world, as if human health and dangers to it are affected by the geographic location!!

Whereas most of the presently operating plants are in areas where they have an importance for the local or even provincial or state labour market, it appears that incentives for new investments or expansion through subsidized low power prices will not be granted anymore.

WHAT WILL THE FUTURE BRING FOR SILICON METAL PRODUCTION?

Obviously, the efforts to use more efficiently all resources will increase, in particular those to be considered scarce. It appears that the possibilities to minimize the use of electric energy do not contain major areas for further improvements as in particular the specific power consumption seems to have come down substantially in most of the well-run plants. Of course, from a merely economic process evaluation, there is still a lot of room for improvement in energy utilization, i.e.

1) the use of the CO generated in the process and flared on the surface of the mix still inside the furnace.
2) The recovery of the sensible heat contained in the gases exiting the process.

The utilization of the CO out of the process is definitely a very challenging task, as it can be done successfully only when a substantial process technology change is implemented: The avoidance of CO oxidation by excess air at the surface of the mix. A very interesting approach to solve this problem and use the CO has been undertaken in a research work in the United States and sponsored by the Department of Energy [1]. In principle it seems fascinating to extract CO and convert it into methanol, which then would be used for the generation of methylchloride, the second base product needed in the manufacture of silicones. On a worldwide bases, this application consumes about 1/3 of all SiMet produced. It appears, however, to me that the complexity of problems in such an integrated process will not allow its practical application within the foreseeable future.

A practical approach which would also reduce the waste of CO in such a modified furnace has been undertaken in a joint U.S. and Canadian research work in Dow Corning's closed furnace concept, based on Direct Current application, in a pilot plant in Selkirk, Manitoba, in Canada. Reports about the progress of this work have been given elsewhere [2] and, therefore, shall not be commented here.

The utilization of the sensible energy of the process gases by waste heat boilers installed as closely as possible to the source of the gases in order to maximize the energy potential have been undertaken in a variety of plants, i.e. in Norway and in France. Extracting the sensible heat of a heavily dust laden hot gas is quite a challenge, in particular when such gas contains dust of the nature of an amorphous SiO_2 and in concentrations many times higher than any other industrial process gas. An efficient and almost continuous removal of SiO_2 deposits on the boiler tubes or fin walls is a prerequisite to avoid rapidly growing heat transfer losses between the gas and the water or steam bearing sections of waste heat boilers. My suggestion to the materials scientists and equipment engineers is:

Develop materials and systems which allow a hot gas filtration with a similar efficiency as presently achieved in bag houses equipped with fiberglass or Goretex bags, to the T for waste heat recovery can be maximized. Low temperature waste heat recovery at gas temperatures after dry filtration in conventional baghouses will not be an economic alternative in our industry.

A further area of improvements in the presently applied processes aims at better yield of all raw materials and consumables to minimize discarding of unsuitable sizes or losses. Expensive consumables, like prebaked electrodes, which are presently the state of the art in SiMet manufacture, receive critical attention in the industry. Not only development work for a DC silicon metal furnace and reported in the last few years [2] is an area in which North America appears to have put more effort into than other areas of the world but also the development of cheaper electrodes like the compound system [3,4] had its origin in North America. Its application now already in 4 furnaces in 3 different continents shall show whether further cost reductions can be achieved without causing other disadvantages which may restrict its general applicability in the SiMet industry.

Those companies exploring new avenues to develop cheaper ways and means to produce silicon, undertake substantial business risks. This should be honored and rewarded by their customers who have or should have an interest in healthy producers committed to technological progress. I am of the firm opinion that this is a more viable way to further develop our industry than trying to force each and any possible producer/supplier to accept a substantial price reduction year after year, just to have the "privilege" of doing business with an overmighty consumer.

It is interesting to see that major efforts to develop new technology, in particular for the silicon metal production, receive some attention and support by governments. It shows that the fate of the alloys and metals industry in North America is still (or again?) of interest to politicians, as research and development funds have been made available both to the DC furnace concepts as well as to plasma smelting of FeCr. The technology utilization of Cr-ore fines through the hollow electrode as well as combinations of the various systems may not remain limited just to the FeCr production. Only with such continuous R&D funding support, the industry may be in a position to achieve what other industries have successfully done:

"Implement improvements in direction towards better products at lower costs with less burden to the environment compared to the present level."

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