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Observation of Anomalous Production of Si and Fe in an Arc Furnace Driven Ferro Silicon Smelting Plant at levels of Tons per day

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Introduction :

Silcal Metallurgic Ltd. was incorporated as a private limited company in the southern Indian Industrial town of Coimbatore in 1978 and attained commercial production in 1980. It employed the well known Ferro Silicon smelting technology involving high current Submerged Electric Arc furnaces. This electro-thermic manufacturing process for Ferro-Silicon alloy is highly power intensive since the temperature in the reaction zone has to be maintained at around 2000^{o}C. Refs. [1,2,3] give comprehensive overviews of this technology. The Silcal furnaces had ratings of 5 MVA and 12 MVA and were operated on a round the clock basis. They deployed the traditional Soderberg self baking carbon electrodes in steel casing which have been successfully used for over a century [4]. The 5 MVA furnace was used for the production of Low Carbon Silico Manganese while the 12 MVA furnace was dedicated to the production of Fe-Si alloy of 70-75% Si grade.

Brief Remarks on the plant and operation :

Raw materials used for production of Fe-Si alloy are low Alumina content Quartz (SiO_2) of 98.7 % – 98.8 % purity, steel scrap and wood charcoal with low ash content which served as the reducing agent. Quartz was sourced directly from selected mines in the state of Tamil Nadu which are known to have low Alumina content. On receipt of the consignment at the plant site, dust and fines were screened out and the stock stored outdoors. Wood charcoal on arrival was tested for moisture and fixed carbon and screened to separate fine dust and placed in storage. Steel scrap was stored in an outdoor yard. All raw materials were analyzed for purity at the in-house testing lab and the data carefully archived.

The screened raw materials were taken by a conveyer system to the 3nd floor and stored in separate over head bunkers. Each of the three raw materials were weighed according to a computerized batching system and transferred into charging buckets running on monorails in the 2nd floor. Charging buckets then discharged the premixed raw materials into the furnace every 10 to 15 minutes through chutes. Shift-wise consumption of all raw materials was totalized to obtain daily (24 hr) consumption data.

The molten alloy product was drained through one of the three tap holes at the bottom of the furnace, every 2 to 2.5 hours into tiltable “teeming ladles” mounted on rail tracks. The teeming ladles were then emptied into large stationary heat resistant cast iron trays to a thickness of approximately 50 mm. Next day, during the day shift, the solidified Fe-Si slabs were manually broken into smaller pieces, weighed and packed into 40Kg bags for domestic consumers or in 1 ton jumbo bags for export. Each batch of Fe-Si was individually analyzed.

For those who may not be familiar with submerged arc furnace technology, it may be mentioned that the voltage applied to the three electrodes is 3-phase alternating current, typically in the 100 to 200 V region, using a step down transformer to convert from 11 KV grid supplied power. Arc currents are in the 30 to 60 KA region. The arc is struck between the vertically mounted steel encased consumable Soderberg electrodes and the floor of the carbon hearth. Both the carbon of the self baking electrodes and its steel

casing are consumed, the consumption being 50 to 60 Kg per ton of Fe-Si. Details of how the electrode material is replenished online without interrupting furnace operation are discussed in references [1 to 4].

The 12 MVA furnace was typically operated round the clock at variable ratings from 7 MVA to 12 MVA, depending on the availability of power. Various charge mix ratios and operating electrical parameters were experimented with in order to arrive at the optimum conditions required for achieving 73% to 74% Silicon content alloy. Systematic records of the total weight of the raw material feed used every day, as also the weight of the product alloy tapped out every day was maintained. Cumulative daily consumption of electrical power was also recorded. A maximum daily production of 27.5 tons of product alloy was achieved whenever the furnace was operated under full load conditions. The main products generated by the plant are Fe-Si alloy drained out at bottom and CO_2 gas emission from the stack. The company was very successful and made good profits, supplying high quality products to both domestic and export markets.

Energy requirement for chemical reduction of SiO_2:

Plant records show that to produce 1Kg of Silicon content in the product alloy, about 11 kWh of energy is consumed. This observation also tallies with the expected energy consumption estimate based on theoretical considerations of the chemistry of the reduction reaction which is endothermic. In our case the product was 73 to 74% Silicon content. Taking an average value of 73.5%, 735 Kg of Si would be present in each ton of product alloy (balance being Iron). Power consumption for producing 1 ton of alloy thus works out to 11x735 = 8085 kWh. However since dissolving iron into molten Silicon is exothermic, 265 Kgs of Iron dissolving into 735 Kgs of Silicon, would release some heat. Assuming this to be about 150 kWh, production of 1 ton of Ferro Silicon alloy of 73.5 to 74% Si content would require a net energy of 8085-150 = 7935 kWh. (Ref [3] also quotes a similar figure.) The relevance of discussing energy consumption considerations will become apparent later in this write-up.

Remarks on inconsistencies observed between weights of input feeds and output products during a 11 week run in 1995 :

During early 1995, the furnace was operated continuously round the clock at a rating of between 8.5 MVA and 8.75 MVA with a daily power consumption of 1,68,000 kWh per day. The feed mixture composition of the raw materials was not changed throughout the 11 week run. Throughout this period the daily average production consistently remained at 24.75 tons of finished Fe-Si alloy of grade 73.8 – 74% Si content, balance being Iron. Variations from day to day were very nominal.

Average consumption of raw materials per day during this 11 week period was as follows :

1. Quartz – 33.377 tons . Accounting for its purity of 98.73%
   the actual weight of SiO_2 in the feed stock works out to ……. 32.955 tons

2. Daily Iron feed …… …….. ……
   (Minor additional contributions from the quartz and …… 5.1 tons
   electrode casing has been considered in this.)

3. Fixed Carbon (FC) input from charcoal
   (Daily Carbon requirement was set based on the FC content,
   moisture in the charcoal and burning losses). …… 13.182 tons
   The theoretical requirement of fixed carbon for reduction
   of 32.955 tons of Quartz was computed to be 13.182 tons.)

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Thus total weight of raw materials (SiO_2, Fe and C) consumed daily was 51.237 tons

Based on raw materials consumption, the maximum possible daily production of Fe-Si alloy at 100% recovery for an alloy of 75% silicon can be computed as follows :

* Component of Silicon present in 32.955 tons of Quartz =	15.379 tons
* Iron (Fe) in Input …… ……..	5.1 tons
Total weight of Si and Fe in Input ……	20.479 tons

In comparison the actual daily production of Fe-Si alloy was however 24.75 tons. The composition of the product alloy was found to be consistently 73.8% to 74.1 % Silicon content.

* Net Silicon content in product alloy was thus 24.75 X 0.74 tons	= 18.315 tons
* Net weight of Fe in Product alloy was …..	= 6.435 tons
Total weight of metal alloy actually produced	= 24.75 tons

Therefore total excess production of Silicon & Iron per day works out to 4.27 tons. Of this excess silicon was roughly 3 tons and balance of ~ 1.3 tons excess iron. Note that this constitutes roughly 20 % excess metal both for Si and Fe.

Discussion and Remarks :

Although we had been observing anomalous excess production of Si and Fe ranging from 200 Kgs to 400 Kgs per day right from 1985 onwards, we were not sure whether these were due to errors in weighing or could be attributed to anomalous generation of Si and Fe. However following the consistent and repeated observation of about 4.27 tons of daily excess metal production over the 11 week round the clock run in 1995, we were convinced beyond doubt that anomalous transmutation processes are indeed occurring, pointing to the existence of new science. It was only after this that we went public and released our findings in a press briefing (See Appendix A).

We are fully aware that our claims of tons level transmutations will be met with intense skepticism. The two most obvious sources of likely doubts leading to invalid conclusion are : (a) Errors in weighing of input feedstock and output alloy produced. Since we are dealing with tons, it is relatively easy to convince skeptics that such errors occurring repeatedly over durations of months and years are not possible.

(b) The other doubt voiced is that somehow additional amounts of Silicon could have entered the furnace without the knowledge of the plant operators. One critic for example suggested that may be the quartz used was not 100% SiO_2 but may have been partly in the form of SiO in which case the weight fraction of Silicon in the quartz would be more than 46.7% (28/60) as assumed by us. Critics argue that this could explain the anomalous appearance of "additional' Si. The main argument against this postulate is that SiO is actually a gas and there is no question of its being a contamination in quartz. References 1 to 4 clearly mention quartz as mined is predominantly in the form of SiO_2.

Had there been unknown amounts of additional SiO_2 in the feedstock it would have shown up in the electrical power consumption records – the so called chemical energy signature. The daily total power consumed would have proportionately gone up such that specific power consumed remained at the level of 7935 KWh per ton of Si produced. But in our case in the presence of transmutation also the total power used remained the same, inspite of quantum of product alloy having increased. The specific power consumption had come down to 6788 kWh per ton of Silicon in place of 7935 KWh per ton of Si. This

observation can be taken to suggest that the additional Si production did not come through chemical reduction processes, but must have arisen through some other cause.

Some amount of SiO gas does get formed during the smelting process if operating conditions are not optimized and this escapes along with CO. (We could clearly observe the presence if any of SiO in the burning off gas, from the blue tinge in the flame caused by CO burning to CO_2.) In our material balance considerations we have not accounted for loss of Si through the SiO mode. We have assumed 100 % recovery. If SiO escape is taken into account the quantum of transmuted Si would actually work out to be even more!

Possible relevance of Carbon Arc experiments known to LENR researchers to our observations :

In quest of an explanation of these anomalous observations, I was advised to meet the then Director of the Indira Gandhi Centre for Atomic Research (IGCAR) at Kalpakkam, Tamil Nadu who himself was a distinguished Metallurgist. He cautioned me that mainstream Science has no ready explanation for these results and suggested that I meet one Dr. Mahadeva Srinivasan, formerly of the Bhabha Atomic Research Centre, (BARC), Mumbai who had been closely following the progress of a new field of research called Cold Fusion/LENR. It is only after discussions with Dr. Srinivasan in the year 2000 that I became aware of the existence of LENR. It was Dr. Srinivasan who first introduced us to the so called Carbon Arc experiments [5,6,7,8] in which anomalous generation of Si and Fe had earlier been reported by many researchers. (See also http://www.nuenergy.org/transmutation-of-carbon/). Indeed the carbon arc experiment itself was pioneered by a Japanese researcher by the name of George Oshawa in 1964 and the iron reportedly generated in such experiments has come to be known as George Oshawa steel in literature. [See http://www.levity.com/alchemy/nelson2_3.html]. (It is believed that the high fluctuating magnetic fields generated by the tens of kiloamp arc currents in the smelting plant could be playing a vital role in facilitating the transmutation reactions.)

To the best of our knowledge nobody in published LENR literature has claimed that the observations of Carbon Arc experiment or that of the glow discharge experiments carried out by many Russian groups, violates Einstein's $E=MC^2$ dictum. On the other hand no one has established a clear correlation between the quantum of transmutation products generated and the heat release either. A noteworthy feature of our observations is that there was no dramatic change whatsoever in the energy dissipation. There was no evidence of massive amounts of nuclear energy being released throughout the 11 week period, giving a handle to the skeptics to question our claims of tons level elemental transmutations !

A simple calculation shows (see Appendix A) that corresponding to 4.27 tons of metal transmutation, the power generated should have been the equivalent of the total thermal power generated by a couple of thousand 1 GWe nuclear power stations in one 24 hr day ! This may truly be termed as an astronomical number! Thus if indeed the Silcal transmutation claims are confirmed it would clearly point to the operation of new Science which is even more bizarre than claimed by most other LENR experiments!

The closest to such behavior is perhaps the claims of carbon to calcium transmutations in hens which lay dozens of eggs, as has been discussed by Kervran and others [9,10,11]. Proponents of Biological Transmutation phenomena have postulated that the Calcium in eggshells is generated by a transmutation process involving Si and C occurring within the body of hens. But since equivalent energy release has not been observed, critics often joke about this "claim", criticizing that the hen should have fried if nuclear processes are present – the common "fried chicken" criticism !

Unfortunately our industry was crippled by power cuts ranging from 30% to 100% and severe power interruptions from 1996 onwards till 1999. Following a dispute regarding violation of Power Tariff agreement with the state government and withdrawal of exemptions from power cut for our industry, the Silcal plant had to be shutdown in 2002 and the company wound up in 2010. This follows from the fact

that cost of electrical power input forms a substantial component of the cost of production of Fe-Si alloy by the smelting process.

For the last 15 years, we have been mulling over various possible ways of improving the technology, hoping to move towards achieving 100% transmutations. We do believe that we now have the design and operational parameters for such an improved plant design. However we obviously need to replicate these results first and have a better understanding of the new science involved before further progress can be registered.

If only we had carried out isotopic analysis of the produced Fe-Si alloy it would have given us very valuable clues. We deeply regret not having thought of doing this those days! The objective of this paper is to share our findings with the LENR community, with the hope that other operators of similar plants elsewhere in the world, especially in Norway, could be encouraged to look for the occurrence of anomalous production of Si and Fe in similar submerged arc furnace smelting plants. On our part we shall be most happy to share our results and experience in a true scientific spirit with anyone interested. Meanwhile we are continuing our efforts to try and set up a new plant where the transmutation results could be replicated once again.

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The author is most grateful to Dr. Mahadeva Srinivasan for sharing his knowledge of the LENR field, especially of anomalous elemental transmutations and his guidance in moving forward in quest of understanding these puzzling observations. I am indebted to him for his help in writing this Extended Abstract. I am also thankful to Prof. V. Ramaswamy, Department of Metallurgy, PSG College of Technology, Coimbatore and Dr.Vasudeva Rao, a former Director of the Indira Gandhi Centre for Atomic Research, Kalpakkam, Tamil Nadu for taking the time to carefully evaluate our claimed findings.

References :

[1] A.G.E.Robiette, *"Electric Smelting Processes",* Griffin, London (1973)
[2] A.Riss and Y.Khodorovsky, "Production of Ferro Alloys", Translated from Russian by I.V.Savin, Foreign Languages Publishing House, Moscow (1978)
[3] Michael M. Gasik, Ed., "*Handbook of Ferro Alloys : Theory and Technology*", 1st Edition, Butterworth-Heinemann (Elsevier), (2013). See Chapter 6 titled "*Ferrosilicon and Silicon Technology*" by Merete Tangstad, Norwegian University of Science and Technology, Trondheim, Norway.
[4] J.W. Richards, "The Soderberg Self-Baking Continuous Electrode [with discussion]", Early Publications of the Lehigh Faculty. Paper 277 (1920). http://preserve.lehigh.edu/
[5] R.A. Monti, "*Low energy nuclear reactions: the revival of alchemy"*, Proceedings of the International Conference Space and Time, St. Petersburg, Russia, p. 178 (2001)
[6] M. Singh et. al., *"Verification of the George Oshawa experiment for anomalous production of iron from carbon arc in water",* Fusion Technol., **26**, p 266. (1994)
[7] R. Sundaresan and J.O.M. Bockris, "*Anomalous reactions during arcing between carbon rods in water"* Fusion Technol ., **26**, 261–265 (1994)
[8] X.L. Jiang, L. J. Han, and W. Kang, "*Anomalous element production induced by carbon arcing under water"*, Proc. 7th Int. Conf. on Cold Fusion, F. Jaeger, Ed., Eneco Inc., Salt Lake City, UT, p.172 (1998).
[9] Louis Kervran, "*Biological Transmutations"*, Swan House, N.Y.,USA (1972)
[10] Vladimir Vysotskii and Anna Kornilova, *"Nuclear Transmutation of Stable & Radioactive Isotopes in Biological Systems",* Pentagon Press, New Delhi (1999)
[11] Jean-Paul Biberian, *"Fusion in All Its Forms: Cold Fusion, ITER, Alchemy, Biological Transmutations",* Amazon Books, April 2015

Appendix A : Atomic Mass Data and Computation of nuclear energy release in Transmutations reactions

Amu data used for computations :

2 Helium	3He	3.016029	0.000137
	4He	4.002603	99.999863
6 Carbon	12C	12.000000	98.93
	13C	13.003355	1.07
8 Oxygen	16O	15.994915	99.757
	17O	16.999132	0.038
	18O	17.999160	0.205
14 Silicon	28Si	27.976927	92.2297
	29Si	28.976495	4.6832
	30Si	29.973770	3.0872
26 Iron	54Fe	53.939615	5.845
	56Fe	55.934942	91.754
	57Fe	56.935399	2.119
	58Fe	57.933280	0.282

Suggested Nuclear reaction leading to production of Si

$_{6}C^{12}$ + $_{8}O^{16}$ => $_{14}Si^{28}$
12.000 15.9949 27.9765 (amu)

Total amu of LHS = 27.9949
Total amu of RHS = 27.9765

Therefore mass lost = 0.0184 amu (Means Energy released)
Multiply by 931 Mev to convert to Mev units
Energy release is 17.13 Mev per nuclear reaction (Exhothermic)

Suggested nuclear reaction path for generation of Iron (Fe^{58})

$_{14}Si^{28}$ + $_{14}Si^{28}$ => $_{28}Fe^{58}$ + 16.85 Mev
27.9765 x 2 55.9349 amu lost =.0181

Alternate possible nuclear reaction path for generation of Iron (Fe^{56})

2 $_{6}C^{12}$ + 2 $_{8}O^{18}$ Þ => $_{26}Fe^{56}$ + $_{2}He^{4}$ 49.58 Mev
2 x 12.00 2 x 17.999160 55.9349 4.002603 amu lost = 0.06326

Total amu of LHS = 59.99076
Total amu of RHS = 59.9375

Mass lost is 0.05326 amu
In Mev units = 49.58 Mev (Exhothermic)

Computation of Nuclear Energy released in Transmuting 1 ton of Si :

Fissioning of 1 gm of U-235 produces 1MWd of energy (Textbook data)
If 17.13 Mev is released instead 1MWd will become (17.13/200) = 0.086MWd.
But 1gm of Si will contain (235/28) more atoms.
So energy released becomes 0.086*235/28 = 0.72 MWd.
Transmutation of 1 ton of Si will generate $0.72 * 10^6 = 720$ GWd.
Or roughly the thermal energy generated by 240 nos. of 1000 MWe Nuclear power plants in one day!
Transmutation of 3 tons of Si would yield 770 nos of 1 Gwe nuclear stations

Nuclear energy that would be generated when 1 ton of Fe produced :

Use 49.6 Mev per atom of Fe produced (Calculated above).
And 1gm of Iron will have (235/58) more atoms.
So energy release during transmutation of 1.2 tons of Fe in one day would be
$1 \times (49.6/200) \times (235/58) \times 10^6 \times 1.2$ MWd = 1200 nos of 1000 MWe nuclear power stations!

Appendix B : Press Release issued in 1999

Coimbatore MD claims breakthrough in chemistry

Our Chennai Bureau

9 AUGUST

A COIMBATORE-based entrepreneur has claimed to have achieved a major breakthrough in the field of chemistry for which research is going on for several decades in rest of the world.

C R Narayanasamy, managing director of The Silcal Metallurgic Ltd said that his basic invention is "a chemical reaction under some specific conditions, obeying a fundamental natural law, can make it possible to convert one element into an another element".

The mathematical derivations and the theory are said to have been derived by him and duly tested in one of the laboratories in India. He claimed that the invention is one of the major breakthrough in the field of research in the current century.

Further research based on the theory will revolutionise and result in new inventions of far reaching importance in various fields in future, Narayanasamy told reporters in Chennai on Saturday.

Silcal has three units and is specialising in the production of ferro silicon, ferro silico magnesium and low carbon silico manganese. It is also implementing two hydro electric power projects in Kerala and Tamil Nadu for captive consumption.

ECONOMIC TIMES, 10TH AUG 1999