THE USE OF FOSSIL FUELS AT FERALLOYS LIMITED

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1. Introduction.

(Please note that this paper is in draft form. The final paper will be tabled at the conference. I apologise for any inconvenience caused.)

Feralloys Limited uses many forms of fossil fuel and these fuels form an integral part of the inputs to the operation. The company produces high carbon ferromanganese (HCFeMn) and refined ferromanganese (RefFeMn) at Feralloys Cato Ridge and high carbon ferrochrome (FeCr) at Feralloys Machadodorp.

Reductants are a continuing concern for Feralloys Limited. Coke costs are escalating rapidly and as a result the company is seeking other forms of reductant. Much of the coke that is used at Feralloys Limited is being imported from China because the delivered prices make this viable.

Limited success has been achieved at Cato Ridge with Chinese coke, whereas at Machadodorp all the coke is imported from China.

Coke plays two separate roles in the furnace. The first role is that of reductant, while the second role is that of bringing burden stability. At the moment, coke is the only reductant that brings stability to the furnace and as a result, it will continue to be charged to the furnace for the foreseeable future. At Machadodorp the coke charge is currently 50 – 55% of the reductant due to the stability that it brings to the furnace burden.

There are ongoing tests with various reductants at the moment. The objective of these tests is the replacement of coke. Some success has been achieved in this regard.

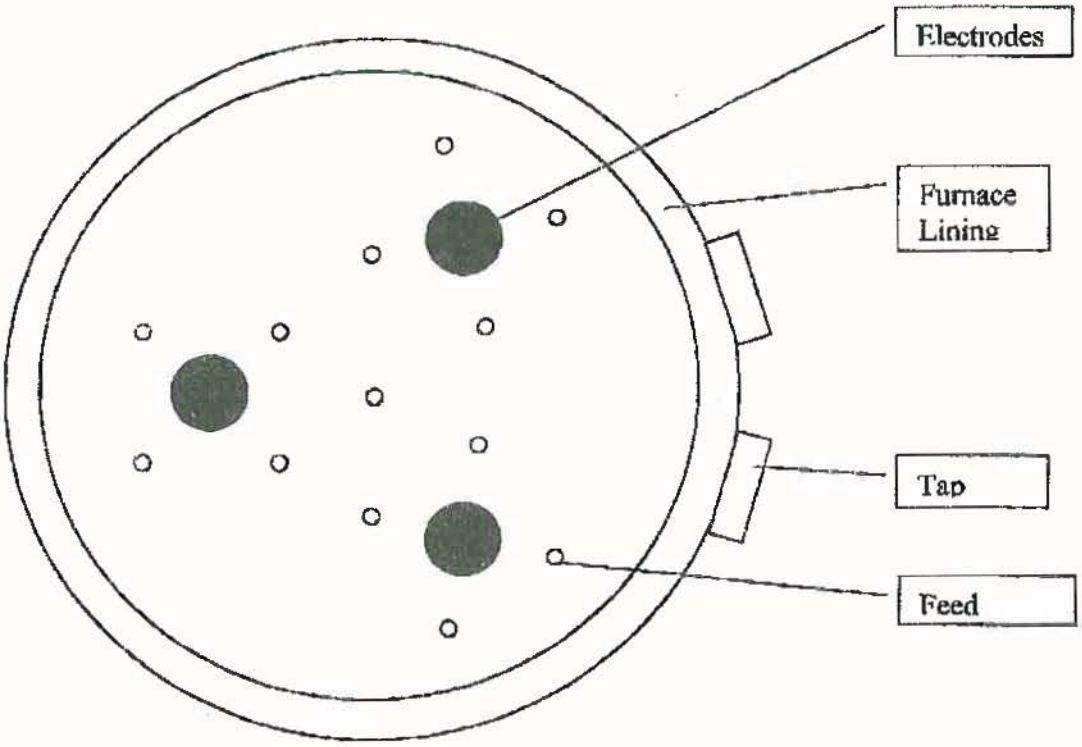
2. Background.

The furnaces that are used at Feralloys Limited are typical submerged arc furnaces. These furnaces are operated on AC power. The principal of electrical operation is typical of the average welding machine, although the amount of power utilised is orders of magnitude greater.

2.1. Plan layout.

The typical submerged arc furnace used at Feralloys Limited is circular with three electrodes set at 120 degrees to each other as shown below.

Diagram 2.1 – Typical plan of a submerged arc furnace.



2.2. Furnace Cross-section.

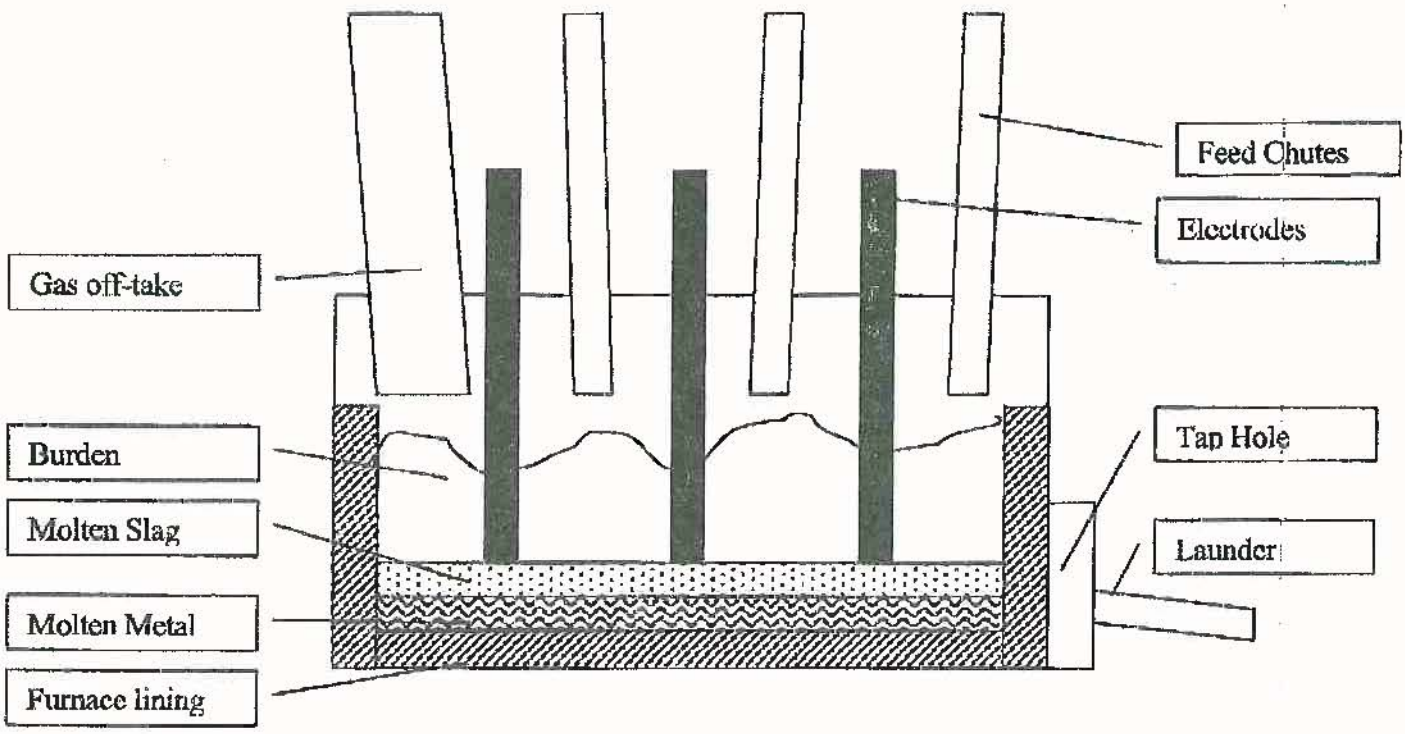
The diagram below shows the arc furnace in cross-section.

The difference in density between the molten slag and the molten metal causes the slag to float on the metal.

The burden is the raw materials that are being heated, but are still solid.

The feed chutes feed the raw materials into the furnace.

The tap hole is opened to allow the metal and slag to flow from the furnace, along the launder into the ladle.



3. Location.

3.1. Feralloys Manganese Division.

HCFeMn is produced at Cato Ridge using six submerged arc furnaces developing 115.6 MVA, which have an annual capacity of 240,000 tons.

The typical annual consumption of carbon based materials is 142, 000 tons as the table below shows.

Table 2.1 – Consumption of carbonaceous materials.

Feralloys Cato Ridge: Carbonaceous Material Volumes.		
Commodity (tons)	**26/06/98 - 25/06/99**	**26/06/99 - 25/01/2000**
Number of months	12	7
Coke peas	19,158.8	14,056.9
China Coke	4,129.0	-
Delta Anthracite	3,988.5	-
Anthracite peas	81,189.0	41,684.2
Electrode paste cylinders	33,175.0	16,928.0
Bulk electrode paste	72.4	35.6
Coke breeze	126.3	162.5
Totals	141,839.0	72,867.2

This translates to 0.6 tons of carbon consumed for each ton of metal produced.

3.2. Cato Ridge Alloys.

The annual refined FeMn production from the converter is 48, 000 tons. This technology was installed in a joint venture with Mizushima Ferroalloy and is subject to secrecy agreements. The only use of carbonaceous materials in the converter is to be found in the lining.

3.3. Feralloys Machadodorp.

There are currently 3 furnaces at Feralloys Machadodorp, which produce an annual production of 150, 000 tons of FeCr.

These furnaces are in the process of being upgraded from 24 MVA to 30 MVA, and a new furnace is being planned that will increase the annual production to 320, 000 tons.

The use of carbonaceous materials in these furnaces in terms of linings is similar to that at Cato Ridge.

4. Types of carbonaceous material used.

Fossil fuels are used in many forms in these plants. The obvious forms are coal, anthracite and coke.

4.1. Reductant.

Table 2.1 refers.

At Cato Ridge testwork is carried out regularly on different reductants. At the moment for example, various anthracites are being tested for suitability.

At Machadodorp, we are currently moving from the very expensive cokes back to anthracite and coal. We are also currently testing gas coke on these furnaces. There is a resultant drop in efficiency, but the saving as a result of the cheaper reductant is bringing the production costs down.

Fine chars are also undergoing trials in various ways at Machadodorp.

4.2. Furnace lining.

Carbon blocks are used as furnace lining and taphole lining, with carbon ramming used as the binder.

Table 4.2 - Carbonaceous materials in the furnace lining.

Feralloys Cato Ridge: Carbonaceous Material Volumes.							
Commodity	**Furnace 1**	**Furnace 2**	**Furnace 3**	**Furnace 4**	**Furnace 5**	**Furnace 6**	**Total**
Cold carbon ramming (ton)	110.0	110.0	78.0	142.0	127.0	340.8	907.8
Carbon expansion paste (ton)	7.5	7.5					15.0
Carbon taphole block (ton)	15.0	15.0	12.0	12.0	15.0	14.3	83.3
Electrode paste (ton)			10.0				10.0
Carbon blocks for floors (ton)			34.0		66.0		100.0
Total	132.5	132.5	134.0	154.0	208.0	355.1	1,116.1

4.3. Furnace electrodes.

Fine coal is used in producing paste at Rand Carbide, where electrode paste is produced for the Söderberg electrodes.

This paste is heated in the electrode by the electrical currents that run down the electrode into the furnace bath (Molten metal and slag.) The paste melts as it heats up until it is completely fluid. In this phase, it fills the spaces between the paste blocks or cylinders. As the temperature continues to rise in the paste, the volatile matter is driven off, causing the paste to set and finally form a hard, stable carbonaceous electrode that is cylindrical in shape.

5. Potential future uses.

5.1. Self-reducing pellets.

Fine coal could be mixed in the correct proportions with other fine material such as metal fines, ore fines and fine fluxes and made into pellets which can be used as part of the furnace feed. The reasoning behind this is that a self-reducing, self-fluxing pellet is formed, which is then charged to the furnace. One of the problems that are encountered, which has to be resolved, is that pellets that are not fired usually break up in the furnace feed system. The action of firing these pellets obviously utilises the fine coal contained in them.

5.2. Retort char.

Retort Char is one form of reductant that has been tested with success at Machadodorp. It is currently 20 – 25 % of the reductant feed, but is still very much in the testing phase.

6. Conclusions.

Carbonaceous materials are used in large volumes in the Ferroalloy Industry and this will continue ad infinitum.

Coke is becoming increasingly expensive and supplies are dwindling, which means that alternative sources of carbon must be found for reduction purposes.

We in the Ferroalloy Industry have expertise in the smelting of metals and in the uses of coal, coke and anthracite in these furnaces, but it would be helpful if we were to receive guidance from the source industry of these reductants.

7. References.

7.1. **Cato Ridge 5-year plan.**
7.2. **Machadodorp 5-year plan.**