**Pre-Feasibility Report**

**Tsumeb Project**

**For**

**ZincOx Resources pie**

**March 2002**

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1. Introduction

Ongopolo Mining & Processing Limited (Ongopolo) was created to exploit the Tusmeb deposits and installations following the bankruptcy of the Tsumeb Corporation. This company exploits local copper mines that contain about 20,000 tons of copper and a copper smelter producing 28,300 tons of copper blister per year including about 8,300 tons of toll treatments.

In the past, Tsumeb was also exploiting a traditional lead blast furnace, but a decision was taken to replace the ageing lead smelter with an Aus melt lead smelter in 1995, and the new furnace was commissioned early in 1997.

However, the furnace never worked properly due to the high volatilization of

lead and plugging of the spray chamber with fume oxides and the severe corrosion of the furnace refractory. Tsumeb attempted several modifications but without success, and the process has been quickly abandoned.

Since the start of the lead blast furnace and the reverberatory furnace, the slogs produced have been accumulated on different dumps that were about 2,000,000 tons of lead slag and about 600,000 tons of copper slag. The lead slag contains not only zinc but also other valuable metals in rather significant quantities such as germanium, indium, and gallium.

Some personnel of ZincOx Resources pie (ZincOx) have been approached by Ongopolo that owned the slags as well as by various finance institutions close to the Namibian authorities to find out if ZincOx would be interested in developing the project for the volatilization of these slags (The Tsumeb Project). Finally, ZincOx and Ongopolo agreed to develop the project utilizing Ausmelt Technology.

At the beginning of 2000, ZincOx approached KZ Engineering Corporation (KZE) to participate in the project as a technology supplier of Ausmelt Technology. Subsequently a general secrecy agreement was signed between ZincOX and KZE. ZincOX has planned to move forward with developing the project in accordance with the specific milestone set out in the joint venture agreement with Ongopolo. The agreement is structured such that on completion of the key milestone the project is evaluated from both technical and economic perspectives, and the decision to continue with developing the project will then be made by ZincOx.

The milestone installed by ZincOx was divided into five main phases, i.e. Phase One - Pre-feasibility Study

Phase Two - Industrial Pilot Test

Phase Three - Engineering Work for Bankable Feasibility Study Phase Four - Project Development

Phase Five - Startup and Commissioning

ZincOx also wanted to have the right to stop the studies after each of the three first phases if it appeared that the project would not be feasible for

technical or economic reasons. I

Upon the agreement of KZE to the request of ZincOx, the "Service Agreement" to execute the Phase One came into effect in January 2002. This "Pre-feasibility Report" was prepared by KZE based on the conditions of the "Service Agreement."

-The future Ausmelt plant built in Tsumeb is provisionally named "The Slag

Furner" and the capacity will be 100,000 9ay tpa of the lead slag. It’s typical

assay is as shown in Table1.

Table 1. lead Slag Analysis (wt.%)

|  |  |  |  |
| --- | --- | --- | --- |
| **Element** | **Content** | **Element** | **Content** |
| Zn | 9.5 | SiO2 | 26.0 |
| Ge | 0.0375 | A’203 | 4.00 |
| Ga | 0.02 | Cao | 22.0 |
| In | 0.017 | MgO | 5.0 |
| Pb | 2.2 | S | 0.5 |
| Cu | 0.35 | F | 0.05 |
| As | 0.3 | CI | 0.1 |
| Mo | 0.25 | C | 0.07 |
| Fe | 17.1 | Moisture | 5.0 |

This plant will be a two-furnace system. A single top submerged lance for injection of fuel coal and air into the furnace bath is installed in the center of furnace. This system has benefits in process flexibility, environmental stability, and low costs for plant construction and operation. The final slag produced from the Slag Furner will be an environmentally safe slag.

KZE will provide metallurgical and engineering support to ZincOx or the joint venture for the construction and operation of the Slag Furner by utilizing the 1 ologjcaLand technological database established over many years of operation at Onsan. This "Pre-feasibility Report" is also executed based on the accumulated experiences in order to produce an accurate assessment for ZincOx.

2. Technology History

Onsan Refinery of Korea Zinc started the Zinc production in 1978. It has rapidly increased its production capacity of zinc from 50,000 tpa to 400,000 tpa during the last 24 years. According to the increase of zinc production, the significant amount of iron-containing zinc plant residue has also been produced. Therefore, the further treatment of the residue has been an important issue because of the limited space for stockpiling residue at the plant.

Another Korea Zinc's material to be treated further was the lead plant slag) produced from the QSL lead smelter which has operated at Onsan Refinery of Korea Zinc since 1992. The QSL slag contained a level of zinc and a little lead, and these metals should be removed to make the slag clean enough for sale.

Korea Zinc investigated the available technologies for a process that could produce the inert materials and meet the limits of the pollution restrictions from the treatment of the above-mentioned materials. The requirements for the new process installed at Korea Zinc were as follows:

Pyrometallurgical process with fuming reactions Utilizing cheap coal for energy source Continuous operation

Ausmelt technology was concluded to be one of the best processes that can meet the above requirements. Korea Zinc made a contract with Ausmelt in 1990 for two projects processing the zinc plant residues and QSL slag respectively. However, the technology had never commercially applied to the zinc fuming process until that time. Korea Zinc set out the small-scale project first to evaluate the performance and applicability of the technology to the commercial process while minimizing investment risk. The first Ausmelt furnace system built at Onsan was the Slag Furner for treating the QSL slag. The Slag Furner started its stream with the capacity of 100,000 tpa in 1992. The Slag Furner established a level of confidence that it can produce an inert clean slag for use in cement industries while recovering valuable metals as a fume oxide. This successful result allowed Korea Zinc to build the second Ausmelt system, the so-called Zinc Furner, to treat the zinc plant residues with the capacity of 120,000 tpa. The Zinc Furner started its operation in 1995.

However, this more complicated process had been plagued with many problems, especially, short life span of furnace bricks resulting in poor operation availability. During the first three years of operation, the plant availability was only 47% and the feed rate was only 12.6 t/h (the design capacity was 16 t/h). Korea Zinc executed several series of campaigns for two years in order to normalize the operation with an investment of approximately one-third of the original capital cost. The cost stems from the

investigation, research studies and modifications of the plant. This program

has been successful and in 2000, the operation recorded 1) 90% of plant availability, 2) annual average feed rate of 16 t/h, 3) metal recoveries of 80 % of zinc, above 85 % of lead, above 85 % of copper and 85 % of silver and 4) production of 82,000 tons of environmentally inert slag. The performance verified that this fuming process was commercially proven.

The distinguishing features of this Ausmelt process are 1) this process secures the production of environmentally safe materials and 2) Korea Zinc is the only company that processes the actual technology for projecting and operating Ausmelt fuming system and is currently operating the commercially proven plants utilizing Ausmelt fuming process.

Considering the contribution of Korea Zinc in the process development, Ausmelt agreed to make a Marketing Agreement in 1998 that allowed Korea

Zinc the right to sell Ausmelt technology in the field of zinc plant residues and

lead plant slags. Korea Zinc also started an Ausmelt furnace in 2000

producing lead bullion from 100,000 tap of secondary lead mixture and planned to add an additional Ausmelt furnace to be operated in series with the present Ausmlet furnace of the Slag Furner. Utilizing the accumulated

know-how in Ausmelt technology, Korea Zinc is also currently executing

another Ausmelt zinc fuming project at Onsan so as to treat another zinc

plant residue that is excessively produced at Onsan according to the

increase of zinc production. Korea Zinc has kept on developing Ausmelt processes.

Korea Zinc has been authorized to sell associated technology, and founded a subsidiary, KZE, so as to specialize in engineering work for the clients having interests in the Ausmelt process.

3. Process Description and Design Basis

ZincOx advised that the Slag Furner was to be designed for smelting 100,000 dry tones per annum of lead slag. The plant has been designed to operate for 7,240 hours per annum which gives a feed rate of lead slag to Fl Furnace of 14 tonnes per hour (dry base). This plant consists of two processing lines, and the configuration of each line is the same as Fl Furnace (Fl) or F2 Furnace {F2) - Membrane Wall Boiler - Quench Tower- Bag Filter.

The auxiliary systems that support the above two lines are as follows:

• Raw material handling and feeding system.

I

• Coal grinding and conveying system.

• Compressed air supply and Oxygen/Nitrogen delivery system

• Slag granulation system; and

• Copper speiss tapping system.

The Slag Furner operation features as follows:

• Continuous feeding of lead slag, assumed that it contains about 5% moisture, to Fl with the feed rate range, ± 14 dry tones per hour

• Reductant coal is fed into Fl together with lead slag.

• Continuous introduction of Fl liquid slag to F2 while continuously producing a cleaned F2 liquid slag; the only solid feed to F2 through a feed port is reductant coal.

• One top-submerged lance, positioned in the center of each furnace; This is submerged into the slag bath during the normal operation: Fl lance consists of 4 concentric stainless pipes delivering fuel coal + coal carrier air, oxygen, combustion air and afterburning air: F2 lance consists of 3 stainless pipes without an oxygen delivering pipe.

• Furnace configuration is shown in Figure 1.

• Furnace bottom refractory: magnetite-chrome oxide refractory containing fused magnetite grain

• Lower part (bottom ~ about 2m level) refractory configurations for both furnace-walls: slag level cooling with copper fingers embedded in magnetite-chrome oxide refractory containing fused magnetite grain

• Upper part (2m level~ Quench Tower) of both furnace-walls: membrane wall type waste heat boiler

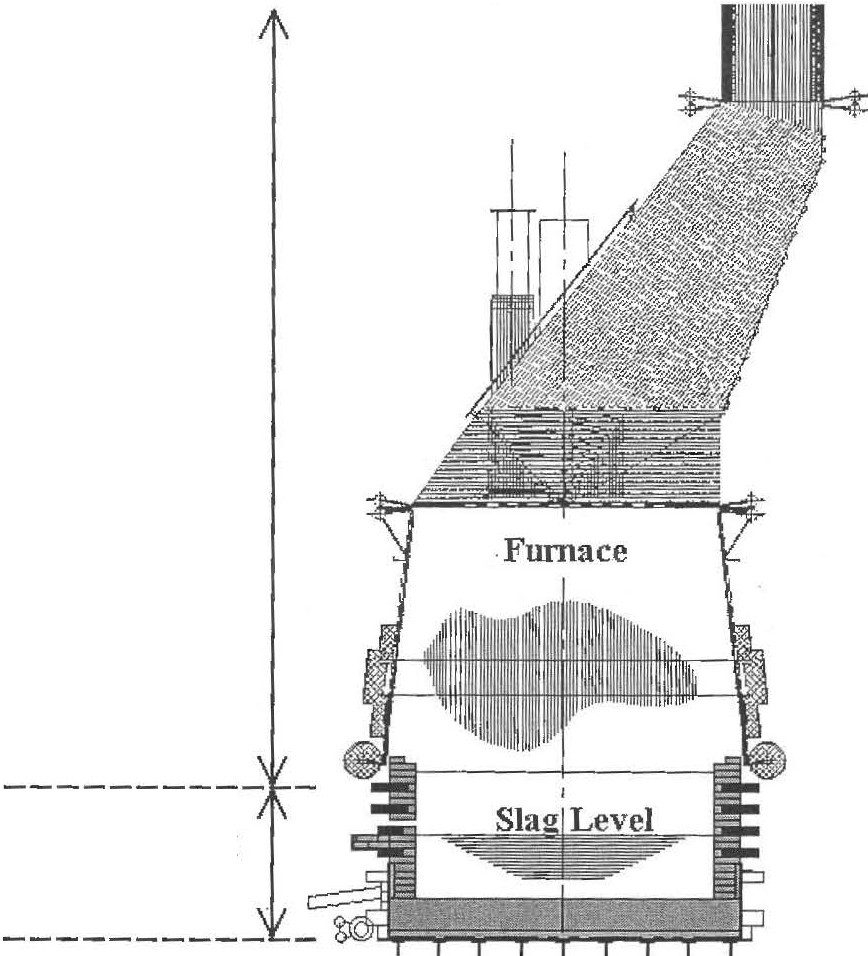
• Intermittent copper speiss-tapping from F2 - tapping frequency depends on the copper input in the feed mixture.

• Slag temperatures: 1,250~1,350 °C each furnace

• Final slag contains about ±3% zinc at a zinc recovery 75% and ±0.3% lead at 91% lead recovery.

• Atmosphere inside the furnace, the so-called Lambda representing the degree of reducing conditions, is determined by coal feed rate and total oxygen supplied by air and oxygen.

• Normal slag is Lime-Iron-Silica based slag



**Membrane Wall Boiler**

**Copper Cooling**

+ **Refractory**

Figure 1 Furnace Configuration of slag Furner

Lead slags are transported to two Slag Hoppers and stored in the hoppers separately depending on the level of valuable metals contained in the slag.

Screened coal with a size of 5-25 mm is used for reduction. The coal is conveyed to two Reductant Coal Hoppers. These hoppers store the reductant coals for the Fl and F2 Furnaces separately.

The slags and the reductant coal of Fl are transferred to the feed port at the top of Fl by a series of conveyors.

The feed material is melted in the furnace with the combustion heat of the

fuel coal injected through the lance. The temperature of the slag bath is kept

to l ,300°C. In normal operating conditions, 35% oxygen enriched air is used for the Fl. A Strong turbulence and splash of molten slag in the furnace accelerate the reactions in the furnace. The metal oxide is reduced to metal by the reductant coal (lump coal) and then immediately goes up with off gas in the form of metal vapor.

The compositions of the fuel and lump coal used in this Pre-feasibility are as shown in Table 2. Because the assays of volatile matters and ash are not available in the data provided by Ongopolo, those figures are assumed by referring to other data of a similar kind of coal.

The metal vapors are then re-oxidized (after burning) in the upper region of the furnace with the afterburning air injected through the lance and captured in the Bag Filter. Molten slag from Fl is transferred continuously to F2.

F2 also operates at 1300°C. The same mechanism of metal vaporization and re-oxidation will happen in F2. The F2 slag will overflow through siphon and will be granulated continuously.

The off gases, which escaped from both furnaces, go through the vertical membrane wall ducts separately which are steam-cooled waste boilers. This waste boiler has a common circulation system connecting two membrane walls of F1 and F2

Table 2 Coal Analysis (wt.%)

|  |  |  |  |
| --- | --- | --- | --- |
| Element | | Fuel Coal | Reductant Coal |
| Fixed Carbon | | 55.0 | 55.0 |
| Volatile Matters | C | 14.0 | 14.0 |
| H | 3.0 | 3.0 |
| 0 | 7.8 | 7.8 |
| N | 1.2 | 1.2 |
| s | 0.7 | 0.7 |
| Ash | SiO2 | 9.0 | 9.0 |
| l Al2O3 | 4.0 | 4. .0., |
| coo | 0.2 | 0.2 |
| Fe2O3 | 1.0 | 1.0 |
| Others | 0.5 | 0.5 |
| Moisture | | 3.1 | 8.0 |
| Size | | over 85% under 88µm | 5-25mm |

The off gases of Fl and F2 passed through membrane walls are introduced into two Quench Towers separately. In this chamber, a controlled amount of water and atomizing air injects into the gas stream to quench the temperature of gas low enough to be passed through Bag Filter.

The off gas, from which the fume oxide is removed, is vented to air.

4. Process Design

4.1 Metallurgical Design

4.1.1 Assumptions

The assumptions used in the metallurgical design of the Slag Furner are listed below:

Fl operating temperature 1300°C

- F2 operating temperature 1300°C

Oxygen enrichment level 35% (v/v) for Fl

- No oxygen enrichment for F2

- Afterburning heat recuperation 25%

- Slag density 3.5 t/m3

- Furnace ingress air 3000 Nm3/hr. for both furnaces Refractory thickness (new)

wall - 350 mm refractory Bottom - 500 mm brick

- Maximum static slag bath depth 1200 mm

4.1.2 Mineralogy

Tsumeb lead slag contains relatively low iron content, compared to the amount of lime and silica content. It can be assumed that the entire amount of lime and most of the iron, zinc and lead would be combined with silica and a small amount of zinc would make compounds with iron.

4.1.3 Energy Balance

Based on the published thermodynamic data and mineralogical breakdown, the following heats for combustion, afterburning, reaction, off gas and water vaporization are calculated.

Tables 3 and 4 detail the energy balances for Fl and F2.

Table 3. Heat Balance of F1 Furnace

|  |  |  |  |
| --- | --- | --- | --- |
| Heat Input (Mcal/h) | | | |
| Combustion heat  After burning recuperation | -  - |  | 25,349  1,597 |
| Total | - |  | 26,946 |
| Heat Output (Mcal/h) | | | |
| Reaction heat |  |  | 15,667 |
| Furnace heat loss |  |  | 815 |
| Off gas heat from combustion |  |  | 9,121 |
| Off gas heat from reaction |  |  | 199 |
| Evaporation of water |  | ,. | l, 144 |
| Total | 26,946 | | |
| Fuel coal requirement; 4,490 kg/h  Combustion Air (including. Coal Carrier Air); 13,850 Nm3/h Oxygen; 3,130 Nm3/h  Afterburning Air; 6,730 Nm3/h | | | |

Table 4. Heat Balance of F2 Furnace

|  |  |
| --- | --- |
| Heat Input (Mcal/h) | |
| Combustion heat  After burning recuperation | - 2,031  - 1,411 |
| Total | - 3,442 |
| Heat Output (Mcal/h) | |
| Reaction heat | 938 |
| Furnace heat loss | 815 |
| Off gas heat. from combustion | 1,522 |
| Off gas heat from reaction | 109 |
| Evaporation of water | 58 |
| Total | 3,442 |
| Fuel coal requirement; 800 kg/h  Combustion Air (including. Coal Carrier Air); 2,800 Nm3/h Afterburning Air; 5,900 Nm3/h | |

4.1.3.1. Combustion Heat

Considering the ratio of CO/CO2 resulted from burning fuel coal the heat was calculated.

4.1.3.2. Reaction Heat

The reaction heat is derived from the reactions such as the following examples for each process stage. It was calculated by multiplying the relevant molar quantities by the relevant heat of reaction.

2ZnO·Si02(sj = 2Zn0(1) + Si02(I) ZnO(I) + C = Zn[g) + CO

4.1.3.3. Furnace Heat Loss

The heat loss through the furnace shell at the operating temperature is calculated from the heat flux consideration of the copper cooling wall system and the bottom shell cooling.

4.1.3.4. Heat in Off gas

The heat contained in the gaseous products calculated, using thermodynamic data, from the heat content of individual components such as CO2, H20, etc. at the furnace operating temperature.

4.1.3.5. Evaporation Heat of Water

The evaporation heat of the water contained in the feed is considered.

4.1.3.6. Afterburning Recuperation

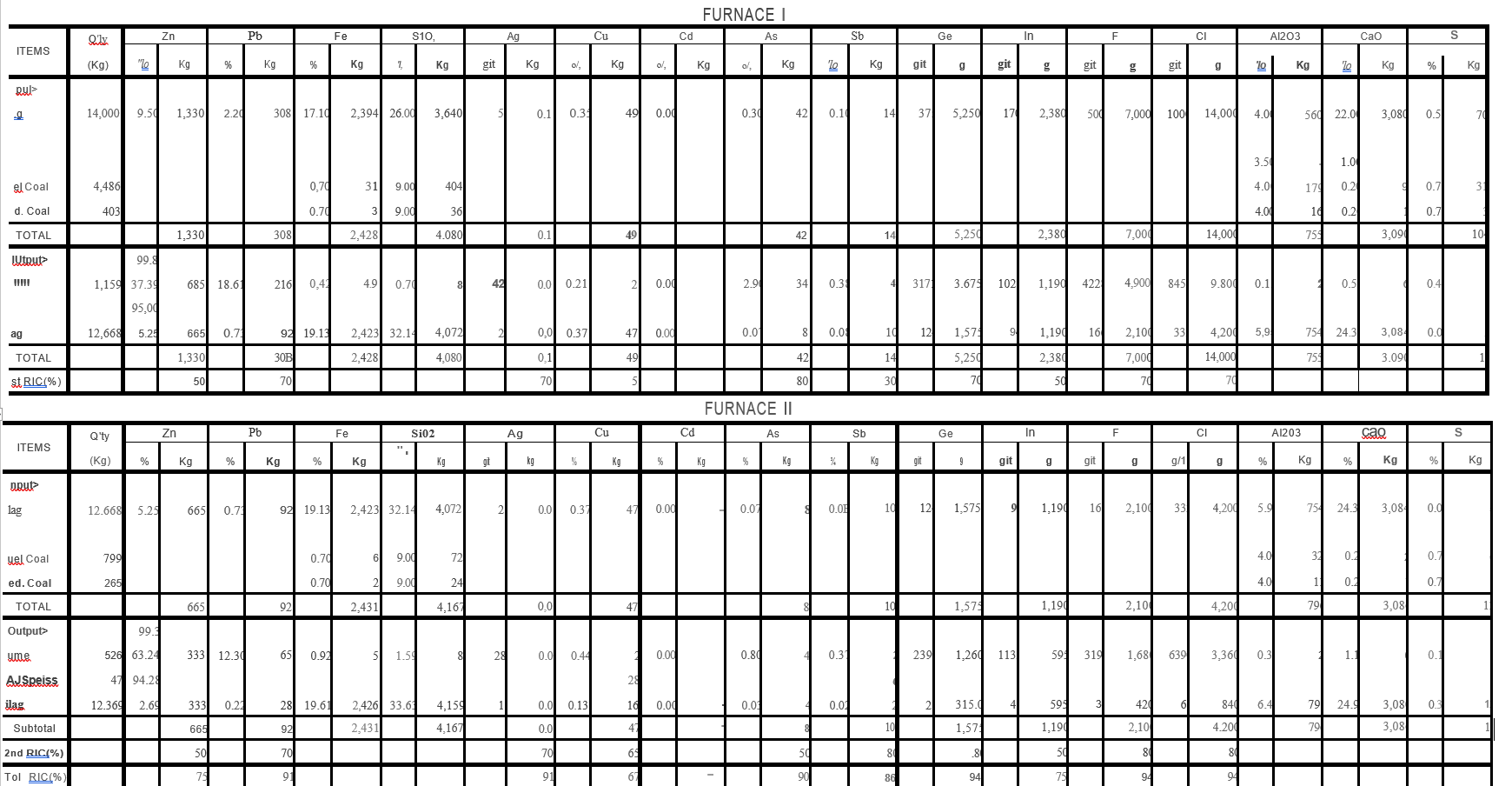
Based on the experience, it is found that about 25% of the available heat from after buming reaction would be given to the bath. The examples of after burning reactions are:

Zn(g} + 1/202 = ZnO(s) CO+ 1/202 = CO2

4.1.4 Mass Balance

Mass balances for the Slag Furner are presented hourly in Table 5.

Table 5. Mass Balance – Hourly Base



4.2 Site Investigation

At Ongopolo Smelter in Tsumeb, the site inspection was conducted over a period of three days from the 11-13 February 2000, the existing facilities have been surveyed. The surveyed areas were the raw material stock building, the

material proportioning area, the existing Ausmelt lead plant, the copper smelting area, the Baghouses, the cooling tower, the STG & blower, the coal stockyard and the stockpile of lead slag.

The primary purpose of the thorough investigation of the existing Ausmelt facilities was to determine whether or not the facilities could be re-used

the future Slag Furner. After some sort of serious consideration, an agreement amongst three parties Ongopolo, ZincOx and KZE was made to build a completely new plant in another place because of the following reasons.

1. The type of existing Ausmelt furnace is quite old-fashioned and does not match the current furnace design of KZE and should be removed entirely if the new furnaces are built in the position of the existing furnace.

2. The facilities never worked properly due to the severe corrosion of the furnace refractory and plugging of the spray chamber with fume oxides. Several modifications have been made but the process has been quickly abandoned because it was understood that there was no way of guaranteeing the successful operation if it was to be used in the new process.

3. Other existing peripheral facilities and buildings are also inadequate for the standard arrangement of a new plant because the new plant requires two furnaces (Fl and f2) and they cannot be accommodated in the existing building without significant modification.

A new location for the Slag Furner in the southwest area of the plant was

suggested by Ongopolo. This place is covered as bare ground at the moment and located nearest to the existing utility facilities. This area is also one of the best positions to access the slag stockpile and the coal stockyard.

An oil lance was used for the previous Ausmelt operation and this oil lance system was suggested to be used for the Slag Furner in order to save the capital cost for the preparation system of fuel coal (coal grinding and supply

system). However, it was proved to be an uneconomic way for a long-term operation because the cost of fuel oil the fuel oil was relatively higher than its calorific value. Also, the capital cost for a coal pulverizing system could be paid back within two years of operation.

Some of existing bins, hoppers, weighing system and conveyors could be re­ used for the new slag fuming plant, but the value of those items will not be applied for the pre-feasibility study.

Oxygen is absolutely required to run the Slag Furner plant, but currently there is fno source to get oxygen. Nitrogen is also necessary for coal handling, but at the moment, it is not available as well. Ongopolo will negotiate with a couple of suppliers to have a neighboring oxygen and nitrogen plant. The pre-feasibility study will be based on the assumption that the provision of oxygen and nitrogen is normal.

Compressors are to be included in the scope of the pre-feasibility study. The existing compressor for the mining process and located is in the old mine area, which was too distant from the smelter plant. It is also very old and runs inefficiently.

Electric power supply system should be included in the pre-feasibility study,

and the system requires 11KV main incoming, which is independent of the existing power station of the smelter plant. There is no allowance to provide required electricity for the Slag Furner thus far.

Basically, the pre-feasibility study will be carried out under the assumption that all other utilities are available in the plant boundary except the above­ mentioned. If required, Ongopolo in-house team needs to account for any

additional cost to up-grade or expand the existing utility facilities separately.

For the general condition of this project in Tsumeb area, refer to section 4.3.

|  |  |  |
| --- | --- | --- |
| 4.3 Mechanical Design |  | |
| 4.3.1 Site Condition |
| 4.3.1.1 Climatic Condition |
| Temperature | Max in Summer Min in Summer | 42 °C  10 °C |
|  | Mean in Summer  Max in Winter Min in Winter | 28 °C  25 °C  0°C |
|  | Mean in Winter | 17°C |
| Atmospheric Pressure |  | 1013 mbar |
| Relative Humidity | Mean in Summer | 35 % |
|  | Mean in Winter | 10% |
| Rainy Season | Duration Average Rain Fall | November to April  450 mm |
| Annual Rain Fall |  | 450 mm |
| Annual Evaporation |  | 540 mm |
| Wind | Average | 4 Km/Hr. |
|  | Max | 45 Km/Hr. |
|  | Design | 40 Km/Hr. |
| Snow |  | N.A. |
| Earthquake |  | N.A. |
| Altitude |  | 1400 rn above sea |

4.3.1.2 Plant Geometrical Condition

|  |  |
| --- | --- |
| The Plant Name | Ongopolo Processing Pty. Ltd |
| Detail Address of The Plant | PO Box 936. Tsumeb Tsumeb Smelter |
| Practical Language | English and African |
| The Nearest Airport | Tsumeb Airport |
| The Nearest Sea Port (The Customs) | Walvis Bay |

4.3.1.3 Infrastructure

|  |  |  |
| --- | --- | --- |
| **E-Power Supply** | **Location of Source** | National Grid which is either fed from  the Ruacana Hydroelectric Scheme or imported from South Africa |
|  | **Main Incoming** | 11.000 V  50 Hz |
|  | **Total Capacity** | 7 MW |
|  | **Fluctuation** | +/-2 % |
| **Industrial Water** | **Source** | Domestic Water from the Municipality and Raw Water pumped from the old Mine Shaft |
|  | **Location of Source** | Boreholes in and around Tsumeb |
|  | **Distance from The Plant** | Around 1.5 Km |
|  | **Head at Source** | 90m above Plant Level |
|  | **Head at The Plant** | 8 bar.G |
|  | **Max Flow Rate** | 200 m3/hr. |
| **Access Road** | **Route from Port** | Tar road from Walbis Bay Port |
|  | **Distance from The Port** | 540 Km |
|  | **Allowable Axle Load** | 8 Ton (Max Vehicle Load: 56 Ton) |
|  | **Max Passage Size** | 8 m wide |
|  | **Traffic Condition** | Light |

4.3.1.4 Utility Available

|  |  |  |
| --- | --- | --- |
| **Provision of Coal** | **Source** | Witbank in South Africa |
|  | **Quality** | Refer attached sheet |
|  | **Unit Price at The Plant** | 427.00 R/Ton  38.80 US$/Ton  ( Exchanger Rate : 1 US$=== R11.00) |
| **Supply of Oxygen & Nitrogen** | **Source** | Afrox(BOC) |
|  | **Quality** | Separately |
|  | **Unit Price at The Plant** | Separately |
| **Fuel** | **Source** | Diesel or Heavy Furnace Oil(HFO)) |
|  | **Quality** | See Attached |
|  | **Unit Price at The Plant** | Diesel : R 3.25/l = US$ 0.30/L  HFO : R 2.00/l |
| **Raw Water** | **Source** | Old Mine Shaft |
|  | **Quality** | See Attached Sheet |
|  | **Unit Price at The Plant** | R 0.50/m3 = US$ 0.04/m3 |
| **Demineralized water** | **Source** | See Attached Sheet |
|  | **Quality** | 36 m3/Doy  1.5 m3/Hr |
|  | **Unit Price at The Plant** | R 10.00 / m3 |
| **Electric Power** | **Transformer Capacity** | Total 7 MW. |
|  | **Voltage Step in the Plant High** | High 11 00 V  Medium 2 400 V  Low 525 V |
|  | **Frequency of Failure** | During Rainy Season (Nov.-Apr.)  Approx. 3 Outages/Month for 5 minutes each |
|  | **Power Cost** | N$ 0.29 / Kwh  R 0.29 / Kwh |
| **Compressed Air** | **Pressure** | 4.5 bar.G |
|  | **Quality ( Oil Free )** | "No Oil Free" |
|  | **Compressor Type & Copa** | Reciprocating    7,000 Nm3/hr |
| **Cooling Water** | **Pressure** | 2.8 bar.G |
|  | **Water Quality** | See Attached Sheet |
|  | **Circulation Flow Rate** | 1,200 m3/hr |
|  | **Temperature** | mean max  28°C  3°C |
|  | **Total Capacity (RT & Kwh)** | 5MW |
| **Steam** | **Source & Capacity** | 2-Waste Heat Boilers in Plant |
|  | **Pressure** | Operating Max  24 bar.G  2gbar.G |
|  | **Temperature.** | Operating Max  285 °C  350 °C |
|  | **Unit Price** | N.A. |

4.3.2 Local Circumstances

4.3.2.1 Environmental Regulation and Constraints

Namibian legislation in the process to be finalized, similar to South African legislation.

Waste Water Disposal

Ongopolo in the process to finalize its application for a water

> permit. Application includes details of waste water disposal.

Emission

Environmental monitoring system introduced by Ongopo!o and supported by external Consultants (WSP) monitors in around Smelter.

Noise

Maximum allowable levels 80db. Before hearing protection has to be used.

4.3.2.2 Assessment of Local Work Force for Plant Operation

|  |  |
| --- | --- |
| Population of Downtown including Suburb | Approx. 18,000 |
| Similar Plant or Industry  in the Same Area | None. |
| Peoples & Language | Owambo English & African |
| Operation Skills | Fair |
| Average Salary | R 5,000/month = US$ 455/month (Including benefits) |
| Salary Grade & Structure (Tax, Insurance, etc.) | See Attached Sheet |
| Normal Working Hours (Shifts] | 195 Hours/month (before overtime) |
| Cost of Benefits | See Attached Sheet |

4.3.2.4 Assessment of Importation

|  |  |
| --- | --- |
| Importation of Foreign Equipment & Materials |  |
| Import Duties | None |
| VAT & Exemptions | Exempted from VAT.  Received EPZ status from Government |

4.3.2.5 Assessment of Local Engineering Condition

Codes, Standards, Regulation and its Authority for Approvals

|  |  |
| --- | --- |
| Safety & Health | NOSA. Based on WHO standards. |
| Building & Fire Fighting | Equivalent on BS. |
| Structural | Equivalent on BS. |
| Pressure Vessel & Piping | Equivalent on BS. |
| Environmental |  |
| Local Engineering Company |  |
| Availability | Good |
| Capability | Good |
| Experience | Good |

4.3.2.6 Assessment of Local Fabricator

|  |  |
| --- | --- |
| Availability | Good |
| Unit Cost (Example)) | See Attached |
| Quality | Good |
| Production Capacity | Good |
| Type of Work | Available for all stated |
| ( Heavy, Light, Plate,  Steel Structure, Piping Spool |  |
| ( Heavy, Light, Plate,  Steel Structure, Piping Spool |  |

4.3.2.7 Assessment of Construction Condition

**Availability of Local Contractors**

|  |  |
| --- | --- |
| Capabilities | Good |
| Capacity | Good |
| Quality Control | Good |
| Equipment  (Crane, Dozer, Excavator, Truck, | 40, 60 tons 2 crane by Ongopolo D8 Bulldozer, Trucks, Front & Loader |
|  |  |
| **General Cost for Construction** |  |
| Unit Cost of Excavation (Labor,M/H) | R 24/m3 for Soft Soil  R 300/m3 for Blasting  R 8/m3 for Transport |
| Unit Cost of Road  (Material & Labor,M/H) | R 800/m for Concrete pavement |
| Unit Cost of Concrete (material & Labor,M/H) | R 510/m3 |
| Unit Cost of Re-Bar (material & Labor,M/H) | R 4,600/ton |
| Unit Cost of Formwork (material & Labor,M/H) | R 142/m2 |
| Unit Cost of Piling (mpterial & Labor,M/H) | To be estimated by unit rate of concrete work. |
| Unit Cost of Steel Structure (material & Labor,M/H) | R 5,000/ton for Material  R 4,500/ton for Labor  R 2,661/ton for Labor  R 12,161/ton for Total |
| Unit Cost of Wall Cladding  (material & Labor,M/H) | R 35/m2 for the Galvanized  R 53/m2 for Cromadeck  R 24/m2 for Labor |
|  |  |
| **Unit Cost of Steel Plate Work** |  |
| Stainless Steel 304,316 (material & Labor,M/H) | R 60,000/ton |
| Carbon Steel (material & Labor,M/H) | Same as Steel Structure Work |
|  |  |
| **Unit Cost of Steel Piping** |  |
| Stainless Steel 304,316 (material & Lobor,M/H) | Some as Stainless Steel Work |
| Carbon Steel Piping (material & Labor,M/H) | Same as Steel Structure Work |
| Plastic Piping (material & Labor,M/H) | N.A |
| Insulation  (material & Labor,M/H} | N.A |
| Local Suppliers for Materials Imported Materials |  |

4.3.2.8 Assessment of Equipment and Manning Cost for Construction.

|  |  |
| --- | --- |
| Unit rate of Manager (including all indirect cost) | R 420/Hr |
| Unit rate of G.Officer  (including all indirect cost) | R 320/Hr |
| Unit rate of Project Engineer Civil (including all indirect cost) Mechanical  Electrical | R 320/Hr  R 320/Hr R  320/Hr |
| Unit rate of Supervisor Civil (including all indirect cost) Mechanical  Electrical | R 180/Hr  R 180/Hr  R 180/Hr |
| Unit rate of Foreman Civil  {including all indirect cost) Mechanical  Electrical | R 150/Hr |
| Unit rate of Tradesman Civil  (including all indirect cost)Mechanical  Electrical | R 75/Hr  R 90/Hr  R 120/Hr |
| Unit rate of Helper  (including all indirect cost) | R 30/Hr |
| Temporary Accommodation(per man, per week) | R 120/Man-Week |
| Mobilization ability at Peak  Civil  Mechanical  Electrical | R 3,l 00/ crew of 5  R 3,100/ crew of 5  R 3,100/ crew of 5 |
|  |  |
| Cost of Equipment | R 320/Hr |
| Excavator R 320/Hr | R 500/Hr |
| Cranage | Fuel & Driver included |
| Bulk Transportation (Truck) | R 8/ton |

4.3.3 Assessment of Existing Plant

4.3.3. Availability of Existing Facility for the Slag Furner

|  |  |  |
| --- | --- | --- |
| Stock Building | **‘d** | Not Required for New Fuming Plant |
| Conveying System | !! | Could be used for New Fuming Plant |
| Weighing System | ‘d | Could be used for New Fuming Plant |
| Bins & Hoppers | ‘a | Could be used for New Fuming Plant |
| Furnace & Lance Handling | ‘d | Not to be used for New Fuming Plant |
| Granulation System | D | New System is required. |
| Quenching Tower | ‘d | Not to be used for New Fuming Plant |
| Boiler with the peripheral | D | New System is required |
| ESP | D | Not Required for New Fuming Plant |
| ID Fan | ‘d | Not to be used for New Fuming Plant |
| Scrubbing Tower | D | Not Required for New Fuming Plant |
| Bag Filters | ‘d | Not to be used for New Fuming Plant |
| Stack | D | Not to be used for New Fuming Plant |
| Water Cooling Tower | ‘d | More pumps are required |
| D.I.Water Plant | !! | Capacity is not enough for New Plant |
| Fuel Storage (Oil) | ‘d | Could be used for New Fuming Plant |
| Fuel Station (Gas) | ‘d | Not Required for New Fuming Plant |
| Coal Handling System | ‘d | Capacity is not enough for New Plant |
| Waste Water Treatment | 0 | Just disposal to Evaporation Yard |
| Oxygen Plant | !! | It is necessary for New Plant |
| Steam Turbine Generator | D | Capacity is not enough for New Plant |
| Compressors | D | Capacity is not enough for New Plant |
| E-Power Supply System | ‘D | New System is required. |

4.3.3.2Existing equipment (item and brief specification)

Conveying system and weighing system

4x Conveyor plus weighing - Width : 750 mm (Nuclear source weightometer) - Length : 15 m

l x 5 m3 day bin on a loadcell

2 x Conveyor plus weighing - width : 600 mm (Nuclear source weight meter) - Length : 8 m

Bin and hoppers

2 x 6 mW x 6 ml x 9 mH - Volume=+/- 240 m3

2x 100 m3

Water cooling tower - Existing with 6 MW capacity.

Fuel storage - Will be erected and supplied by shell, the local supplier of fuel.

Waste water treatment - Existing cooling and evaporation ponds.

Steam turbine generator

2 x turbine of which one is for standby and the second is running at two thirds of full capacity.

Afterburn blower supplying air at l .02 bar G. and 14,500 Nm3/hr

4.3.4 Design Criteria

4.3.4. Fl Furnace

A. Feed material

-Ongopolo Lead Slag

-Capacity : 100,000 tpa

-Composition: same as Table 5

B. Feed rate

-14 dry t/h (14.7 wet t/h}

-. 302 dry t/d (318 wet t/d) ·>

C. Operating time

-Utilization : 90 %

-335 days/year, at 21.6 hours/day (7,2\_40 hours/year)

D. Recovery of metals

- Zn; 50%, Pb; 70%, Ge; 70%, In; 50%

E. Products.

- F-1 Fume Oxide: 1,159 kg/h (57%Zn, 19%Pb, 0.32%Ge, 0.1%In}

- F-1 Slag: 12,666 kg/h {5.3%Zn, 0.7%Pb}

-Off gas at the Furnace Exit:

28,286 Nm3/h at 1,3380C

(22.1%CO2, 3.6%02, 10.4%H20, 0.08%SO2, 63.8%N2}

4.3.4.2 Fl Furnace Boiler

1. Inlet Off gas

28,286 Nm3/h at 1,338oc

(22.1%CO2, 3.6%02, 10.4%H20, 0.08%SO2, 63.8%N2)

1. Outlet Off gas

31,286 Nm3/h at 100°c

(20.0%CO2, 5.2%02, 9.7%H2O, 0.08%SO2, 65.0%N2)

C. Feed water conditions

-Water: Demineralized Water

-Temperature: 105°C

D. Steam Condition

-Steam Generation: 14.7 t/h

-Pressure (Operating): 40 bar

4.3.4.3 Fl Quench Tower

Al Inlet Off gas

31,286 Nm3/h at 700oC

(20.0%CO2, 5.2%02, 9.7%H2O, 0.08%SO2, 65.0%N2)

B. Outlet Off gas

43,595 Nm3/h at 1oo0c

(14.4%CO2, 4.1%02, 33.7%H2O, 0.05%SO2, 47.9%N2)

C. Consumption

- Water: 9.3 t/h at 30°c

- Air: 700 Nm3/h 700 at 30°c

4.3.4.4 F1 Bag Filter

A. Inlet Offgas

,-43,595 Nm3/h at 1000c

B. Outlet Off gas

45,095 Nm3/h at 175°C

(13.9%CO2, 4.6%02, 32.7%H2O, 0.05%SO2, 48.8%N2)

4.3.4.5 F2 Furnace

A. Feed material

-Fl Slag

-Capacity : 95,000 tap

-Composition: same as Tables 5

B. Feedrate

-13 dry t/h

-273 dry t/d

C. Operating time

-Utilization : 90 %

-335 days/year, at 21.6 hours/day [7,240 hours/year}

D. Recovery of metals

- Zn; 50%, Pb; 70%, Ge; 80%, In; 50%

E. Products

- F-2 Fume Oxide: 526 kg/h [63%Zn, 12%Pb, 0.24%Ge, 0.11%In)

- F-2 Slag: 12,369 kg/h (2.7% Zn, 0.2%Pb]

- Offgas at the Furnace Exit: 12,464 Nm3/h at 1,315°c

{8.8%CO2, 14.5%02, 4.9%H2O, 0.04%SO2, 7l .8%N2)

4.3.4.6 F2 Furnace Boiler

A. Inlet Off gas

12,464 Nm3/h at 1,315oc

(8.8%CO2, 14.5%02, 4.9%H2O, 0.04%SO2, 7l .8%N2)

B. Outlet Off gas

12,464 Nm3/h at 700°C

{8.8%CO2, 14.5%02, 4.9%H2O, 0.04%SO2, 71.8%N2)

C. Feed water conditions

- Water: Demineralized Water

- Temperature: 105°C

D. Steam Condition

-Steam Generation: 5.2 t/h

-Pressure (Operating): 40 bar

4.3.4.7 F2 Quench Tower

A. Inlet Off gas

12,464 Nm3/h at 700°c

(8.8%CO2, 14.5%02, 4.9%H2O, 0.04%SO2, 7l .8%N2)

B. Outlet Off gas

17,0l 1 Nm3/h at 100°c

(6.4%CO2, 10.9%02, 29.2%H2O, 0.03%Sb2, 53.5%N2)

C. Consumption

- Water: 3.5 t/h at 30°c

- Air: 200 Nm3/h 700 at 30°c

4.3.4.8 F2 Bag Filter

A. Inlet Off gas

17,011 Nm3/h at 180°C

(6.4%CO2, 10.9%02, 29.2%H2O, 0.03%SO2, 53.5%N2)

B. Outlet Of Gas

21,011 Nm3/h at 175°c

(5.2%CO2, 12.7%02, 24.2%H2O, 0.02%SO2, 57.9N2)