Steel slag Application in China

CIMM Group Co.,Ltd.

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Table of contents

- 1. About CIMM Group
- 2. China Policy of solid waste treatment and comprehensive utilization
- 3. General- Agriculture application status in China
- 4. Introduction–a way of application of steel slag - model of circulating economy
- 5. The treatment process and application of steel slag under two different slag treatment method

ABOUT CIMM GROUP

Group Introduction

CIMM Group is an integrated international conglomarate of Technology, manufacturing and trade with the process technology and project engineering as basis.

The group has been put speical emphasis on development , application and promotion of the environment friendly technology and applications in the field of iron and steel industry, Cement industy and power industry in terms slag treatment and application,desulfurization, dust collection,waste heatrecovery, water treatment with a goal to contribute to a clean world.

CIMM has working together with the most advanced and matured process technology provider in China and we introduce our achievements to worldwide mills and bring the advanced technology from overseas to further improve the industries in China.

We hope to enjoy the progress and the achievements of Chinese development with the friends all over the world.

MISSION

- Help the world share the first-class technology, equipment and service from China
- Help China share the first-class technology, equipment and service from the world

Vision

Construction of China's new private leader in the field of International EPC project, to contribute to a prosperous future of human being.

2. China Policy of solid waste treatment

and comprehensive utilization

China Industry waste disposal policy

- On Feb. 28, 2003, The state council has issued the no.369 decree, Since July 1, 2003, the waste disposal cost will be charged.
- Levying criteria：

Slag RMB 25/t $3.8/t	**Fly ash RMB30/t, $4.5/t**
Furnace slagRMB25/t $3.8/t	**Coal gangue RMB5/t, $0.8/t**
TailingRMB15/t $2.3/t	**Other slag（Including semi-solid、liquid waste）RMB25/t $3.8/t**

China ‘s Industry waste comprehensive utilization rate

- 2006 State National Development and Reform Commission has issued the <plan for comprehensive utilization of waste resoruces>

2010 to utilize the industry solid waste by 60%。
2010 to utilize the melting slag by 86%

Preferential policy for comprehensive waste utilization

State development and reform commission, Finance ministration, General tax bueau jointly issued the documents(2004) 73 :

Company who use the steel slag for production of steel and construction, their tax will be decreased or exempted.

Steel slag powdering technology is in the name of tax reduction process and will be supported by the dedicated fund for development

Circular economy law

- Aug. 29, 2008, Circular Economy Promotion Law of the People's Republic of China was issued, and was in force on Jan. 1, 2009.
- The law encourges to put the waste directly into production as raw or futher processed raw material, and encourages to use the no hazardous solid waste to manufacturer constrution material.

3. General- Agriculture application status in China

General- Agriculture application status in China

Agriculture application status

- China is not applying in a large scale the slag fertilizer.
- From soil conditioning concern, the requirement is less, the acid soil is mainly in North China, but soil condition is improving due to the rain will bring the acid to the soil and improving the condition.
- Although the heavy chemical in the slag is containd in the form of solid solution, It can be considered as non poisonious. But systmic study on the environment impact has not been carried out, and as there are no much study has been done for its pollution effect for the underground water, and toxicological study for the biology.

General- Agriculture application status in China

Field Study on Silica & Phosphorus slag fertilizer

- The major chemical that is useful for plant growth is Si, P,Ca and Mg, besides there are Zn, Mn, Fe, Cu etc. will be helpful to improve the fertilile conditon of the soil.

- Si, is the major nutrition content for rice growth, Field test has been conducted by the scientist : to apply the steel slag with SiO_2 >15% grinded to size less 60mesh(<0.25), apply 150kg/hectare, can achieve more 10% output of rice.
- Phosphorus slag fertilizer requires at least the content of P_2O_5>4%, when use the high content P hot iron to produce steel, if didn”t put the fluospar for slagging, the slag generated can be used to produce Phosphorus slag fertizer. As the F can reduce the restraint-dissolveing ability of P_2O_5, so the F content requires to be less than 0.5%., the higher the CaO/SiO_2 value, the higher restraint ability can be achieved.
- The temperary standard for Phosphorus slag fertilizer in Maanshan steel requires the P_2O_5 >10%. The Phosphorus slag fertilizer is good for acid soil , it can also be applied in the alkaline soil short of P, it can be used in the paddy field, it can have effect in glebe field.

4 Introduction about circulating economy- a way of application of steel slag.

Circular Economy Principal

- **Turn the waste into resources is the focus of the circular economy under development in China now.**
- **The core of cirular economy is to improve the efficiency of natural resources utilization, reduce the resources consumption and environment cost, to make the social economy system in harmony with the nature ecosystem and to maintain the sustainable development of the society.**

in China ,this industry will undegone huge development driven both at the Policy stimulation and enonomy stimulation.

An circulating enomonic model for steel slag application

Circular Economic Technology

The principal of use waste to treat waste is relized in this process

The steel slag has been used as the absolvent of the SO2 from the sinter plant, the SO2 emission is reduced, the steel slag is used, while the outcome of the desulpurazation can be used as fertilizer and conditioning material for the saline and alkaline soil

- **SO2 absorbent can be adjustable to local conditions:**
  - Slag
  - Grain slag
  - And many other industrial solid waste such as flying ash, red earth from alumina plant can be used as solvent.

- **Outcome of desulfurization:**
  - Sulphur-silicon fertilizer (base fertilizer)
  - Land conditionaing material
  - Modification of saline and alkaline

Recycling Economic Technology

SO_2 air pollution control
Comprehensive use of solid industrial wastes
Sandy and wasteland modification

Deal with 3 hardest world wide issues.

Recycling Economic Technology Flow Process

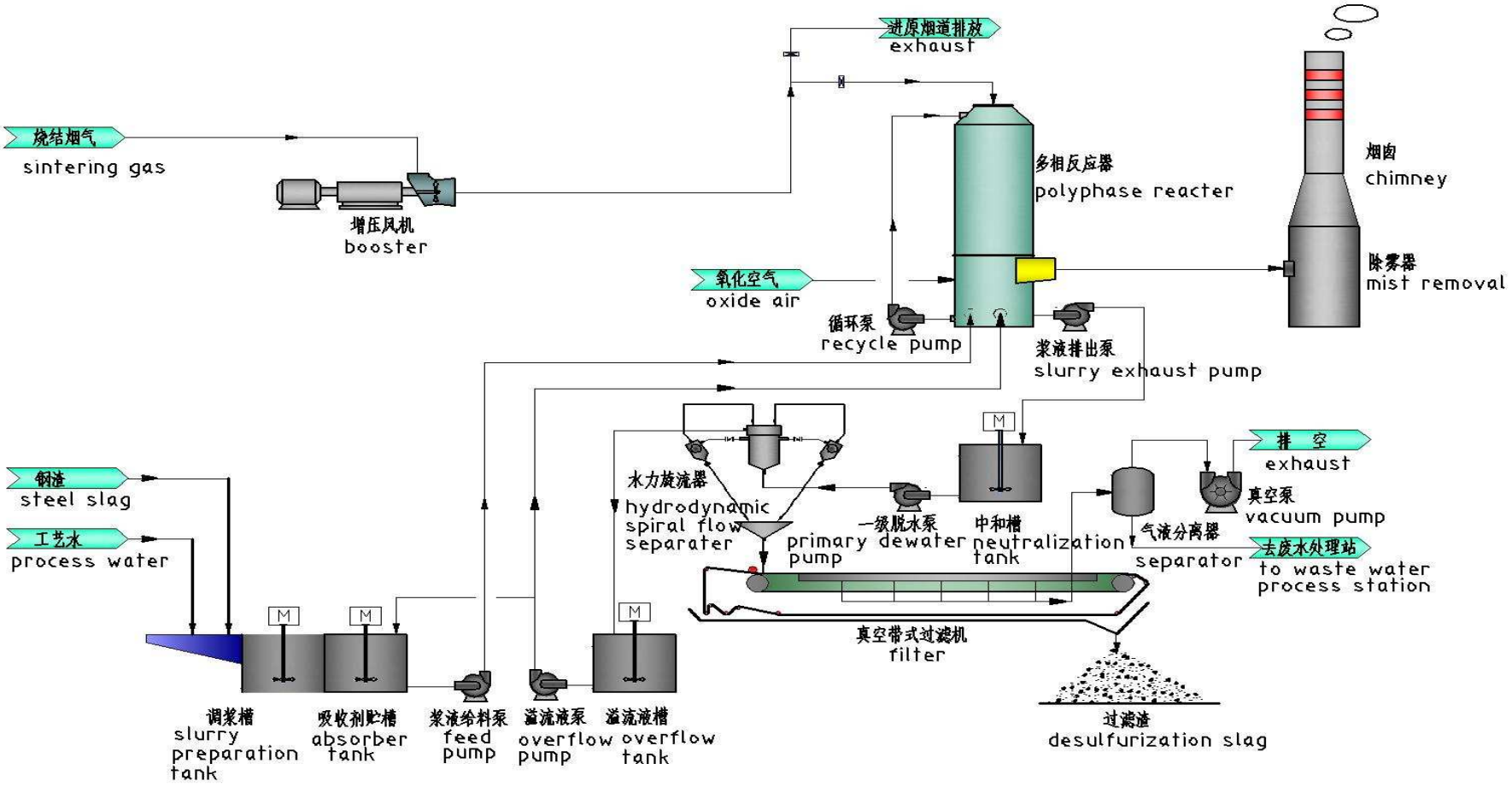
Current Situation of Desulfurization

At present, 90% desulfurization system adopt the **limestone/gypsum process** FGD(Flue Gas Desulfurization)

- **Advantages:**
  - The natural limestone is rich, wide distribution
  - The purchasing cost of absorbent is less
  - The technology is comparatively mature
  - The system investment is small
- **disadvantages:**
  - Fire of limestone consumes a mass of resources
  - Discharges a large numbers of CO_2 synchronously
  - The outcome of desulfurization can not be treated
  - Most of desulfurized gypsum are piled up

Desulfurization process introduction

The process flow



工 艺 流 程 图

technological process diagram

Feature of sinter waste gas

- Big volume of fume，about 4000～6000m3 will be generated for 1t sinter。
- High fume temperature, the fume temperature is around 150C under different operation conditions。
- Quantity of dust in the fume is high。
- High moisture, about 10& of water by volume.
- With corrosive gas, during BF gas burning and sinter process, SOx、NOx will be generated, it will turn in to acid when meet water, it will erode the steel structure.
- low SO2 content，for different raw matriaql and fuel, it will be aroud 1000～3000 mg/m3 。

The feature of slag

The steel slag is composed of different ore bodies, it's main chemical composition are Ca, Fe, Si, Mg oxide and traces of Al, Mn, P oxide. the main ore phase are tricalcium silicate ($3CaO \cdot SiO_2$)、dicalcium silicate（$2CaO \cdot SiO_2$）、monticellite（$CaO \cdot MgO \cdot SiO_2$）、manganolite $(MnO,MgO,CaO) \cdot SiO_2$、 gehlenite $2CaO \bullet XAl_2O_3 \bullet (1-X)Fe_2O_3$) and Si, Mg, Fe, Mn, P oxide are in the form of solid solvent, and free CaO and metal Fe are also exist.

Converter slag compostion in 4 different steel mills in China(%)

Steel mill	CaO	MgO	SiO_2	Al_2O_3	FeO	Fe_2O_3	MnO	P_2O_5	f-CaO
A	40-49	4-7	13-17	1-3	11-22	4-10	5-6	1-1.4	2-9.5
B	45-50	4-5	10-11	1-4	10-18	7-10	0.5-2.5	3-5	11-5
C	45-51	5-12	8-10	0.6-1	5-20	5-10	1.5-2.5	2-3	4-10
D	42-54	3-8	12-20	2-6	4-18	2.5-13	1-2	0.2-1.3	2-10

Steel slag composition in EAF (%)

Steel	Slag type	CaO	MgO	SiO_2	FeO	Al_2O_3	MnO	P
A	Oxidize slag	29-33	12-14	15-17	19-22	3-4	4-5	0.2-0.4
B	Reduction slag	44-55	8-13	11-20	0.5-1.5	10-18		

The process and Principal of steel slag desulpuration

By the previous analysis of the composition, the steel slag composition will be different in different process and different stage of smelting, but the differents mainly differs in quantity, the chemical content is almost the same, and the ore composed of the steel slag are also similar。

The reaction of steel slag as absolvent with the SO2 can be realized in several phase：

SO2 dissolving and oxidizing in water

when SO2 dissolving in the water, it will firsly turn into H2SO3, in the form of ion in water

$$SO_2 + H_2O = H_2SO_3 = (HSO_3)^- + (H^+) \quad (1)$$

$$(HSO_3^-) = (SO_3)^{2-} + (H^+) \quad (2)$$

as there are superfluous o2 in the fume, so part of the (SO3)2 - will be oxidized to (SO4)2 - :

$$(SO_3)^{2-} + (1/2)O_2 = (SO_4)^{2-} \quad (3)$$

Reaction

The free CaO, Mgo and MnO etc in the steel slag will be reacted with the SO2 in the solvent

$$CaO + (SO_3)^{2-} = CaSO_3 \quad (4)$$

$$MgO + (SO_3)^{2-} = MgSO_3 - \quad (5)$$

The reaction with the Ores in the steel slag

The ore bodys of the steel slag will react with the SO2 solvent

$(3CaO\cdot SiO_2) + 3H_2SO_3 = 3CaSO_3 + SiO_2 + 3H_2O$ (6)

$(2CaO\cdot SiO_2) + 2H_2SO_3 = 2CaSO_3 + SiO_2 + 2H_2O$ (7)

$(CaO\cdot MgO\cdot SiO_2) + 2H_2SO_3 = CaSO_3 + MgSO_3 + SiO_2 + 2H_2O$ (8)

$(MnO,MgO,CaO)\cdot SiO_2 + H_2SO_3 = (Mn,Mg,Ca)SO_3 + H_2O$ (9)

$(2CaO\bullet XAl_2O_3\bullet(1-X)Fe_2O_3) + 2H_2SO_3 = 2CaSO_3 + XAl_2O_3 + (1-X)Fe_2O_3 + 2H_2O$ (10)

The reaction with the Ores in the steel slag

$3CaO \cdot SiO_2) + 3H_2SO_4 = 3CaSO_4 + SiO_2 + 3H_2O$ (11)

$(2CaO \cdot SiO_2) + 2H_2SO_4 = 2CaSO_4 + SiO_2 + 2H_2O$ (12)

$(CaO \cdot MgO \cdot SiO_2) + 2H_2SO_4 = CaSO_4 + MgSO_4 + SiO_2 + 2H_2O$ (13)

$(MnO,MgO,CaO) \cdot SiO_2 + H_2SO_4 = (Mn,Mg,Ca)SO_4 + H_2O$ (14)

$(2CaO \bullet XAl_2O_3 \bullet (1-X)Fe_2O_3) + 2H_2SO_4 = 2CaSO_4 + XAl_2O_3 + (1-X)Fe_2O_3 + 2H_2O$ (15)

there are superfluous O_2 in the fume, the SO_3 will be futher oxidized in to SO_4, the reaction is as following:

$MeSO_3 + 1/2O_2 = MeSO_4$ (16)

Tangshan Delong Steel Co., Ltd.
230m² sinter Flue Gas desulfurization Project

- Fume temperature：180℃
- Moisture content：6%
- SO2content：1000-3000mg/Nm³
- Fume volume：1440000/m³h

- Desulphrizaiton rate：95-99%
- Annual SO2 emission reduction: around 6600T
- Annual CO2 emission reduction: around 4600T
- Annual Slag consumption: around 20000T
- Annual Outcome of desulfurization slag: 23000T
- Annual lime stone saving: about 16000T
- Annual saving of coal: around 1200T st.
- Annual saline and alkaline soil treatment: 1, 67000m2
- Operation cost: $0.6-0.7 /T sinter output
- The traditional operation cost is at $1.8-4/T

Tangshan Delong saline land improved by the desulfurization slag

Saline, Alkaline and Sandy land modification project:

Delong Steel Co., Ldt, Tangshan

Sandy wasteland modification

The original appearance of sandy wasteland of Shougang Jing-Tang Company in Caofeidian.

After-modification of sandy wasteland of Shougang Jing-Tang Company in Caofeidian

Fertilizer and soil improvement

Project site of saline and alkaline land modification of the south bank of Shitangjiang in Cixi.

Dr. Mazharh. Naqyi ,the world-known saline and alkaline expert is investigating the result of saline and alkaline land modification in Cixi

Jinhua Soil Improving Project

Various kinds of vegetables growing on the sandy wasteland which have been modified successfully:

Projects of Jinhua Soil Modification:

The output of rape, letuce, watermelon and cotton etc. were increased by 15-20%.

Delong steel 230m²sinter desulphurzation

Method	DS Recycling Econimic Technology (CaO 5%)	(MgO 85%)	Limestone Methods (CaO 80%)
Unit price of agent	Use the steel slag	850 yuan/ton	350 yuan/ton
Consumption per 1 tSO2desulpurization	3 ton	0.735 ton	1.14 ton
Quantity of desulpurization unit put output	3.43 ton (dry base)	1.9 or 3.84 ton	2.43 ton
Absorvent total consumption	About 20,000 ton	About 5,000 ton	About 8,000 ton
Total desulphurization output	About 23,000 ton	About 12,500-25,000 ton	About 16,000 ton
The place of Final recidues go	saline and alkaline treatment Cement additives	MgSO4 Discharge to waste water treatment	**Gypsum** disposal
Energy saving	1,200 ton/year (Standard Coal)	0	0
Total cost for reaction agent	0	4.25 million	2.63 million

Benefits comparison of different soil modification methods

- **Traditional Soil Modification Methods：**
  - Secondary salification will be occurred after 2-3 years.
  - Soil changing, 1mu(667m2) saline and alkaline land modificaiton = 1 mu(667m2) fertile land destroying.

- **By desulfurization slag soil improvement method：**
  - Only need 30% investment cost of the traditional one.
  - Once modification without secondary alkalinization
  - No need of changing soil

Field test has been carried out since 2002 in the saline and alkaline land.

every year the sample is collected and the result shows

PH value has been steady decreased and no secondary alcalination has take place

soil fertile condition is imporved and ion has been reduced.

soil partical size is increased

Safty concern in the soil condition material

the desulfurization slag may contain heavy metal such as: Cu、Zn、Pb、Cd、Hg、Cr、As

There are risk of pollution of the soil by the heavy metal, when applying the slag into the soil, we must make sure there will be no heavy metal pollution to the soil, other wise the conditioning will be no sense.

1)、heavy metal limit

Up to now, there are no national standard for the heavy metal limit regulation for the slag soil conditioner, but with reference to two national standard for heavy metal content in GB8173-87《pollution control standard for agriculture application purpose fly ash》and

GB 4284-84《pollutant control standard for agriculture mud》with reference fo this two national standard, we have set up the heavy metal limmit for slag soil conditioner

“slag desulfurization conditionaer heavy metal limit (mg/kg) (dry base)

item	Metal limit in the soild
Cd incluidng cd in the compound	10
Hg including Hg in the compound	15
pb including Pb in the compound	500
Cr including Cr in the compount	500
As including As in the compount	75
B incluidng B in the compound	50
Cu incluidng Cu in the compount	500
Zn including Zn in the compount	1000
Ni including Ni in the compound	200
Mo including Mo in the compound	10
Se incluidng Se in the compound	15

the quantity of the slag in compliance with above limit should not over 30000kg within 10 years(dry base)。

5. Treatment process and application of steel slag under two different slag treatment method

two advanced treament method

-- Granulating -- Slag Granulation Plant
-- Powdering -- Splashing in closed box

SGP Process Principal

Slag Granulation Plant

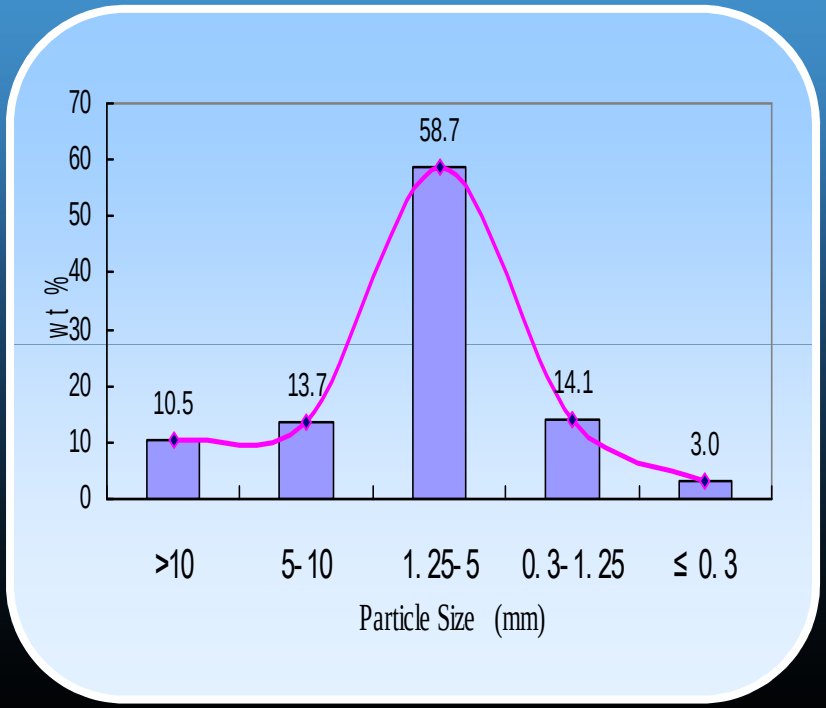
Merits of SGP：

- Short Flow
  - Dwell time: 2 minutes
  - Small land occupation（10m×10m）
- Cleanliness
  - Centralized exhaust of steam, good for installation of dedusting device
- Qualified Slag
  - Good separation of slag from scrap
  - Recovery rate of iron ＞85%（for A type slag）
  - Even granulated slag，easy for post-treatment & utilization
- High Safety

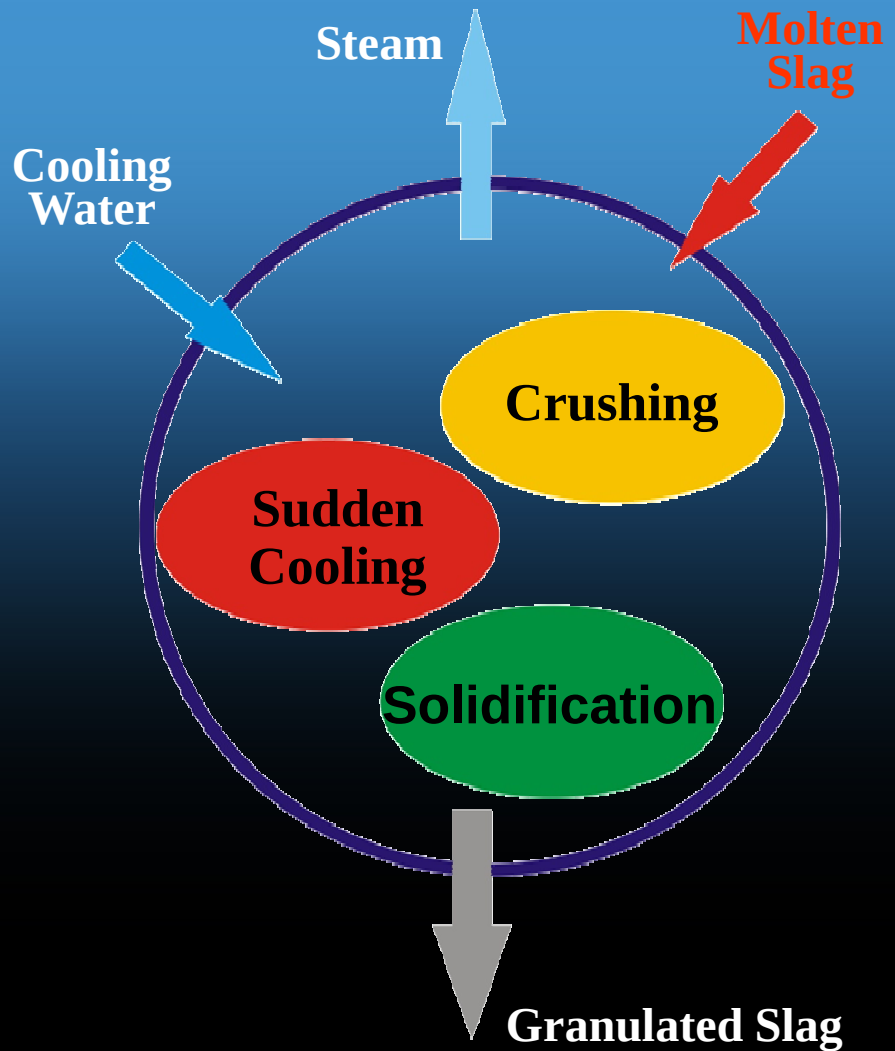
S G P

Slag Granulation Plant

Particle Size Distribution of SGP Finished Slag

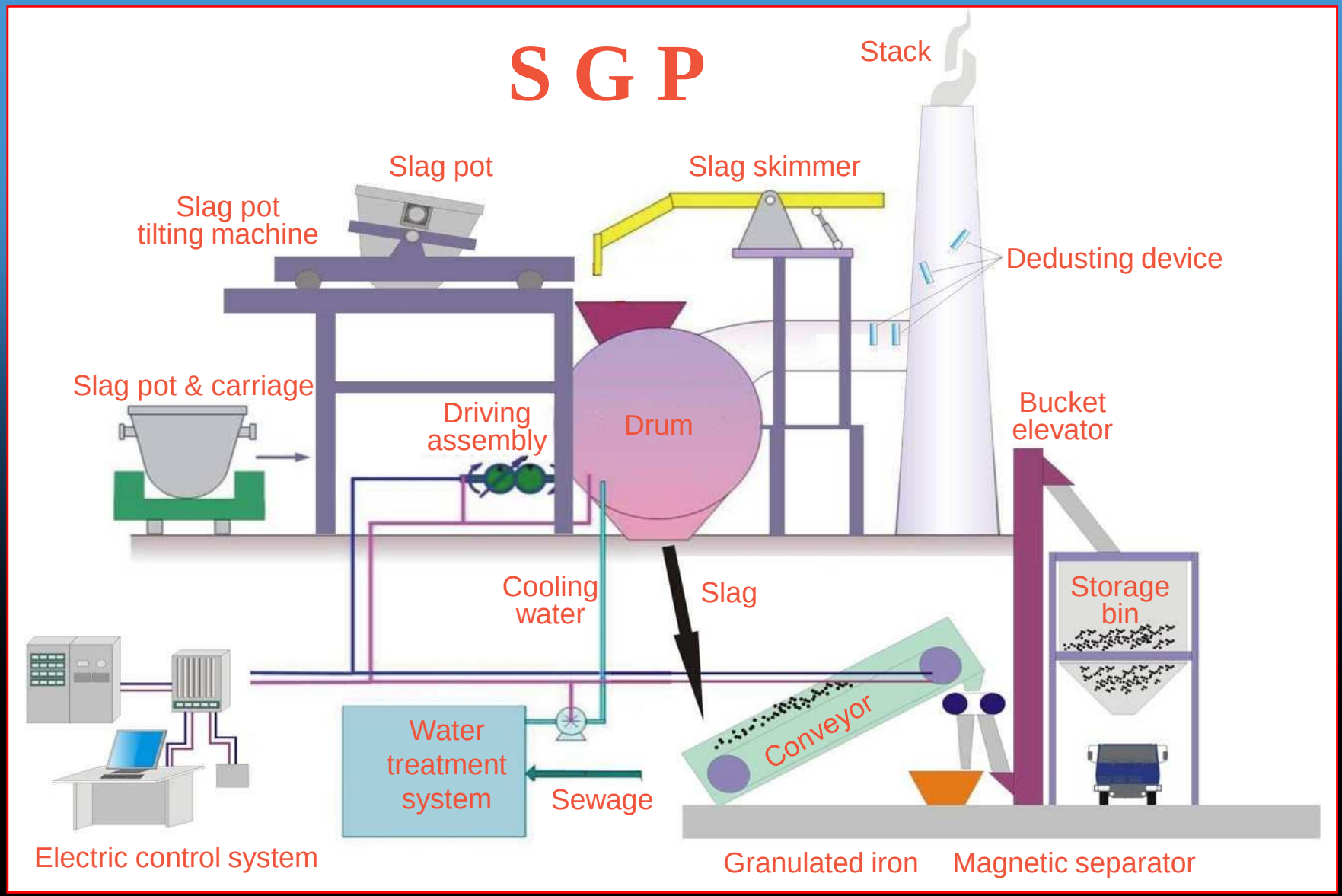


Principle



- Use of different contraction of slag and iron
  →Good Separation of Slag from Iron
- Use of medium for primary cooling & crushing, and use of separated space
  →High Safety
- Adequate granulation
  →Good Stability

S G P


Stack
Slag pot
Slag skimmer
Slag pot
tilting machine
Dedusting device
Slag pot & carriage
Driving
assembly
Drum
Bucket
elevator
Cooling
water
Slag
Storage
bin
Conveyor
Water
treatment
system
Sewage
Electric control system
Granulated iron
Magnetic separator

Composition

- Main Body
- Auxiliary System
  - Feeding System
  - Water Treatment System
  - Steam Exhausting System
  - Finished Slag Transporting & Processing System
- Electric Control System

Job Site Photos

Tilting machine

Slag skimmer

Tilting machine

Slag skimmer

Processing of 1 ton slag：

Water：0.25-0.3 t

Electricity：Approx. 6kW·h

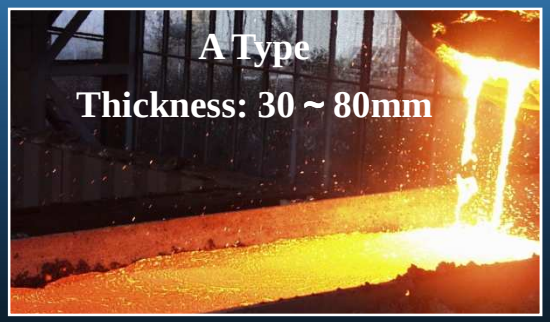
Compressed Air：Under 800m^3/h　(TYPE-B)

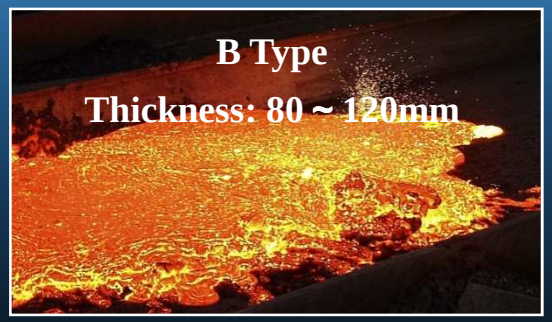
SGP Slag Application

Production Rate & Classification of BOF Slag

- Slag Production Rate：8-12%
- Classification：

Slag of Low Viscosity





Slag of High Viscosity

- In general, during the production of steel, we can encounter all kind of slag as A, B, C, D, according the stability of different kind of steel slag, we select different different directions of application(by the SGP process, it is easy to control and realize):

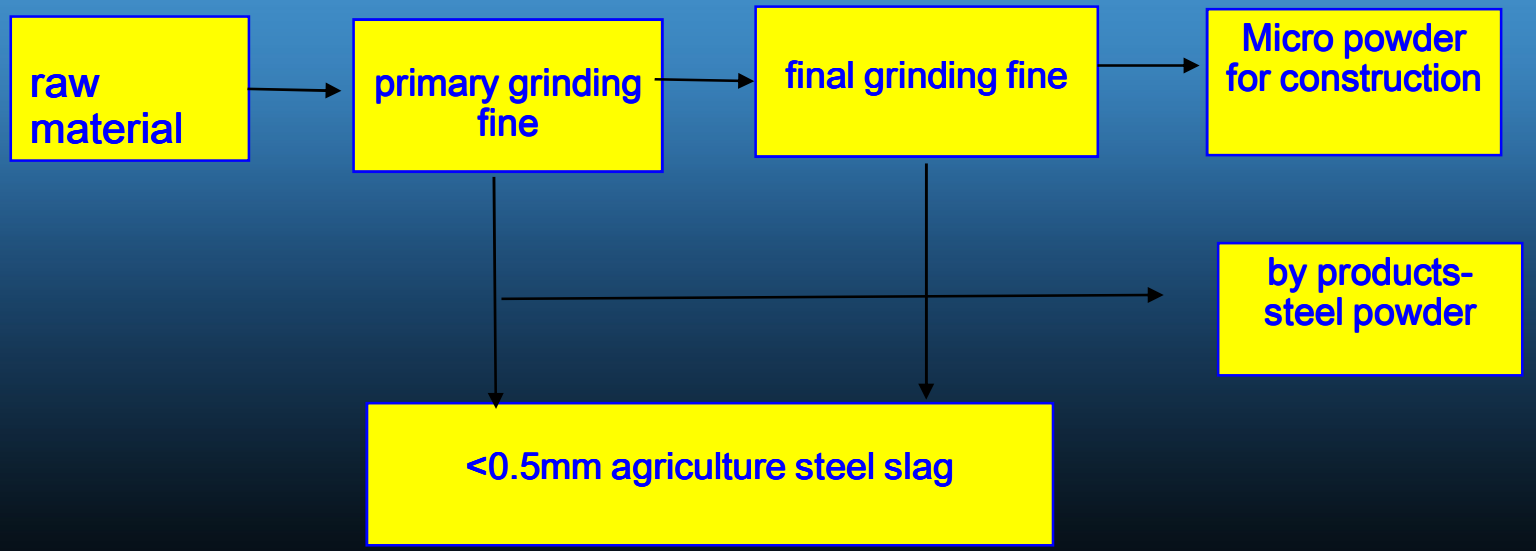
Slag application according size- taken a 500000 million ton slag treatment for an example

category	application	Size specification
1 CD slag	**Agriculture**	**<0.5mm**
	Micro powder	**<45um**
2 AB slag	**Special concret**	**>C20**
	Road brick	**C30/40**

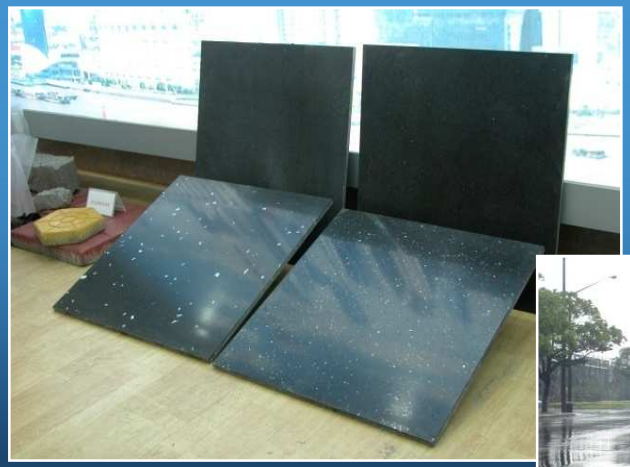
Experienced size distribution in baosteel SGP plant

Size	CD/AB slag content
>6mm	30%
3-6mm	40%
<3mm	30%

1. Process flow for fertilizer fine and micro powder



2. Application for new construciton material and road brick



Artificial Marble

Derusting Abrasive

Permeable Material

Wear-resistant Floor

Asphalt Filler

Road Laying

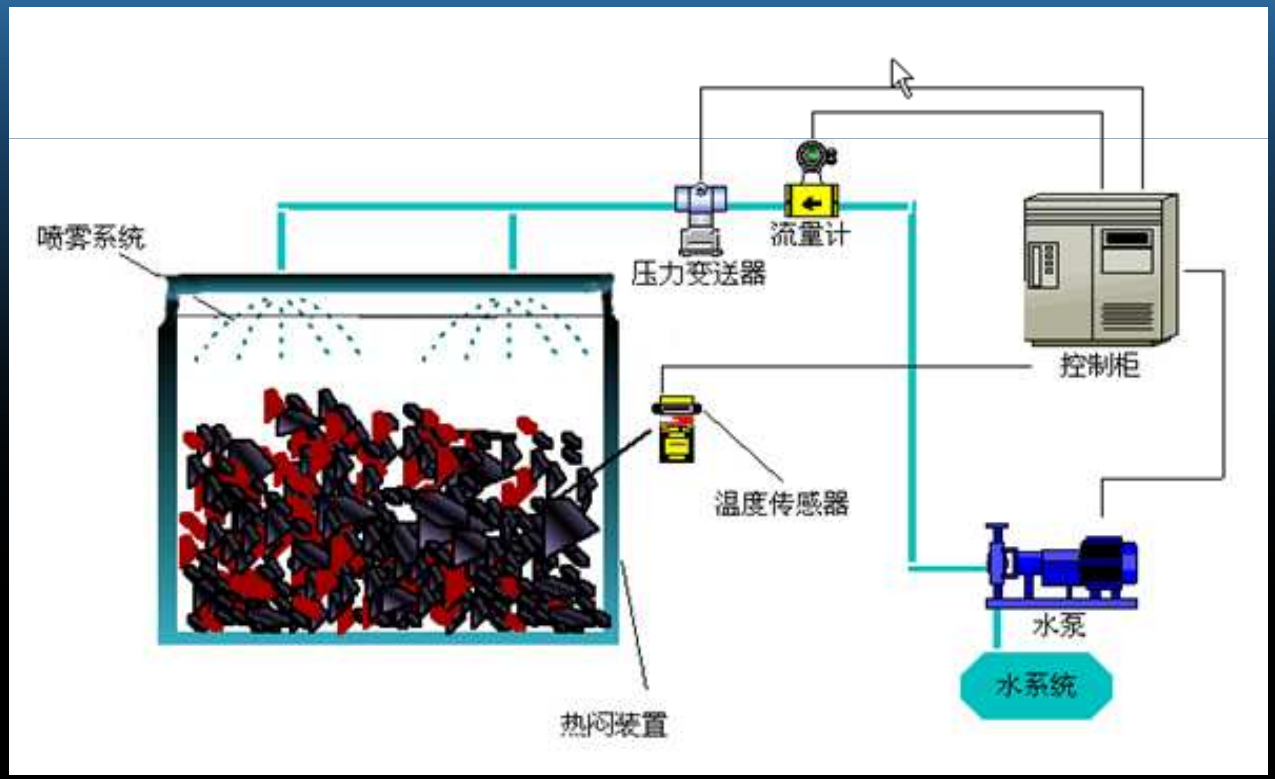
To Sinter

Cement Aggregate

Technology of slag treatment in the closed box and Application

The third generation technology of slag treatment in the closed box

- The slag is put into the closed box, spring with water to consolidte the furface of the slag, put the lad and spray water discontinuously until the temperature reduced to after 65C, the process stoped. 。



The physical and chemical reaction during the process

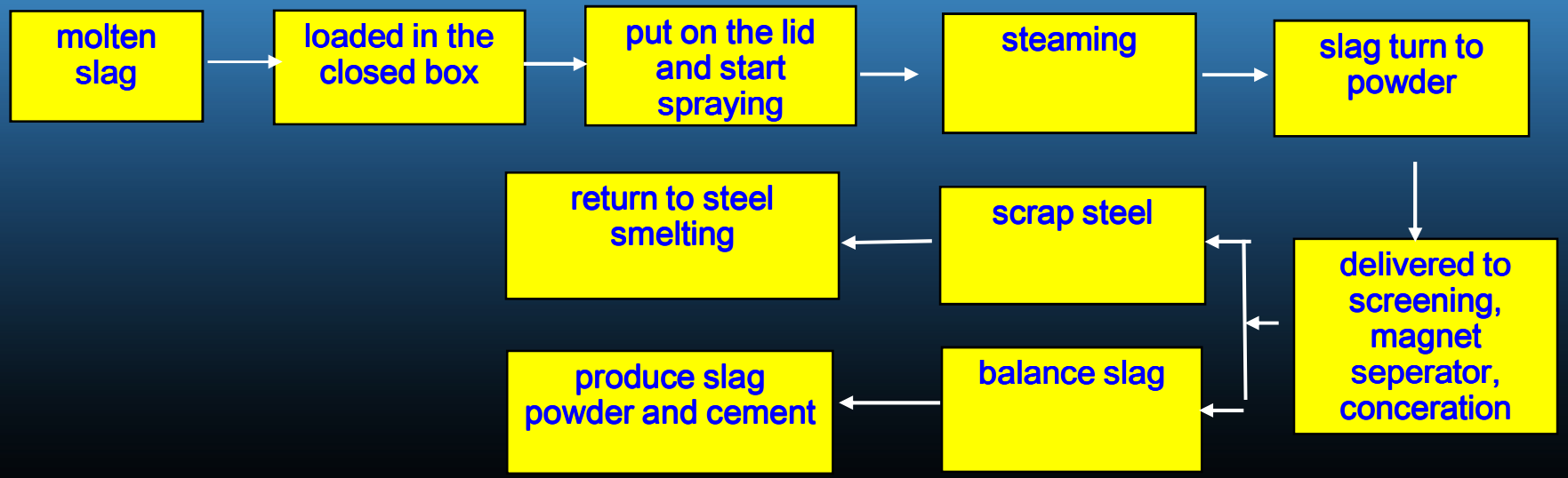
- (1) sudden cooling and smash.
- (2) steaming: the high temperature slag together with watre will generate a lot supersaturated steam with temperature higher than 105C,pressure above 0.24kpa. The slag under this atmosphere will continue to turn lose under the temperature strain.

- （3）The chemical reaction of f-CaO and f-MgO
- The fast steel making process will result in the incomplete reaction, there will be f-CaO and f-MgO will be covered by some other minerals; during the slag is cooling down, C_3S is dissolved into C_2S and CaO，and thisCaO is also in free state,. And the unreactioned lime added in the end of steel making is also covered by the slag, it will bring more f-CaO, there are also some FeO in the form of solid solvent contained in the slag,the material became deadburned lime stone.

The f-CaO inside the slag

After stoping the water spraying, the steaming starts, under the supersaturated steam, the f-CaO，f-MgO reacts with water：	
$CaO + H_2O \rightarrow Ca(OH)_2$	Volume expand by 98%
$MgO + H_2O \rightarrow Mg(OH)_2$	Volume expand by 148 %
At the same time，when temperature reaching 675℃， the silicate will also dissolve, result in the volume expand	
The above physical and chemical process will enable the slag to be powdered, slag became stable and slag and steel is seperated。	

process flow of steaming in closed box



Pouring the Slag hull

Slag hull in the steel

steaming

Steel slag generated

Technical features

- （1）after treatment, the f-CaO，f-MgO is dissolved, the slag is stable, the slag can be 100% utilized

In Japan, the slag stableness standard is JISA5011-4:2003，the watered expansion rate less than 1.5% is qualified

China standard is GB/T 24175-2009，under 20 atmospheritic pressure, maintain is the container for 3 hours under 215.7℃，

the powdering rate less than 2% is qualifed。

80℃ watered expansion less than 2.0% is qualified。

Slag stablity test

Treatment method	duration	MgO%	Powred rate%(under P T)	Powdered rate in water%
splashing	5years	11.36	5.30	4.9
splashing	5years	10.29	14.10	6.7
splashing	5years	10.40	3.60	2.2
splashing	5years	14.81	3.67	2.3
splashing	5years	10.44	2.30	1.8
Steaming in CB	24hours	13.96	0.83	0.8
Steaming in CB	24hours	11.85	0.72	0.7
Steaming in CB	24hours	12.27	1.10	1.3
Steaming in CB	24hours	13.60	0.77	1.0
Steaming in CB	24hours	9.78	0.44	0.5

Technical features-2

- 2. Has no limit to all kinds of slag with different viscosity, Can even treat the slag hull and realize 100% slag treatment。
- 3. After steaming, the size less than 20mm accounts 65%~70%，it can reduce the crushing and grinding work for further application and the power consumption.

Technical features-3

- （5）the steel scrap and slag seperately naturally, with the rod mill to process the slag and the dynamic double roll Magnetic seperator. The Mfe in the tail slag is less than 2% can be used directly to produce slag powder.
- （6）no noise, no waste water discharge.
- （7）Use the heat from the slag to generate steam, it is power saving.
- （8）Full automation is realized, safe and reliable.

The steamed slag will pass the vibrating screener, remove the scrap steel above >200mm，by belt conveyor, to screening- magnet seperating- purification.

Size distribution

sample	screen mm	53	37.5	31.5	26.5	19	16.0	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075	-
An gang	seperated (%)	1.4	8.4	4.2	6.4	12.9	6.7	18.4	16.4	8.2	4.2	2.1	2.1	1.5	6.1	0.6
	accumulated (%)	1.4	9.8	14.0	20.4	33.3	40	58.4	74.8	83.0	87.2	89	91.4	92.9	99.0	99.6
Xin yu	seperted (%)		2.6	3.3	7.4	16.4	7.5	9.7	20.2	14.2	8.9	3.2	3.1	1.2	0.9	1.3
	accumulated (%)		2.6	5.9	13.3	29.7	37.2	46.9	67.1	81.3	90.2	93.4	96.5	97.7	98.6	99.9

field picture of the process

Angang steel

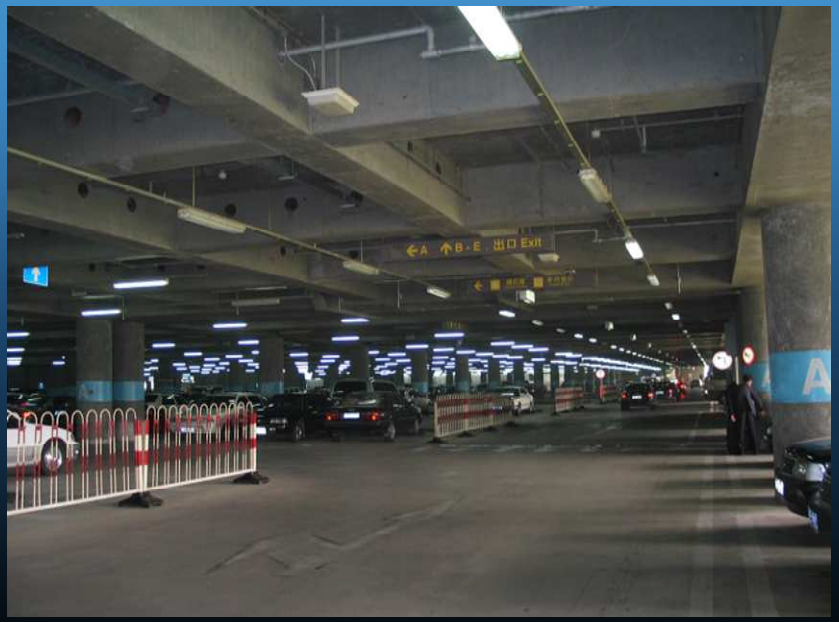
800000t/y

Capital steel

1600000t/y

The slag powder function in the cement

Slag powder application-3



Beijing Captical airport terminal 3

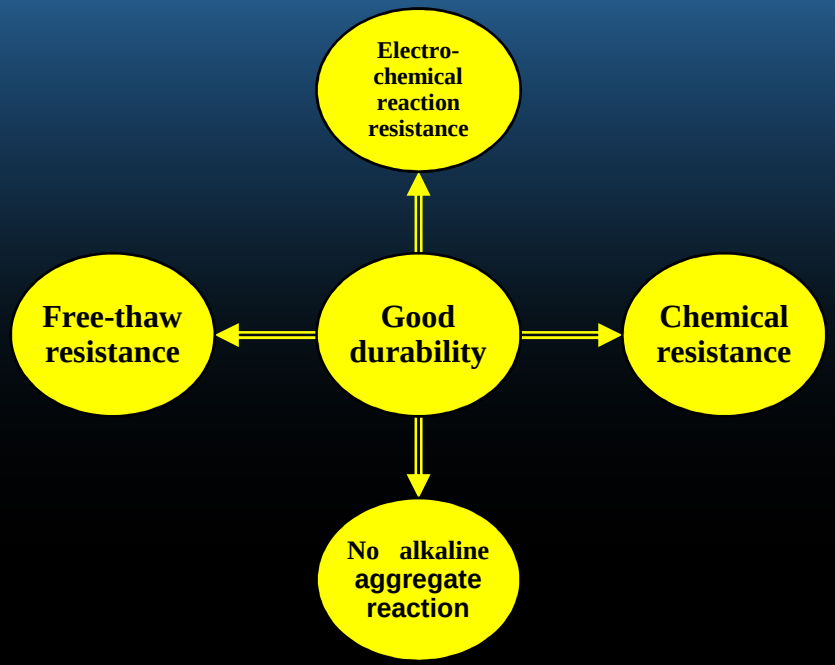
Beijing Metro no. 8 line

The function of steel slag in the concret

- （1）the steel slag powder can replace 10%~30% of cement and inprove the strength of the 28days strength of the concret, later stage strength and tensile strength
- （2）with the specificaiton 400kg/m^3 motar, steel slag can replace 20% cement and produce C70 cement, it can improve the grade of normal cement by one degree
- （3）can improve the anti-frozen, anti-penetration, anti-errosion, anti-wear, reduce the hydration heat property of the concret.
- （4）the cement 3 days and 7 days strength is low
- （5）use steel slag to replace partial cement can reduce the lose of clapse, improve the mixing property, and prevent the crack in the early stage of concert shinkage.

The mixter of steel slag with BF slag is a good concret material

- **The nowdays concret work such as oversea bridge, high building, GYM, undersea tunnel, etc has strict requirements on the durability and service life of cement.**

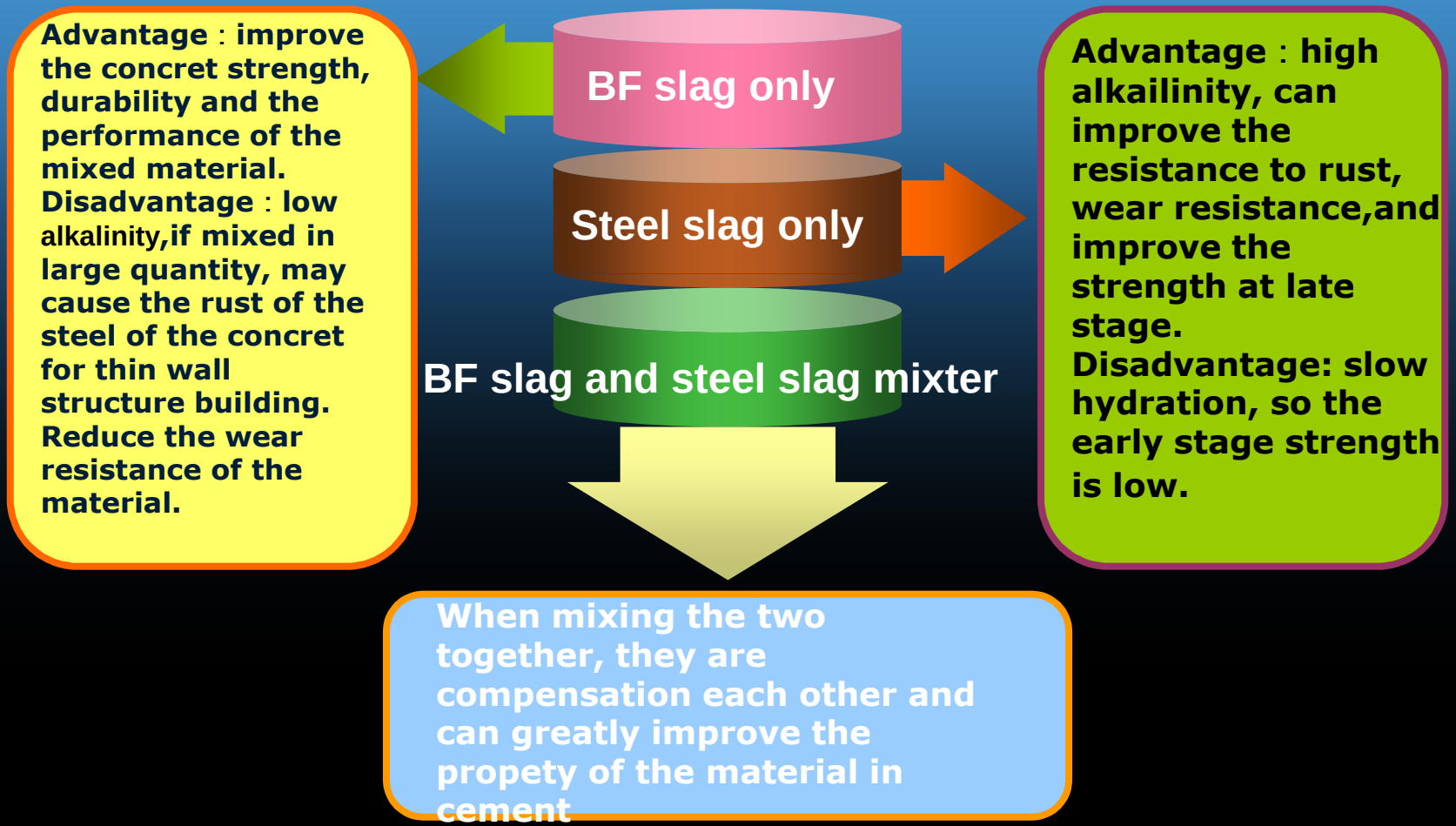


The crossion of the reinforced steel in the concret is a major reason of the fail of the concret struture

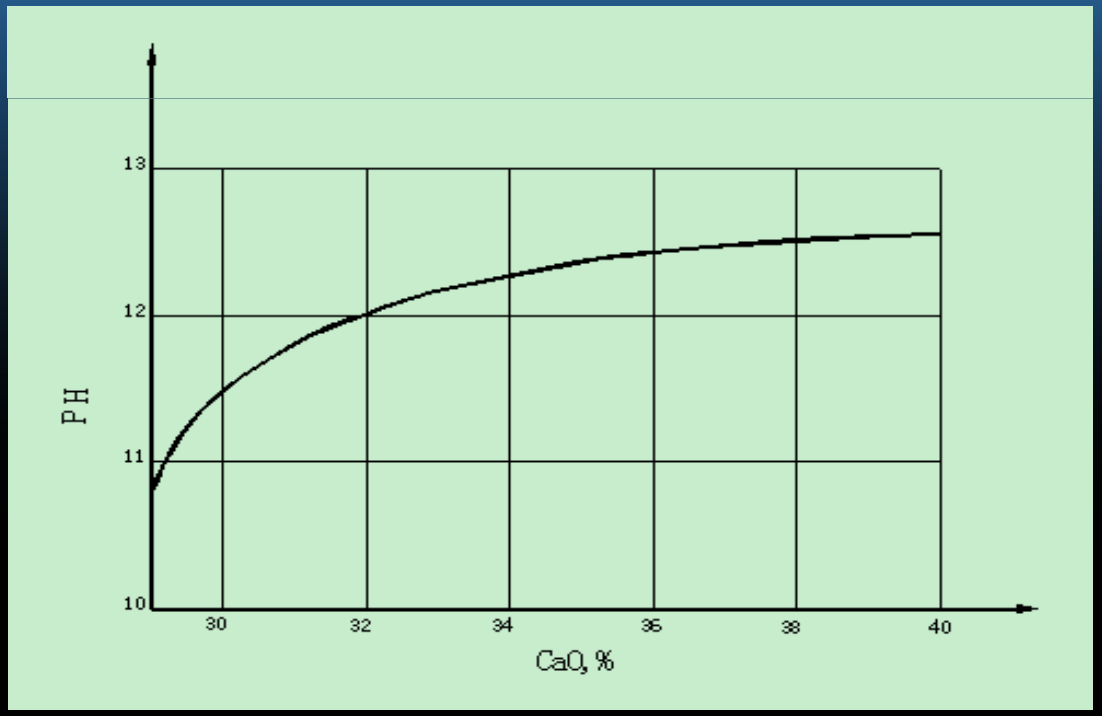
- The reason that the steel inside the concret not be erosioned is because the PH is around 13, under the basic condition, a protection film γ-Fe_2O_3 on the surface of the steel will be generated to reduce the penetration speed of O, and prevent invation the CO2

- Usually the CO2 in the air can react with the hydrate in the concret, it can reduce the PH of the concret from 12.5-13.5 to 8.3, this will destroy the protection film to the steel. So to increase the alklinity is important to improve the durbility of the concret.

The Mixter of steel slag and iron slag has good durability

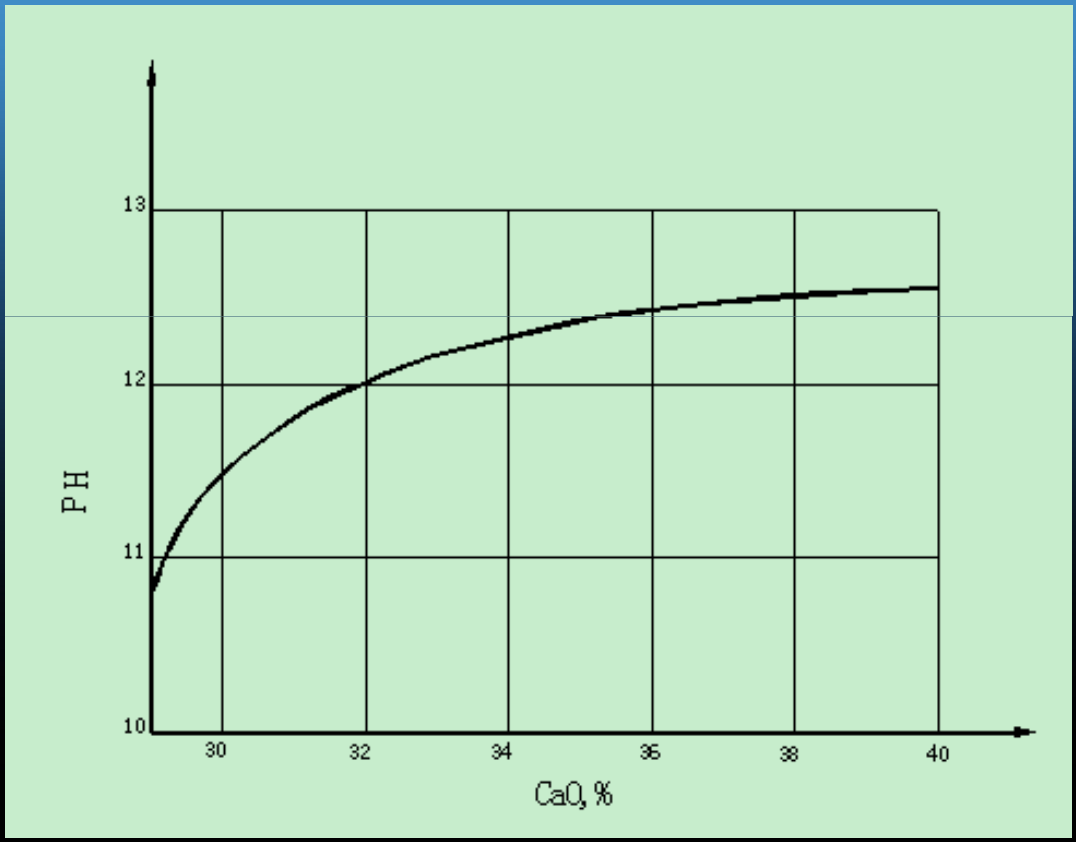


- **The mixter of BF slag and steel slag has the characteristic of good wear resistance, impermeability and high late stage strength.**
- **By different mixing percentage, the CaO content will differs a lot.**
- **The relationship between CaO content in the mixter and PH value of the liquid concret.**



CaOcontent	pH value
29.5%	10.75
40.5%	12.5

- Besides the CaO，there are also f-CaO in the mixter, it has big influence on the PH value



f-CaO content	pH value
0	11.2
1	12.25

Normally, there are f-CaOin the steel slag while not contained f-CaO in BF slag.

The advantage of the mixter of steel slag and BF slag :

（1）no corrosion of steel reinforce bar	**The reinforced steel in the concret has no sign of corrossion with the adding of 30%mixter.**
（2）good permeability	**The C40 concret made with the mixter, under 3.2MPa pressure, there are no permeate. That is because when mixing the slag mixter, the microstructure has changed, capillary openings turned small, and the structure of the capillary get improved. Those has changes has improved the impermeability of the concret.**
（3）low heat of dydration of cement	**See the column below**
（4）good wear resistance	**The abrasion value of 42.5ordinary portiland cement is 3.32kg/m^2。The abrasion value of cement with 30% slag mixter is 20kg/m^2**

	Hydration heat kJ/kg	
Cement grade	**3 days**	**7 days**
42.5 ordinary portiland cement	**240**	**268**
With 30% slag mixters	**238**	**259**

China standard release situtation

- 31 nos of stardard related with the metallurgy waste has been completed or underway. to be completed, 20 nos has been issued, 8 nos has been submited for approval and 3 items are under preparation.

Standardization progress-1

category	no	Name of the standard	Standard no
Products standard	1	Steel slag silicate cement	GB 13590-2006
	2	Slag powder for cement and concret	GB/T 20491-2006
	3	Low heat steel slag silicate cement	JC/T 1082-2008
	4	Steel slag road cement	JC/T 1087-2008
	5	Steel slag bricklaying cement	JC/T 1093-2008
	6	Steel slag road cement	Submit for approval(national standard)
	7	Low heat steel slag and BF slag cement	Submited for approval
	8	Steel slag and iron slag powder	In progress
	9	Road application slag sand	YB/T 4187-2009
	10	Granulated BF lslag for cement and concret	GB/T 18046-2008
	11	Concret application crushed BF heavy slag	YB/T 4178-2008
	12	Silica and manganese slag for cement and concret	Submited for approval
	13	Lithium slag application in cement and concret	Submited for approval
	14	Steel slag in cement	YB/T 022-2008
	15	Slag steel for backfill	YB/T 801-2008
	16	Steel slag for metallurgy load	YB/T 802
	17	Steel slag for road	Submited for approval
	18	Concret mutiporous brick and road brick	Submited for approval
	19	Magnesia slag for cement	In progress

Standardizaiton progress-2

category	no	Standard name	Standard no.
Standard basis	20	The terms in use in ironand steel slag disposal and application	YB/T 804
Method standard	21	Steel slag stabless test method	GB/T 24175-2009
	22	Chemical analysis method for steel slag	YB/T 140-2009
	23	Testing method for testing the magnite metal content in the steel slag.	YB/T 4188-2009
	24	The method for testing the total Fe in steel slag	YB/T 148-2009
	25	The testing metho for testing the wearibility of the slag	YB/T 4186-2009
	26	Method for testing the size distribution of the slag-laser diffract	YB/T 4183-2009
	27	Method for testing the non-magnetic metal content	Submited for approval
Regulations and creterion	28	Technical creterion for applying the steel and iron slag in concret	GB under approval
	29	Mineral mixter application creterion	GB submit for approval
	30	steel slag mixer road laying applycation creterion	YB/T 4184-2009
	31	Tail slurry creterion	YB/T 4185-2009

Reuiremens for steel slag used in cement and concret

item			Grade 1	Grade 2
Density per specific surface area (m^2/kg)		No less than	400	
density (g/cm^3)		No less tan	2.8	
Water content (%)		no more than	1.0	
F-Cao content (%)		No more than	3.0	
SO3 content(%)		No more than	4.0	
Alkalinity Coefficient		No less than	1.8	
Active index(%)	no less than	7d	65	55
		28d	80	65
Flowbility(%)		No less than	90	
Stability	boiling		qualified	
	Pressue and steaming		When the MgO content mor than13%, it is qualifed	

Steel slag silicate cement technical specifications

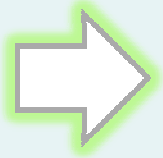
SO3	SO3 should no more than 4%。
Density surface area ratio	No less than 350m^2/kg。
Coagulating time	Initial coagulating time no earlier before 45min，final coagulating time no later than 12h。
Stability	Must past stability test, the cement with MgO morethan 13% must pass pressure steaming stability test.

Cement strength grade and the strength in different stages MPa

Strength grade	Tension strength		Transverse strength	
	3d	28d	3d	28d
32.5 42.5	10.0 15.0	32.5 42.5	2.5 3.5	5.5 6.5

Steel slag utilization & sustainable development

Energy saving by steel slag powder manufacturing

The steel slag powder will only need fine grinding, it reduced the process as in the cement production raw material milling and clinker aggregate calcination		
60kw.h will be saved for production of steel slag compatred with production of 1ton cement.		To calculate as per the quantity of production 800000t slag powder, it will save 48million kw.h energy
It will save 121kg coal for produce 1 ton slag powder compared with production of cement.		To calculate as per the quantity of 800000T slag powder, it will save 96800t coal standard coal.

Steel slag powder for cement can reduce the consumption of resources

The BF and Steel slag can save the cement raw material such as limestone, clay	
1 ton cement production	800000 ton steel slag production
Consume1.1ton limestone	Save 880000 limestone
Consume 0.18 t clay material	Save 144000ton clay

BF and Steel slag powder production can help to reduce CO_2

- The most of emission of CO_2 is from metallurgy industry, non-ferrous, construction, chemical, sugar, paper and thermal power industry. And metallurgy accounts 16.6%of the total ，and cement industry accounts for 13%。

To produce 1 ton cement	0.815 t direct CO_2 generation	From the burning of the fuel: 0.390t
		From limestone 0.425ton
To produce 800000t iron and steel slag	650000 t CO_2 reduction	

THANK YOU!

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