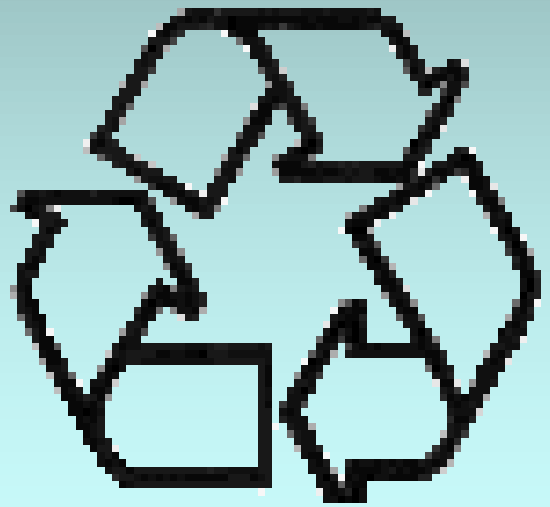

Recycling of Fused Flux
For the
Submerged Arc Welding Process

The industrialized world is consuming natural resources at a pace unseen before in human history

As we exhaust these resources, the space/land to store this waste is disappearing equally as rapidly.

Scientific study has revealed that we have no choice but to re-use ‘non-renewable’ resources wherever possible.

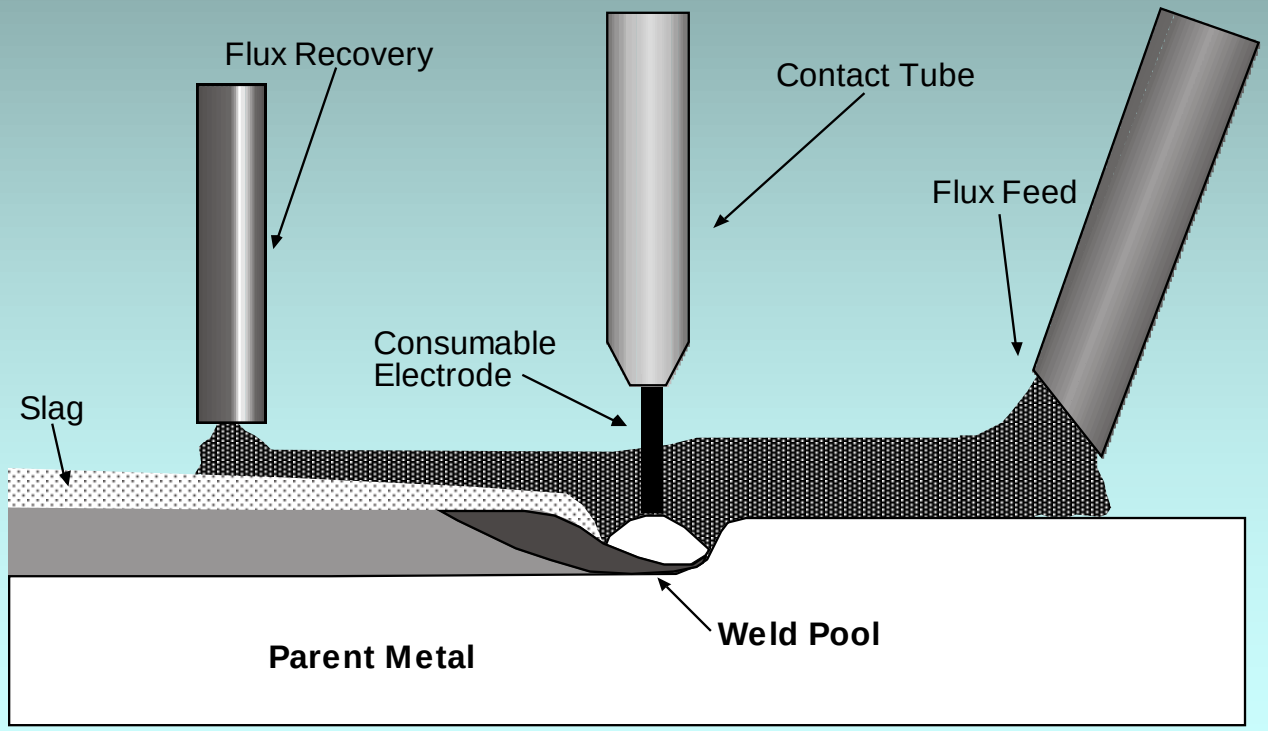


Waste is No Longer Waste

SUBMERGED ARC WELDING

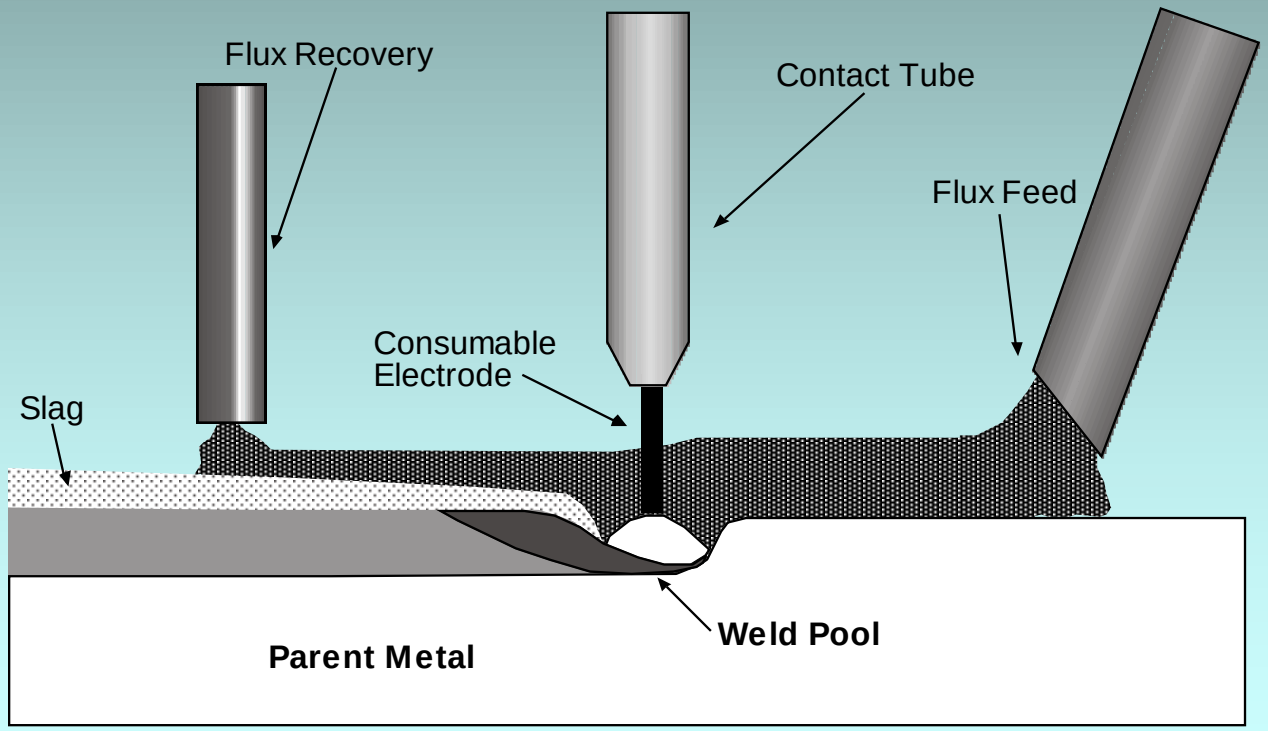
SUB ARC WELDING

- The arc is submerged under a blanket of granular flux powder



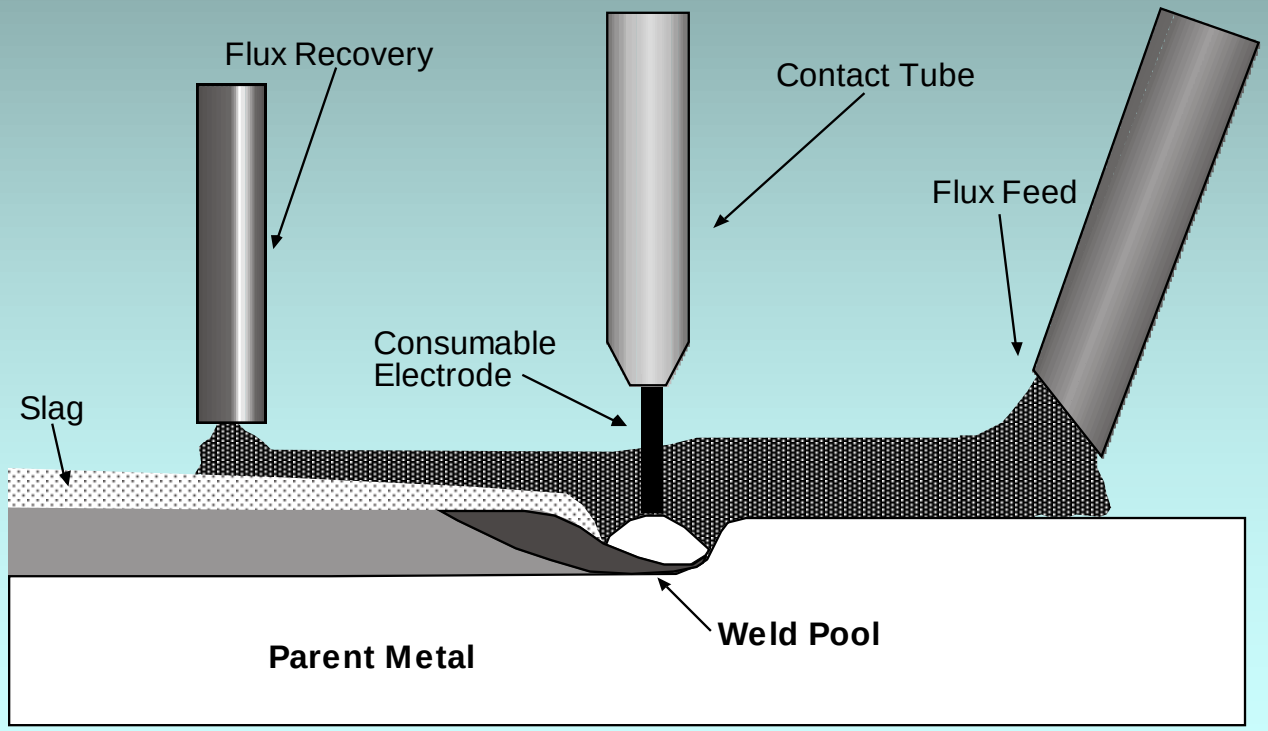
SUB ARC WELDING

- Electric arc is maintained between a wire electrode and the work piece



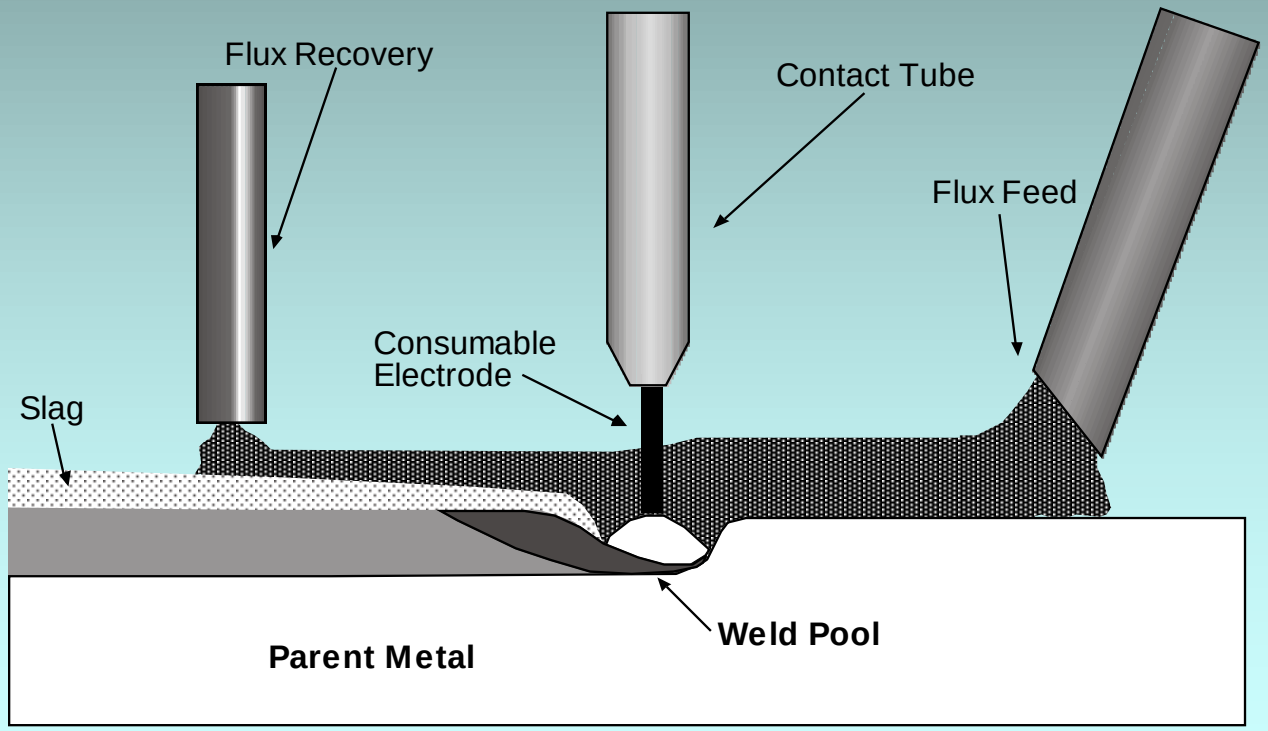
SUB ARC WELDING

- The flux granules/powder melt, forming a liquid slag which floats on the surface of the weld puddle



SUB ARC WELDING

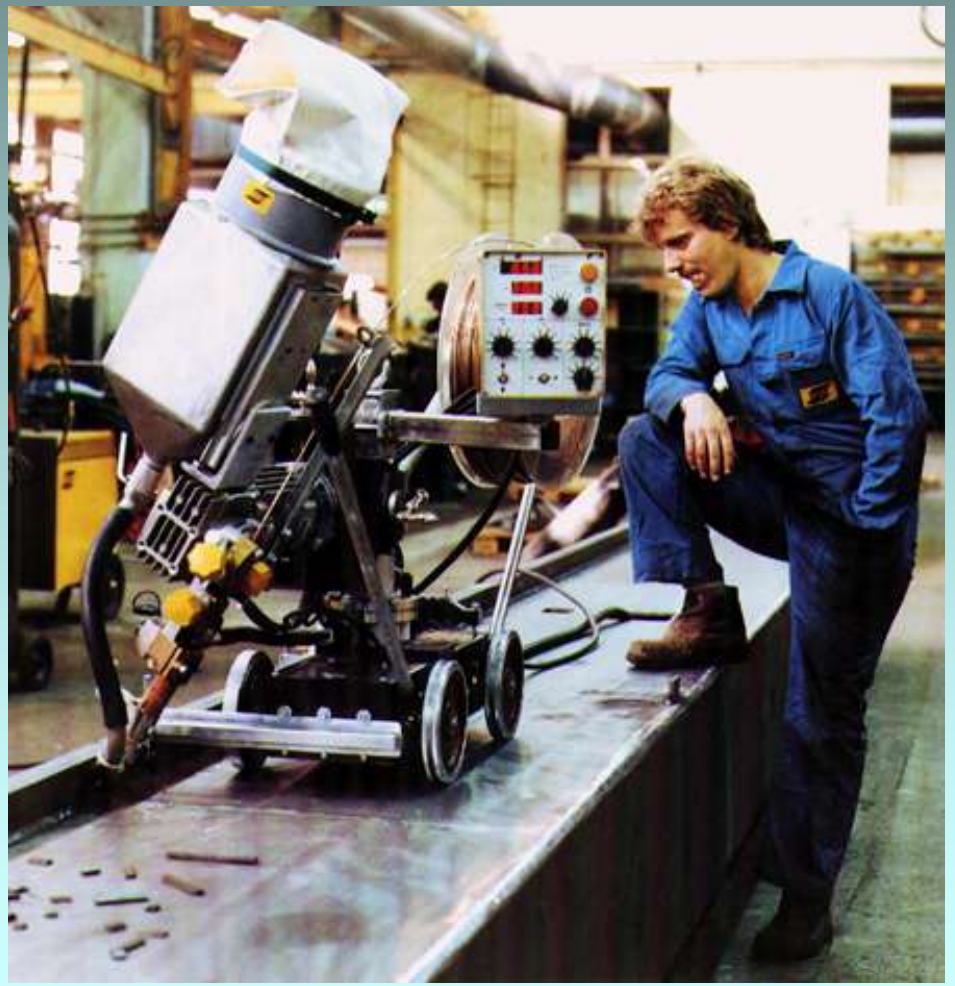
- After solidification, the slag detaches, leaving a clean, smooth weld bead



SUBMERGED ARC WELDING

ADVANTAGES

- High Welding Currents
- Deep penetration of weld metal
- High deposition rates of weld metal
- Fast travel speeds
- High quality deposits



SAW FLUX

PRIMARY PURPOSE OF FLUX

- Shield the weld metal from contaminants in the air, preventing nitrogen pick-up

SAW FLUX

SECONDARY BENEFITS

- Stabilize the arc
- Mechanical support to weld metal
- Shield operator from arc glare
- Limit smoke and fumes
- Alters the chemistry of the weld deposit through slag-metal reactions

MANUFACTURE OF VIRGIN FLUXES

FUSED

- Minerals/Granules dry blended
- Added to electric furnace
- Heated to 1500°C forming a molten pool
- Cooling into a slag
- Slag is crushed/sized/packaged

Resulting particles are homogenous, have the same composition, and are not hydroscopic.

MANUFACTURE OF VIRGIN FLUXES

BONDED/AGGLOMERATED

- Minerals/Granules dry blended
- Cementing or bonding agent added
- Mix is dried by heating up to 900°C
- Granules are crushed/sized/packaged

All bonded fluxes during welding operations become fused in the heat of the welding arc.

Classification of Fluxes

- SAW Fluxes are not classified by the properties or chemical composition of the flux itself.

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- Classification is based solely on end performance (of the wire-flux combination) and the standards allow any method of flux manufacture that results in compliance with the standard.

MANUFACTURE OF FLUXES FROM CRUSHED SLAG

RECYCLED SLAG

- Minerals/granules in powder form
- Subjected to electric arc
- Heated to 1500°C forming a molten pool
- Cooling into a slag
- Slag is crushed/sized/packaged

Resulting particles are homogenous, have the same composition, and are not hydroscopic

MANUFACTURE OF FLUXES

	VIRGIN FLUX	
	FUSED	**RECRUSHED**
Granules/Powder	Yes	Yes
Electric Arc	Yes	Yes
Temperature	1500°C +	1500°C +
Cooling	Yes	Yes
Crush/Size/Package	Yes	Yes
Homogenous Particles	Yes	Yes
Hydroscopic	No	No

RECRUSHED SLAG

- When the flux is melted, all the components go into solution and form a stable, glass-like substance
- The ingredients are completely reacted and in a stable and fixed condition
- No further chemical reaction can take place

RECRUSHED SLAG

Research proves that recycling SAW slag can be reliable, repeatable, and economical

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Published June 1996, AWS Welding Journal

Tested under AWS D1.1-94/A5.01-87, A5.17-789, A5.23-90

Electrode…….Lincoln L-61 (5/32")

Flux type…..……Lincoln 860……..100% recrushed

RECRUSHED SLAG

Chemical Analysis

Element	AWS Requirement	First Recycle	Third Recycle	Sixth Recycle
Carbon	0.050/0.150	0.070	0.050	0.060
Manganese	0.800/1.250	1.150	0.900	1.140
Silicon	0.100/0.350	0.310	0.320	0.250
Sulfur	0.030 max.	0.019	0.026	0.012
Phosphorous	0.030 max.	0.018	0.016	0.015
Copper	0.350 max.	0.210	0.250	0.230

RECRUSHED SLAG

Mechanical and Radiographic Results

	AWS Requirements Data (ksi)	First Recycle (ksi)	Third Recycle (ksi)	Sixth Recycle (ksi)
All-Weld-Metal				
Yield	58 min.	63.6	61.7	61.4
Tensile	70/95	72.5	73.6	74.9
% Elongation	22 min.	32.5	32.5	29.7
Radiography Results Method E142	See AWS A5.17	Passed	Passed	Passed

RECRUSHED SLAG

Impact……Charpy V-Notch

Charpy V-Notch Impact Values	First Recycle Results Ft/lb	Third Recycle Results Ft/lb	Sixth Recycle Results Ft/lb
Sample 1	33	17	57
Sample 2	40	23	63
Sample 3	44	53	86
Average	**39**	**31**	**69**
AWS Minimum	20	20	20
Test Temp	-20°F	-20°F	-20°F

AWS Code Requirements for Recrushed Slag

Standard			Use of Recrushed Slag	
Number	Title	Latest Edition	Reference	Clause
AWS D1.1	Structural Welding Code Steel	1998	*Permitted*	5.3.3.4
AWS D14.1	Industrial & Mill Crane & Other Material Handling Equipment	1997	*Permitted*	6.3.3
AWS D15.1	Railroad Welding Specification – Cars & Locomotives	2001	*Permitted*	11.3
AWS D1.5	Bridge Welding Code	1996	*Not Permitted*	4.8.4
AWS A5.17	Specification for Carbon Steel Electrodes & Fluxes for S.A.W	1997	*Permitted*	A6.1.5
AWS A5.23	Specification for Low Alloy Steel Electrodes & Fluxes for S.A.W.	1997	*Permitted*	A6.1.5
CSA W48	Filler Metals for Metal Arc	2003	*Permitted*	5.6.1
ASME Section IX	Welding and Brazing Qualifications	1995	*Permitted*	QW-404.36

……“ The advantages of reclaimed flux over virgin flux are cost, and in some cases, improved weldability over virgin flux”……

J.G. Feldstein
Chairman
ASME Committee IX


TITUS FLUX
RECLAIMING

TITUS FLUX RECLAIMING

- Reclaiming for 25 years
- USA/Canada/Mexico
- Locations in:
  - Cartersville, Georgia
  - Toronto, Canada
- Subsidiary of Titus Steel Company
  - (49 years of service)

TITUS FLUX RECLAIMING

Recycling your slag is:

A. "A CLOSED LOOP" process as defined by AWS:
   - Your slag – and only your slag
   - Your flux – and only your flux

B. A Partnership

FABRICATOR -TITUS FLUX RECLAIMING

TITUS FLUX RECLAIMING

Identical to Virgin Flux, these are the only reason Recycled Flux will not perform…..

SLAG CONTAMINATION

- Water
- Oil
- Non-metallic material

TITUS FLUX RECLAIMING

Partnership for Success

Fabricator:

- Slag is Company Asset
- Care in collecting slag
- Store Indoors
- Not trash bins
- Employee education

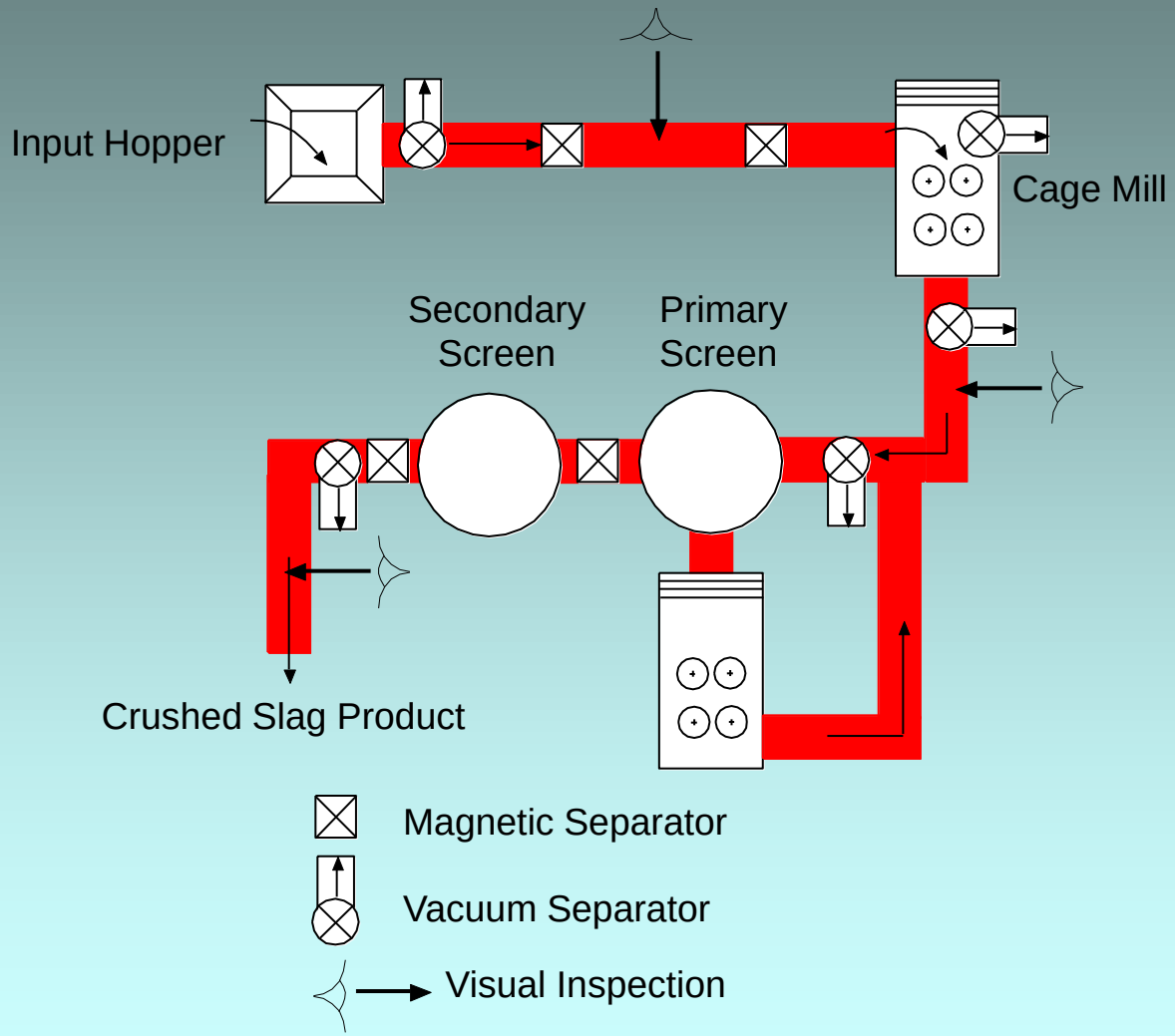
TITUS FLUX RECLAIMING

Partnership for Success

Titus:

- After initial test batch, customer profile developed to include:
  - Flux type
  - Optimum Top/Bottom Screen
  - Optimum Grain Size
  - Optimum % Silica added
  - Optimum % Virgin added
  - Optimum packaging

MANUFACTURE OF FLUXES FROM CRUSHED SLAG



TITUS FLUX RECLAIMING

MANUFACTURING

- Same equipment used by Lincoln/ESSAB for virgin flux including Industrial Cage Mill
- 7 magnetic separators
- Air separation of non-metallic material
- 4 sizing screens for exact

  grain size and distribution
- High speed bagging
- Vacuum removal systems

TITUS FLUX RECLAIMING

FINISHED PRODUCT

- Homogenous Particles
- Less Dust
- More Finished Product
- Non Hydroscopic

TITUS FLUX RECLAIMING

SAVINGS

- 40 – 70% of the cost of virgin flux
- All disposal costs
- The Environment

TITUS FLUX RECLAIMING

Free Test Batch

1. Save 250 lbs of slag
2. Titus will pick up, process and deliver
3. Titus representative plant visit to witness the test weld

The proof is in the weld

AWS, ASME, CSA approved

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ESTIMATED SAW FLUX USAGE AND POTENTIAL SAVING

ANNUAL NORTH AMERICAN SAW FLUX USAGE:

700,000,000 lbs.

ESTIMATED SAW FLUX USAGE AND POTENTIAL SAVING

- ANNUAL SAW FLUX USAGE: 700,000,000 lbs.

POTENTIAL ANNUAL SAVING TO ENVIRONMENT:

420,000,000 LBS

ESTIMATED SAW FLUX USAGE AND POTENTIAL SAVING

- ANNUAL SAW FLUX USAGE: 700,000,000 lbs.
- ANNUAL SAVING TO ENVIRONMENT: 420,000,000 lbs

ANNUAL SAVING TO INDUSTRY:

$262,000,000

Waste is No Longer Waste