ERMS SR and Related Processes

Application to the Murray Basin

4th Global Mineral Sands Conference

Melbourne - March 25, 2003

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Overview

- Development of Austpac's technologies
- The technologies
  - ERMS Roasting
  - LTR Roasting
  - ERMS SR process
    - ERMS SR roast
    - Ilmenite leaching
    - EARS HCL acid regeneration
- Benefits and applications

History

- 1988 - Westport, New Zealand
- 1990 - ERMS Roast (Patented)
- 1992 - EARS HCl Regeneration (Patented)
- **1994 - Present**
  - Refined SR process (roasting, leaching, acid regeneration)
  - Evaluated potential SR projects – India, Murray Basin, others
  - Developed LTR fluid bed roasting know-how
  - Technologies now being commercialized

Newcastle Pilot Plant

- Fluid Bed Roasting
- Magnetic Separation
- Bulk Leaching
- Fluid Bed Calcination
- F.B. Agglomeration
- Acid Regeneration

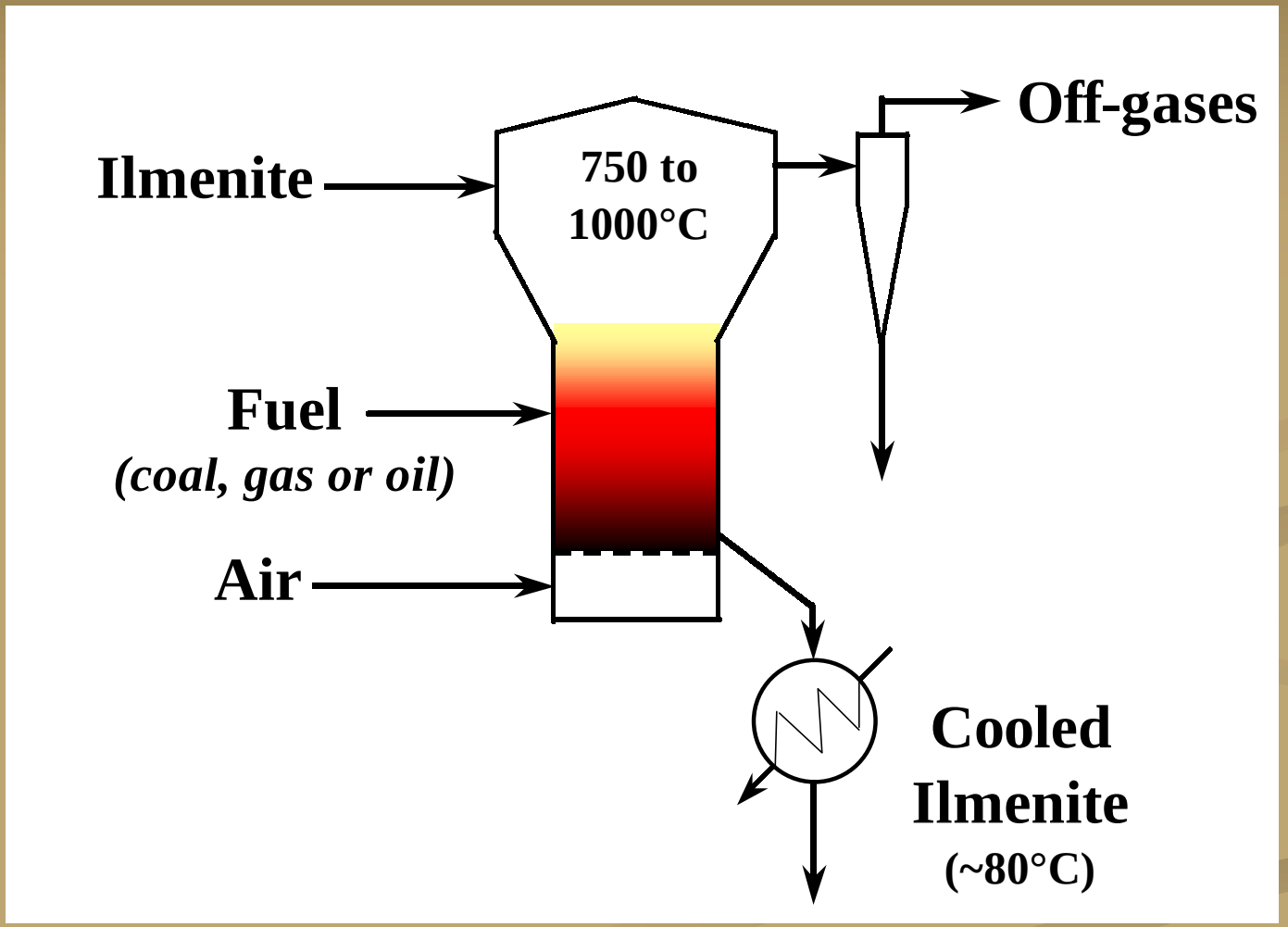
Over 75 different types of ilmenite successfully tested

AUSTPAC'S Technologies & Know-How

- **ERMS**[1] – high temp magnetising roast (>750ºC)[FB]
- **LTR** – low temp magnetising roast (<650°C)[FB]
- **ERMS SR roast** – high temp oxidation/reduction (<995°C)[FB]
- **HCl leaching** – batch[FB], continuous[2] leach vessels
- **EARS**[1] – regeneration of HCl from Fe chloride[FB]

[FB]Fluid bed process, [1]Patented, [2]Patent pending

Fluid Bed Roasting



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The ERMS Roasting Process

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ERMS Roasting

- "High temperature" roast: 750-950ºC, 30-60 min
- ERMS controls the O_2 potential in the fluid bed
- Forms a skin of Fe_3O_4 (magnetite) – L.I. mag. sep.
- Effective on fresh and weathered ilmenites
- High ilmenite recovery – generally >95%
- TiO_2 in ilmenite is "rutilized", thus insoluble in acid – only suitable for slag or chloride process

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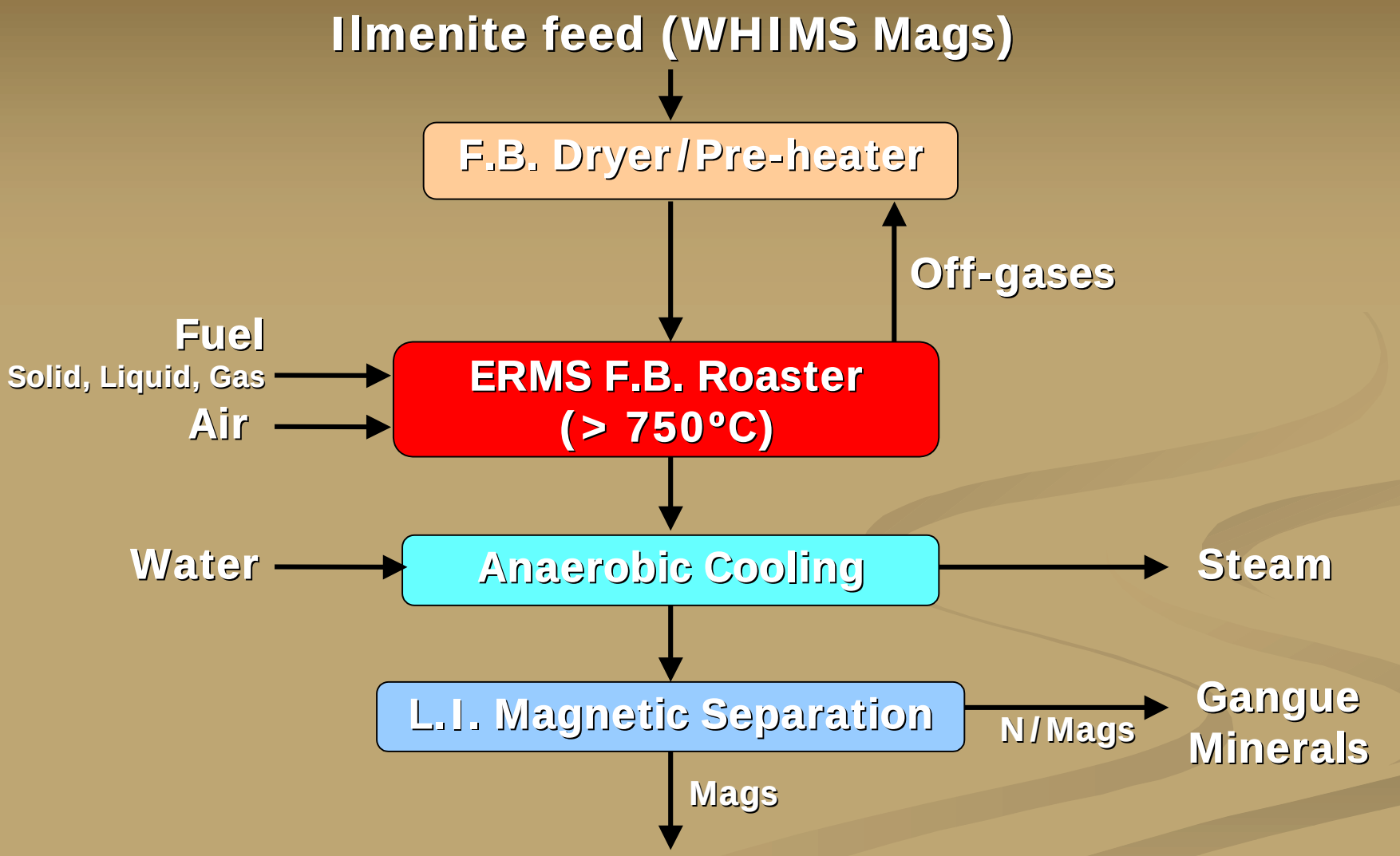
ERMS Roast



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Ø 500mm Fluid Bed Roaster

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ERMS Roast - Results

Component (%)	Murray Basin (1)		Murray Basin (2)	
	Feed	Product	Feed	Product
TiO_2	54.9	63.5	60.2	68.3
Fe_2O_3	28.5	34.2	28.5	30.4
Cr_2O_3	1.10	0.18	1.14	0.09
SiO_2	4.66	0.98	3.11	0.93
Al_2O_3	3.15	0.84	2.02	0.97
P_2O_5	0.25	0.09	0.29	0.06

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The LTR Roasting Process

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LTR Roasting

- "Low temperature" roast: <650ºC, 20-30 min
- "Homogenizes" iron so Fe(II):Fe(III) = 3:1
- High intensity RE drum separation
- Effective on fresh and weathered ilmenites
- High ilmenite recovery – generally >90%
- TiO_2 in ilmenite is not rutilized, thus soluble in acid – suitable for chloride and sulfate process

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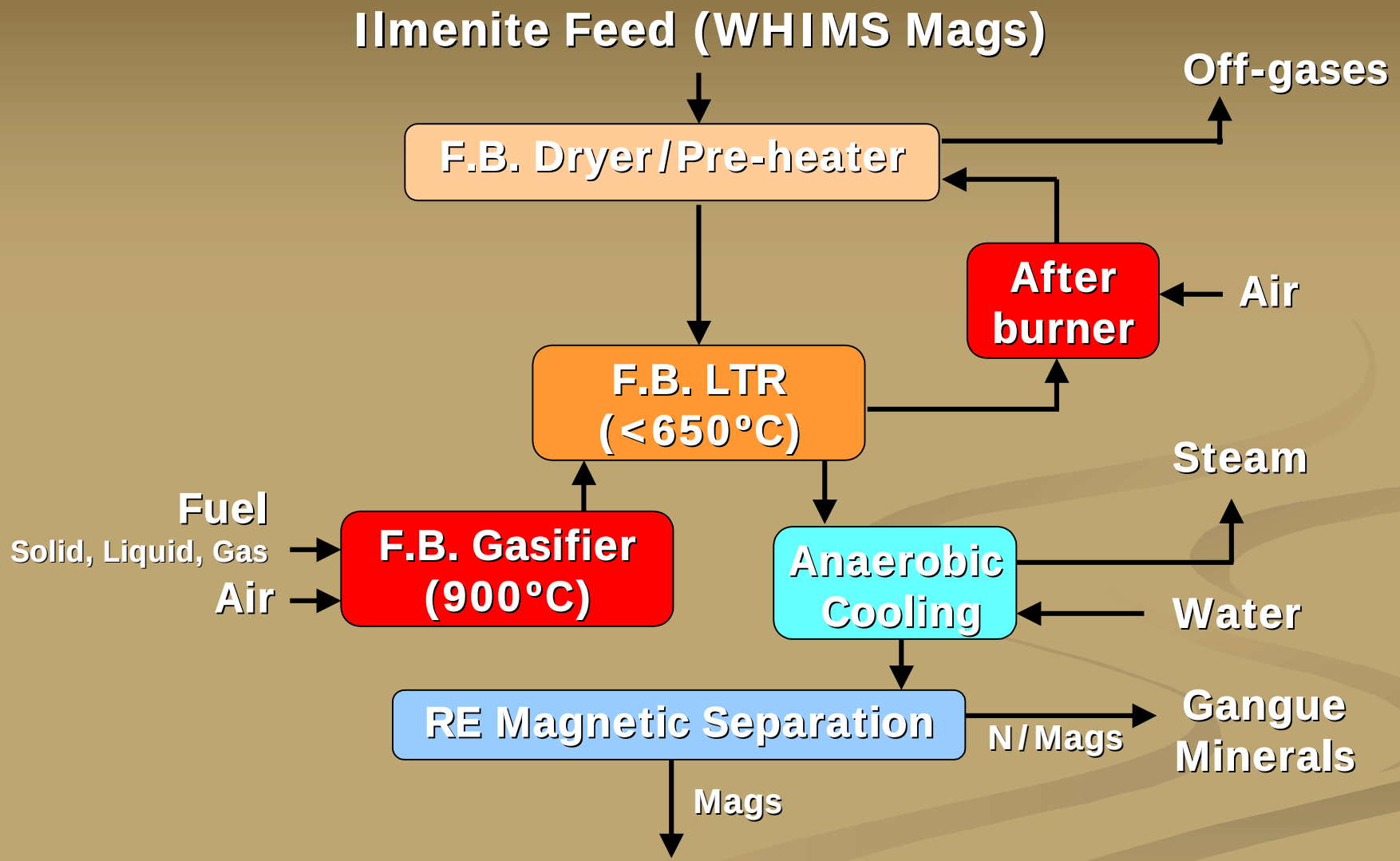
LTR Roast



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LTR Roaster

LTR Roast - Results

Component (%)	Murray Basin (3) Feed	Murray Basin (3) Product	Murray Basin (4) Feed	Murray Basin (4) Product
TiO_2	55.0	61.5	59.1	63.0
Fe_2O_3	28.6	35.4	31.8	34.3
Cr_2O_3	1.17	0.28	1.30	0.24
SiO_2	4.03	0.82	0.61	0.63
Al_2O_3	2.99	0.72	1.17	0.84
P_2O_5	0.30	0.09	0.13	0.12

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The ERMS SR Process

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ERMS SR – Roasting

$FeO/Fe_2O_3.TiO_2$ - ilmenite

- Oxidation/reduction roast, >750ºC
- Enhances mag. susceptibility of ilmenite, allows ready separation from gangue minerals
- Conditions ilmenite for rapid leaching in hydrochloric acid
- Renders the TiO_2 insoluble (rutilized)
- Increases the solubility of the iron and other unwanted constituents

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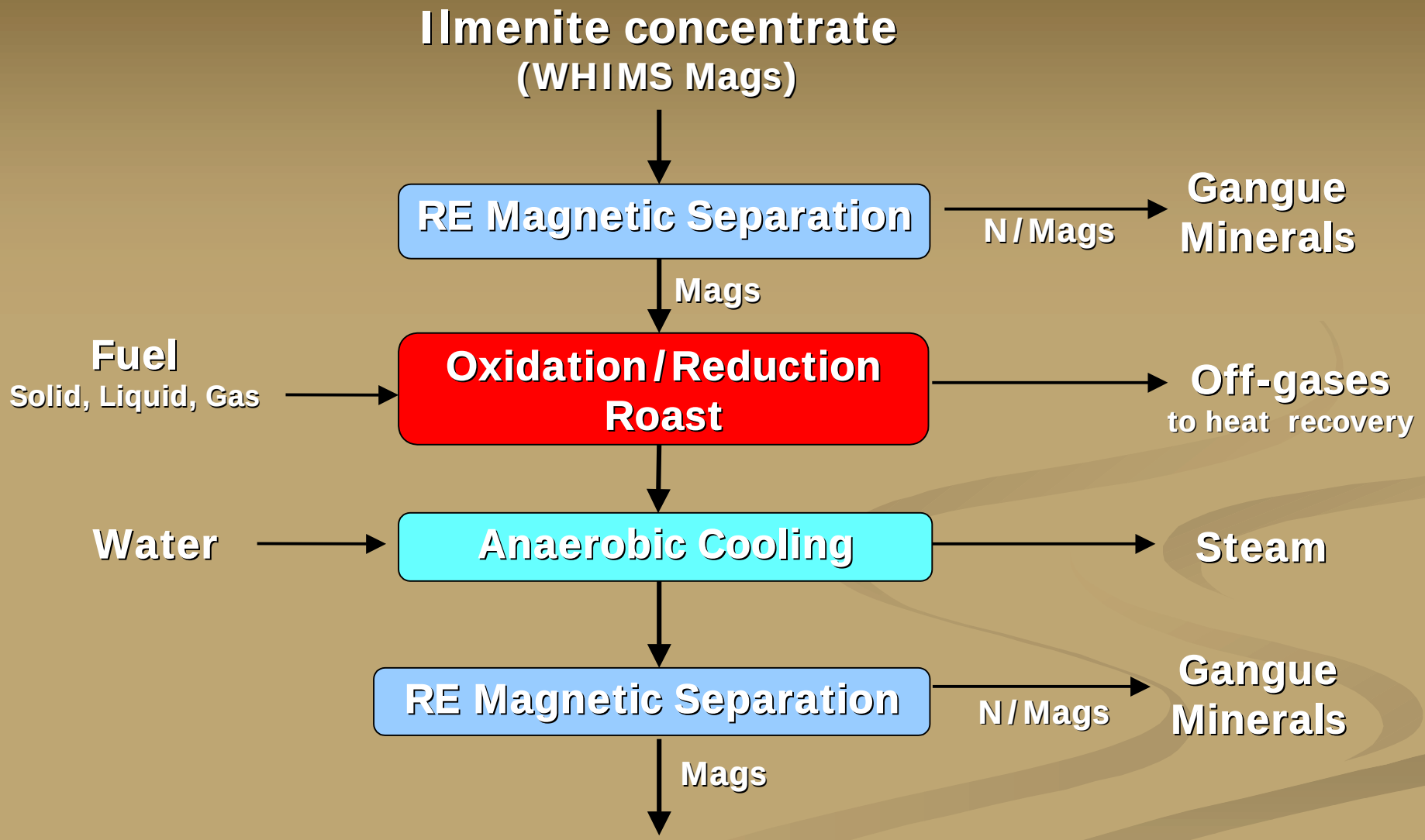
ERMS SR Roast



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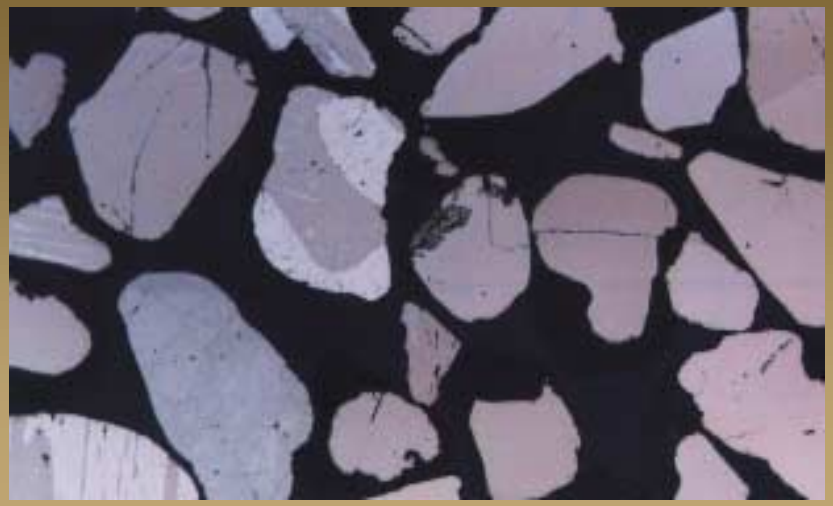
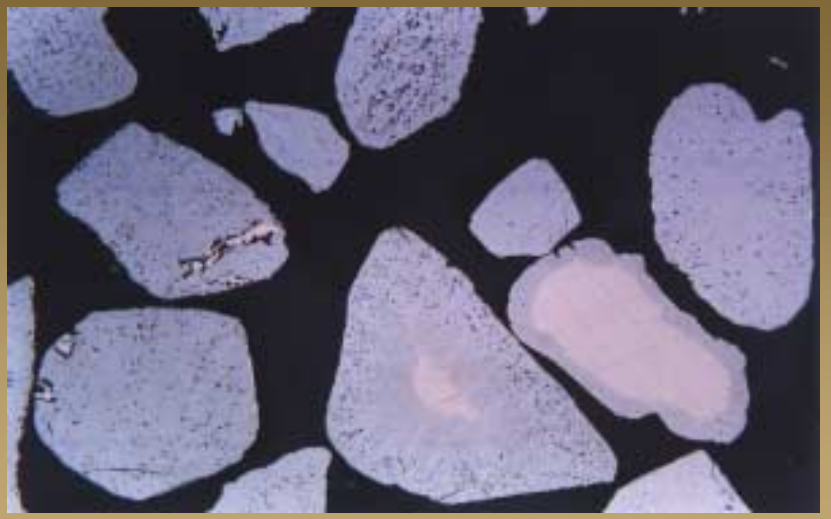
ERMS SR

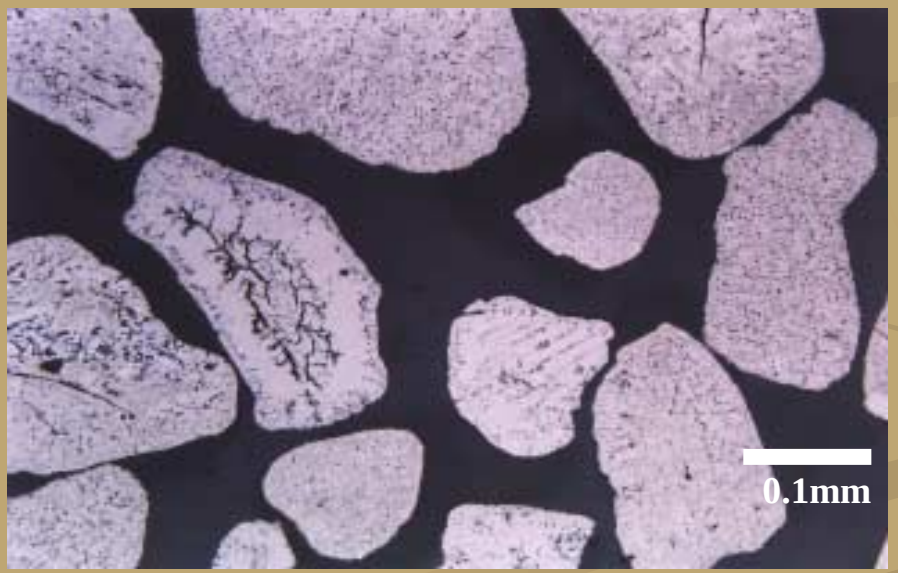
Oxidation - Reduction Roasters



Unroasted Ilmenite



Oxidised Ilmenite



Reduced Ilmenite

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ERMS SR Leaching

$$FeO.TiO_2 + 2HCl = TiO_2 + FeCl_2 + H_2O$$

- Strong acid leach (25% HCl)
- TiO_2 in rutile form insoluble – not removed
- Iron and other metallic oxide impurities form respective chlorides
- Some silica is also removed
- Original ilmenite grain size is retained

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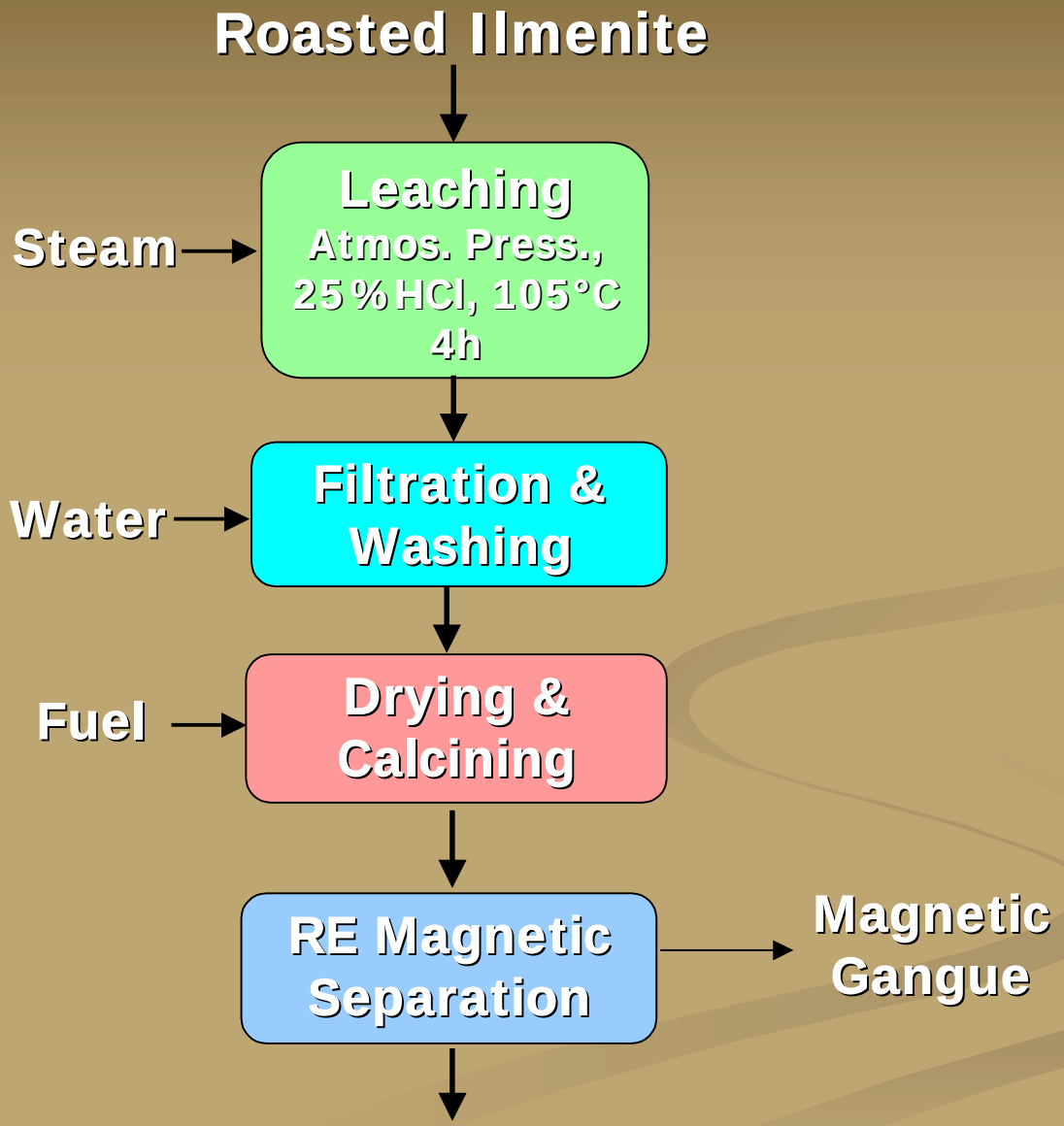
ERMS SR Leach



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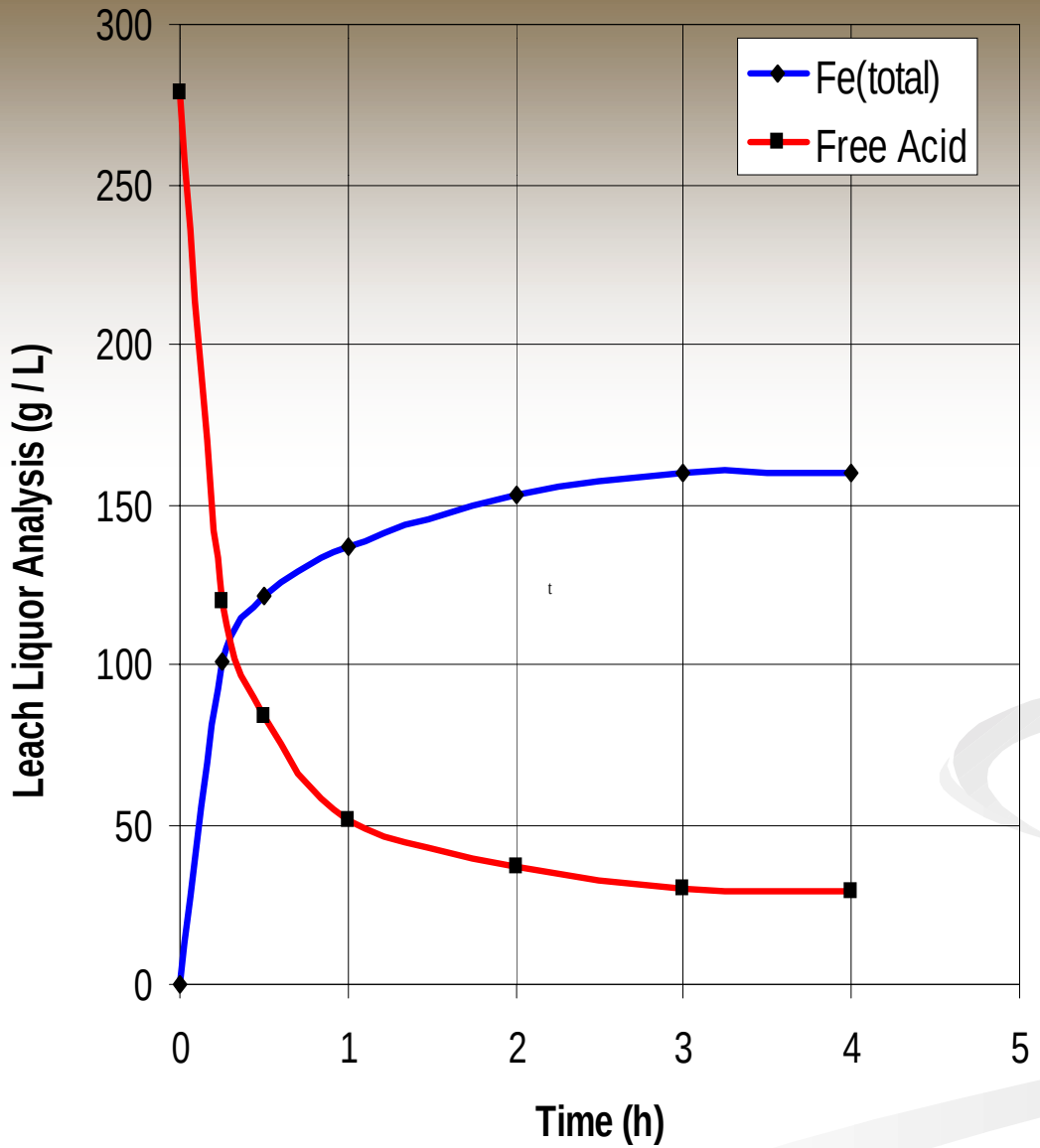
Ilmenite Leaching



Leach Vessels at Pilot Plant

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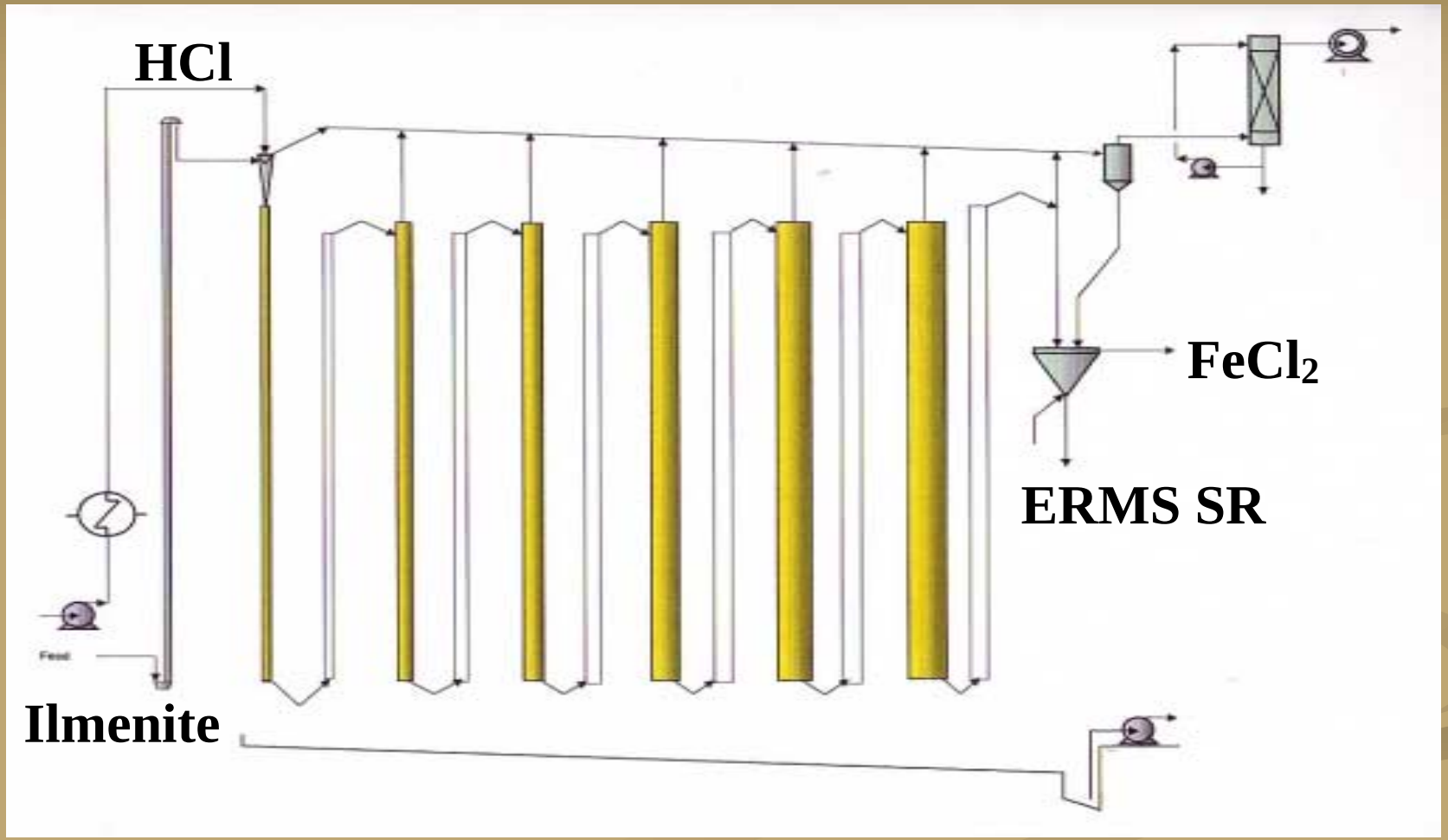
Continuous Leach Reactor

(Patents pending)



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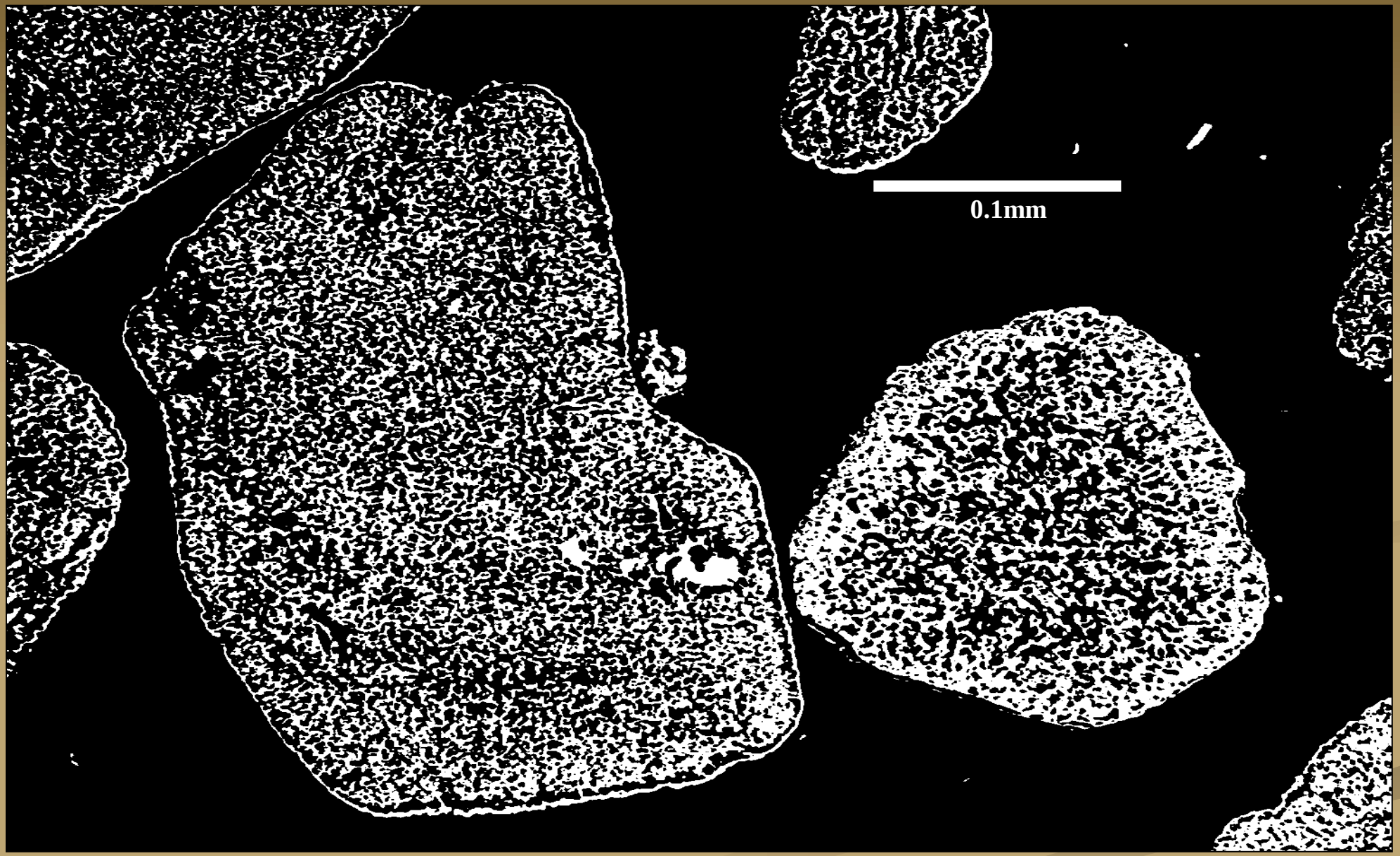

ERMS Synthetic Rutile

4th Global Mineral Sands Conference

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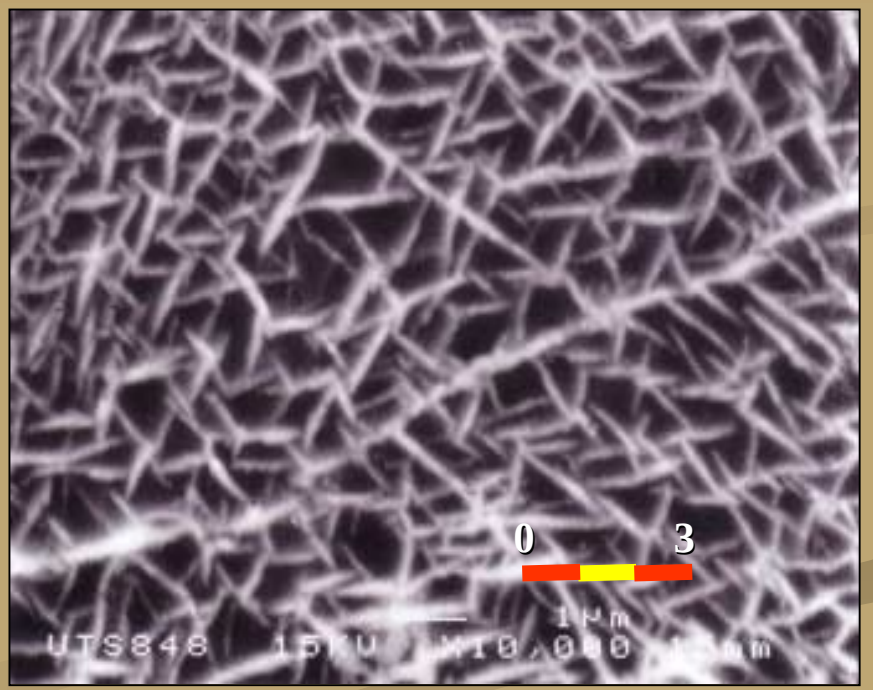
ERMS SR

Typical Chemical Analysis

TiO_2	97.50%
Fe_2O_3	0.82%
SiO_2	0.77%
Al_2O_3	0.13%
Cr_2O_3	0.02%
CaO	0.02%
MgO	0.01%
MnO	0.01%
U+Th	<15ppm



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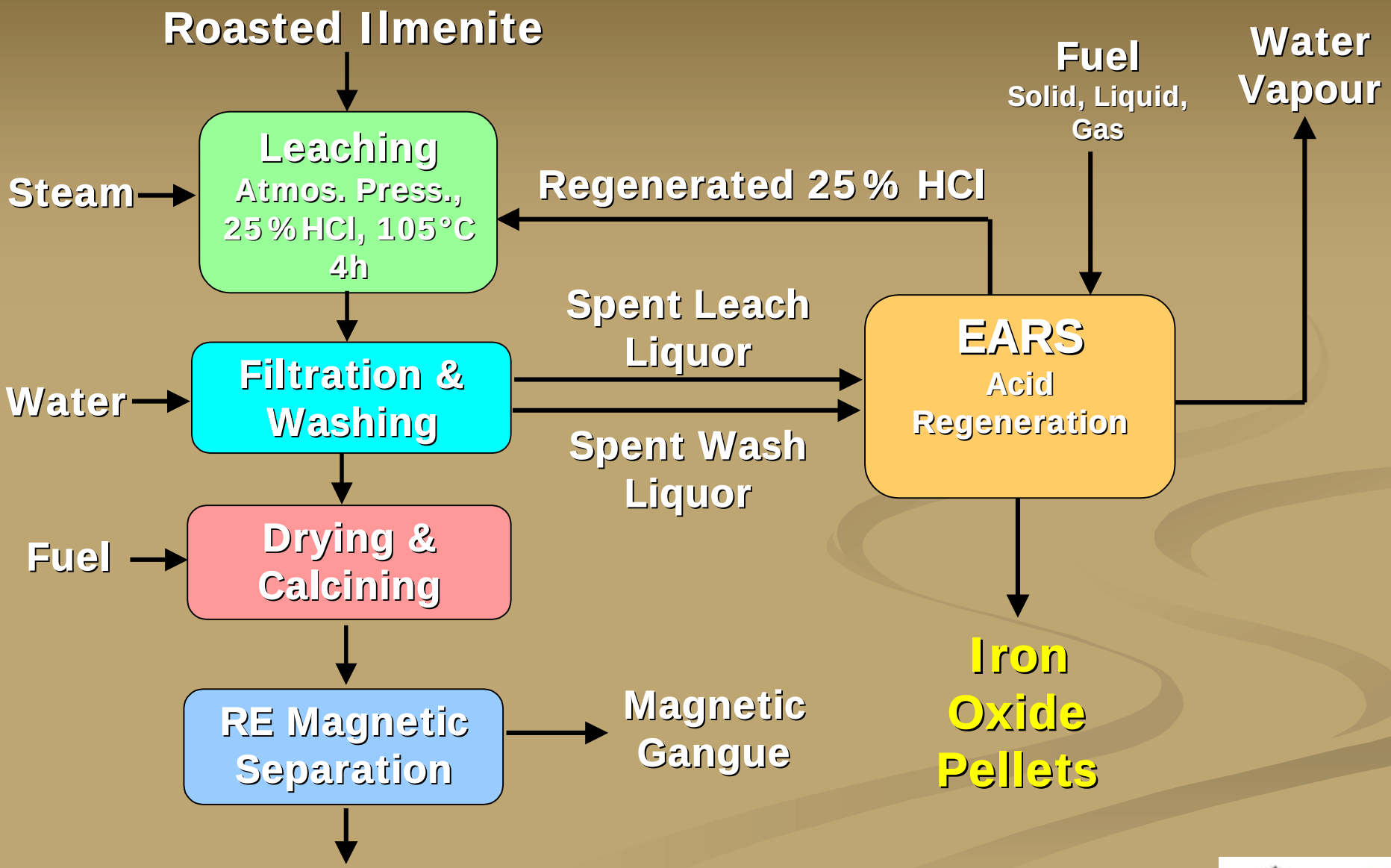
ERMS SR Leach & EARS A.R.



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EARS Acid Regeneration

- Spent leach liquor is evaporated in a fluid bed forming dry metal chloride pellets at *low temperature* (~ 140°C)
- Pyrohydrolysis takes place in a fluid bed roaster at a *high temperature* (~ 800°C)

$$3FeCl_2 + 3H_2O + 0.5O_2 = 6HCl + Fe_3O_4$$

- Makes *superazeotropic* acid (25%w/w)
- Can use solid, liquid or gaseous fuels
- Metal (iron) oxide is discharged as hard *pellets* (not dust)
- Hydrochloric acid is recycled to leaching

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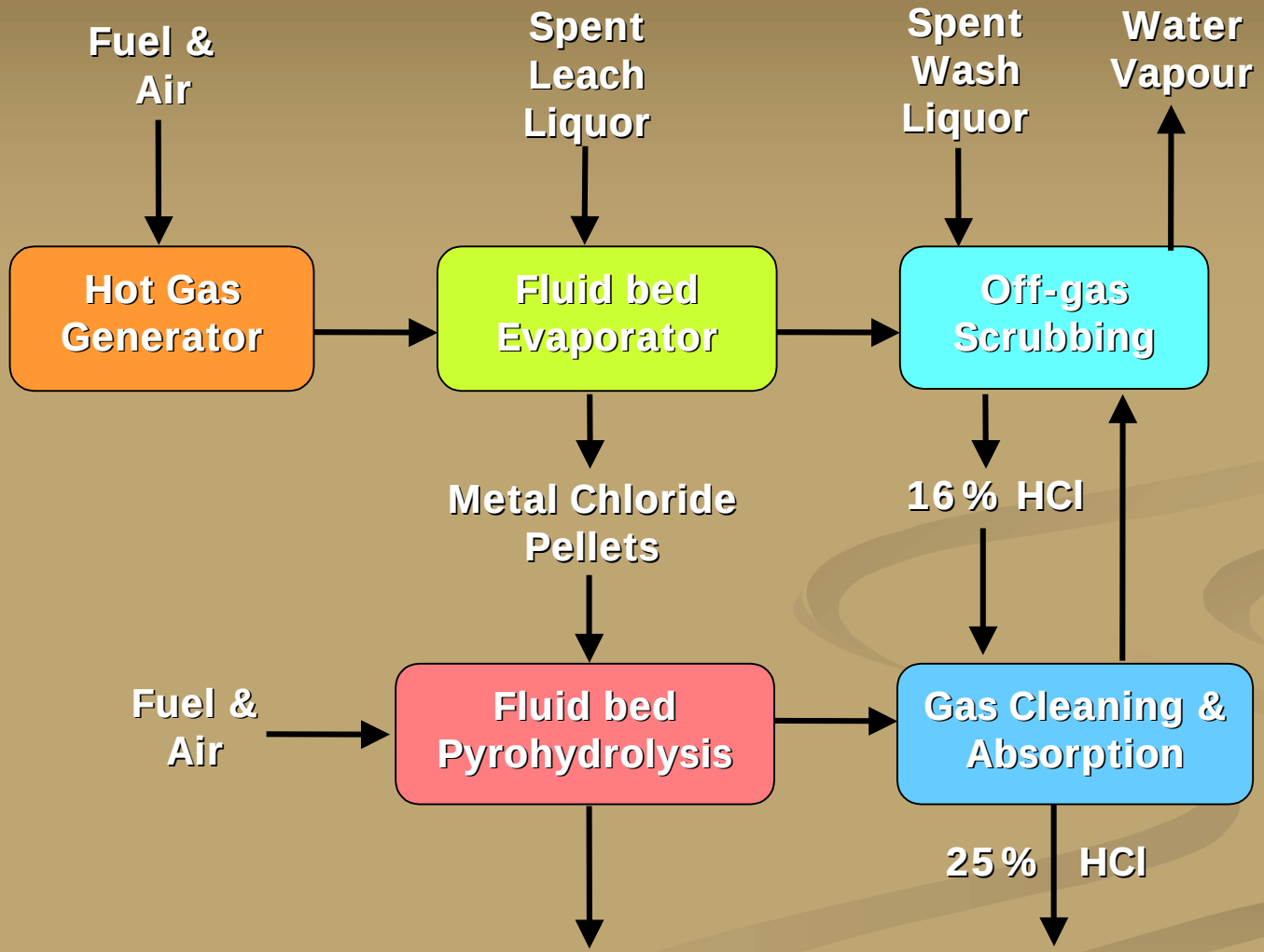
EARS Flow Sheet



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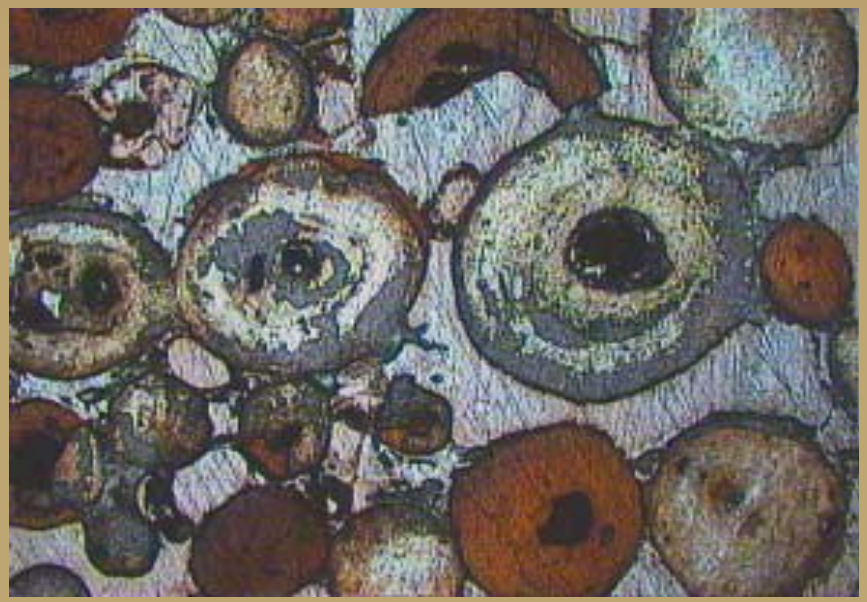
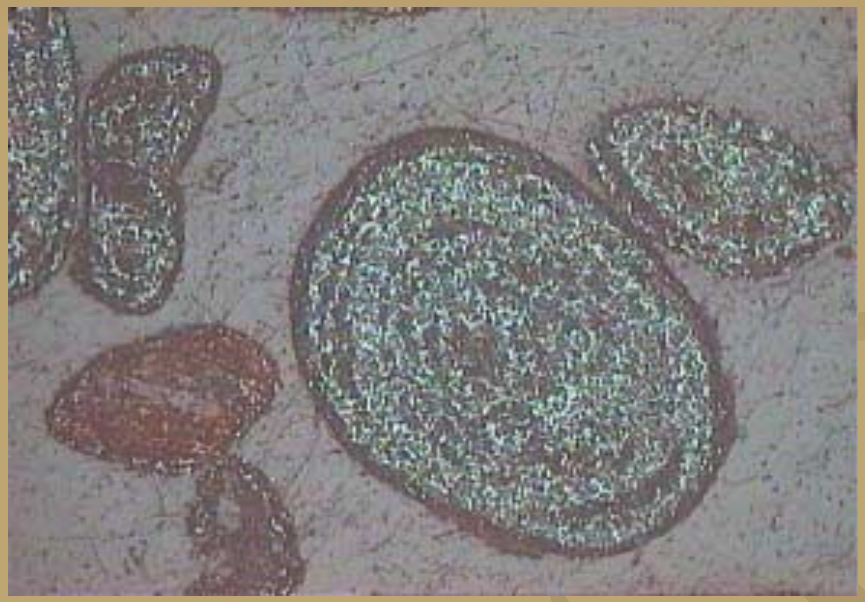
Pelletization in the EARS Process

Metal Chloride Pellets ($FeCl_2.xH_2O$)



2 mm

Metal Oxide Pellets (Fe_3O_4)



1 mm

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Pyrohydrolysis Roaster

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HCl absorption columns

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Comparative benefits of ERMS SR

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Ilmenite Upgrading

Process	Ilmenite Feedstock	Impurity Removal	Limitations
Titania Slag	Low TiO_2	None	Power Cost
Becher SR	High TiO_2	Some Mn	Coal, Fe Oxide
Benilite SR	Wide range	Mg,Ca,U+Th	Acid, Fe Oxide
ERMS SR	Wide range	Mn,Mg,Ca, U+Th,V, Cr	None

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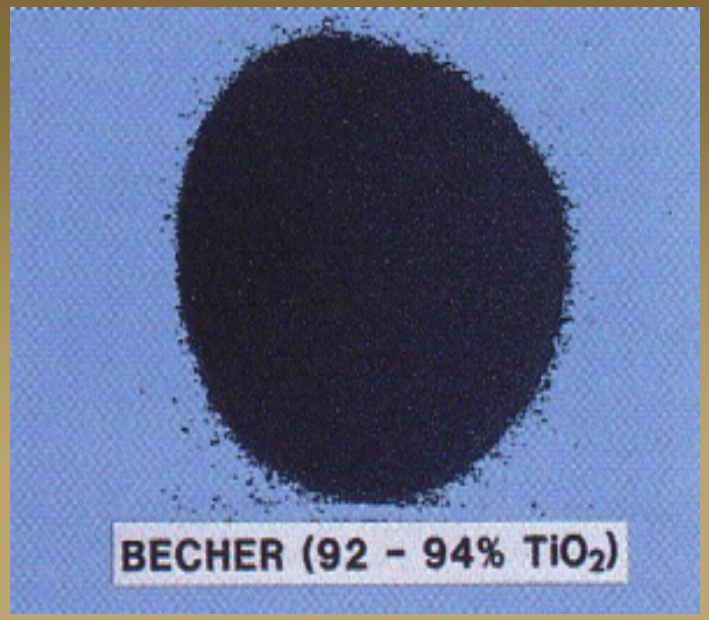
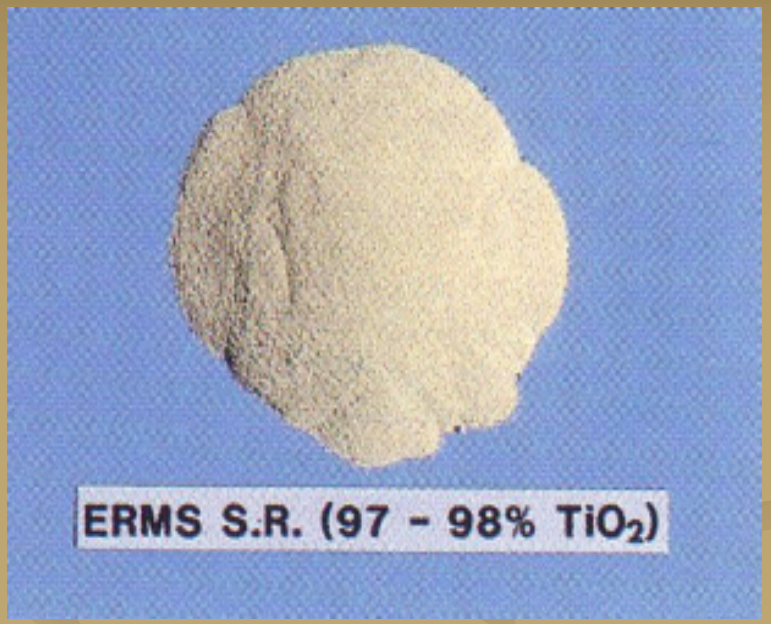
SR Quality





Ultra high grade feedstock for TiO_2 pigment and titanium metal

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The Environment

- **Solids**
  - Saleable iron oxide pellets
- **Liquids**
  - No liquid effluents, all water recycled
- **Gases**
  - Scrubbed water vapour (steam)
  - Dioxins and Furans – not detectable
- **Energy**
  - Waste heat used to generate electricity for the plant
- **ERMS SR is the most environmentally acceptable process**

Technical Advantages of ERMS SR

- Applicable to all grades of ilmenite
- Simple flowsheet, uses standard equipment, cost-effective and low technology risk.
- Completely continuous process
- Able to use solid, liquid or gaseous fuels
- Ultra high quality synthetic rutile product (>97% TiO_2)
- Negligible product particle breakdown
- Iron oxide saleable and in the form of easily handled pellets

Commercial Advantages of ERMS SR

- Low capital and operating costs
- Other SR processes use batch operations
- Valuable iron by-product (>95% iron oxide)
- Other SR processes produce fine iron oxide waste with disposal problems
- Very environmentally acceptable process

30,000 tpa ERMS SR PLANT

High grade feedstock for the future