

Hydrometallurgical Recovery of Zinc and other valuable metals from Secondary Feeds



TECNICAS REUNIDAS

October 8th 2025, Lisbon

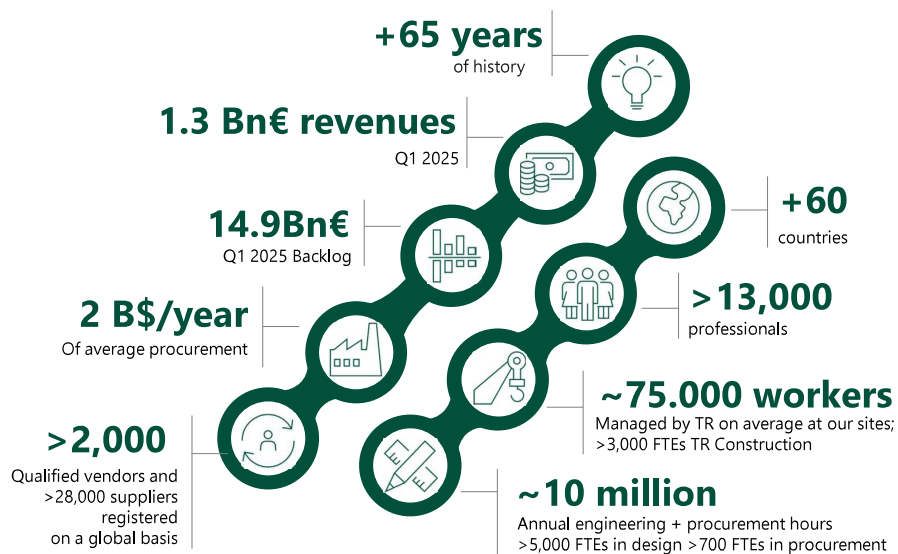
Index

1. Who we are: Tecnicas Reunidas
2. Proprietary Technology Development Division
3. ZINCEX Process: Basic Principles
4. Complementary technologies
5. Zn Ongoing projects
6. Remarks

Index

1. Who we are: Tecnicas Reunidas
2. Proprietary Technology Development Division
3. ZINCEX Process: Basic Principles
4. Complementary technologies
5. Zn Ongoing projects
6. Remarks

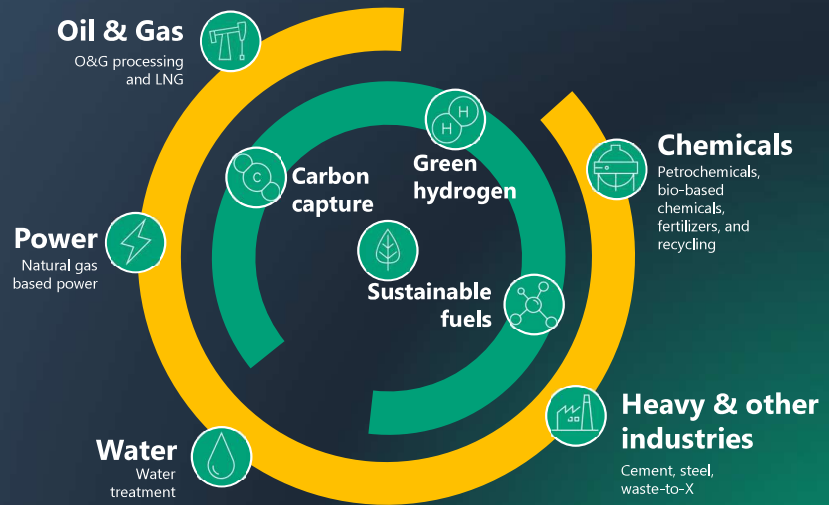
We are an integrated services contractor with a comprehensive toolkit for project execution with an E-P-C expertise and global presence



We have a well-established presence in traditional sectors and a growing track record in low carbon sectors

 Traditional

 Low Carbon 



5

We are a true global company of +13,000 employees

+30 countries with presence

Madrid technological hub & Headquarter

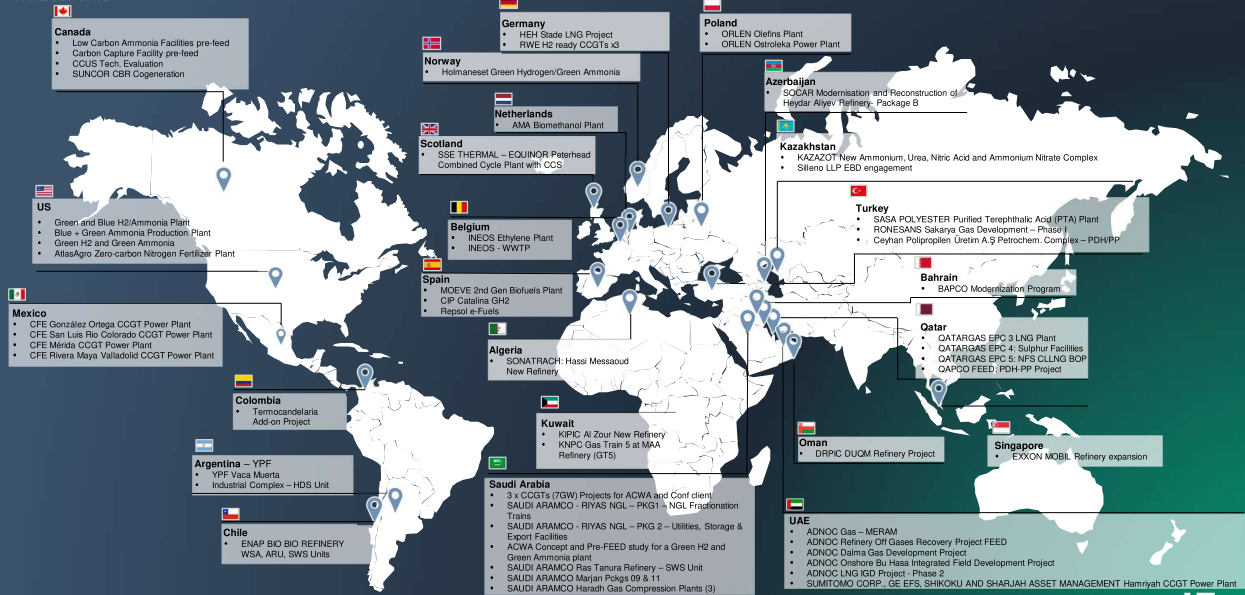
5 global operational centers (India, Abu Dhabi, Turkey, Chile, KSA)



6

We have a consolidated global track-record

NON EXHAUSTIVE



Full reference list available upon request

Our value proposition revolves around 7 core elements



A | Proprietary Technology development



B | High qualified procurement mgmt. team



C | Construction-driven engineering



D | Modularization



E | Integrated project management capabilities



F | Digitalization



G | Global footprint

Index

1. Who we are: Tecnicas Reunidas
2. **Proprietary Technology Development Division**
3. ZINCEX Process: Basic Principles
4. Complementary technologies
5. Zn Ongoing projects
6. Remarks

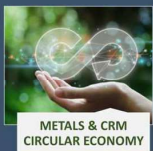


A | Proprietary Technology Development Division

José Lladó Technology Centre



> 50 years of experience



METALS & CRM
CIRCULAR ECONOMY



ENERGY TRANSITION
& ENVIRONMENT

Other KPIs

Number of employees	60
Number of licenses Plants	11
Number of patents	13
Number of R&D projects	
National Consortium	17
European Consortium	18

Proprietary Technology Development Division (PTDD) is Tecnicas Reunidas' Business Unit focused mainly on Critical Raw Materials and Metals, Circular Economy and Energy Transition (H₂ and CO₂)

- Products: Technologies and knowledge
- Technology Center: Development of proprietary technologies from idea to Industry
- Commercialization – Go to market: Technology Package (License, BED, Proprietary Equipment, Detailed Engineering Supervision and start up) + Engineering services

Offer

PROPRIETARY TECHNOLOGIES

- **Critical Raw Materials and Metals recovery (CRMs)**
 - PHOS4LIFE® (TRL 9): Phosphoric acid production from incinerated swage sludge ash
 - ZINCEX® (TRL 9): Zinc metal production through solvent extraction from minerals and industrial byproducts/residues
 - ECOLEAD® (TRL 9): Lead and silver recovery from waste
 - HALOMET® /LIP4CAT® / DATMOS® (TRL 9): Zn and other metals from residues/byproducts
 - RARETECH® (TRL 9/6): Production of rare earth concentrate and separated rare earths oxides products from monazite-type minerals
 - MN25GAIN (TRL 9): hydrometallurgical solutions to obtain High Purity Manganese products from primary and secondary streams
 - RECYCLION® (TRL 7): Li, Co, Mn, Ni recovery as batteries precursors from black mass of EoL EV batteries.
 - RESIL2VOLT (TRL 7): Process for solar panel recycling from grey mass
 - GALIUM (TRL 5): Ga recovery from industrial byproducts
- **Energy transition: Technologies in development for green hydrogen and carbon capture**
 - VCAL (TRL 5): Carbon capture technology using a Calcium/Chemical Looping process
 - AEM (TRL 5): Green hydrogen production by proprietary Anion Exchange Membrane concept
 - POWER to X (TRL4): electrochemical conversion of CO₂ into products

KNOWLEDGE

- ❑ METALS, CRITICAL RAW MATERIALS, BIOMASS, E-WASTE RECYCLING, GREEN HYDROGEN, CCUS, PLASTIC RECYCLING

Main projects

Industrial



R&D



Dowa Minerals, Japan. ZINCEX®



Befesa, USA. ZINCEX®



Future PHOS4LIFE® plant in Zuchwil, Switzerland

JOSÉ LLADO

TECHNOLOGY CENTRE

Laboratories. Electrochemistry, Solvent Extraction, Microscopy, Critical Raw Materials, Biorefinery and Waste and Water Treatment.

Pilot and Demo Plants. Leaching, Solvent Extraction, Electrowinning, Filtration, selective precipitation and Biorefinery

Analytical Laboratories. Characterisation of both organic and inorganic compounds, specializing in the determination of elements in solids and solutions.

Workshop. Prototype manufacturing



STRATEGY TO MARKET – PTDD

Value Proposition

...AN OPPORTUNITY BASED ON THE FOLLOWING:

01



EXPERIENCE+FACILITIES

Fast-track and industrial scale-oriented piloting

02



FLEXIBILITY

Customized technology based on client's products specifications

03



FULL EXECUTION
GUARANTEES

Single responsibility (Process & EPC)

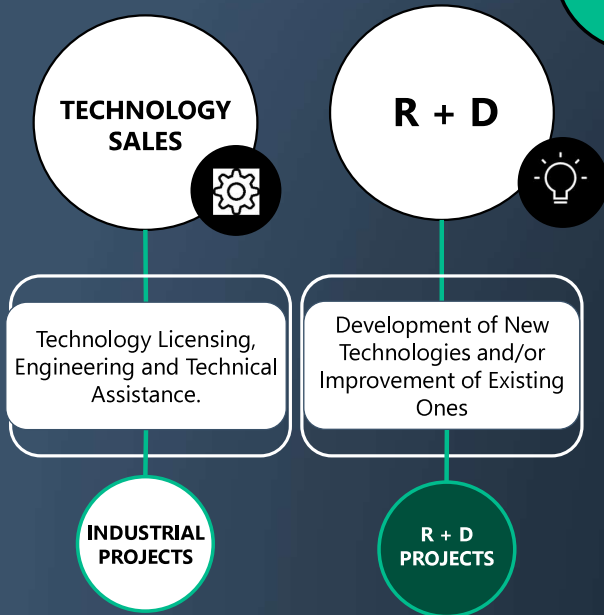
04



FIRST IMPLEMENTATION
BENEFITS

Great saving in technology license

STRATEGY TO MARKET – PTDD Business Model



SALES PHASES

SERVICE PHASES		OBJECTIVE	MONTHS
POC	Proof of Concept	Raw Material / technology validation	2
LATs	Laboratory Amenability Test	Adaptation and determination of diff. Process variables	4
PPD	Pilot Plant Demonstration	Technology on Pilot Plant scale	3-6
PFS	Preliminary Feasibility Study	Estimation CAPEX & OPEX	5
TP	Technology Package	License, Technology Supply and Basic or Adv. Eng.	12
EPCm /EPC	Industrial Plant	Detailed Engineering, Construction	24
			48

List of Hydrometallurgy References showcasing our Proprietary Technologies expertise

- Laboratory Studies
- Feasibility Study
- Engineering
- Consultancy
- Basic Engineering Design
- Procurement
- Demonstration
- Turn-key
- Project Budget Estimate
- Licensed Plants by TR



INDUSTRIAL REFERENCES



AKITA (USA) **DOWA**

20,000 tpa Zn
Secondary zinc oxide concentrates such as waelz oxide, crude zinc oxides and fumes. Refurbishment of existing plant.



SARDINIA (USA) **GLENCORE**

20,000 tpa Zn
Secondary zinc oxide concentrates such as waelz oxide, crude zinc oxides and fumes. Refurbishment of existing plant.

BEFESA

MOORESBORO (USA)

135,000 tpa Zn, 6000 tpa Pb, 17 tpa Ag
Secondary zinc oxide such as Waelz oxides and floating creams. New plant.



METALQUIMICA DEL NERVIÓN (Spain) **ZINCEX**

First hydrometallurgical plant in the world to use solvent extraction techniques to produce SHG zinc: The ZINCEX Technology.



vedanta
zinc international

ROSH PINAH (Namibia)

150,000 tpa Zn
Primary Zinc Ore



pilagest

BARCELONA (Spain)

Plant for the recycling of spent household batteries to obtain ultra-pure zinc sulphate

LISBOA (Portugal)

Second reference of the Zincex Process for the production of Zinc via solvent extraction.



tr
TECNICAS REUNIDAS

15

Index

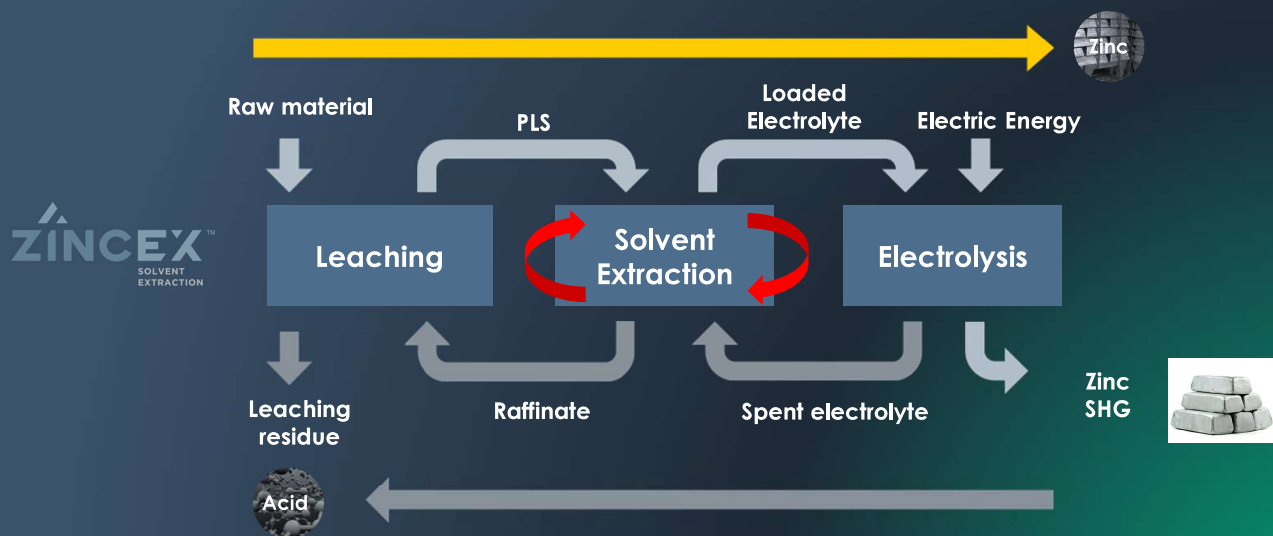
1. Who we are: Tecnicas Reunidas
2. Proprietary Technology Development Division
3. **ZINCEX Process: Basic Principles**
4. Complementary technologies
5. Zn Ongoing projects
6. Remarks

tr
TECNICAS REUNIDAS

16

Advantageous hydrometallurgical Process to produce Zn SHG

ZINCEX™ Basic Principles



LAY OUT PLANT



Horsehead NC Zinc Plant

Image # 140321 0176
Date : 03.21.2014
Plate 888.542.0231



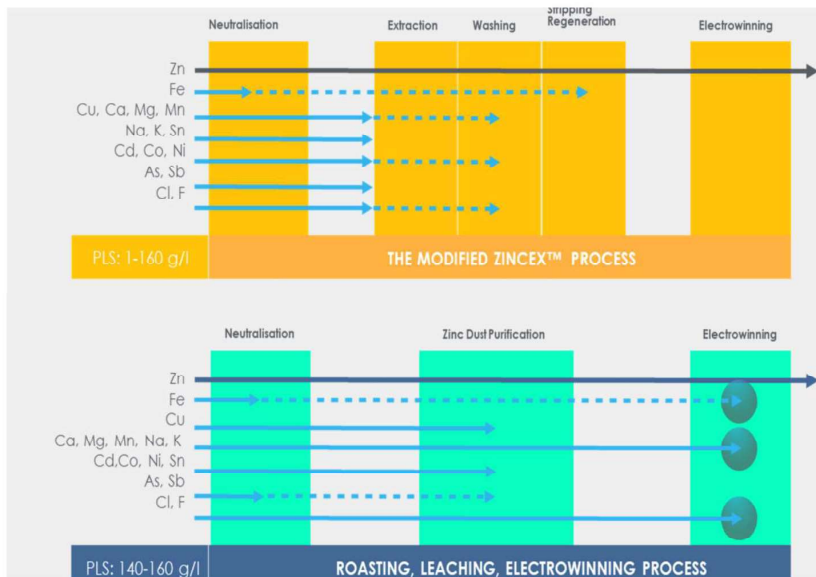
Horsehead NC Zinc Plant

888.542.0231
Date : 03.21.2014
Plate 888.542.0231
TECNICAS REUNIDAS

SX stages



Technical advantages



- Two independent circuits (Leaching and EW connected by organic cycle of SX) that lead to safer and more robust Operation
- Flexible to deal with unexpected amounts of impurities
- Extreme pure electrolyte produced by the SX system
- Leaching in softer conditions: no loss in Zn total recovery
- Lower amount of iron is leached (jarosite/goethite production is reduced, if any at all)
- Direct Leaching of various types of Zn raw materials are technically and economically feasible

In the EW stage:

- Lower cell voltage: power consumption
- Chlorides and Fluorides are much lower
- Gypsum free electrolyte
- Improvement in the morphology
- Longer electrode lifecycle

Economic advantages

PROCESS STAGES		ZINCEX® CHEAPER?		REASONS
RLE	ZINCEX®	CAPEX	OPEX	
Crushing and Milling	Crushing and Milling	The same	Yes	Optimized because no minimum zinc content in concentrates.
Roaster	No	Yes	Yes	No Roaster at ZINCEX®
Gas Handling and Scrubbing	No	Yes	Yes	Not required, no gaseous emissions.
Sulfuric Acid Plant	No	Yes	Yes	No SO2 produced in ZINCEX®.
Leaching	Leaching	Yes	The same	ZINCEX® leaching conditions are much softer.
Leaching Residue Handling	Leaching Residue Handling	Yes	Yes	No Jarosite production. Therefore, no Jarofix unit in ZINCEX®.
Zinc Dust Purification & Others	Solvent Extraction	The same	Yes	CAPEX: One ZINCEX® stage substitutes many in RLE. OPEX: No zinc dust and other reagents addition in SX.
Zinc dust production	No	Yes	Yes	Not needed in ZINCEX®
Electrowinning	Electrowinning	Yes	Yes	CAPEX: Lower capacity for same production (no 4% zinc dust production and recycling) OPEX: Improved efficiency
Melting and Casting	Melting and Casting	The same	The same	Same stage
Effluent and Wastes treatment and Disposal	Bleed Treatment	No	No	More complete process, however, is smaller since only a bleed off is treated. Valuable metals are concentrated in this bleed and can be recovered.
Drainage Systems	Drainage Systems	The same	The same	Same stage
Storage and distribution of reagents	Storage and distribution of reagents	The same	The same	Same stage

Index

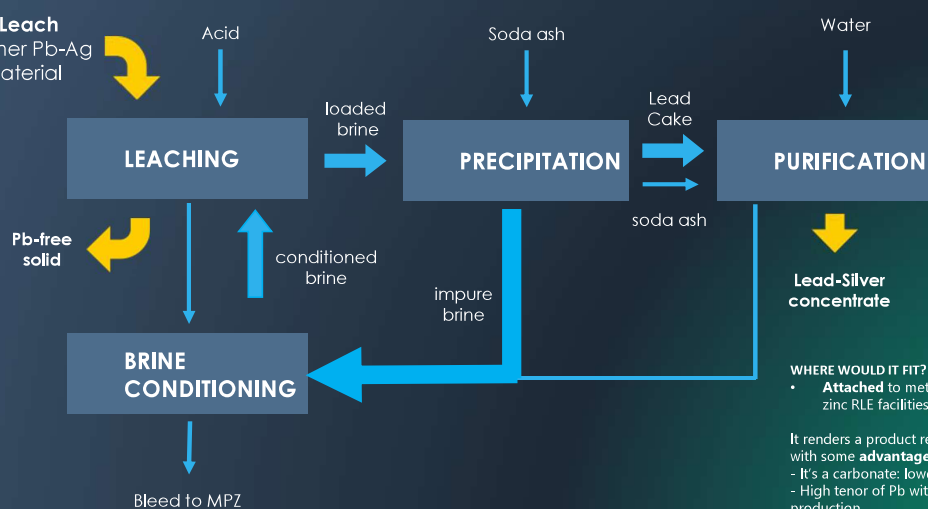
1. Who we are: Tecnicas Reunidas
2. Proprietary Technology Development Division
3. ZINCEX Process: Basic Principles
4. **Complementary technologies**
5. Zn Ongoing projects
6. Remarks

Complementary technologies



ECOLEAD™ PROCESS

ZINCEX™ Leach
Residue or other Pb-Ag
bearing material



WHERE WOULD IT FIT?

- **Attached** to metal refineries. Suitable for zinc RLE facilities (but not only)..

It renders a product ready to feed lead smelters, with some **advantages**:

- It's a carbonate: lower smelting temperature.
- High tenor of Pb with low impurities: low slag production.
- Silver adds a significant value.

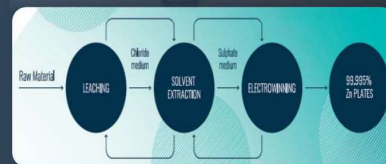
Complementary technologies



- From **calcines**
- SCL: Soft calcine leaching; ZnO is dissolved in soft acid conditions at a low temperature using the acid solution obtained in the SFL stage
- SFL: Strong ferrite leaching; Solid obtained undergoes strong acid treatment at a high T° to enhance the dissolution of zinc ferrite
- 3-stage countercurrent configuration
- Severity of the reaction conditions is greatly reduced



- From **metal sulphides**
- Atmospheric pressure, short reaction times and high metal recovery under mild conditions
- Low-grade and high-grade zinc-bearing sulphide concentrates, without roasting stage
- Direct leaching I: ZnS is dissolved under soft acids conditions using O2 as an oxidizing agent and the recycled solution from DL II stage
- Direct leaching II: Solid is treated with a combination of O2 and SO2 which produces more oxidizing conditions and dissolves the ZnS
- ZnSO4 solution enters ZINCEX process

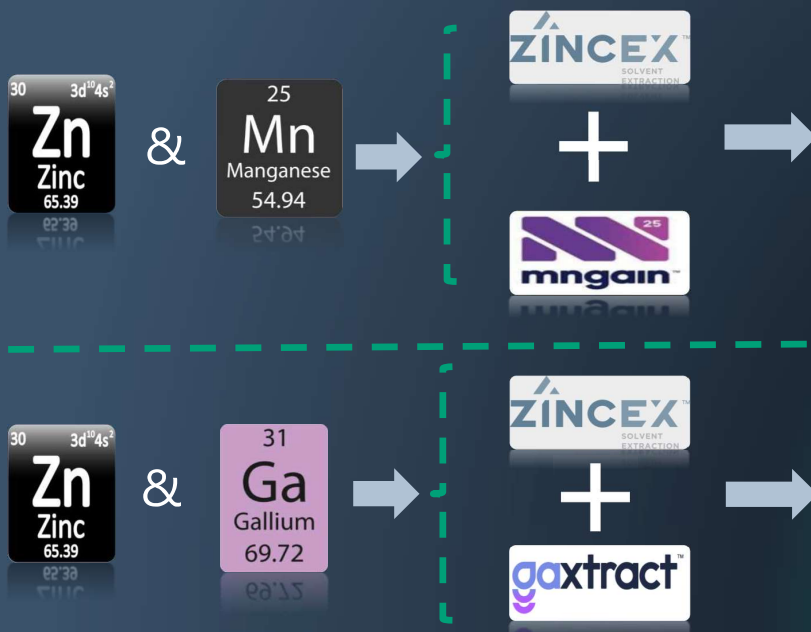


- From **urban waste incineration residues** where sulphuric acid is not effective
- SX in chloride medium to maximize dissolution of metals, (refractory behavior), and to minimize residue production
- Low grade and depleted materials

Index

1. Who we are: Tecnicas Reunidas
2. Proprietary Technology Development Division
3. Modified ZINCEX Process: Basic Principles
4. Complementary technologies
5. Zn Ongoing projects
6. Remarks

ZN ongoing projects: Zn and other added value metals



- From secondary streams containing Zn, Mn
- Precipitation: To convert Mn into MnO
- Redissolution and Neutralization: To produce PLS with high concentration and purity of a MnSO₄

Possible end product Routes:

- (I) Purification: to be used as additive for electrodeposition of Zn production, increasing profitability
- (II) Crystallization: High-Purity Manganese Sulphate Monohydrate (HPMSM)

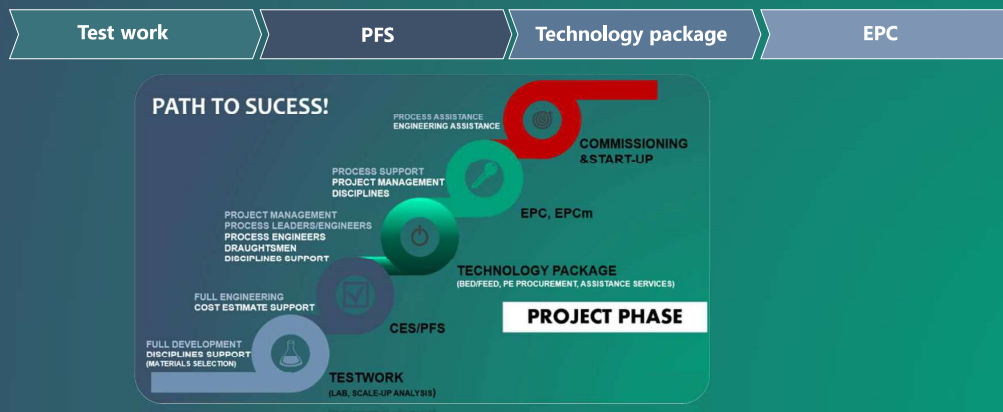
- From complex PLS /industrial streams industrial byproducts
- Using dedicated SX unit
- High recovery efficiencies: >95%
- Product: High purity Ga electrolyte ready for EW

Index

1. Who we are: Tecnicas Reunidas
2. Proprietary Technology Development Division
3. ZINCEX Process: Basic Principles
4. Complementary technologies
5. Zn Ongoing projects
6. **Remarks**

Remarks

- Proprietary Technology ZINCEX and its complementary technologies can recover **Zn** contained in ore /secondary streams/ Waste residue
- Solution for high content of CL, F, and high content of Mn. High moisture materials
- Solution in cases of fluctuating composition
- Fully automated process
- Mn, Ga, Pb, Ag containing in Zn secondary streams can be recovered in the form of a marketable product using TR's Technologies and Know-How
- Business model based on technology package sales, together with EPC (Engineering, Procurement and Construction)



jmanzano@tecnicasreunidas.es

iherraez@tecnicasreunidas.es

October 2025