Revalorisation of Residues in the Scope of the Circular Economy

Insights from the Fertiliser Industry

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A (the?) defining principles of the circular economy are resource conservation and optimised use efficiency (Zero Waste):

a) The default condition is that accessing “primary” resources is necessary only when “secondary (reusable)” resources are not sufficiently available

b) Linear “Extractive” industries require a new, “circular” narrative, based on redefined “life-cycles” for all resources

c) All resources stay within the system boundary, even if no foreseeable solution to their current status as “waste” is available

d) Risk/benefit models and algorithms need to be fundamentally rethought

End of “Waste” in the Circular Economy- NORM Industries in a Circular Context: Time to reboot

Adopt and apply Sustainable Development Goals (SDG) as an essential condition for resource management. See SDG 12: Responsible Production and Consumption

NORM regulation must pivot away from defining itself as exclusively about “safe” waste management and disposal.

The regulator has to create the conditions for NORM industries to serve equally and equitably the needs of People: Planet: Prosperity. This means it must accompany the entire resource life-cycle, and in its new circular form.

Is it investing in making the necessary tools and instruments to do this (for example to meet new Environmental, Social and Governance (ESG) finance and investment requirements)?
The Phosphogypsum (PG) Timeline: change starts with IAEA

- PG is the co-product of “wet process” phosphoric acid production. 215 million tonnes a year are produced. 4-5 billion tonnes of legacy PG are stored around the planet.

- **Hypothesis**: misconceived regulation of Europe’s phosphate industries in regard to management of its NORM residues – phosphogypsum (PG) – led to its near extinction, resulting in phosphate rock now being included in the EU list of critical materials and the wider industry always on the edge of bankruptcy. Result: wholly avoidable negative outcomes.

- **1989/1992**: US Environmental Protection Agency declares PG a “hazardous waste” on radiological grounds, with mandatory “stacking” (ie disposal) on land – has set the US industry off on a similar path
  - Now some 4-5 billion tonnes have accumulated on land, with stacks in 50+ countries

- **1992-2010**: Growing body of evidence that USEPA is wrong; regulators eg in Belgium, Brazil and India start to lead to a “graded approach” way out...

- **2005-2011**: Start of project “Stack Free by ’53” (2005-2011) funded by Florida Industrial and Phosphate Research Institute (FIPRI) PI Julian Hilton... **2008 Constructive Regulation** proposed for PG


- **2015**: Sustainable Development Goals adopted by 193 UN member countries – Sustainable Production and Consumption (SDG12) – reduce/eliminate waste

- **2016**: International Fertilizer Association (IFA) publishes first PG Report on Sustainable Management and Use – PG reuse rising to 25-20 mt/y (annual production at ~215 mt)

- **2020**: IFA publishes second PG Report – PG reuse now at 60mt/y+ (annual production still at ~215mt but growth Post COVID expected

- **2020**: China reaffirms strategic goal of “comprehensive utilization” (100%) of PG both current (70-80mt/y) and legacy 450mt

- **2020**: October 14, USEPA approves use of PG for road-building – law suit challenges anticipated (April 2021)
Constructive Regulation (IRPA 2008, Buenos Aires)

“There are both negative and positive reasons for a new look at regulatory policies and objectives regarding the phosphate industry, especially the co-product, phosphogypsum.

On the negative side, the policy of stacking, regarding the indefinite containment of phosphogypsum as the best option, is now under pressure on reasons of cost, safety and environmental impact and because it erroneously defines a reusable material as a waste, for which there are increasingly stringent controls on disposal.

On the positive side, new attitudes to waste prevention, combined with principles such as IAEA Safety Principle 7, that enjoins stakeholders to prevent the transmission of legacy wastes from one generation to the next, where possible, are provoking a fundamental rethink of attitudes to phosphogypsum.”

Changing the PG narrative

Transformational Attitudes to Phosphogypsum... not “waste” but co-product - opening the gate to yield...

- **Core Values** - Leadership, Innovation, Partnership
  - Values matter - not just what we are doing but **why we are doing it** (Lord Kelvin)
  - Sustainable Development, Circular Economy, Zero Waste, Primary Resource Conservation
  - These values are embedded in all case studies

- **Industry led** - IFA PG Working Group - members from IFA companies and invited technical experts

- **Global** - Unique overview of PG uses worldwide in its policy and regulatory context

- **Case Studies** (Section 2)
  - Case studies (10) and Overviews (4) are from many areas of the world: Canada (1), Kazakhstan(1), China (Overview), Belgium (1 + Overview), India (2 + Overview), Russia (2), Brazil (Overview) and Morocco (3 + Overview)

- **Resources in PG2**
  - 28 Tables including global PG regulatory inventory
  - 120 Figures (photos, diagrams, maps, flowsheets, planting schemes...)
  - 83 References
  - 113 Footnotes with url linkages to websites, documents (eg regulations, guidelines)
  - Sample Safety Data Sheet, Quality Protocol Template with Table of Contents

- **PG100** - Plan for 100% use; UN support

- **2019 Annual Use of PG** – 60mt (2015 30mt)
Innovation (SDG 9) is sometimes about optimisation, sometimes disruption.

New...

- Processes
- Materials/ combinations
- Products
- Data
- Projects....

Case Studies
- Forestry/ Agriculture
  - Soil remediation
  - Crop yield
  - Nutrient efficiency
  - Water efficiency
  - CO₂ sequestration
  - S/ Ca rich fertilisers
  - Anthrosols
- Materials/ combinations
  - PG/ flyash
  - PG tailings
- Products
  - Plaster/ wallboard
  - Zypmite
  - Ceramics
  - Roads
  - Growth media
- Projects
  - 100% use
Partnership (SDG 17) is fundamental to all progress – see PG2 case studies.

Partnerships are between:

- Phosphate industry and partners (JVs/long-term customers)
- Government
  - Investor
  - Regulator
  - Standards
- Academia
  - Science and technology innovation (national and international)
  - Independent validation

Government
Policy, regulation, investment, incentives & International Agencies eg UN

Industry
Phosphate and Partners – agriculture/forestry, materials, roads...

Academia
- Innovation
- Science and peer review
- No conflict of interest

100% PG Use
New PG based fertilisers / soil amendment

- **Zypmite** – Soil conditioner (Paradeep Phosphate Ltd)
- **Urea Calcium Sulphate** (SABIC)
- **Growing media** - 80-90% PG/10-20% soil – for fast-growing trees for green energy (Nutrien/ Canadian Forestry Service/ U Alberta)
- **Soil Amendment** - yield restoration – saline/ degraded soil (Kazakhstan)
- **Nutrient fixation** - PG used to fix P in soils and stop P runoff (Yara)
- **Adjust soil pH** – PG can modify soil pH to significantly enhance both nutrient uptake efficiency and water use efficiency
IAEA / Industry Cooperation as Context

- Origins of the scientific effort behind the TFI petition in project Stack Free by '53 (2005-2011) funded by Florida Industrial and Phosphate Research Institute (FIPRI), Florida Polytechnic University
- Supported by IAEA from 2006 including dedicated PG Working Group with funded special meetings 2006, 2007 hosted by FIPRI
- Led to close collaboration on IAEA SR 78 notably on Phosphogypsum chapter
- Regular participation in NORM conference series following invitation from Rafael Garcia Tenorio, Seville 2007
- 2012 - IAEA presented draft SR78 at first meeting of IFA PG NORM Working Group, Tashkent and attends subsequent meetings
- 2013 – IAEA SR 78 NORM residues in phosphate industry
- 2014 – IFA Leadership commissions industry response to SR 78
- 2014 – Arab Fertiliser Association holds first 3 day dedicated industry workshop on PG
- 2016 – IFA publishes Sustainable Management and Use of PG
- 2017 - UNECE begins cooperation with IFA PG NORM WG on behalf of UNECE
- 2019 UNECE recognises PG as “anthropogenic resource”
- 2020 – IFA published PG 2
- 2020 – a good time to start IAEA SR78 2.0!
- A case study in why SDG 17 – Partnership – works
- US is not longer the driving force. Leadership has moved to the BRICS – See PG2 for leadership from Brazil, Russia, India and China
The “Just Transition” – From Linear to Circular Economy

- **Process Technologies**
  - Linear economy
  - Standard
  - R&D
  - Optimised
  - Disruptive
  - Market levers
  - Policy & fiscal levers

- **Materials Flows**
  - Raw materials
  - Production
  - Use
  - Non-recyclable waste
  - Waste “designed in” for disposal
  - Waste reduction – recovery and reuse
  - Non-recyclable waste

- **Outputs / Outcomes**
  - Materiality
  - Investor return
  - Social Licence to Operate
  - Sustainable Development
  - Triple Bottom Line
  - Negative externalities
  - Waste hierarchy

- **UNRMS**
  - New “Better” Equilibrium

- **The “Just” Transition**
  - Double Materiality – Incentives Aligned
  - Nash Equilibrium – win/win investor & stakeholder return
  - Social Resource Contract – Public Good Resources
  - Resilience - managed resource criticality
  - Positive internalities (Waste hierarchy is not enough)
  - Industrial eco-system diversification
  - Sustainable Prosperity

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Obrigado!

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