Oil Shale Processing Technologies in Operation

A Short Introduction

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Agenda Extract

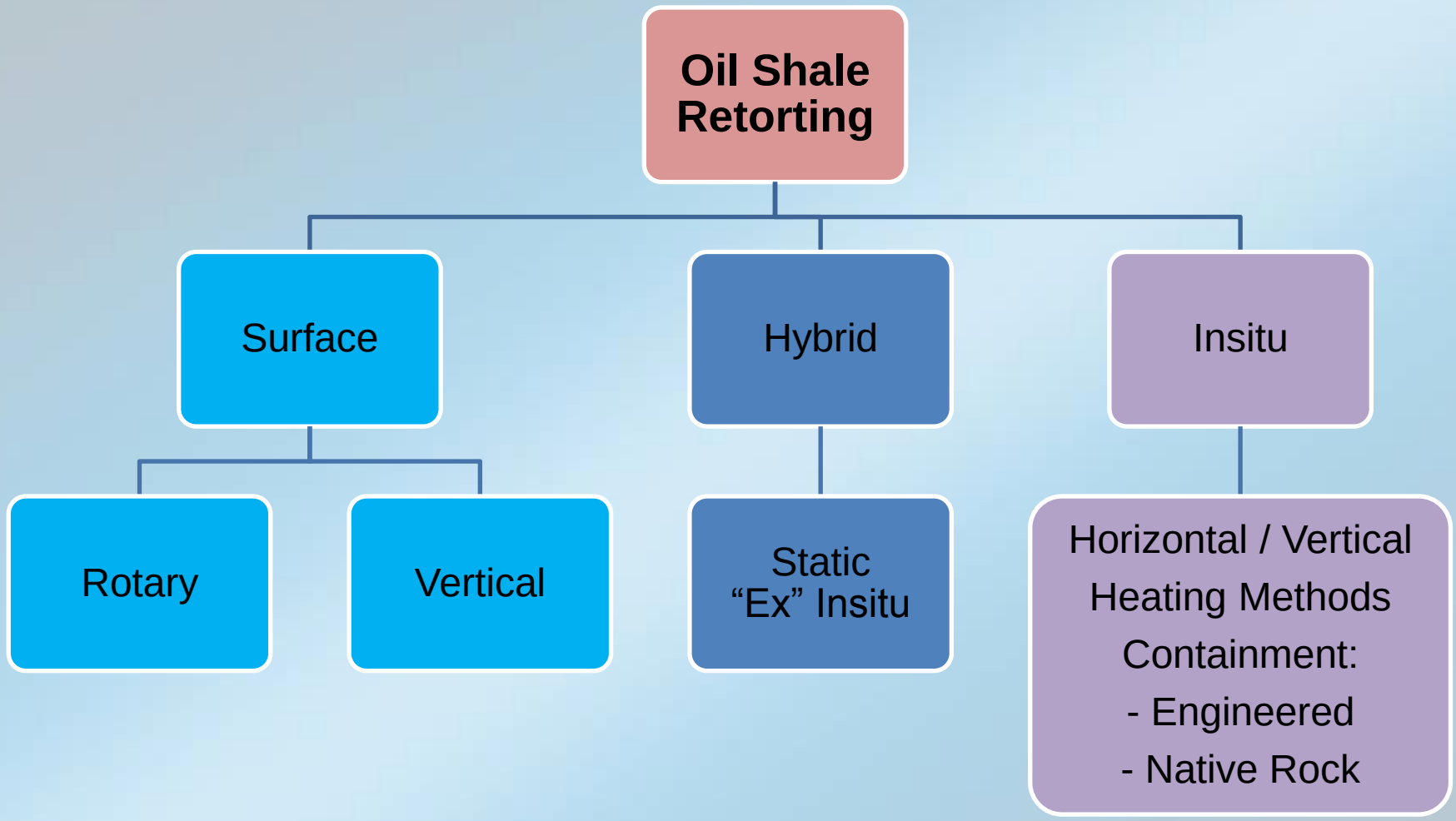
Panel: Technologies in operation, the latest developments and global projects

- Discussing the latest technology developments in the last two years
- Assessing the most up-to-date drilling procedures
- Examining the main surface and in situ technologies, how they function, similarities, differences
- Assessing commercialization of technology on an international scale, oil shale projects in China and Australia and other hot spot areas

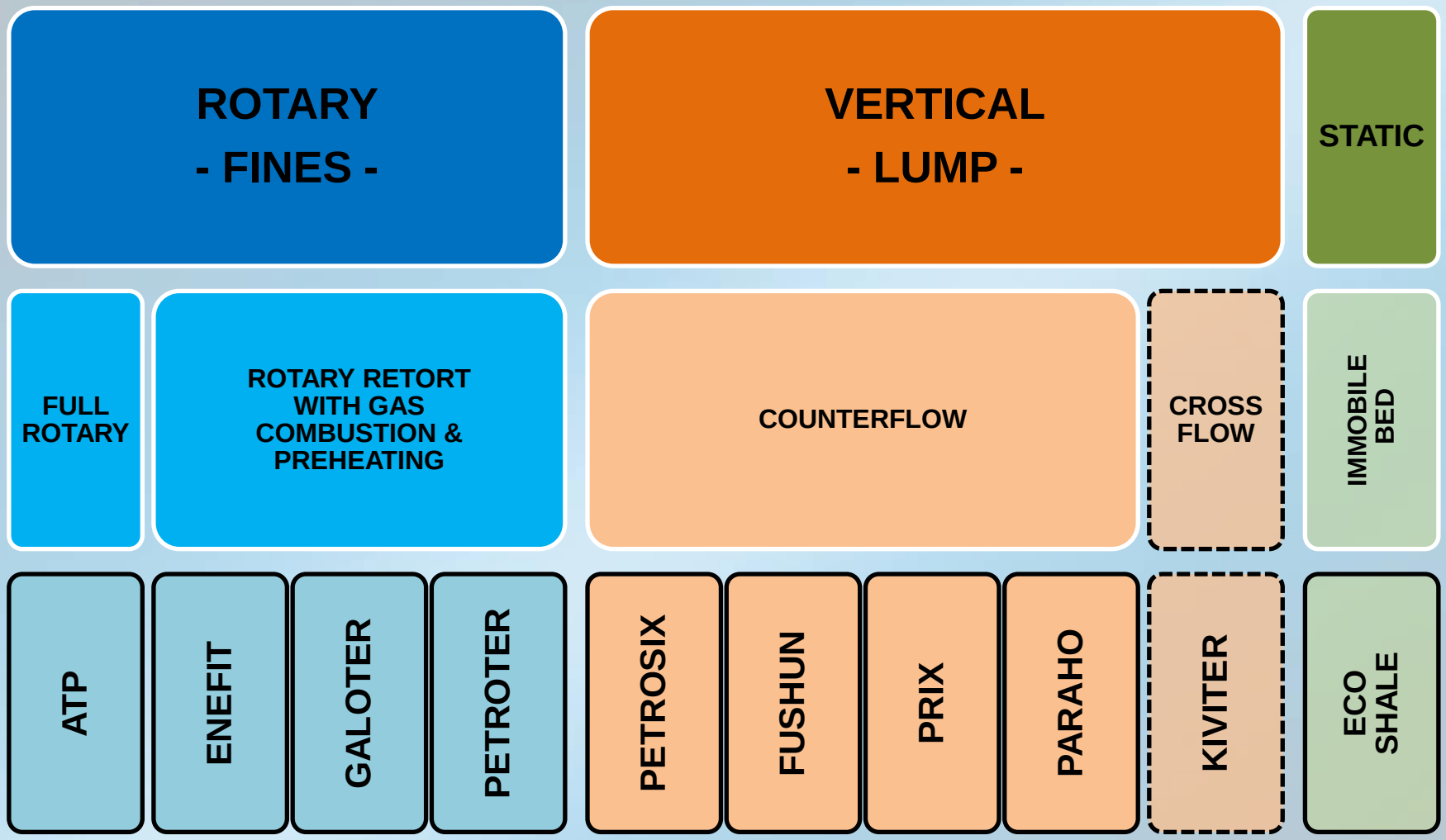
Short Intro Agenda

- **Overview of Retort Technologies by Class**
- **The Rotary Retorts**
- **Recent Activities and Developments**

Oil Shale Retorting Approaches



Surface Retorts



Rotary Retort Attributes

1) Allow for Full Resource Utilisation
2) Thorough Mixing and Reliable Reactions Achieved
   - Employ Mechanical Energy to Achieve Bed Mixing
3) Rapid Heating of Solids / Solids as Heat Carrier
4) Scale-up is Predictable
5) Tolerant of ROM Ore Variations

Rotary Retort Characteristics

Performance Characteristics of the Rotary Retorts:

- High Oil Yields (ATP: >90% MFA, ≈ 100% FA)
- Full Boiling Point Spectrum Product Oils (ATP: C4 to ≈ 525°C)
- Bottomed Oil Product (ATP: BOR to Extinction)
- Undiluted, High Heating Value Off Gases
- Hydrocarbon Free Spent Ash
- Higher Severity Pyrolysis (mono and di olefins)

Process Cousins – Different Approaches

Process Stage		ATP	ENEFIT / GALOTER / PETROTER
Ore Preheating	Device: Method: Heat Source: Environment:	Rotary Indirect Heating Solids / Flue Gas Steam	Gas Suspension Direct Contact Flue Gases N2/CO2/O2
>> Free Moisture Recovery, Securely Handle Thermally Sensitive Ores			
Retorting	Device: Method: Heat Source: PSD Max.: Speed:	Rotary Direct Solids < 10 mm 3 to 4 rpm	Rotary Direct Solids < 6mm / < 25 mm ≈ 1 rpm
>> Fast Mixing / Rapid Through Particle Heating & Pyrolysis / Short Gas Path			
Combustion	Device: Method: Solids Transport:	Rotary Cross Flow Uncoupled From Gas Flow	Gas Suspension Co-current Coupled to Gas Flow
>> Solids Flow and Gas Flow (hence heat release) are Independent – Control Response / Transient Operability			

Recent TKIS UMATAC Development Focus

FMG Plant Commissioning:

- First Oil Shale Operations in 2013
- Technical Support to FMG
- Guidance on Operating Organisation and Operations Plan
- Opportunity to Conduct and Assess ATP Operation Q2 and Q3 2014

Learnings to Date:

- ATP has Done its Job and is Performing Well
- There is NO Substitute for Experienced and Capable E-P-C Team
- Proper Material Handling and Ore Preparation is a Core Requirement
- Cultural Challenges:
  - Modern Process Facilities Require Skilled and Empowered Operations Group
  - Knowledgeable and Autonomous Decision Making in CCR is Fundamental

Recent TKIS UMATAC Development Focus

New Project Developments:

- Understanding Your Ore
- “Wild Oil” from a New Source into a Conservative Market
- Marketing Implications and Upgrading Assessments

Future Projects Implementation:

- Large Vessel/Component Fabrication Approaches
- TKIS Project Delivery E-P-CM / Design-Supply / E-P-C

Proponent (i.e. Future Owner) Education:

- Oil Shale is Predominantly a Mineral Processing Industry
- Your “Retort” is NOT your Major Cost Driver
- You are Starting a New Industry - Not Just a New Project.

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