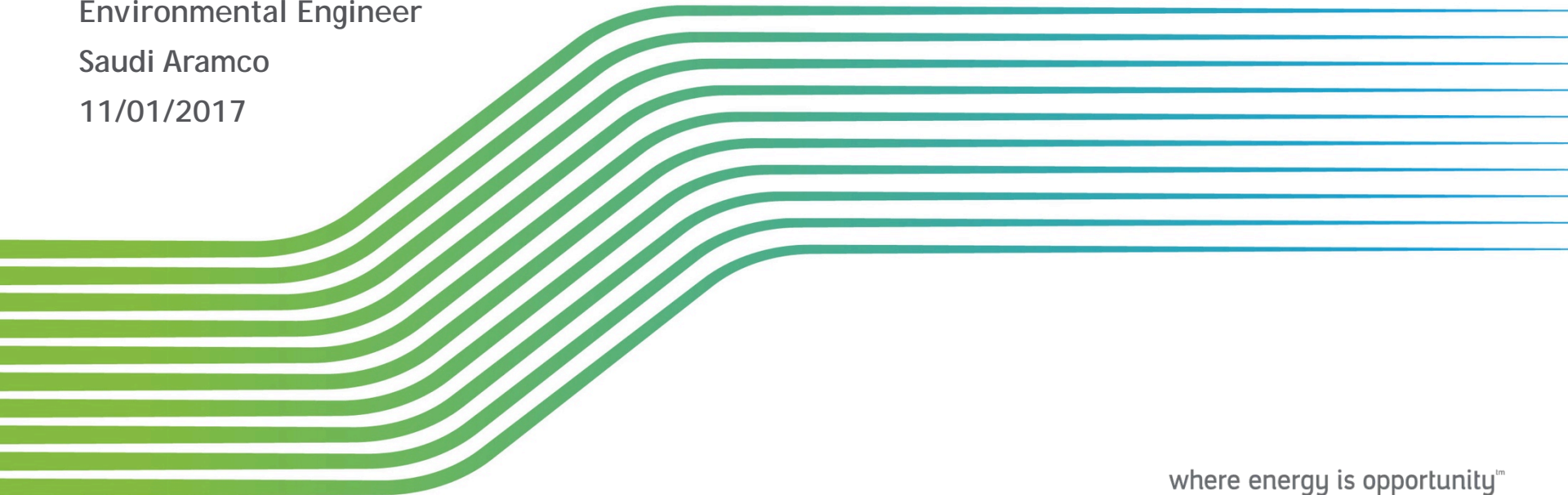


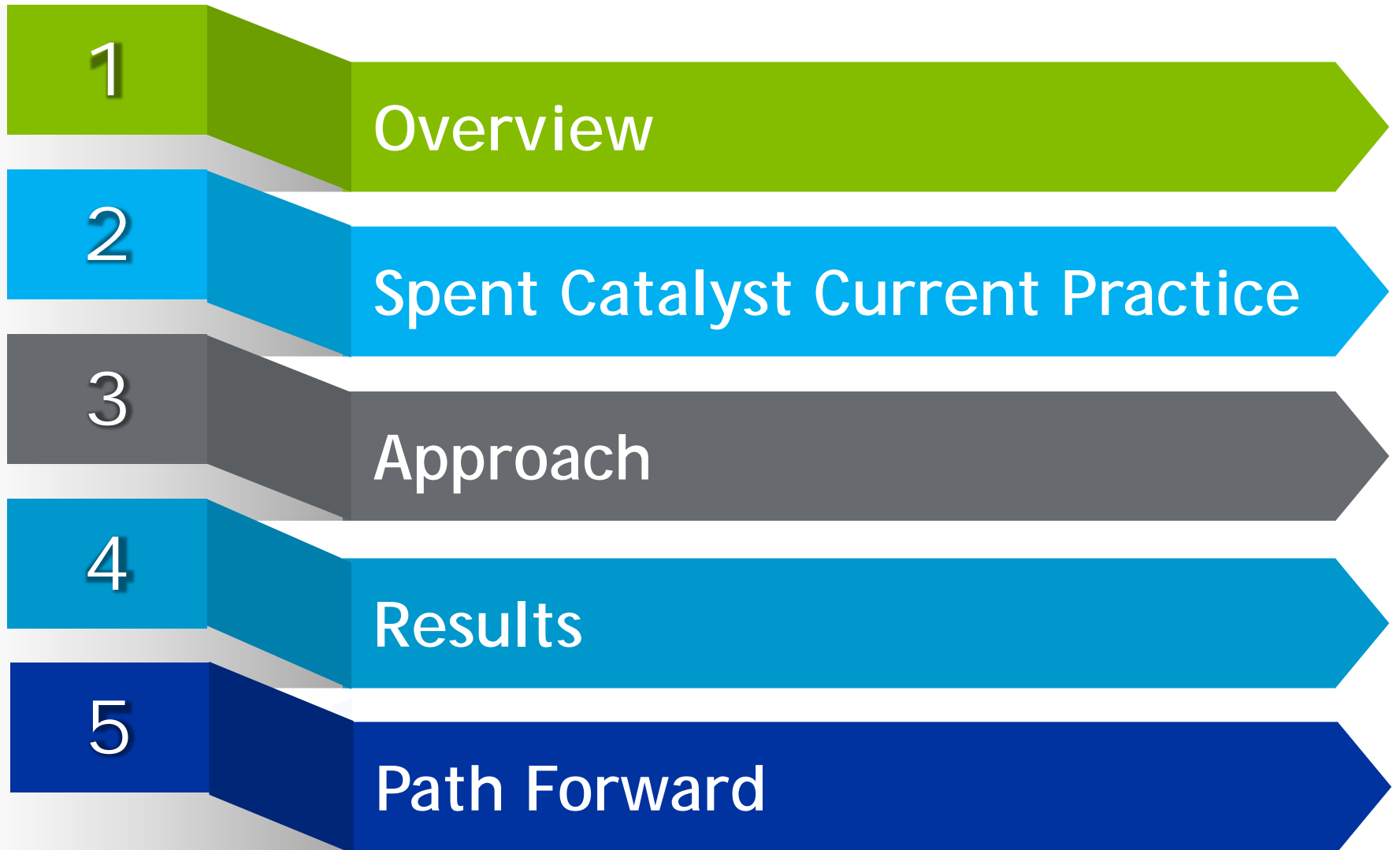


Alternatives to the Conventional Management of Spent Catalyst

Abdullah Al-Duaiji
Environmental Engineer
Saudi Aramco
11/01/2017

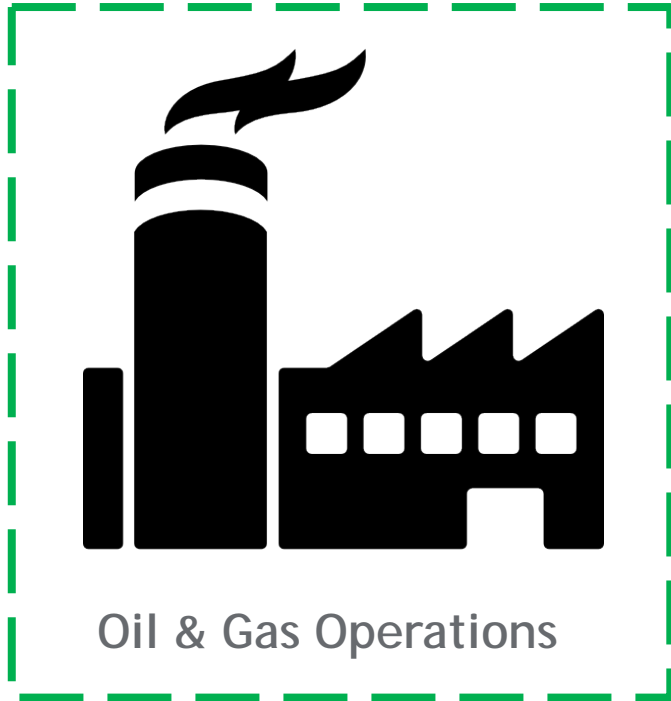


Outline



Overview

Sources of Spent Catalysts in Saudi Aramco



Drilling & Workover

Overview

Sources of Spent Catalysts in Saudi Aramco



Refineries



Hydrocrackers
Rheniformers



Gas/NGL Plants



Sulfur Recovery Units (SRUs)

Overview

Types of Catalysts



Refineries



Alumina /Titania



Gas/NGL Plants



Superclaus

Spent Catalyst Current Practice

In the Company, hazardous waste is tracked using an online manifesting system; which showed that huge quantities of spent catalyst is landfilled.

The screenshot displays the 'myhome Corporate Portal' interface. The top navigation bar includes 'Home', 'Business Intelligence', 'Systems', 'Services', and 'Finance Online'. A search bar is located in the top right corner. The main content area is titled 'Environment Health & Safety' and contains a sidebar menu with options like 'Incident Reporting', 'Injury/Illness - WCD Process', 'Recommendations', 'Waste Management', 'Work Area Management', and 'Assessment'. The central form is for creating a waste manifest, with fields for 'Generator Details', 'Transporter', 'Disposer', and 'Waste'. The 'Generator Details' section includes fields for 'Waste Generator', 'Generator Order No. (Purchase Requisition)', 'Generation Date' (set to 12/30/2008), and 'Signatory' (set to GHALABFA). The 'Transporter' section includes 'Waste Transporter', 'Purch Doc/Ship No. (Service Order)', 'Purchase Order No.', 'PO Item' (00000), and 'Pick Up Date'. The 'Disposer' section includes 'Waste Disposer', 'Purchasing Doc. No. (Service Order)', 'PO Item' (00000), and 'Delivery Date'. The 'Waste' section includes 'Waste', 'Description', 'Outgoing Quantity' (0.000), and 'Unit of Measurement'. A 'Remarks' field is at the bottom.

Spent Catalyst Current Practice



95% of Spent Catalyst is Landfilled

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environmental protection policy

Policy Statement

Saudi Aramco considers environmental protection an integral pillar of its social license to operate. Emanating from this firm belief, the Company will ensure that its projects/operations are in compliance with the Kingdom's environmental regulations and do not create undue risks to the environment, public or workers' health. Saudi Aramco will strive to conserve natural resources and minimize emissions and the environmental footprint of its activities through continuous optimization of Company operations, and leveraging technology advancements and industry best practices. The Company will work toward promoting the conservation of natural biodiversity within its reservations.

Regulations

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- In all its projects/operations, the Company will attain the highest level of compliance with the Kingdom's environmental regulations. Where there are no established national regulations, the Company will develop environmental standards aligned with industry best practices and compatible with the Kingdom's environmental protection objectives.
- It is the responsibility of each Company organization to ensure that its facilities are designed, constructed and operated in compliance with the corporate Environmental Protection Policy.
- The Company will maintain corporate environmental programs to monitor the compliance of Company organizations with environmental regulations/standards.
- Each Company organization shall strive to continuously enhance its environmental performance to conserve natural resources, reduce the environmental footprint of its activities and conserve biodiversity within areas of its operations.

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President & Chief Executive Officer

ABDULLAH.DUAIJI

خطة حماية البيئة

بيان الخطة

تعتبر أرامكو السعودية حماية البيئة ركيزة أساسية من ضمن مسؤولياتها تجاه المجتمع. و من هذا المنطلق ستضمن الشركة أن مشاريعها و أعمالها ملتزمة بالأنظمة البيئية وأنها لا تشكل مخاطر على البيئة أو الصحة العامة أو العاملين. وستبذل أرامكو السعودية قصارى جهدها للمحافظة على الموارد الطبيعية و تقليل الإنبعاثات والحد من الآثار البيئية لأعمالها من خلال التحسين المستمر لأعمال الشركة بالاستفادة من أحدث التطورات التقنية وتطبيق أفضل ممارسات الصناعة. وستعمل الشركة على تعزيز المحافظة على التنوع البيولوجي ضمن محجوزاتها.

الأنظمة

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- ستتقيد الشركة بأعلى مستويات الالتزام بالأنظمة البيئية في جميع مشاريعها أو أعمالها. وحيثما لا توجد أنظمة وطنية مطبقة، ستعد الشركة معايير بيئية تتطابق مع أفضل ممارسات الصناعة وتتماشى مع أهداف حماية البيئة في المملكة.
- تقع على عاتق كل دائرة في الشركة مسؤولية ضمان تصميم مرافقها وإنشائها وتشغيلها وفقاً لخطة حماية البيئة في الشركة.
- ستحرص الشركة على تنفيذ برامج بيئية مركزية لمراقبة التزام دوائرها بالأنظمة و المعايير البيئية.
- يتعين على كل دائرة في الشركة أن تسعى إلى تحسين أدائها البيئي باستمرار من أجل المحافظة على الموارد الطبيعية وتقليل الآثار البيئية لأنشطتها والمحافظة على التنوع البيولوجي ضمن مناطق أعمالها.

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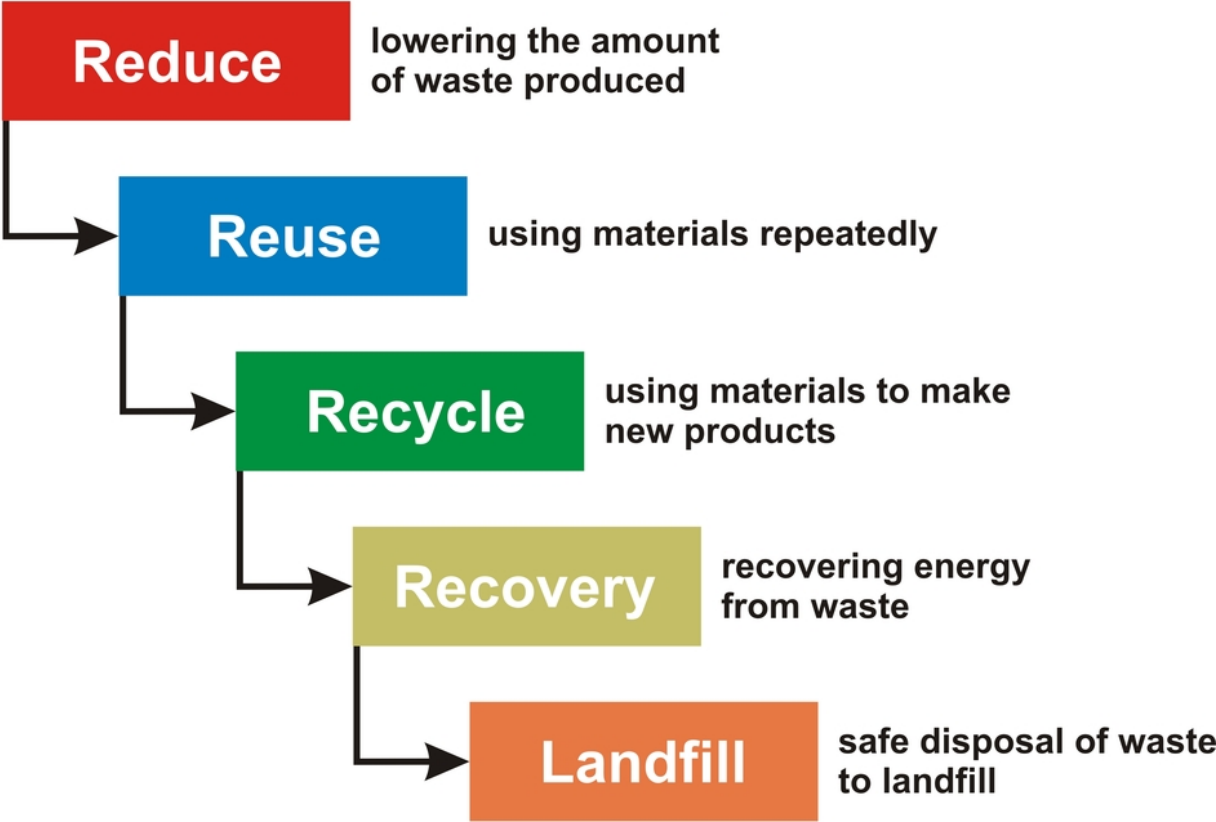
الرئيس و كبير الإداريين التنفيذيين

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Approach

Most favoured option



Least favoured option

Approach

The assessment included:



Survey Company's Operations &
Local Market



Literature Review



Collaboration with Company's
R&DC



Feedback from Operations

Results

Mitigation of Catalyst Poisoning

Catalyst Regeneration

Catalyst Rejuvenation

Precious Metal Recovery

Reuse of the Spent Catalyst

Spent Catalyst Disposal

Results

Sampling and Analyzing Spent Catalyst

1 Mitigation of Catalyst Poisoning

2 Catalyst Regeneration

3 Catalyst Rejuvenation

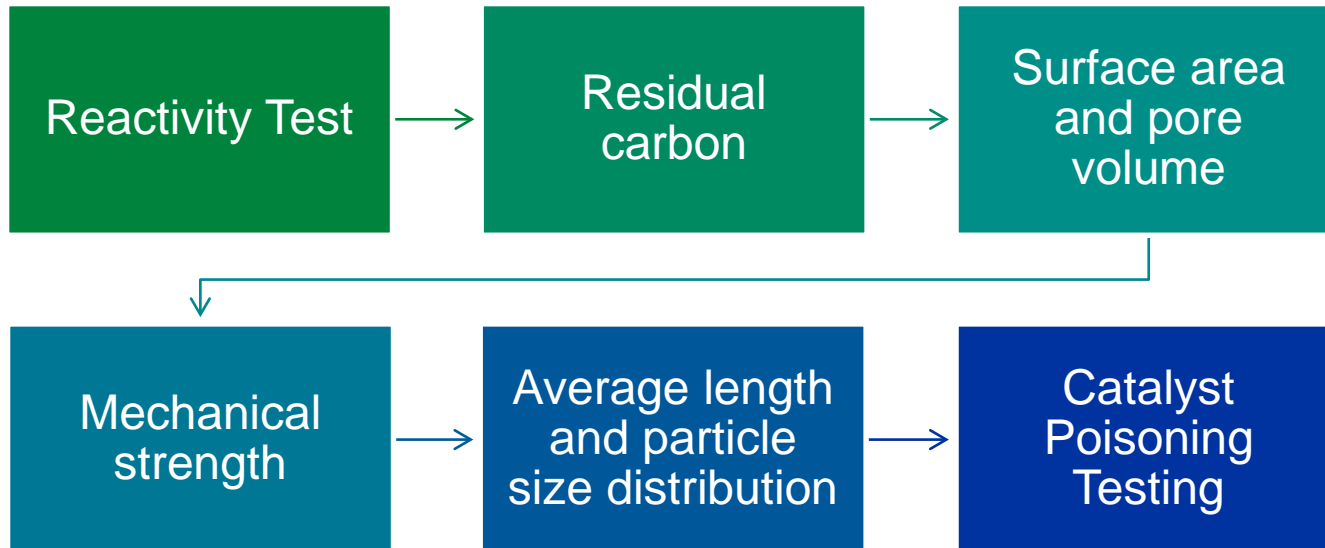
4 Precious Metal Recovery

5 Reuse of the Spent Catalyst

6 Spent Catalyst Disposal

Results

Sampling and Analyzing Spent Catalyst



Results

Sampling and Analyzing Spent Catalyst

1 Mitigation of Catalyst Poisoning

2 Catalyst Regeneration

3 Catalyst Rejuvenation

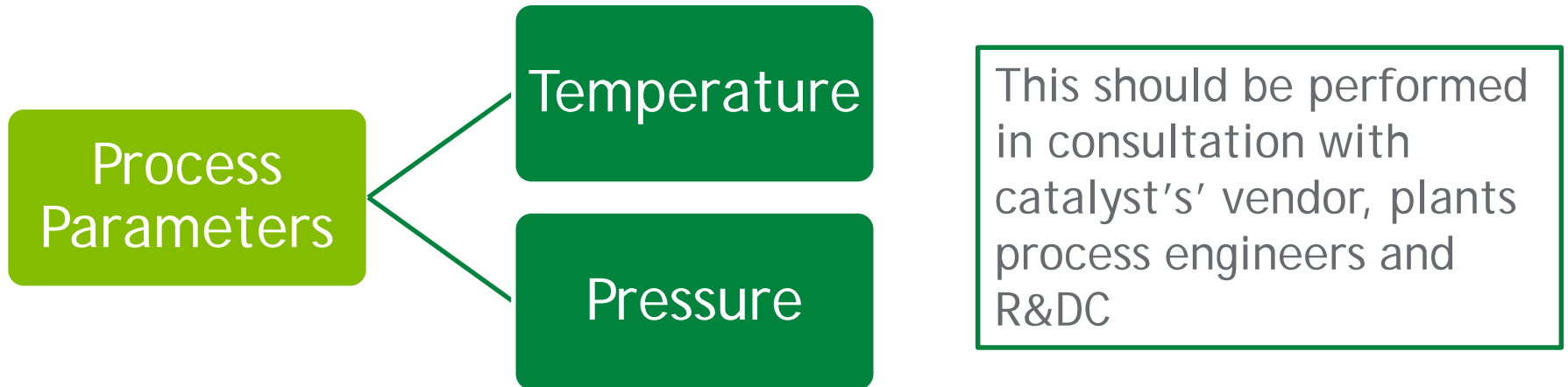
4 Precious Metal Recovery

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Results

Mitigation of Catalyst Poisoning



Results

Sampling and Analyzing Spent Catalyst

1 Mitigation of Catalyst Poisoning

2 Catalyst Regeneration

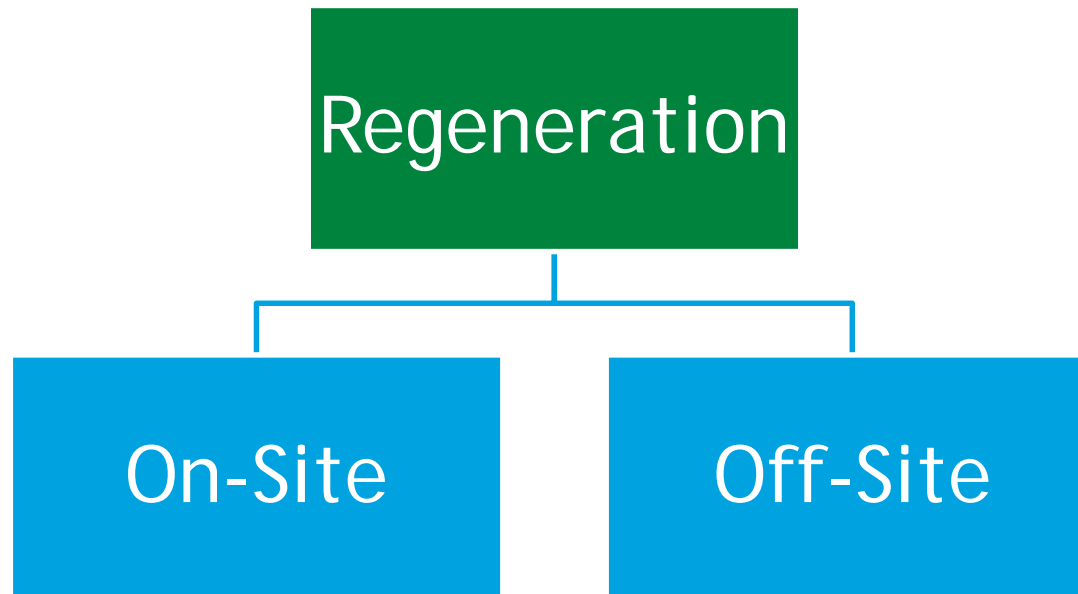
3 Catalyst Rejuvenation

4 Precious Metal Recovery

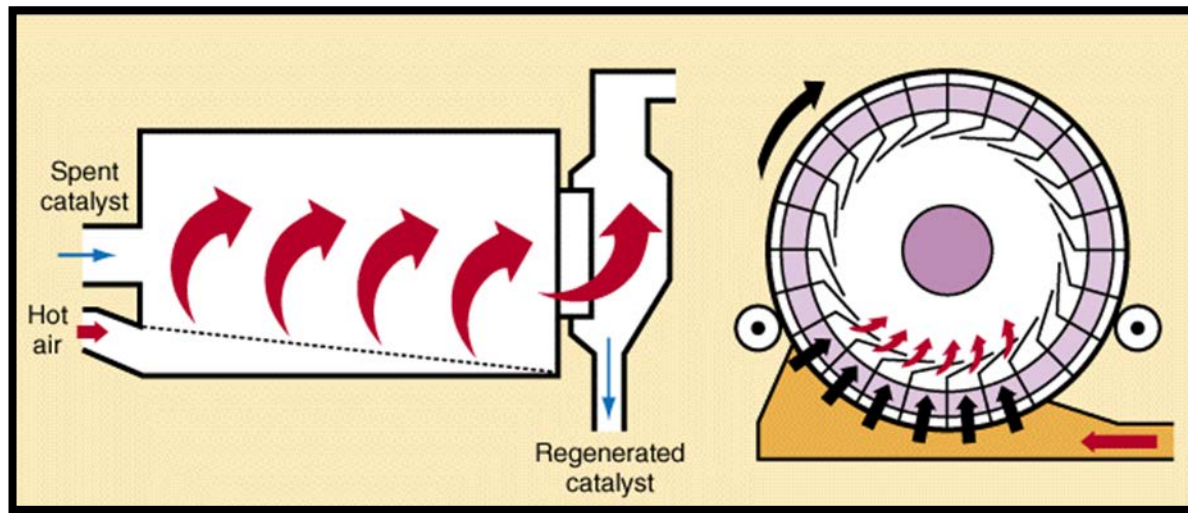
5 Reuse of the Spent Catalyst

6 Spent Catalyst Disposal

Catalyst Regeneration



Catalyst Regeneration



ROTO-LOUVRE Oven Technology

Results

Sampling and Analyzing Spent Catalyst

1 Mitigation of Catalyst Poisoning

2 Catalyst Regeneration

3 Catalyst Rejuvenation

4 Precious Metal Recovery

5 Reuse of the Spent Catalyst

6 Spent Catalyst Disposal

Catalyst Rejuvenation

- Further step to regeneration

Rejuvenation:

The process of restoring catalyst's activity by removing *both contaminant metals and coke deposit* through certain processes.

Results

Sampling and Analyzing Spent Catalyst

1 Mitigation of Catalyst Poisoning

2 Catalyst Regeneration

3 Catalyst Rejuvenation

4 Precious Metal Recovery

5 Reuse of the Spent Catalyst

6 Spent Catalyst Disposal

Results

Precious Metal Recovery

Some Types of spent catalysts useful & valuable metals

Alumina

Molybdenum

Nickel

Cobalt

Vanadium

Platinum

Results

Sampling and Analyzing Spent Catalyst

1 Mitigation of Catalyst Poisoning

2 Catalyst Regeneration

3 Catalyst Rejuvenation

4 Precious Metal Recovery

5 Reuse of the Spent Catalyst

6 Spent Catalyst Disposal

Results

Reuse of the Spent Catalyst

Once physical and chemical properties as well as the catalytic activity are completely lost, the spent catalyst can't be used back in its original process

However, it might be used in another processes:



Reuse of Spent Catalyst to form new catalyst compositions



Reuse of Spent Catalyst in Cement Process

Results

Reuse of the Spent Catalyst



Reuse of Spent Catalyst to form new catalyst compositions



Fluid catalytic cracking
(FCC) & Superclaus
spent catalysts



New Catalyst

Results

Reuse of the Spent Catalyst

➤ Reuse of Spent Catalyst in Cement Process



Manufacture of Portland cement using spent superclaus catalyst
"AlShafei, M.A., US patent no. 8,029,618"

Results

Sampling and Analyzing Spent Catalyst

1 Mitigation of Catalyst Contamination

2 Catalyst Regeneration

3 Catalyst Rejuvenation

4 Precious Metal Recovery

5 Reuse of the Spent Catalyst

6 Spent Catalyst Disposal

Results

Spent Catalyst Disposal

Ultimately the spent catalyst could be disposed of at Class I or Class II landfills.”

Prior disposal the following should be taken into account and performed:

- Toxicity characteristic leaching procedure (TCLP)
- Total petroleum hydrocarbons (TPH)

Results

Sampling and Analyzing Spent Catalyst

1 Mitigation of Catalyst Contamination

2 Catalyst Regeneration

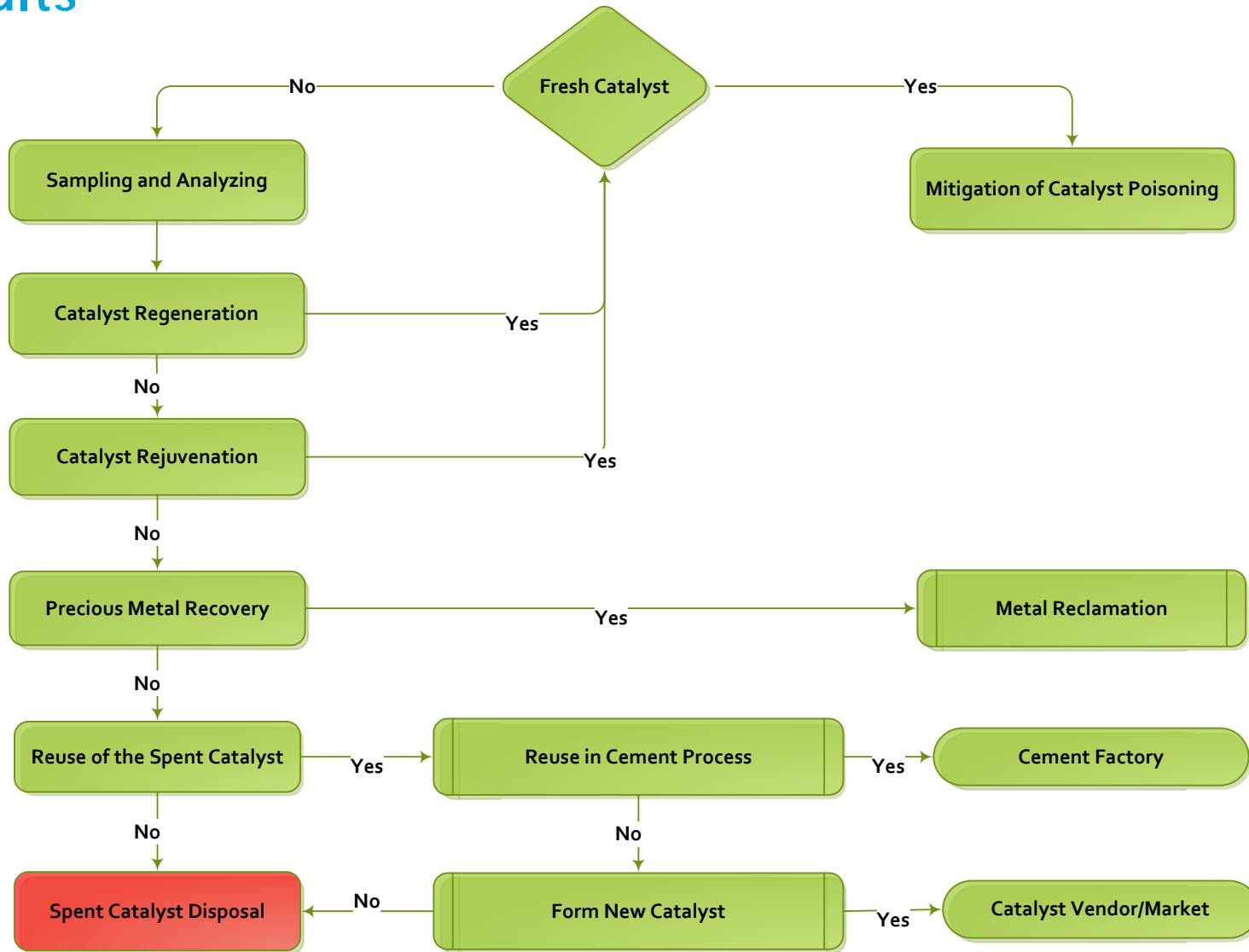
3 Catalyst Rejuvenation

4 Precious Metal Recovery

5 Reuse of the Spent Catalyst

6 Spent Catalyst Disposal

Results



Best Practice

SABP-S-003

Spent Catalyst Management Methods

Document Responsibility: Environmental Standards Committee

Saudi Aramco DeskTop Standards

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Previous Issue: New

Next Planned Update: TBD

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Path forward

- Monitor Best Practice Implementation by Saudi Aramco Facilities,
- Keep abreast of new technologies and practices,
- Partner with industries to explore opportunity for reuse or recycle spent catalysts.

Thank you

أرامكو السعودية
saudi aramco

