

The Karrick Process

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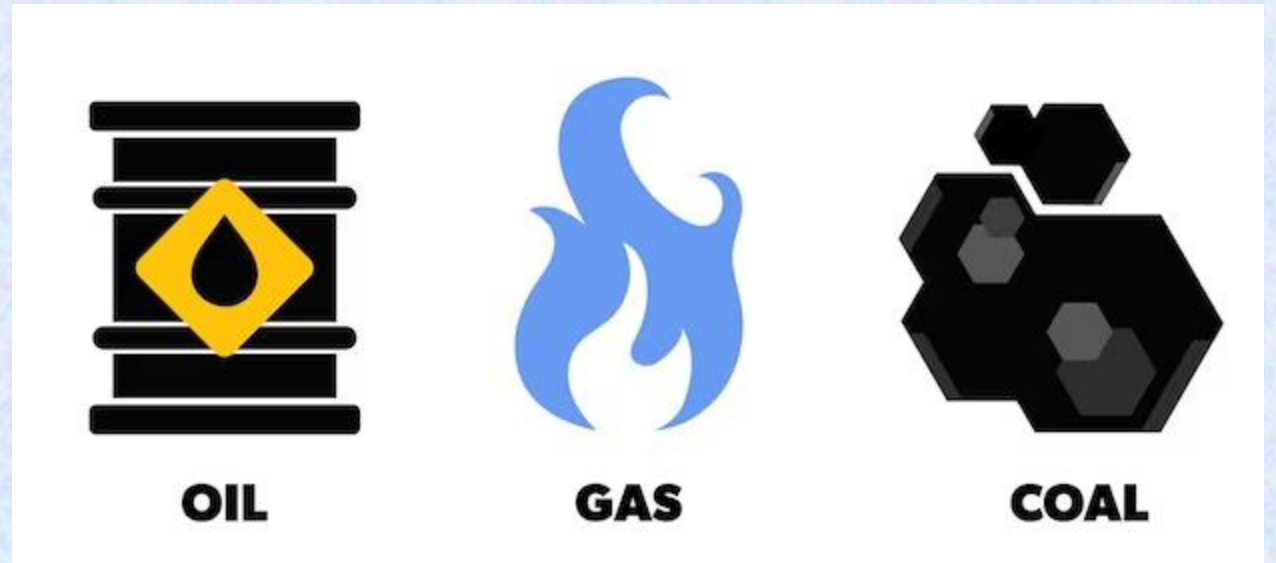
- ❖ Process Description

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Introduction

- ❖ Mankind is constantly looking for new energy sources or improved conversion methods of energy sources
- ❖ Fossil fuels have been supplying 80% of the world's energy sector for more than 150 years
- ❖ Processes that turn fossil fuels to liquid fuels helps reduce dependency on crude oil which is unevenly distributed globally
- ❖ Examples of such processes are:
 - The Karrick process
 - The Bergius process
 - The Fischer Tropsch
- ❖ The Karrick process converts coal and oil shale to liquid fuel as well as other useful products
- ❖ Coal is the most abundant recoverable hydrocarbon resource making the Karrick process ideal to use
- ❖ The process was created to address the difficulties in disposing of organic waste while utilising fossil fuels



Aims and Objectives

❖ Aims:

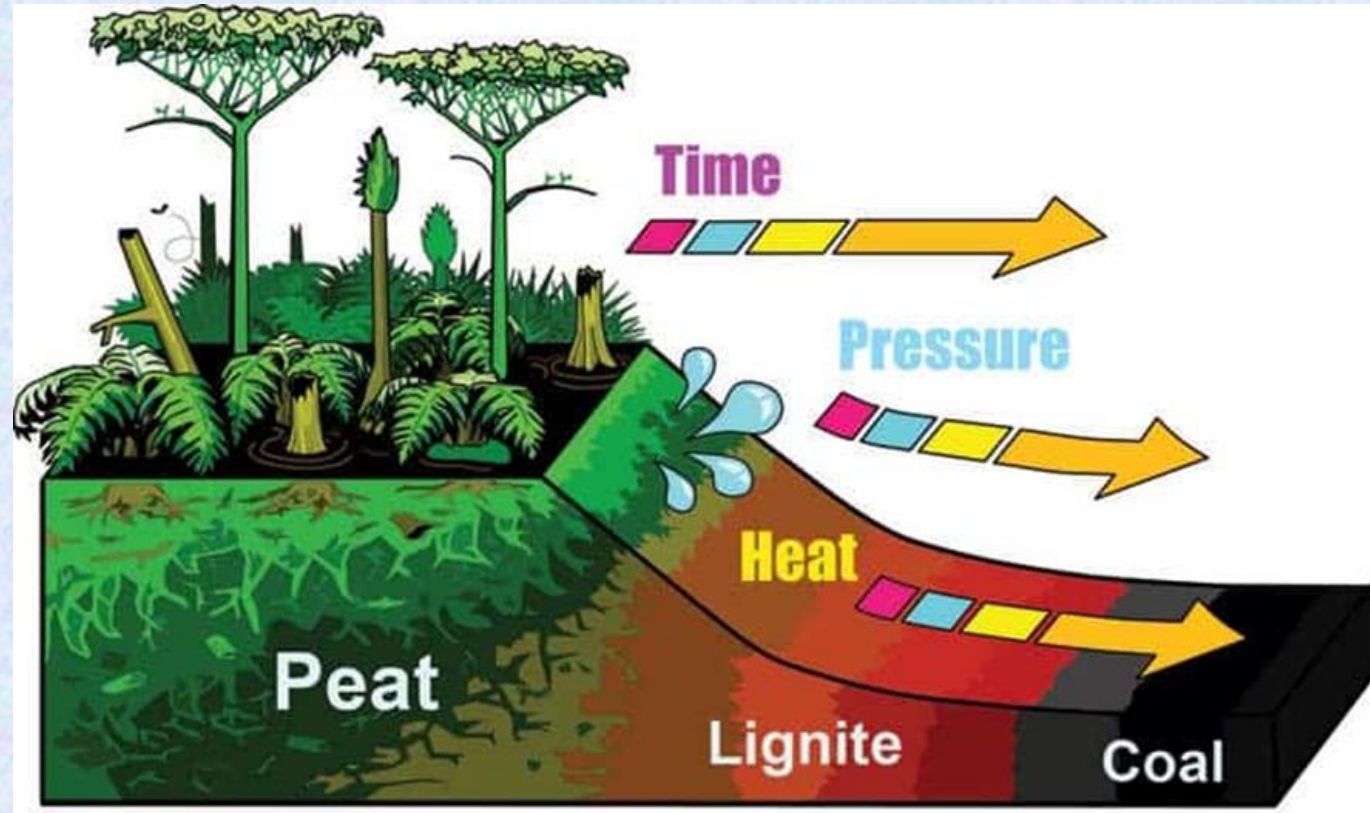
- Provide an overview of the Karrick process

❖ Objectives:

- Perform a literature review on the Karrick process and its main feedstock
- A detailed description of the Karrick process
- Discuss the advantages and disadvantages of the process
- Compare the Karrick process to other processes

Literature review: Coal and shale formation

- ❖ Accumulation of plant material, mainly dead vegetation, in swampy environments
- ❖ Plant material undergoes partial decomposition in waterlogged conditions, forming peat
- ❖ Accumulated peat undergoes burial and experiences increasing pressure, leading to compaction
- ❖ Increasing heat and pressure during burial contribute to the maturation of coal
- ❖ Over millions of years, lignite transforms into bituminous and anthracite coal through processes known as coalification
- ❖ Lignite(low grade), Bituminous, Anthracite (High grade)



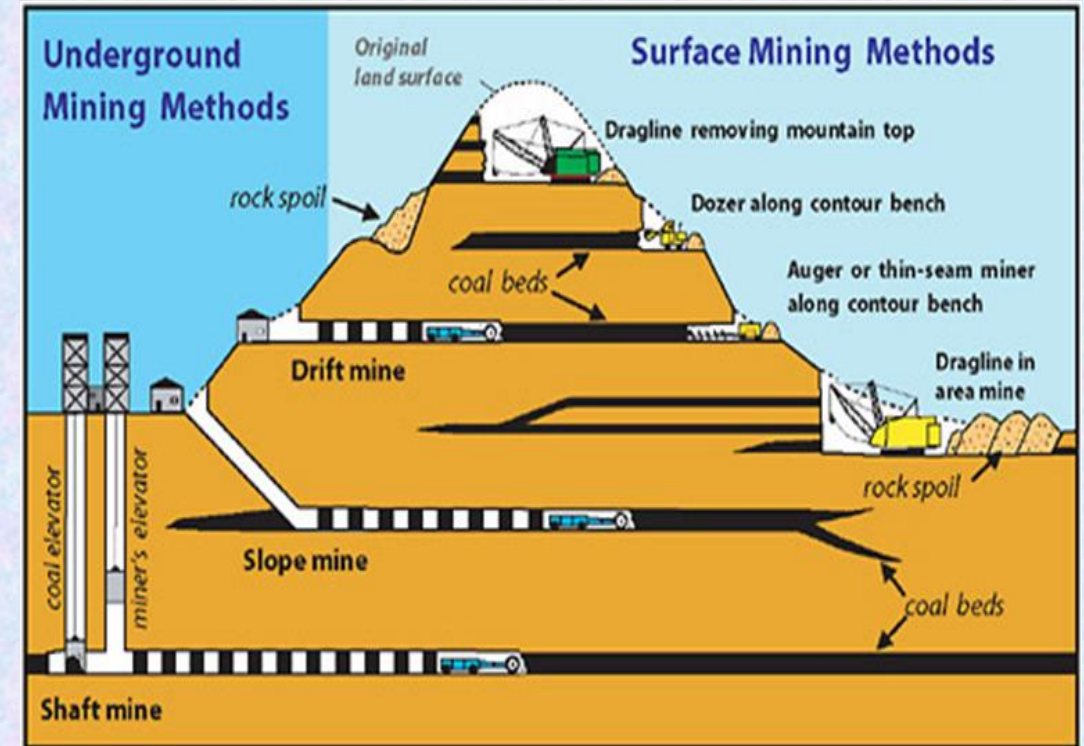
Literature review: Coal and shale Mining

Surface mining

- ❖ Strip mining- removal of overburden in broad strips to expose coal
- ❖ Contour mining- mining that occurs along the natural contour of the terrain
- ❖ Mountain top removal- removing the top of a mountain to expose coal

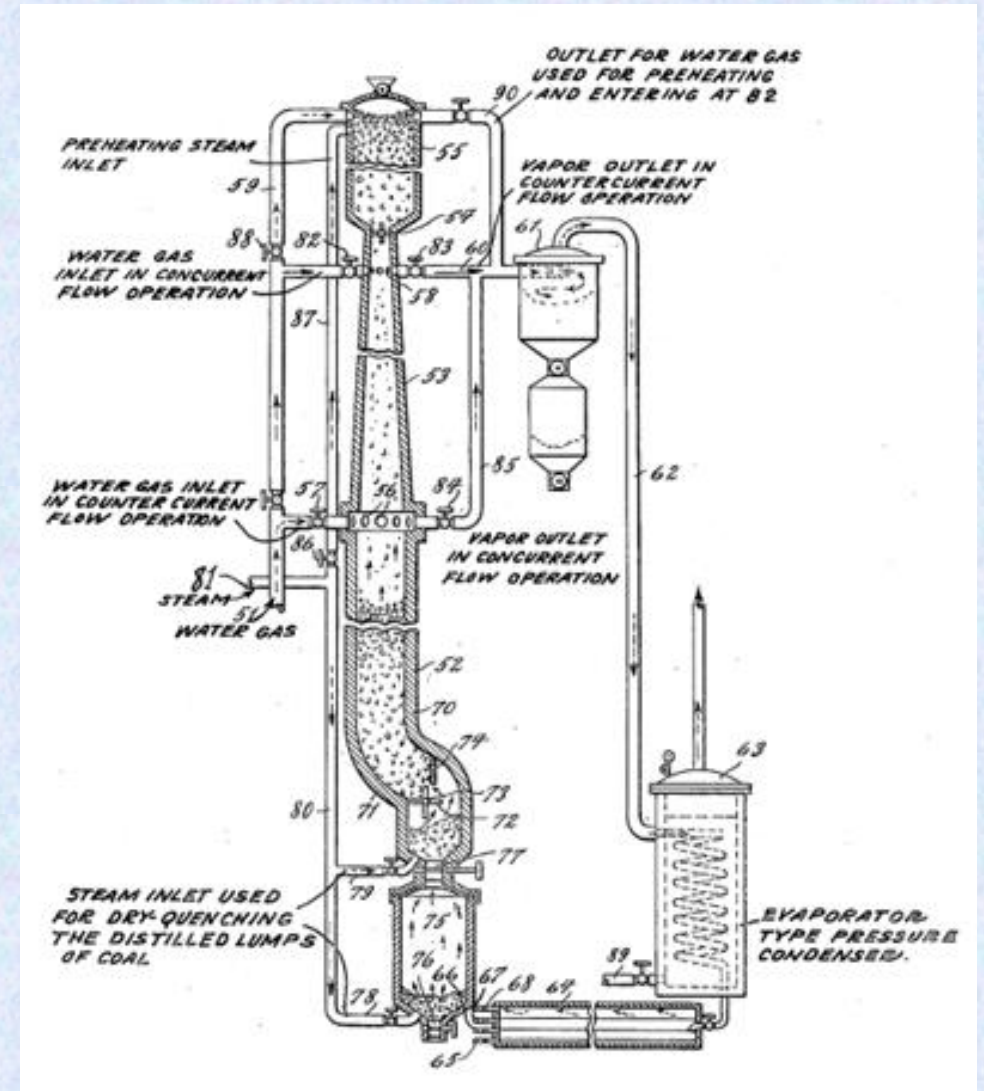
Underground Mining

- ❖ Longwall mining- mining uses a shearer to extract coal along a long face
- ❖ Room and pillar mining - creates a grid of chambers and pillars, leaving support structures to extract coal systematically underground
- ❖ Retreat mining- removing coal pillars to extract remaining coal, causing the mine roof to collapse and close the area



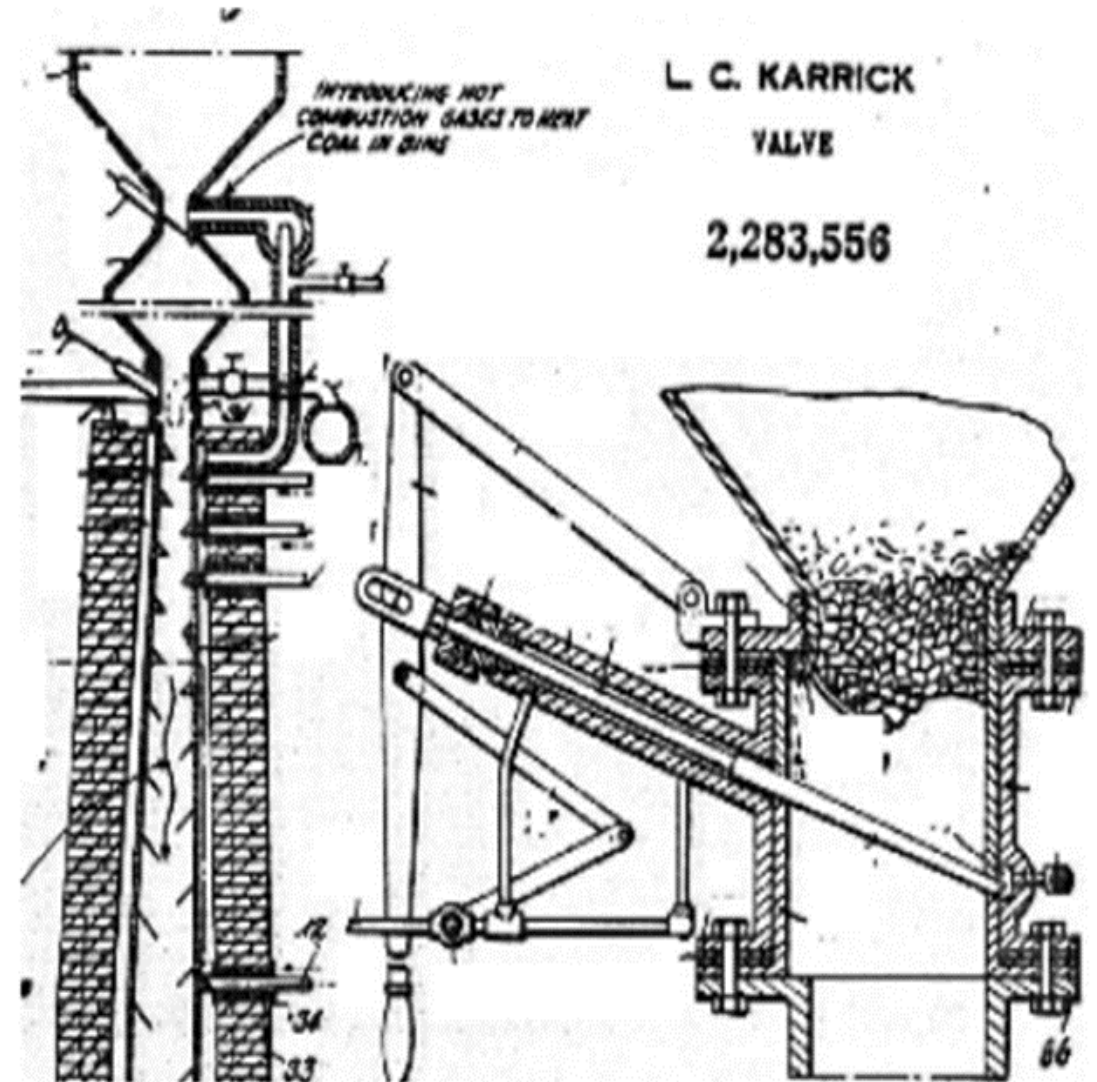
The Karrick process

- ❖ Invented by Lewis Cass Karrick in the 1920s
- ❖ A low temperature carbonisation (LTC) method used for carbonaceous materials
- ❖ Used to treat coal, oil shale, biomass or plastics
- ❖ The feed is heated between 450-700°C in the absence of oxygen to distil synthetic fuels and oils
- ❖ The products of the Karrick process are:
 - Smokeless coal
 - Fuel gas
 - Cresols
 - Crude oil
 - Electricity



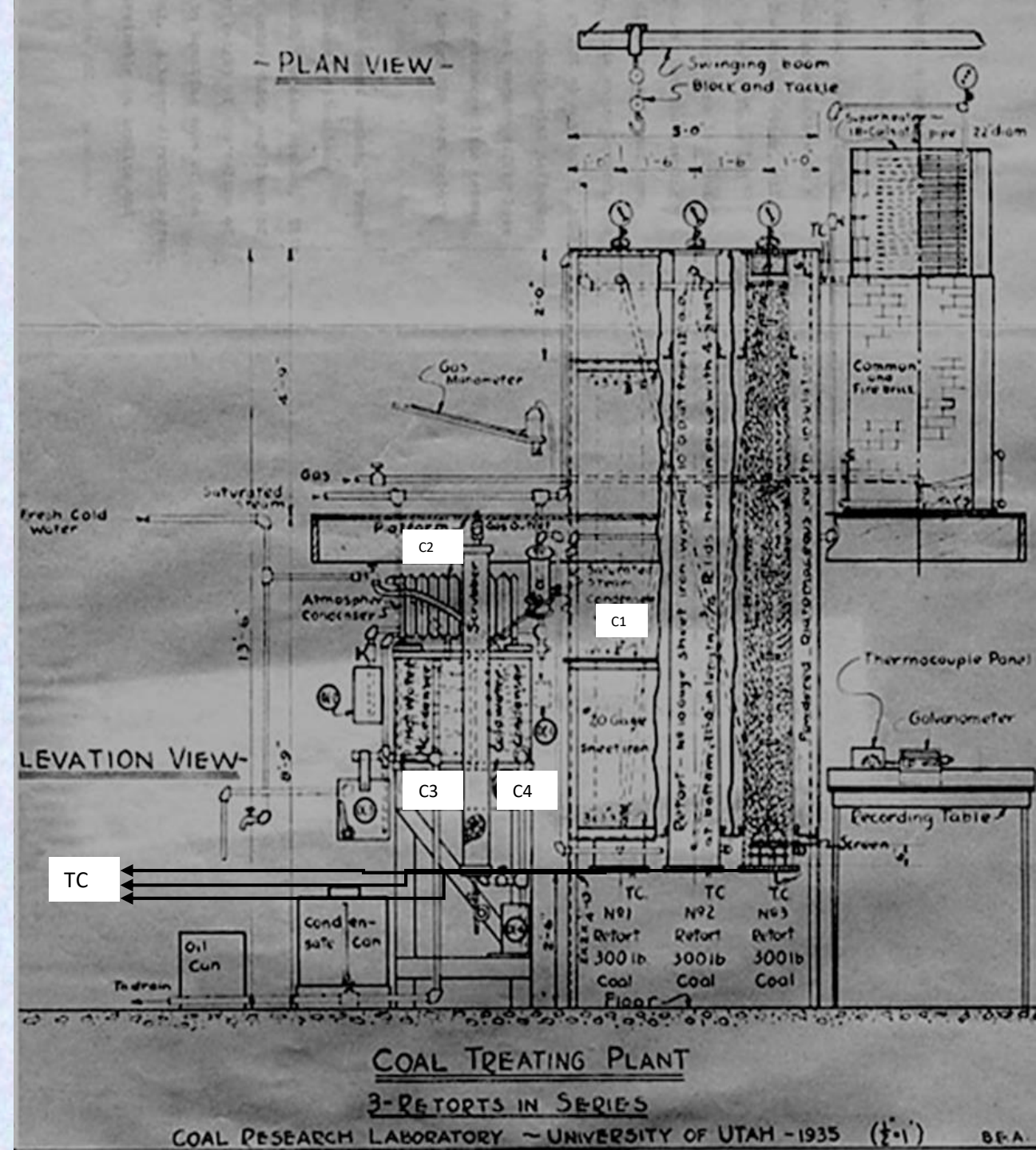
Process description

- ❖ The two methods employed using the Karrick method are:
 - The continuous method
 - The batch method
- ❖ A hermetic retort is used
- ❖ In the continuous method a conveyor belt supplies coal to the retort
- ❖ Superheated steam is used to carbonise the coal
- ❖ In the batch method the coal is dried and preheated to 150-315°C in a retort
- ❖ After completion the coal is transferred to a new retort and LTC occurs
- ❖ The products are removed and the smokeless coals are removed and screened
- ❖ Oil, gas, smokeless coal and electricity can be produced by combining a carboniser, refinery, city gas works and electric station



The Karrick plant setup

- ❖ Retorting plant structure
- ❖ Steam flow and Superheater
- ❖ Coal column regulation
- ❖ Steam superheater and combustion chambers
- ❖ Heat transfer and condensation
- ❖ Temperature control
- ❖ Overall process control



Discussion and Comparison (Fischer Tropsch)

	Fischer-Tropsch Process	Karrick Method
Feedstocks	Natural gas, coal, biomass	Coal, lignite, plastic, biomass
Fuel Output	Synthetic fuels (diesel, jet fuel, gasoline)	Hydrocarbons, gases, and byproducts
Environmental Impact	Lower contaminants (sulphur, aromatics), efficient, fewer emissions	Effective in reducing landfill waste, versatile
Resource Intensity	More energy-intensive, requires catalysts	Lower energy intensity, no need for a catalyst
Financial Resources	Higher financial resources required	Potentially lower financial requirements
Applications	Versatile in creating traditional fuels	Versatile for converting organic waste into various products
Commercial Status	Established commercial applications	Less established in commercial applications

Discussion and comparison (Bergius Process)

	Karrick Process	Bergius Process
Process Type	Low-temperature carbonization	high-pressure hydrogenation.
Catalyst Requirement	No catalyst required.	Iron catalysts used in the hydrogenation process.
Temperature and Pressure	Low temperatures for depolymerization; no high pressure.	High pressure (200-250 atm) and high temperature (400–450 °C).
Final Products	Liquid, gaseous, and solid residues.	Synthetic crude oil, gasoline, middle oil, and heavy oil.
Focus and Application	Waste management and resource recovery.	Addressing fuel shortages during specific periods.
Long-Term Sustainability	Provides a sustainable, long-term solution for organic waste.	Historically significant but may be more event-driven.

Advantages and Disadvantages

Advantages

- ❖ Smokeless coal production
- ❖ High quality fuels
- ❖ Reduced CO₂ emissions

Disadvantages

- ❖ Limited commercialization
- ❖ Scale limitations
- ❖ Increased CO emissions

Financial Investigation of Karrick process

Approximate costs per year	
Power plant @ 2000\$/KW	30 000
Treatment plant 65000\$/ton	29 250
Maintenance	50 000
Land	80 000
Coal (low grade) 18\$/ton	295 650
Labor	250 000
Water 2\$/ton	32 850
insurance	30 000
Interest on loan	150 000
Total (\$)	947 750

Approximate Income per year	
Smokeless coal 25\$/ton	246 375
Fuel gas 0.05\$/m3	73 000
Crude oil 2.50\$/gallon	912 500
Total (\$)	1 231 875



Conclusions

- ❖ In the past the American government withheld the Karrick process from the public
- ❖ In the present, further investigation can be done to implement the Karrick Process
- ❖ LTC processes require less energy input which reduces environmental impact
- ❖ Smokeless coals have clean-burning properties and has low emissions of pollutants
- ❖ Cost effective method of extracting liquid fuel from coal
- ❖ A highly profitable method

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