CO_2 Capture in Large Industries: The Post-Combustion Method

NATIONAL TECHNOLOGICAL UNIVERSITY, PARANÁ REGIONAL SCHOOL

Students of electromechanical engineering:

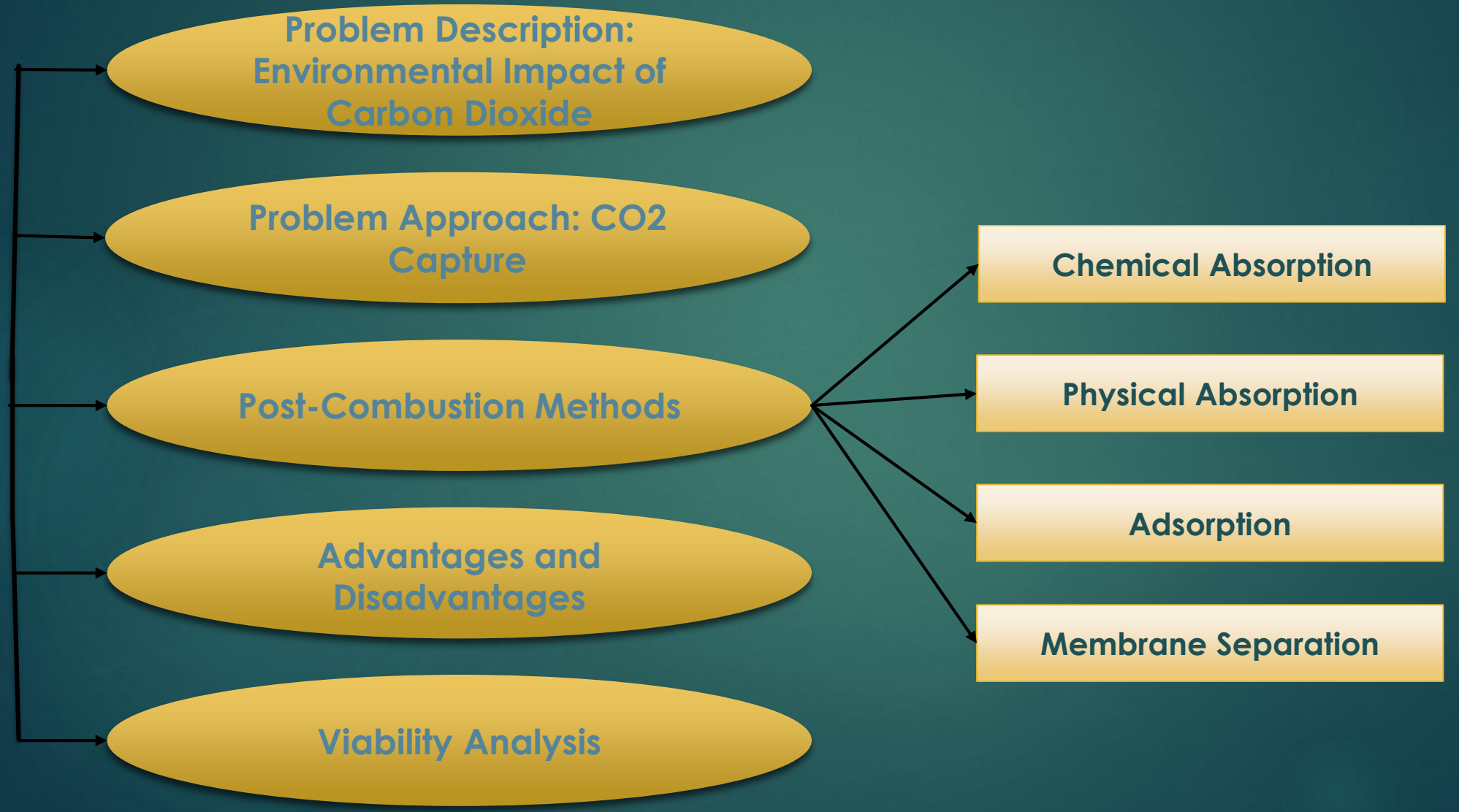
- Maximiliano Lódolo
- Martin Rausch

English II - 2023

Introduction

- **Carbon dioxide: emission sources**
- **Relationship with SDG 13, “Climate Action”, of the United Nations 2030 Agenda**
- **Objective of the paper: CO2 capture**
  - Methods of post-combustion capture
  - Comparison between these methods
  - Feasibility for large-scale application

Map of the Presentation



Problem Description: Environmental Impact of Carbon Dioxide

- **Climate change:**
  - Increase in the Earth's average temperature
- **Natural Causes:**
  - Distance of earth to the sun
  - Variation in the angle of rotation of the Earth
  - The energy emitted
- **Impact of greenhouse gases:**
  - Where are they produced?
  - Why are they negative?

Process	CO_2 concentration in gas stream % by vol.	Number of sources	Emissions ($MtCO_2$)	% of total CO_2 emissions	Cumulative total CO_2 emissions (%)	Average emissions/source ($MtCO_2$ per source)
CO_2 from fossil fuels or minerals						
Power						
Coal	12 to 15	2,025	7,984	59.69	59.69	3.94
Natural gas	3	985	759	5.68	65.37	0.77
Natural gas	7 to 10	743	752	5.62	70.99	1.01
Fuel oil	8	515	654	4.89	75.88	1.27
Fuel oil	3	593	326	2.43	78.31	0.55
Other fuels[a]	NA	79	61	0.45	78.77	0.77
Hydrogen	NA	2	3	0.02	78.79	1.27
Natural-gas sweetening	NA[b]	NA	50[c]	0.37	79.16	
Cement production						
Combined	20	1175	932	6.97	86.13	0.79
Refineries	3 to 13	638	798	5.97	92.09	1.25
Iron and steel industry						
Integrated steel mills	15	180	630[d]	4.71	96.81	3.50
Other processes[d]	NA	89	16	0.12	96.92	0.17
Petrochemical industry						
Ethylene	12	240	258	1.93	98.85	1.08
Ammonia: process	100	194	113	0.84	99.70	0.58
Ammonia: fuel combustion	8	19	5	0.04	99.73	0.26
Ethylene oxide	100	17	3	0.02	99.75	0.15

TABLE 1-Profile of worldwide large CO2 stationary sources emitting more than 0.1 Mt CO2 per year [4]

Problem Approach: CO2 Capture

- **Current methods available:**
  - Pre-combustion
  - Oxy-fuel combustion
  - Post-combustion
- **Post-combustion is the method more generally used**

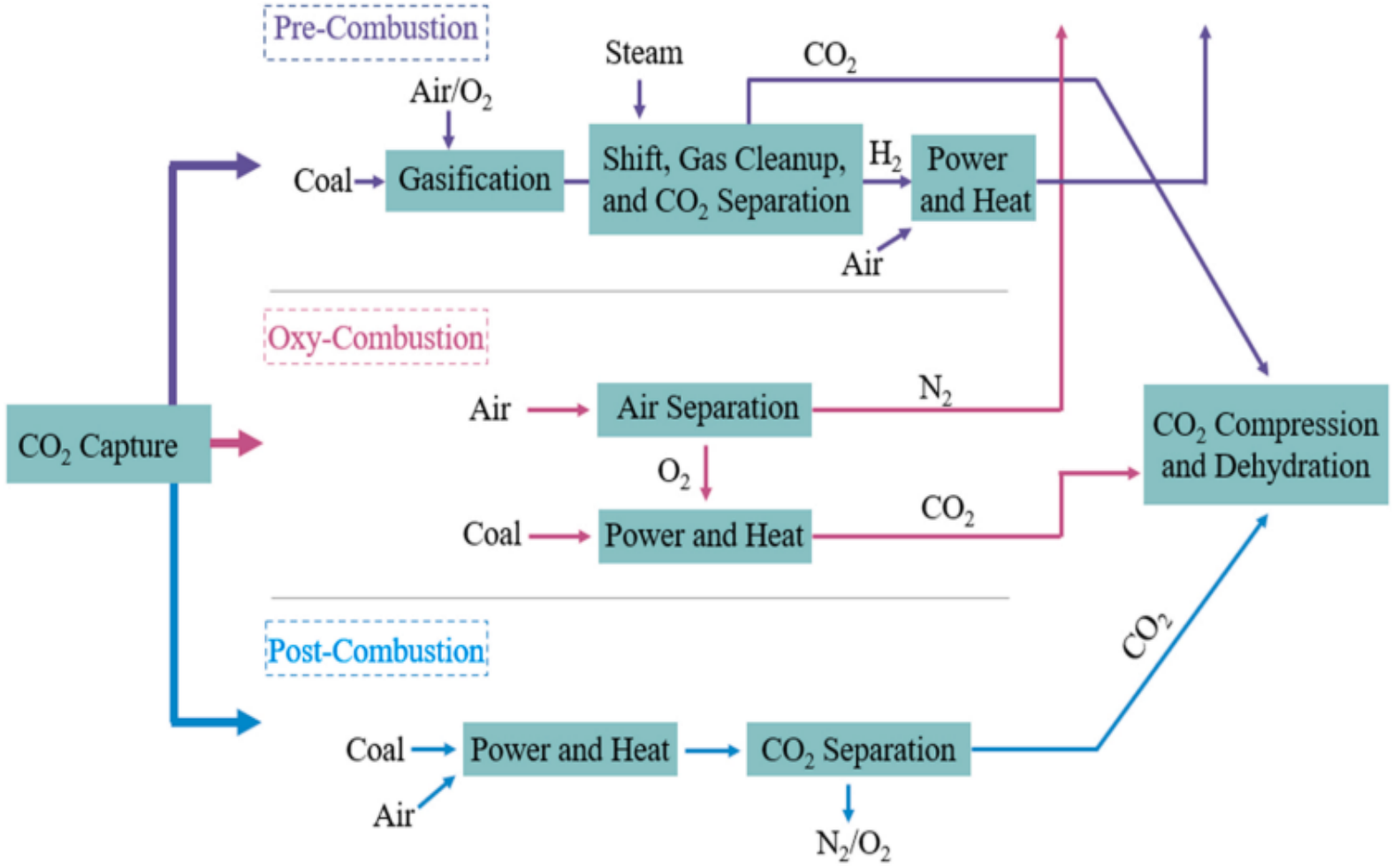


Fig. 1 Diagram of the different methods of CO2 capture [2]

Post-Combustion Method: Chemical Absorption

► **Process description**

► **Chemical solvents:**
- MEA
- DEA
- MDEA

► **Main parameters:**
- Flow of combustion gases
- CO2 concentration
- Elimination of CO2
- Solvent flow
- Energy requirements
- Others

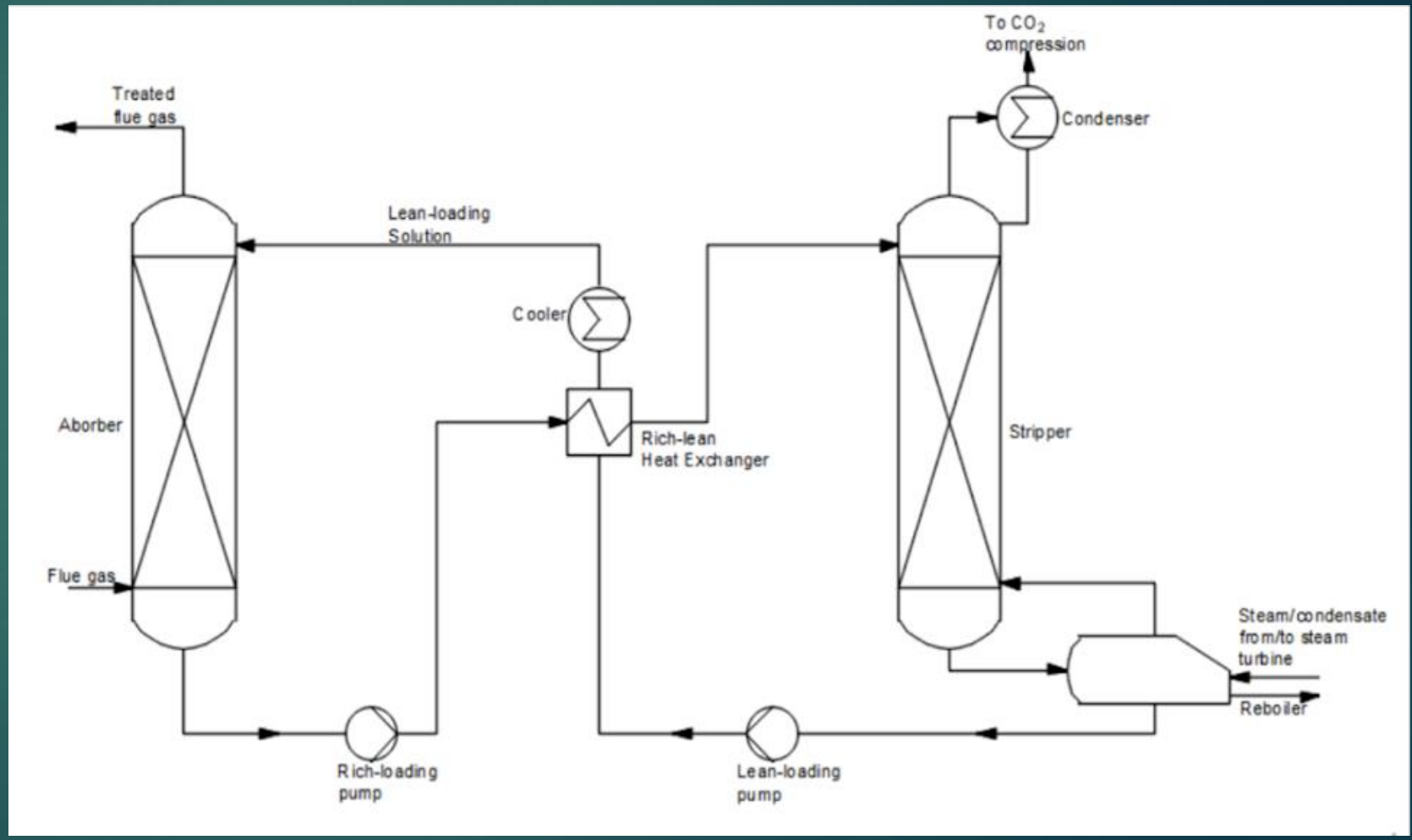
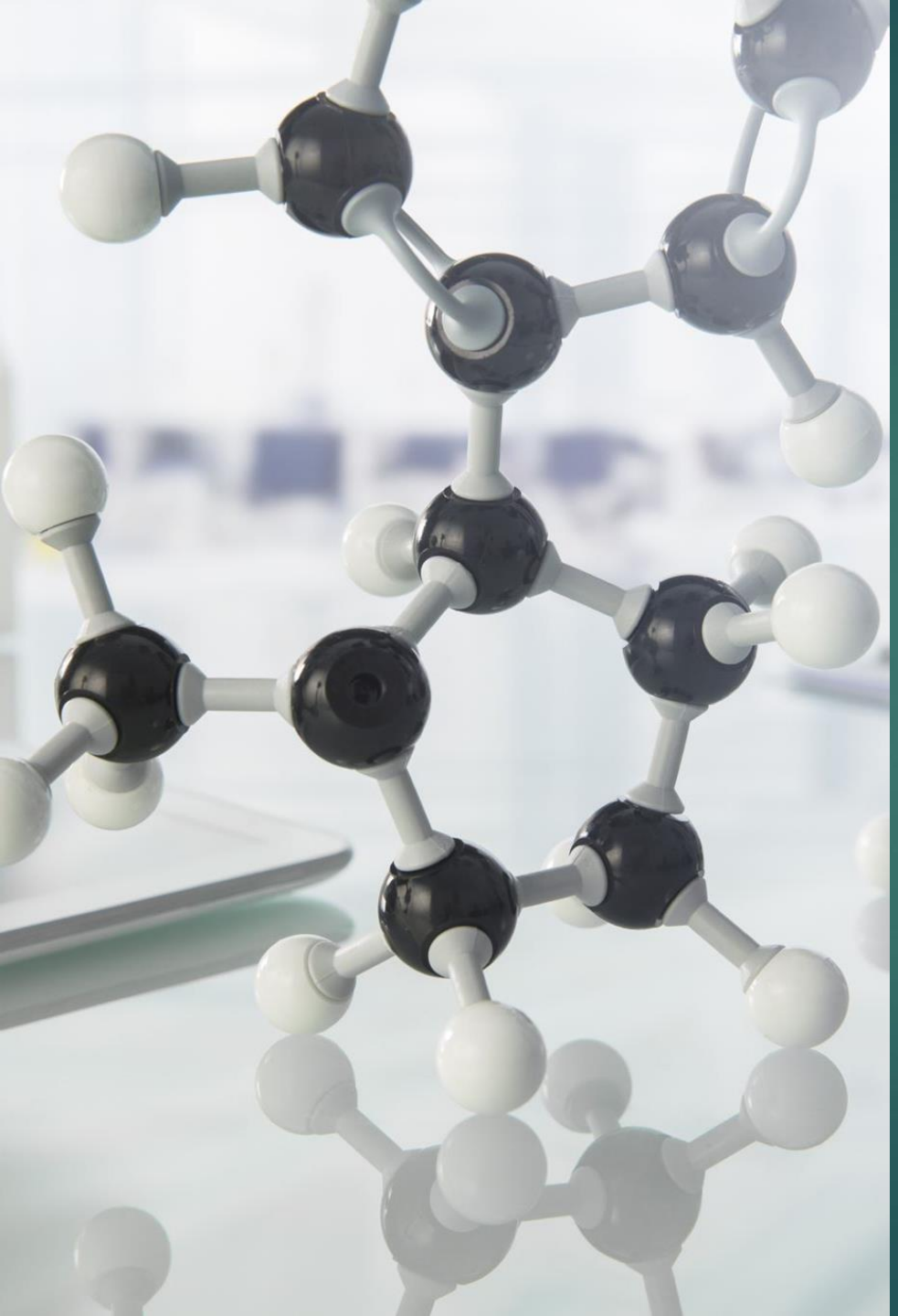


Fig. 2 Chemical absorption process [6]

Post-Combustion Method: Physical Absorption

- **Process description**
- **Application:**
  - Capture of CO2 from the coal gasification process

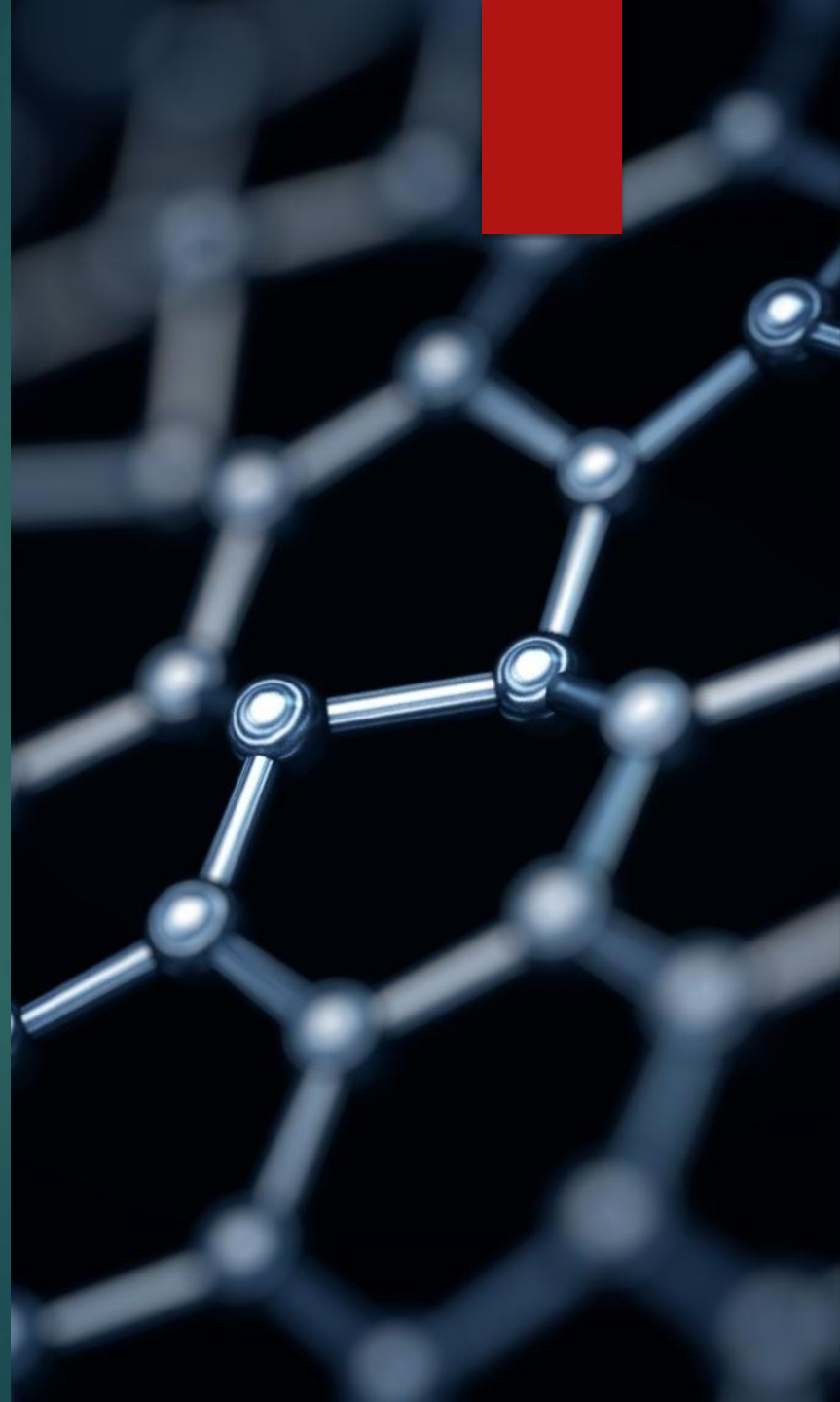


Post-Combustion Method: Adsorption

- **Process description:**
  - Adsorption
  - Regeneration
- **Techniques:**
  - Physical
  - Chemical
- **Most used materials**

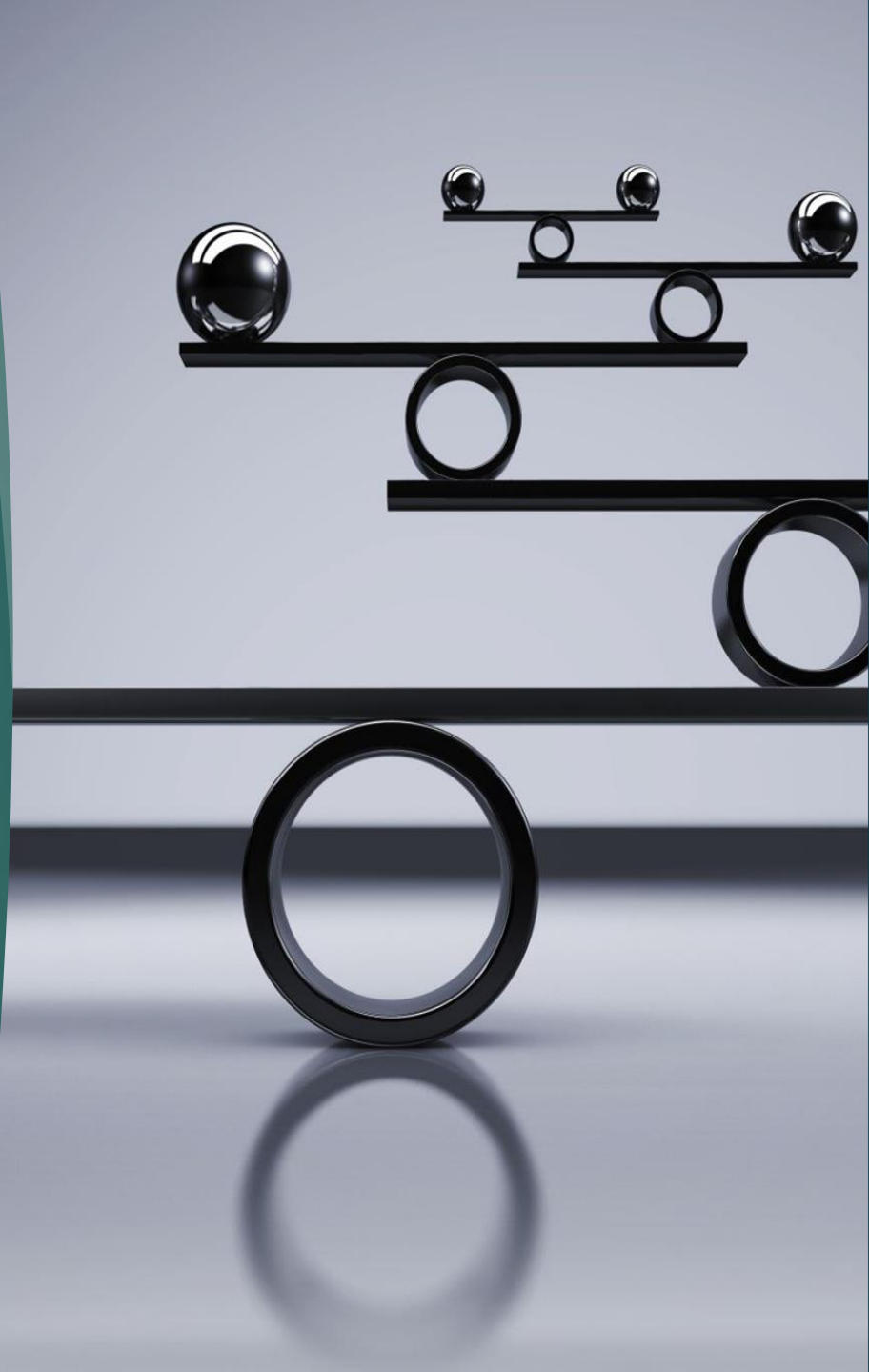
Post-Combustion Method: Membrane Separation

- **Process description**
- **Membrane types:**
  - Polymeric membranes
  - Inorganic membranes



Viability Assessment and Advantages and Disadvantages of Post Combustion Methods

- **Chemical absorption:**
  - Low partial pressure
  - High capture capacity
  - Large energy consumption
  - Solvents are corrosive
- **Physical absorption:**
  - It allows the selective of CO_2
  - High capture efficiency
  - It needs high pressures and concentrations
- **Adsorption:**
  - Application versatility
  - High capture efficiency
  - It requires prior compression of the gas
  - High energy consumption
- **Membrane separation:**
  - High selectivity
  - High partial pressure is required
  - Membranes are expensive



Economic Study

- **Costs impact**
  - Increment of costs with capture
- **Largest Plant in the World:** "Orca"

plant type	cost	high/low
coal	47	55/37
natural gas	76	114/49

TABLE 2-COST OF CO2 CAPTURE PER TONS [7]

Type	Costs in US$/KWh
New non-capture fossil fuel plants	0.03 - 0.06
New fossil fuel plants with capture	0.04 - 0.09
Capture by itself	0.01 - 0.03

TABLE 3-COST OF CO2 CAPTURE [11]

Conclusion

- The use of fossil fuels will remain inevitable until renewable energy is developed on a large scale.
- The energy sector is the one that must be urgently addressed.
- Carbon capture is a good option.
- Industries can opt for a type of capture technique.
- There must be commitment of governments and companies to the environment.

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THANK YOU FOR
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