Unit Operations for ICS security professionals

One big and expensive **“Lego”**

Oscar J. Delgado
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Who am I?

- ✓ Chemical/Process Engineer (13+ years)
- ✓ Project Engineer & Project Manager
- ✓ Experience: **Oil & Gas**, Mining, Water & Wastewater
- ✓ Penetration Testing Student

Agenda

- ✓ Why is this important?
- ✓ Ammonia Production
- ✓ Unit Operations
- ✓ Process Diagrams

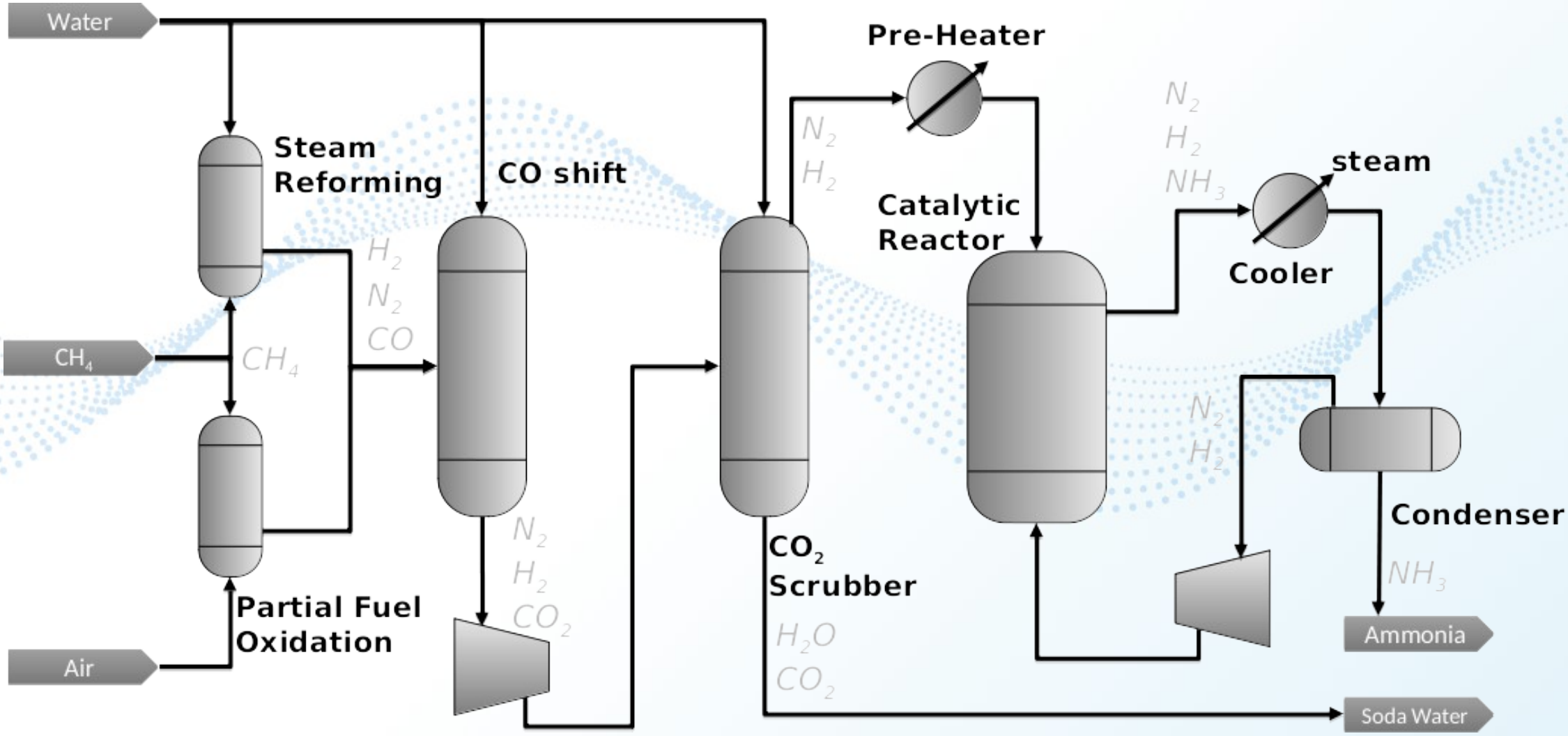
Why is this important?

Improves effective communication between Management, Operations teams and Security teams.

Allows for a better understanding of the process, which helps to **make better decisions**.

Ammonia Production

Adapated from: https://erichaberprocess.weebly.com/



Unit Operations

Unit Operations -> **groups of operations with common techniques and/or same underlying principles**.
Concept created to help understanding chemical processes.

There are **thousands** of complex processes, but **only a few** Unit Operations (“building blocks”).

Keywords: **Driving force** & **Equilibrium**

Source: https://pixabay.com/photos/chef-flour-dough-baking-5813413/

“Cooking” Unit Operations

There are millions of different recipes. Instead of studying every single one, chefs study **basic techniques** (e.g., searing, roasting, blanching) and then, integrate them.

Unit Operations

- ✓ **Fluid Mechanics**
- ✓ **Heat Transfer**
- ✓ **Mass transfer**
- ✓ **Particle Solids**

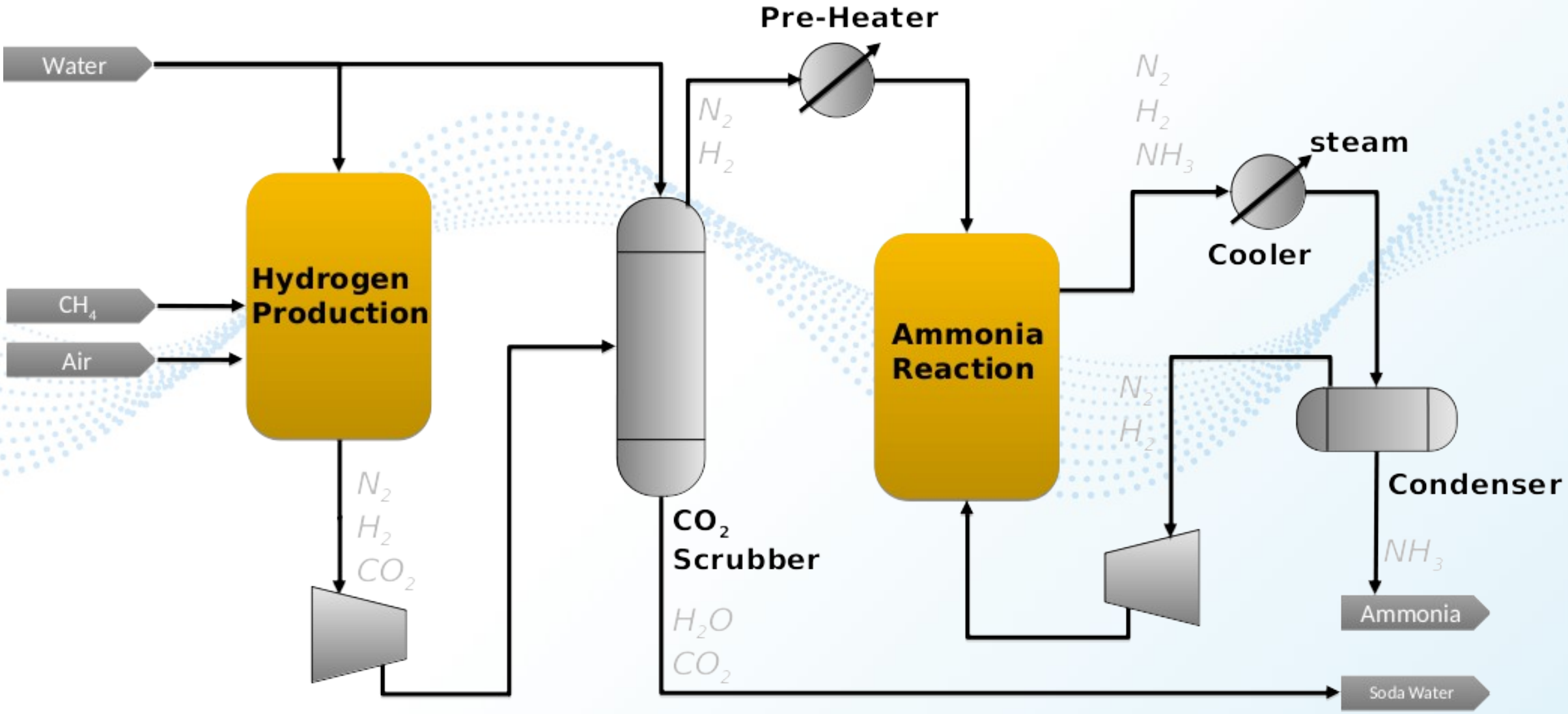
The trick is to integrate these **“building blocks”** in a way that is convenient for our business (e.g., better performance, safer operation, etc.)

What about Chemical Reactions?

Unit Operations mostly involve **moving & preparing** raw materials; and then, **purifying** intermediate/finished products.

Chemical Reactions (thermodynamics & thermochemistry) are also an important part of several processes. However, we consider them as “black boxes”.

Ammonia Production



1-Fluid Mechanics

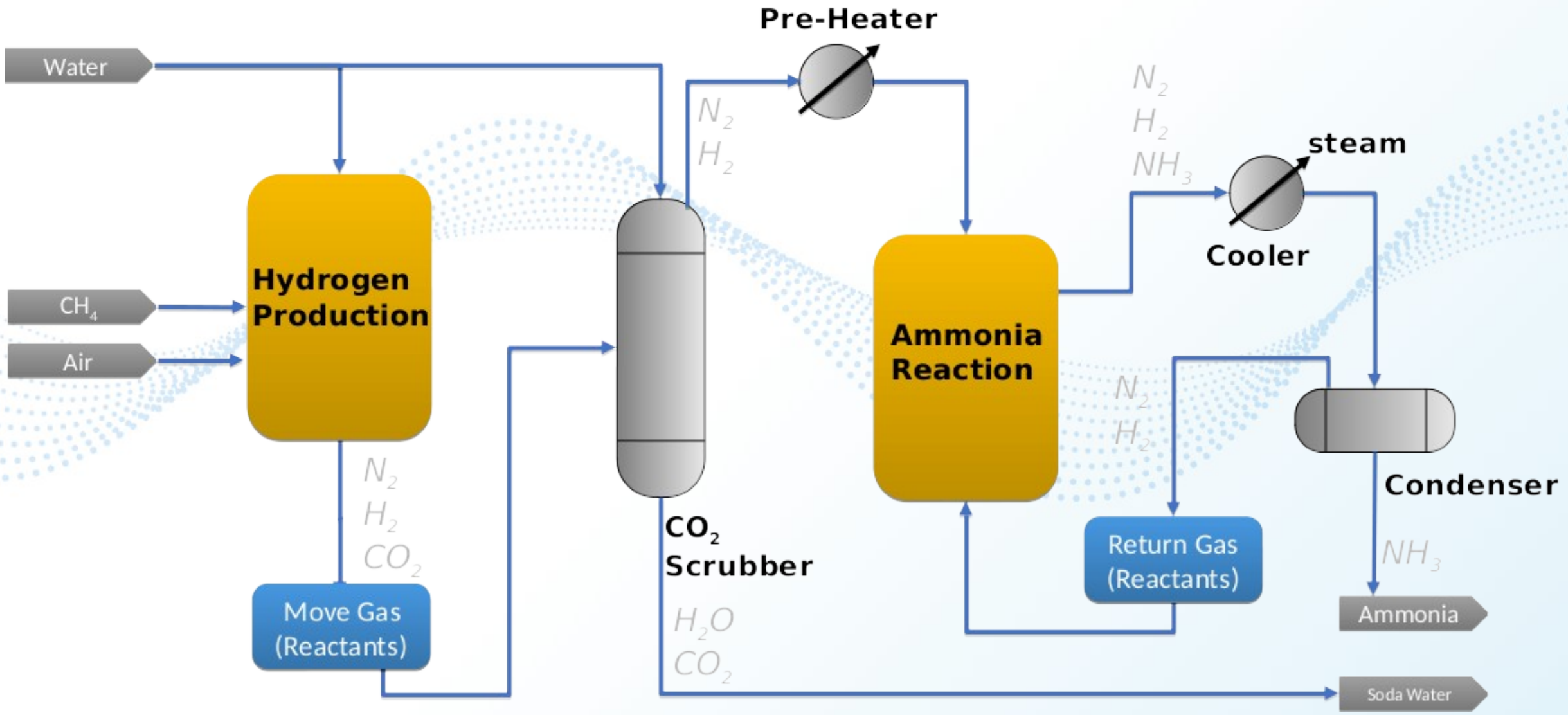
Move a fluid (liquid/gas) from one place to another.

Think pipes, pumps & compressors, etc.

Driving force: “pressure” difference.

Source: https://pixabay.com/photos/oil-oil-rig-industry-oil-industry-3629119/

Ammonia Production



2-Heat Transfer

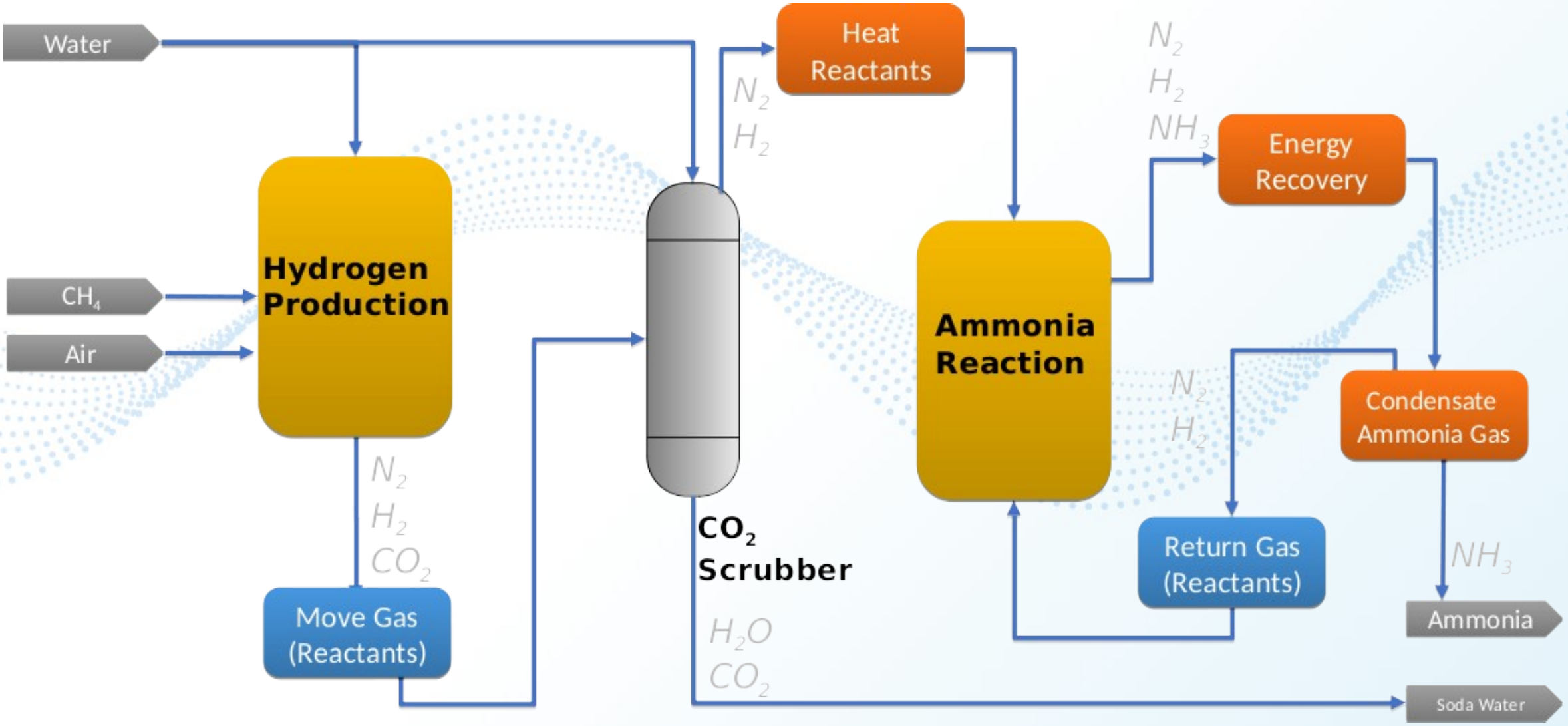
Source: https://pixabay.com/photos/abstract-blaze-bonfire-burn-1868624/

Change in temperature (heating or cooling).

Think heat exchangers (with different names based on intent: boilers, condensers, etc.)

Driving force: “temperature” difference.

Ammonia Production



3-Mass Transfer

Move components within one phase or to another phase (liquid-> liquid, gas->liquid, liquid->gas, etc.).

Think columns (towers): distillation, absorption, liquid extraction, etc.

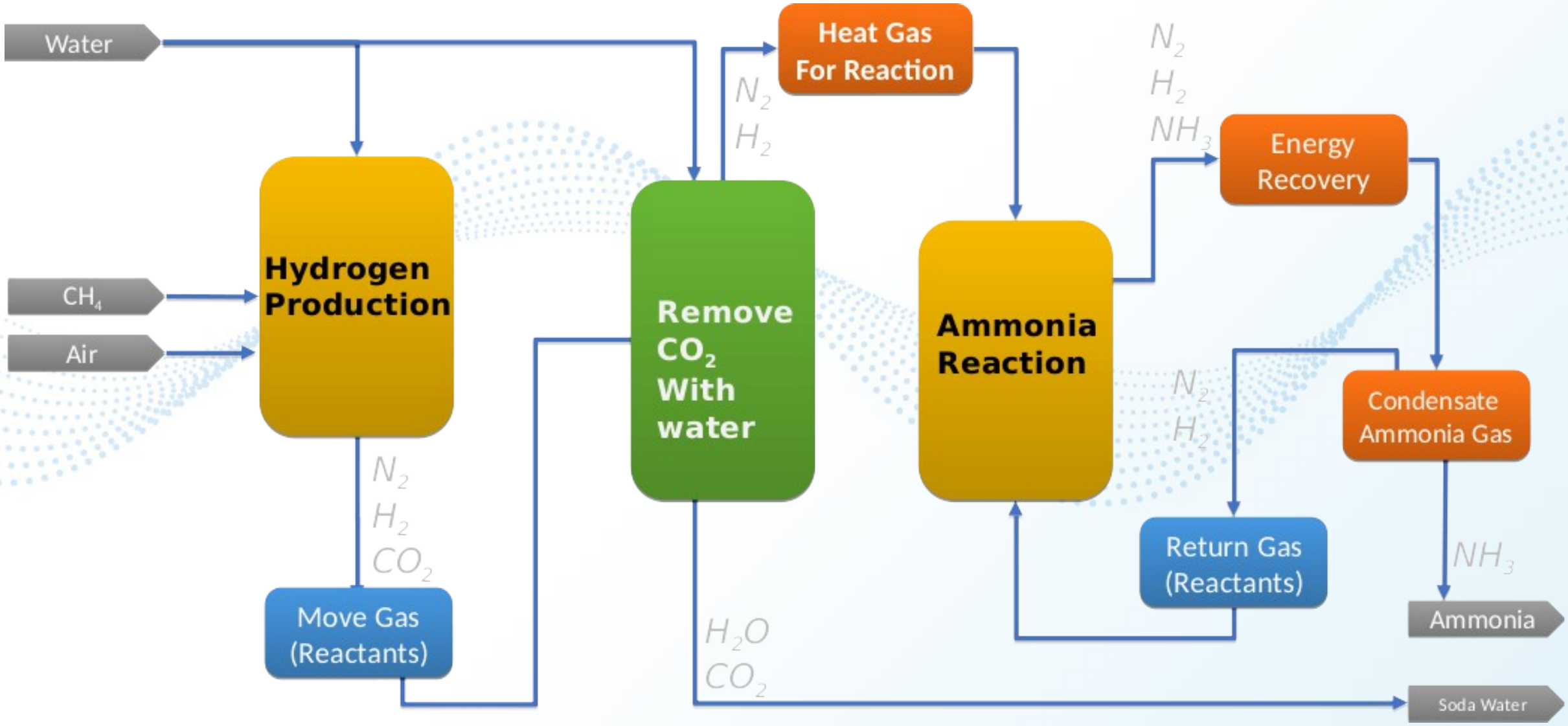
Driving force: “concentration” difference.

Source: https://pixabay.com/photos/mie-prefecture-oil-factory-1362785/

Day to day examples of mass transfer

- ✓ Fragrance moving from one room to another in the house
- ✓ Few drops of dye in water -> after a while, we would get a uniform colour
- ✓ Reducing a sauce -> evaporate the water from the sauce (remove water leaving “heavier” components)

Ammonia Production



4-Operations involving solids

Source: https://pixabay.com/photos/machine-crusher-coal-mining-3037669/

Size reduction, screening, and separation of solids.

Think crushers, grinders, screens, centrifuges, filters (including some membranes), etc.

Ammonia Production

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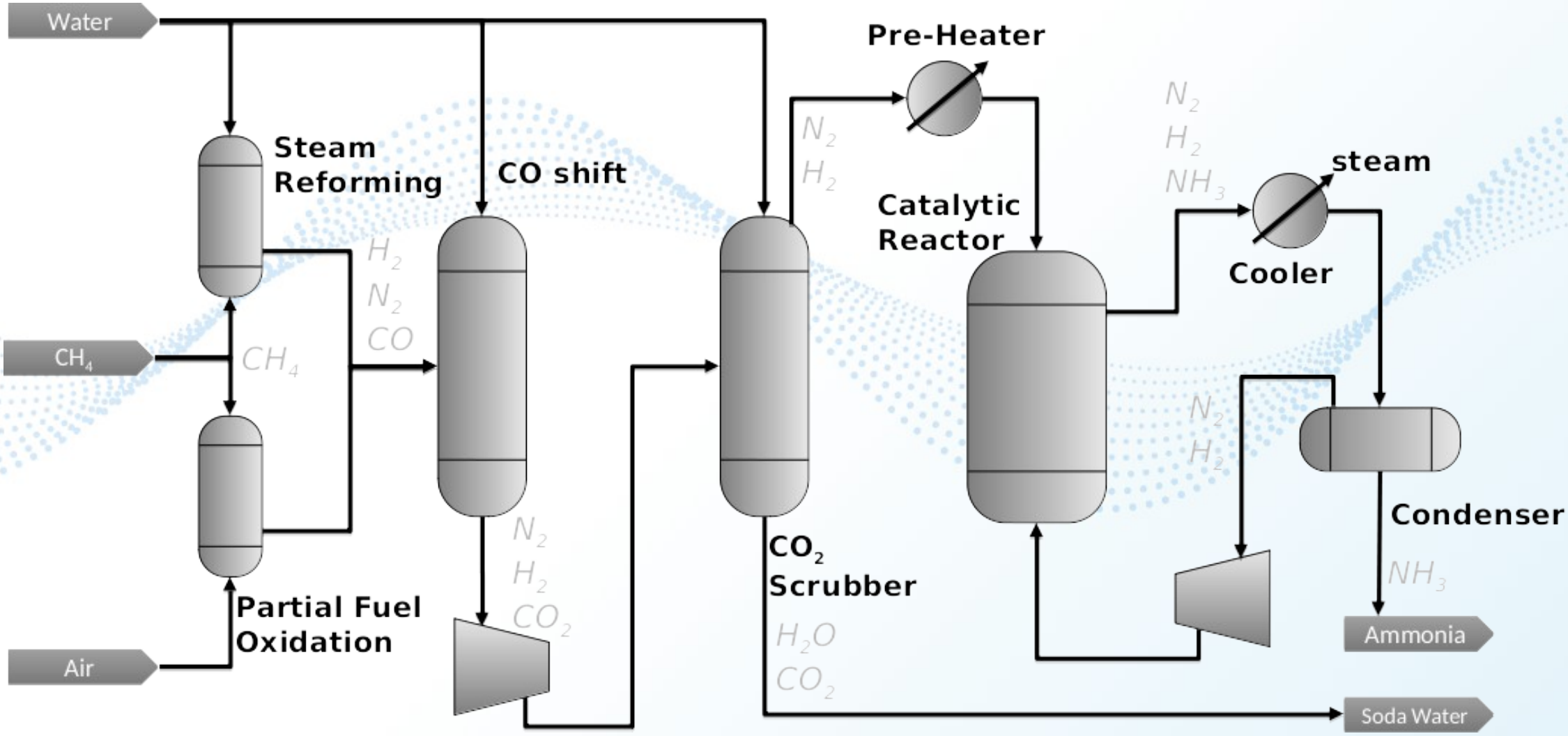
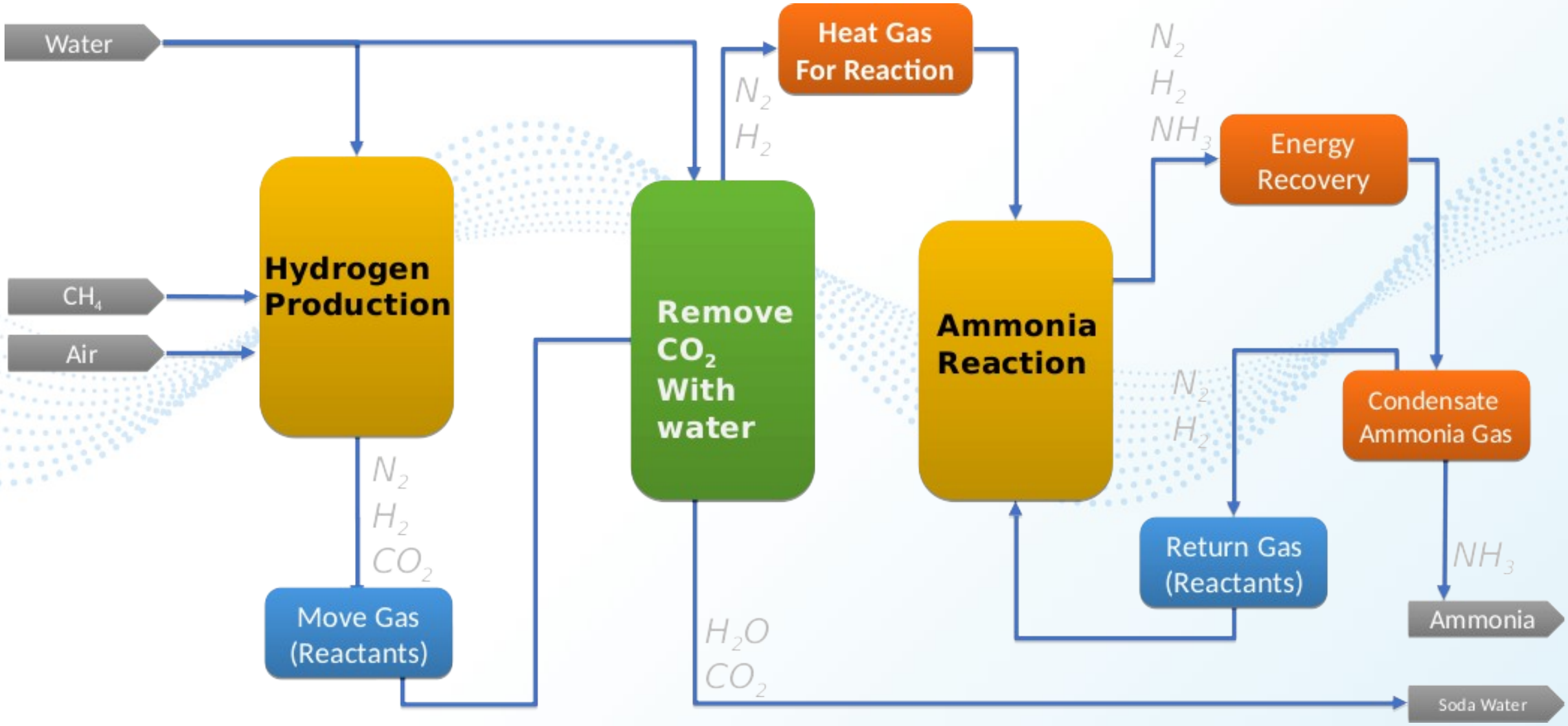


Ammonia Production



3rd Diagram: Block Flow Diagram

- ✓ Not exactly Unit Operations, but **very** simplified
- ✓ The first diagram developed by process engineers
- ✓ **Thousands P&IDs -> Hundreds PFDs -> Tens BFDs**

Normally not included with engineering deliverables. However, there are good chances that your fellow Process Engineer has one. Just ask.

Key Takeaways

- It is essential to know your “**business**”. It could be the key to open several doors in your company
- There are thousands of complex processes, but a few basic building blocks
- There is a **THIRD** Process diagram: BFD

Thank you

lijantropique@protonmail.com