# Novel technologies for integrated biogas separation and compression

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## Introduction

Biogas upgrading and the production of biomethane nowadays is a state-of-the-art-process of gas separation. A number of different technologies to fulfil the task of producing a biomethane stream of sufficient quality to act as a vehicle fuel or to be injected into the natural gas grid are already commercially available and have proven to be technically and economically feasible. Nevertheless, intensive research is still in progress to optimise and further develop these technologies as well as to apply novel technologies to the field of biogas upgrading.

| Parameter | Biogas | Landfill gas | Natural gas |
|---|---|---|---|
| Methane [vol%] | 60-70 | 35-65 | 89 |
| Other hydrocarbons [vol%] | 0 | 0 | 9,4 |
| Hydrogen [vol%] | 0 | 0-3 | 0 |
| Carbon dioxide [vol%] | 30-40 | 15-50 | 0,67 |
| Nitrogen [vol%] | up to 1 | 5-40 | 0,28 |
| Oxygen [vol%] | up to 0,5 | 0-5 | 0 |
| Hydrogen sulphide [ppmv] | 0-4000 | 0-100 | 2,9 |
| Ammonia [ppmv] | up to 100 | up to 5 | 0 |
| Lower heating value [kWh/m³(STP)] | 6,5 | 4,4 | 11,0 |

Table 1: Typical gas compositions of biogas and landfill gas and these values are compared to natural gas

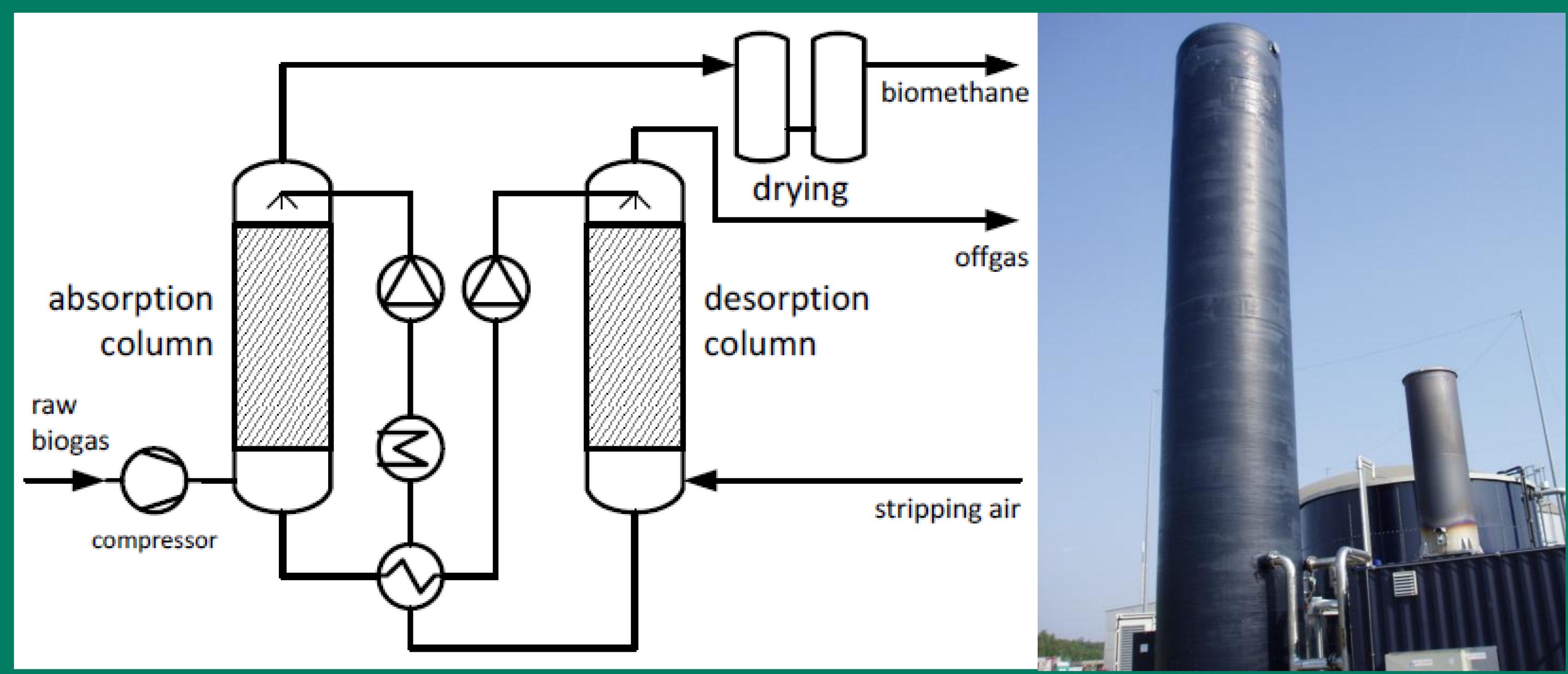



Figure 2: Flowsheet of a typical biogas upgrading unit applying pressurised water scrubbing; picture of the upgrading plant Könnern, Germany with a raw biogas capacity of 1250m³/h (Source: Malmberg)

## Experimental:

The aim of this project is to explore an available way to separate $CO_2$ from biogas, I started with economical amine solutions, below is my synthesis system, $CO_2$ uptake ability of my alcohol amines is comparable with activated methyldiethanolamine.

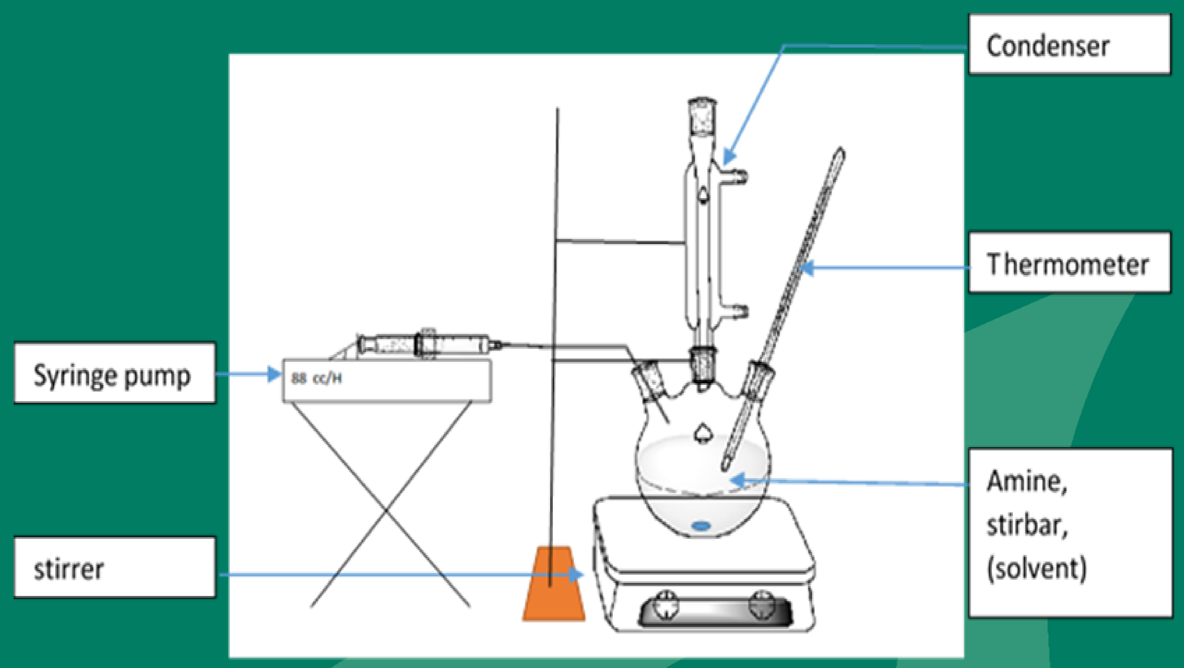
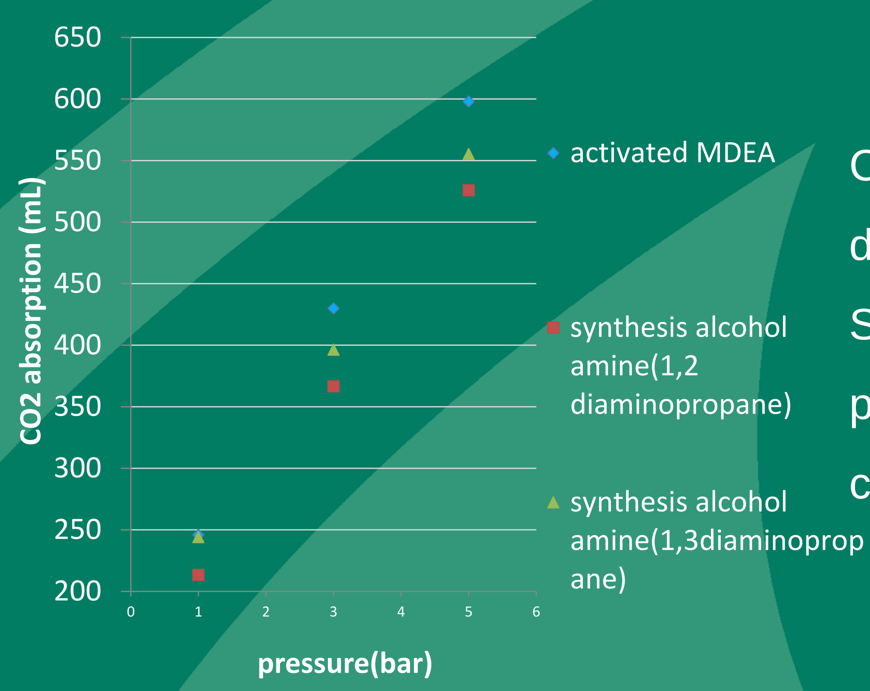



Figure 1:System for synthesis of alcohol amines




Compare with activated MDEA (Methyl diethanolamine) which is the benchmark, Synthesis acohol amine 1,2 diaminopropane and 1,3 diaminopropane show their comparable $CO_2$ uptake ability.

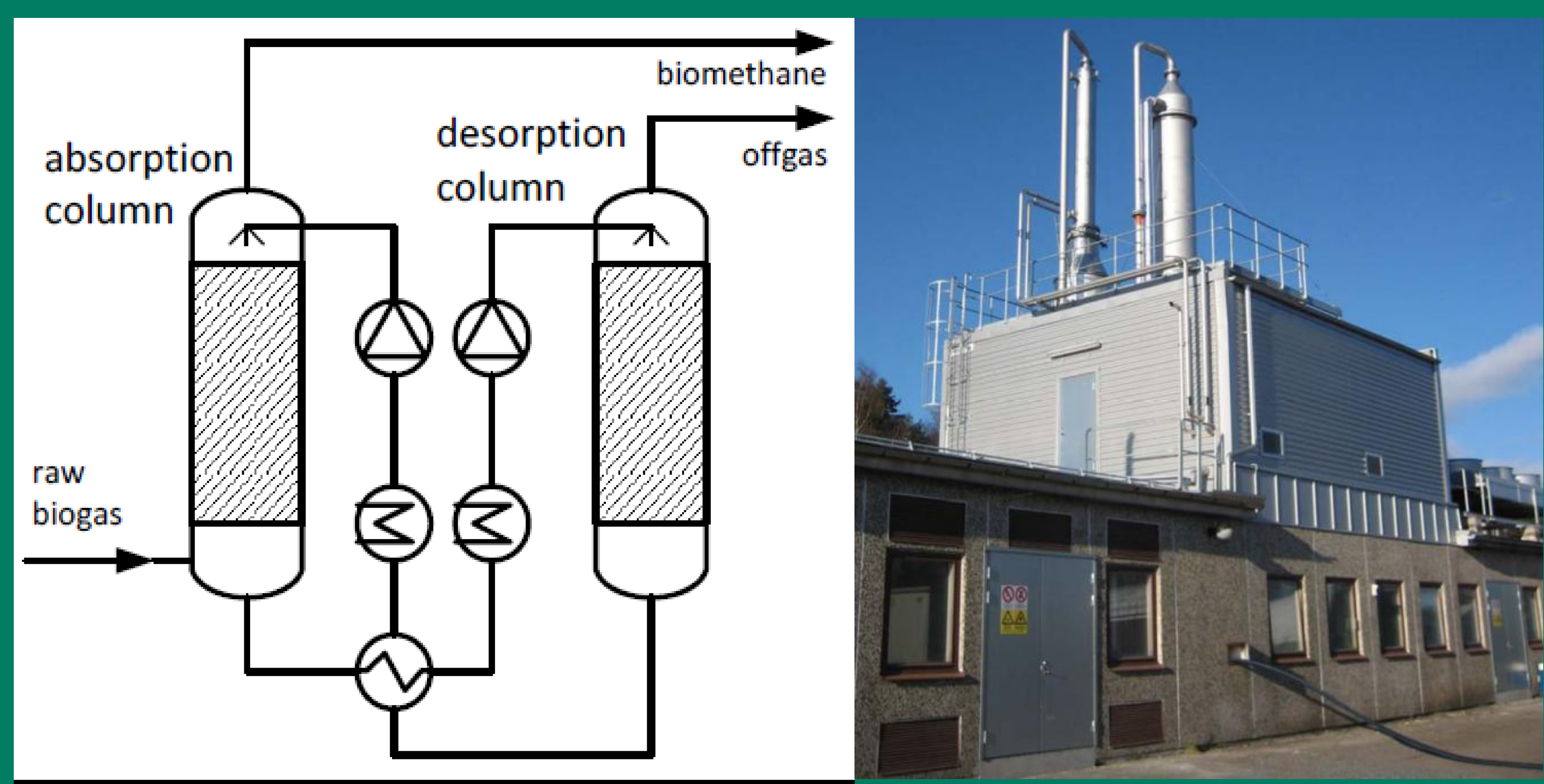



Figure 3: Flowsheet of a typical biogas upgrading unit applying amine scrubbing; picture of the upgrading plant Gothenburg, Sweden with a raw biogas capacity of 1600m³/h (Source: Cirmac)

## Biogas upgrading and biomethane production technologies

Nowadays, a number of different technologies for the major biogas upgrading step are commercially available. This major step comprises the drying of the raw biogas and the removal of carbon dioxide, and thus, the enhancement of the heating value of the produced gas.

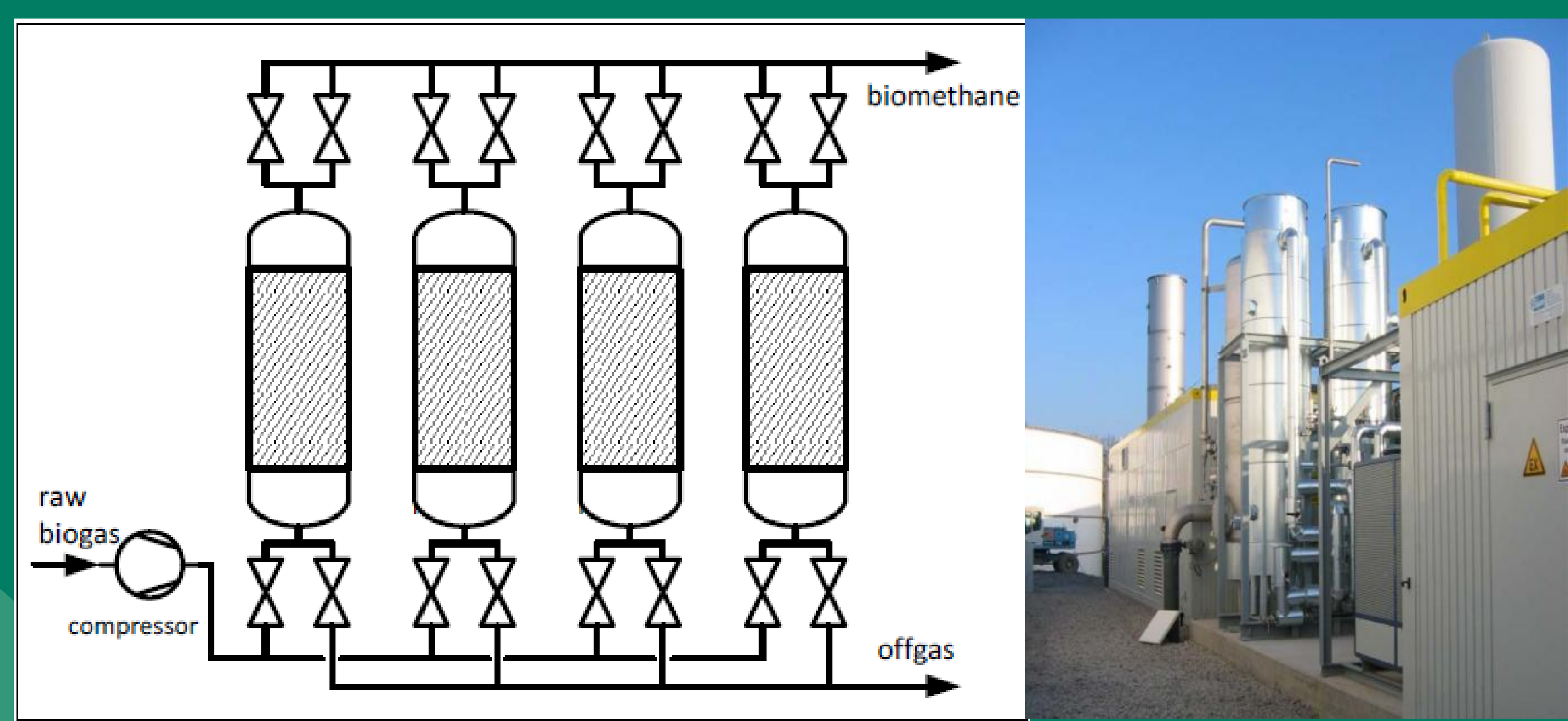



Figure 4: Flowsheet of a typical biogas upgrading unit applying pressure swing adsorption; picture of the upgrading plant Mühlacker, Germany with a raw biogas capacity of 1000m³/h (Source: Schmack CARBOTECH)

These proved technologies will be presented in the following section.

1. Absorption
1.1 Physical absorption: Pressurised water scrubbing (Fig2)
1.2 Organic physical absorption
1.3 Chemical absorption: amine scrubbing (Fig3)
2. Adsorption: Pressure swing adsorption (PSA) (Fig4)
3. Membrane technology: Gas permeation (Fig5)

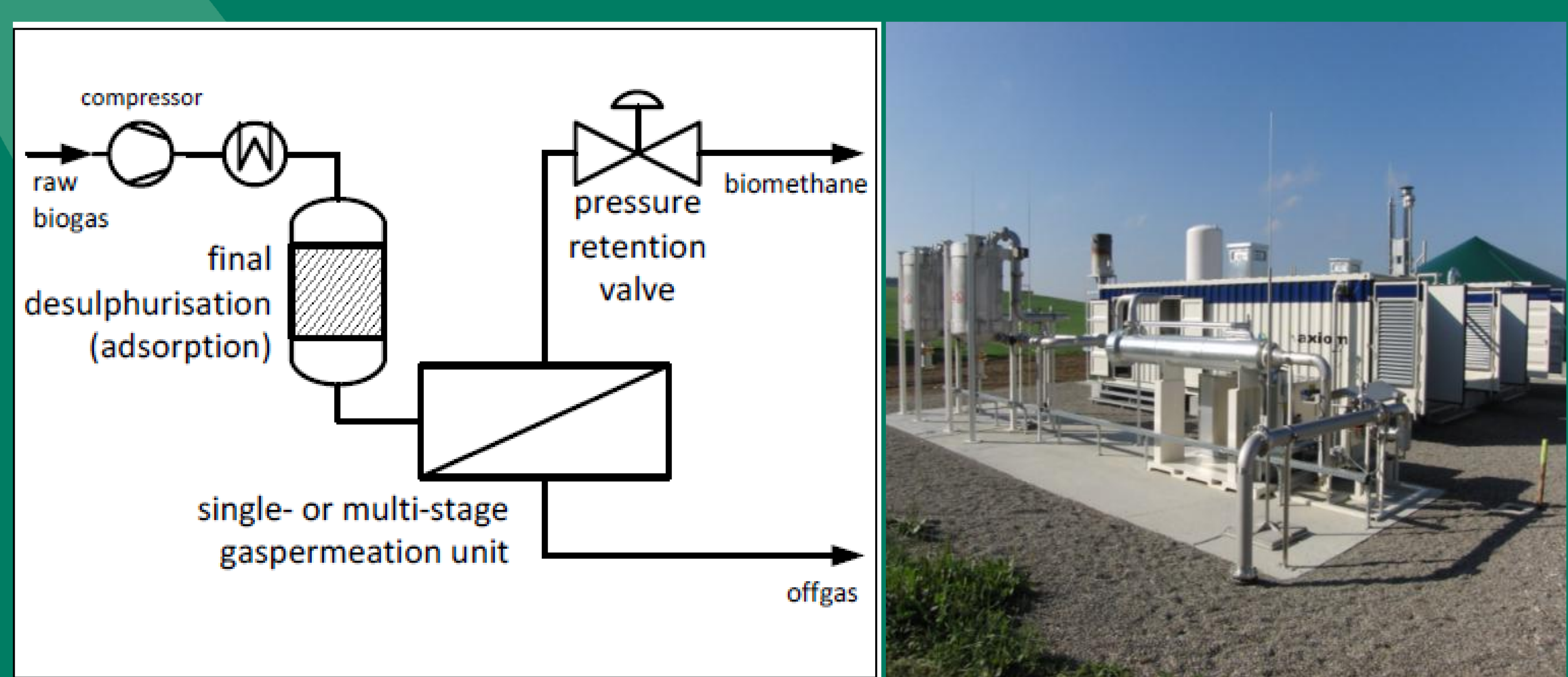



Figure 5: Flowsheet of a typical biogas upgrading unit applying the membrane technology gas permeation; picture of the upgrading plant Kisslegg, Germany with a raw biogas capacity of 500m³/h (Source: AXIOM Angewandte Prozesstechnik)

## Conclusion:

It is hard to give a universally valid comparison of the different biogas upgrading technologies because many essential parameters strongly depend on local circumstances. Furthermore, the technical possibilities of a certain technology (for example regarding the achievable biomethane quality) often do not correspond with the most economic operation. The technical development of most biogas upgrading methods nowadays is typically sufficient to meet any needs of a potential plant operator.

Reference: BIOGAS TO BIOMETHANE TECHNOLOGY REVIEW, VIENNA UNIVERSITY OF TECHNOLOGY (AUSTRIA)