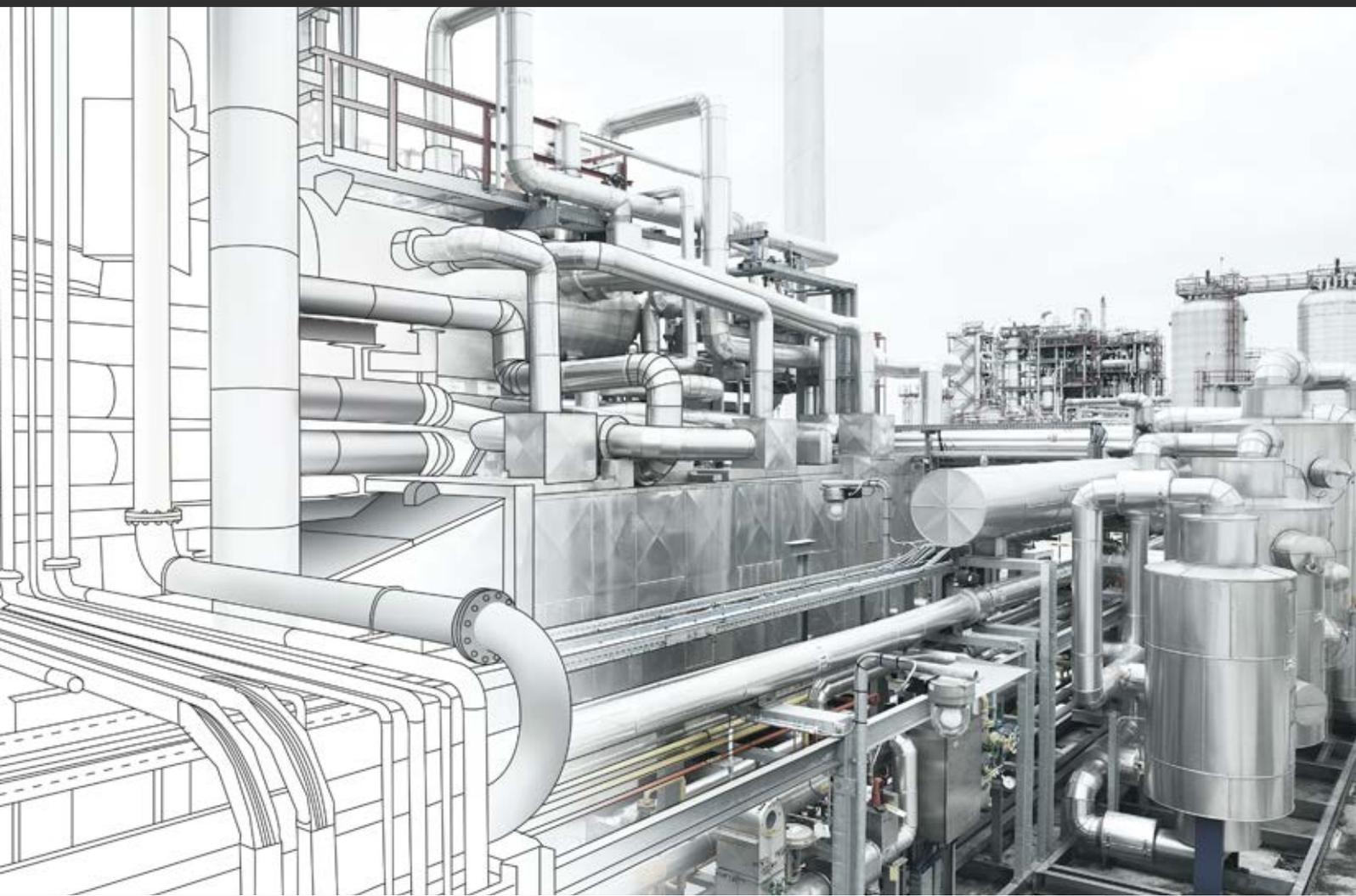




CUSTOMIZED QUALITY



CALORIC ANLAGENBAU GMBH

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CALORIC is one of the leading companies in Europe specialised in designing and manufacturing of gas generating plants and incinerators for chemical and pharmaceutical industries.

The company specializes in customer-specific, cost-optimized solutions. A key characteristic of the plants is their high level of prefabrication, which makes it possible to deliver and commission high quality plants in short time. The company is headquartered in Gilching near Munich/Germany. CALORIC was founded in 1965, originating from an engineering

consultant based in Munich since 1937. Since its foundation CALORIC has steadily accumulated a great wealth of unique technologies and know-how.

More than 500 plants of various types in all parts of the world proudly demonstrate CALORIC's high technical standard.



PORTFOLIO

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H₂ GENERATION PLANTS

CALORIC provides a wide range of processes to generate pure hydrogen (up to 99.9999 vol.-%) most economical for the customer. Depending on the availability and commercial attractiveness of different feed stocks, CALORIC is capable to provide plant designs based on natural gas, LPG, naphtha, methanol or hydrogen rich gases from several sources.

Besides the aspect of feedstock CALORIC's customised plants will follow customers' preferences in focusing on investment costs (CAPEX) and/or operational costs (OPEX). A variety of design and plant options will be

available to fulfill customer needs and requirements, e.g. minimizing feed stock consumption, maximizing steam by-product or highest thermal efficiency.



Methanol reformer for 840 Nm³/h hydrogen purity (99.9999%)



Steam reformer for 4000 Nm³/h hydrogen (purity 99,9%)

Syngas Plant for 1500 Nm³/h

SYNGAS GENERATION PLANTS

CALORIC has developed and supplied syngas generating plants based on the steam reforming HC process, the MeOH reforming HM process or the CALCOR CO generation process. Depending on the required H₂ to CO ratio, purity requirements and feed situation, various plant configurations are available.

Typically the syngas generation process is close to the conventional reforming processes. Depending on the specific requirements of the downstream process using the syngas for the final product, the H₂ / CO ratio is of major importance for process efficiency. Beyond the adaption of process parameters, e.g. reforming temperature and pressure, several selective process units can be implemented to achieve the requested ratio, e.g. shift reactors, CO₂ recycle or selective membranes.

The CALORIC reforming technologies provide optimized syngas generation systems capable to handle associated and stranded gas for GtL plants. Furthermore GtL plants provide specific challenges which are met by the well proven CALORIC reforming processes.

GAS PURIFICATION PLANTS

CALORIC offers several processes to purify gas streams most cost efficient for the customer (up to 99.9999 vol.-%). A variety of design options will be available to fulfill customer requirements, based on catalytic, absorptive and adsorptive processes as well as selective permeation.

A variety of design and process plant options will be available to fulfill customer needs and requirements, e.g. PSA or membrane.

Membrane Purification

Clean gas is generated by purification of the feed gas using membrane technology of globally leading suppliers. Depending on the required product purity and the efficiency, the systems including amount and configuration of membranes are arranged.

Pressure Swing Adsorption (PSA)

The feed gas passes the molecular-sieve PSA unit in which the hydrogen is isolated to the specified purity. The PSA unit separates the residual impurities from hydrogen at high-pressure level and it consists of 4/5/6 adsorber vessels with several layers of different adsorbents. At any time one adsorber vessel is active for H₂-production while the other 3/4/5 adsorber vessels are in different regeneration steps.



PSA unit for hydrogen purification in the Netherlands

Calcor® plant for 530 Nm³/h

CO-GENERATION PLANTS

The Calcor® standard process is a dry reforming process combined with a CO₂ recovery and a CO purification step. The feed (either natural gas or LPG) is mixed with CO₂. Whilst passing the catalyst in the reformer, the mixture of CO₂ and feed is converted into a CO-rich syngas.

After leaving the reformer, the syngas is cooled to ambient temperature prior to undergoing the CO₂ removal and recovery. In this process step the CO₂ from the reformer flue gas as well as the CO₂ from the syngas is absorbed in packed towers by an amine solution (MEA). In a stripping column, the CO₂ is separated from the scrubbing liquid and recycled back to the reforming process. The syngas which typically consists of 70 % by vol. CO and 30 % by vol. H₂ and still carries traces of CO₂ and CH₄ enters the CO

purification step. The selective properties of membranes make it possible to simultaneously separate H₂ and CO₂ from the CO product, which results in a simplified design of the Calcor® process. In this “economy” version of the Calcor® process, the CO₂ recovery is eliminated and imported CO₂ is used instead of recovered CO₂.



Amine recovery skid during manufacturing

GAS SWEETENING PLANTS

With the SCB process, carbon dioxide (CO₂) and/or hydrogen sulphide (H₂S) are removed from gas streams. The SCB process is designed for gas sweetening at highest efficiency from various sour gases using aqueous amine solutions (e.g. MEA or MDEA).

CO₂ and/or H₂S rich carrier gas is sent to the absorber. The absorber is designed as packed tower with an aqueous amine-solution as scrubbing liquid. Downstream of the absorber a demister is installed to avoid droplet entrainment into the treated gas.

The sour gas enriched amine-solution from the bottom of the absorber column is led to the regeneration unit prior passing a heat exchanger for preheating. The regeneration unit comprises the stripper and the reboiler. The stripper is designed as packed tower with

a demister on top. The rich solvent is regenerated using the steam produced in the reboiler. The stripped CO₂ and/or H₂S is cooled in a heat exchanger before vented to the atmosphere.

The lean solvent out of the stripper is cooled down and anti-foam is dosed before pumping it back to the absorber. Before entering the absorber the lean solvent is partly sent to an activated carbon filter unit to remove degradation products of the amine-solution and other impurities if any.

PILOT/DEMONSTRATION PLANTS

CALORIC's strength is gained from more than 50 years' experience in the design of small scale and modularized industrial process plants according to actual customers requirements. Our strength includes the management of such complex projects while providing a highly but not over-engineered product to the customer.

CALORIC's design team is prepared to focus on

- High reliability by industrial design
- Operability and maintainability
- High operational flexibility
- Economically feasible solutions
- Programming and measurement ensuring enhanced data analysis
- Fast and easy installation "plug and play"



CO₂ removal within bio DME demonstration plant



Skid mounted steam boiler is placed on prepared foundation

WASTE HEAT MANAGEMENT SYSTEMS

CALORIC has acquired indepth know-how on waste heat management systems with the implementation of steam boilers into syngas generating plants and into hazardous waste incinerators.

Based on this know-how, CALORIC is in the position to offer individual waste heat management systems to the market as standalone product. Our emphasis is on the

non-standard applications with requirements on special process conditions as well as extensive equipment specifications.

ENGINEERING

Since the company's foundation, CALORIC has extensive experience in process development and engineering to supply clients with the most suitable solutions.

CALORIC offers the full range from first feasibility studies to entire detail engineering packages. The processes and technologies offered by CALORIC are proprietary and have been developed in-house. To maintain the competitive edge, permanent research and development activities are going on.

Depending on clients request CALORIC will design and engineer according to major European, American and Asian standards and codes, as well as to clients engineering specifications, e.g. world class chemical companies, oil & gas companies and globally operating EPC companies.



Valve skid



Mechanical revamp

SERVICE

One of CALORIC's strengths is the support of our clients over the total lifetime of their plants.

CALORIC provides services throughout the plant life cycle. The various services will start from turnkey erection and comprises also operator training, optimisation of the process as well as complete maintenance schedules or revamp services.

- Spare parts supply
- Operator training
- Process optimization

- Remote services
- Approval management
- Maintenance
- Revamps (process, mechanical, electrical)

CALORIC develops project specific schedules to get the job executed on time and within budget.



Natural gas steam reformer capacity 1750 Nm³/h during erection

DESIGN CONCEPT: MODULAR SKID CONSTRUCTION

A key component and basis for fixed prices and short delivery times is the successful modular design concept of pre-manufactured skid-mounted equipment for CALORIC's various types of plants.

Due to this modular design concept the skids can be fully pre-fabricated and pre-assembled in CALORIC's own factory. This includes fabrication, assembly, painting and cabling of the skids. To ensure highest quality, the entire

fabrication process is permanently controlled according to the quality management system and finalised by the FAT (factory acceptance test).

DESIGN CONCEPT – PROCEDURE

Step 01



Pre-manufacturing of skid in CALORIC's production facility

Step 02



Pre-assembly of the plant in CALORIC's production facility

Step 03



Factory acceptance test in CALORIC's production facility

Step 04



Easy transportation of container adapted modules

Step 05



Placement of skid on prepared foundation

Step 06



Assembly of the plant at site

Step 07



Start-up of the plant

PORTFOLIO

Caloric is one of the leading companies in Europe specialised in designing and manufacturing of gas processing plants, as well as related engineering services and system supply.

 H₂ Generation Plant	200 to 13.000 Nm³/h
 Syngas Generation Plant	200 to 21.000 Nm³/h
 Gas Purification Plant	100 to 20.000 Nm³/h
 CO Generation Plant	50 to 1600 Nm³/h
 Gas Sweetening Plant	up to 30.000 Nm³/h carrier gas steams
 Pilot/Demonstration Plant	
 Waste Heat Management System	up to 25 MW
 Engineering	
 Plant Revamping	

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