FLEXIGREEN®

METHANOL

BioFLEX

Casale's sustainable loop for bio-Methanol

CASALE

We are a global partner
in the chemical industry,
offering **integrated technologies, engineering, contracting and construction solutions**
for over a century.

Our mission

Contribute to shape a new sustainable planet with our plants for the production of fertilizer, methanol, hydrogen, melamine and derivatives, and help our customers creating value respecting the environment.

We are a global company front leader in the energy transition: a key player in the sustainable transformation of the chemical and energy industry, from a social, economic and environmental point of view.

Our values

INNOVATION PEOPLE CARE **PROFESSIONAL EXCELLENCE**
QUALITY **SAFETY** ETHIC **SUSTAINABILITY**

BioFLEX

As we embark on the journey to discover more environmentally responsible methods for producing essential base chemicals, renewable methanol derived from biomasses is gaining prominence as a feasible alternative to the conventional approach that relies on fossil fuels. Its distinct advantage lies in its capacity to significantly reduce carbon dioxide (CO_2) emissions, making it an attractive and sustainable option for meeting our chemical production needs.

Capacity

- Up to **2500 MTD** in a single line

Performances (With ATR integration)

- Carbon efficiency ($CH_3OH/(CH_4+CO+CO_2)$): **+93%**

Enviromental Impact

Total CO_2 emissions per ton of methanol produced:
• 0.1

ATR fired heater NOx emissions:
• less than 140 mg/Nm³

With the addition of a Selective Catalytic Reduction stage (SCR):
• less than 20 mg/Nm³.

Casale bio-methanol plant's carbon intensity compared to coal and NG-based plants:

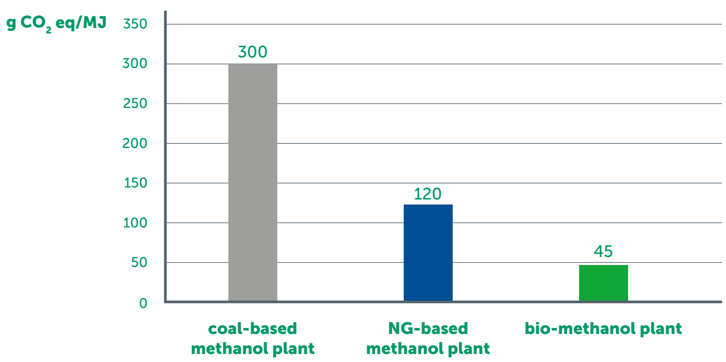


Fig. 1
Bio-methanol plant carbon intensity compared to coal and NG-based plants:
- methanol production increase: + 30%
- carbon efficiency increase: +30%
- specific CO_2 emissions decrease: - 80%

Casale technical assets

- CO-shift conversion section (located upstream methanol synthesis section)
- ATR section
- IMC® methanol converter

CASALE APPROACH

In biomass-based methanol plants the composition of the raw synthesis gas can be characterized by:

- high content of carbon oxides and methane
- deficiency of hydrogen, making it suboptimal for methanol synthesis.

To re-balance the gas composition, specifically the stoichiometric ratio, and thereby enhance the methanol yield, Casale recommends implementing the following steps or a combination of them:

- add a Casale Axial-Radial® CO-shift section and an acid gas removal stage in the front-end section. Both enhance the H_2 yield and reduce the excess CO_2 content
- add green or low carbon hydrogen (if available) in such a way to take advantage of all the carbon oxides contained in the raw syngas
- install a Hydrogen Recovery Unit (HRU) to recover a significant portion of the hydrogen present in synthesis loop purge
- add a steam-oxygen Auto-Thermal Reforming (ATR) section on the tail gas of the HRU purge gas section to transform the unreacted methane present in the make-up gas, when it exceedes 5% into valuable syngas, thus improving the overall carbon efficiency of the methanol synthesis process.

PROCESS OUTLINE

COMPRESSION

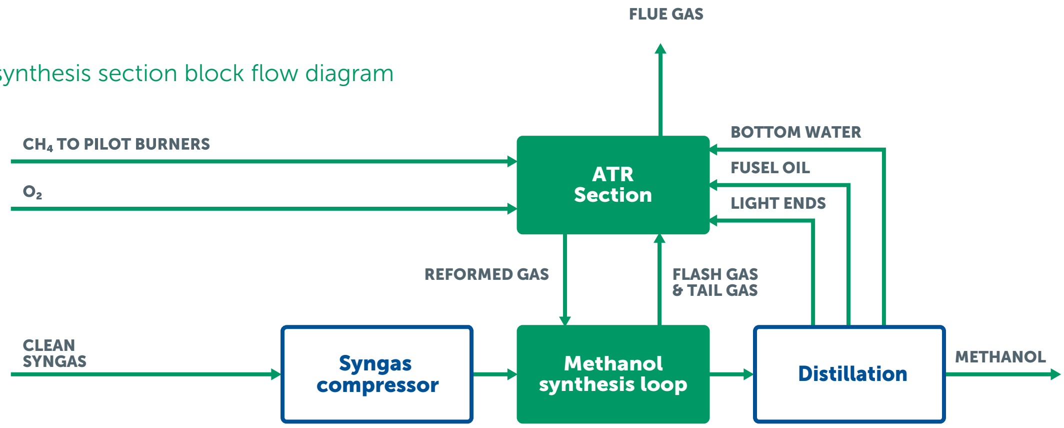
The fresh make-up gas from upstream units is mixed with the hydrogen rich streams coming from Hydrogen Recovery Unit (HRU) and, if present, in the ATR section and, after compression, is sent to a catalyst guard bed where sulfur compounds, still present in the make-up gas from upstream units, are removed.

METHANOL SYNTHESIS

The compressed stream is mixed with the loop's recycle gases at the discharge of the circulator and routed to the converter feed/effluent heat exchanger where it is heated up to converter inlet temperature.
The preheated feed gas enters the highly efficient Casale IMC® converter (Isothermal Methanol Converter). A notable feature of this patented design is its array of proprietary, heat-exchanging plates. These plates are embedded in the catalyst and serve the essential function of removing the reaction heat by generating medium-pressure steam through a circulation of hot boiler feedwater within the plates. The paramount advantage of this configuration lies in its ability to maintain the catalyst temperature at a nearly constant level, closely aligned with the optimum value for methanol synthesis.

Fig. 2

Methanol synthesis section block flow diagram



REACTION HEAT RECOVERY AND METHANOL SEPARATION

The hot effluent from the converter is firstly routed to the feed /effluent heat exchanger, then to the distillation's topping column reboiler and finally to the trim condensers where final condensing temperature is reached.
The crude methanol is separated in the high-pressure separator, then is let-down to the low-pressure separator where the dissolved vapors are washed by a stream of water and methanol from purge gas washing column. The flash gases from the low-pressure separator are used as fuel outside battery limits or in the ATR section, while the crude methanol is sent to the distillation section.
From the high-pressure separator, the vapors containing non-converted reactants are recycled back to the synthesis loop through the syngas compressor circulator. A stream of purge gas is removed from the recycle gas to control the inerts' concentration in the synloop and it is washed in column by a stream of bottom water from the distillation section to recover the traces of a methanol. The washed purge gas from the top of the column is sent to the HRU unit to recover as much as possible of the hydrogen, which is recycled back to the synthesis gas compressor suction. The tail gas from HRU unit is sent, as feed, to the ATR section , which is present only in case of high methane content in the fresh make up gas, otherwise it is sent as fuel outside battery limits.

ATR SECTION

The O_2 blown ATR converts the unreacted methane in the syngas generating additional H_2 and carbon oxides. It comes with:

- a gas saturator to recover, as process steam, the distillation bottom water and the process condensate
- a fired heater to preheat the ATR's feed as well as to generate and superheat steam.

DISTILLATION SECTION

The crude methanol is finally purified in a two-columns distillation section, fully integrated with synloop to maximize the relevant heat recovery. It must be underlined that the steam produced by the IMC® reactor together with the steam produced by ATR section covers widely the distillation demand. It is matter of overall complex steam net balance to rely, for distillation reboilers, on low pressure steam import or on internally produced steam.
A distillation section based on three columns can be applied, if required, to enhance further the steam consumption.

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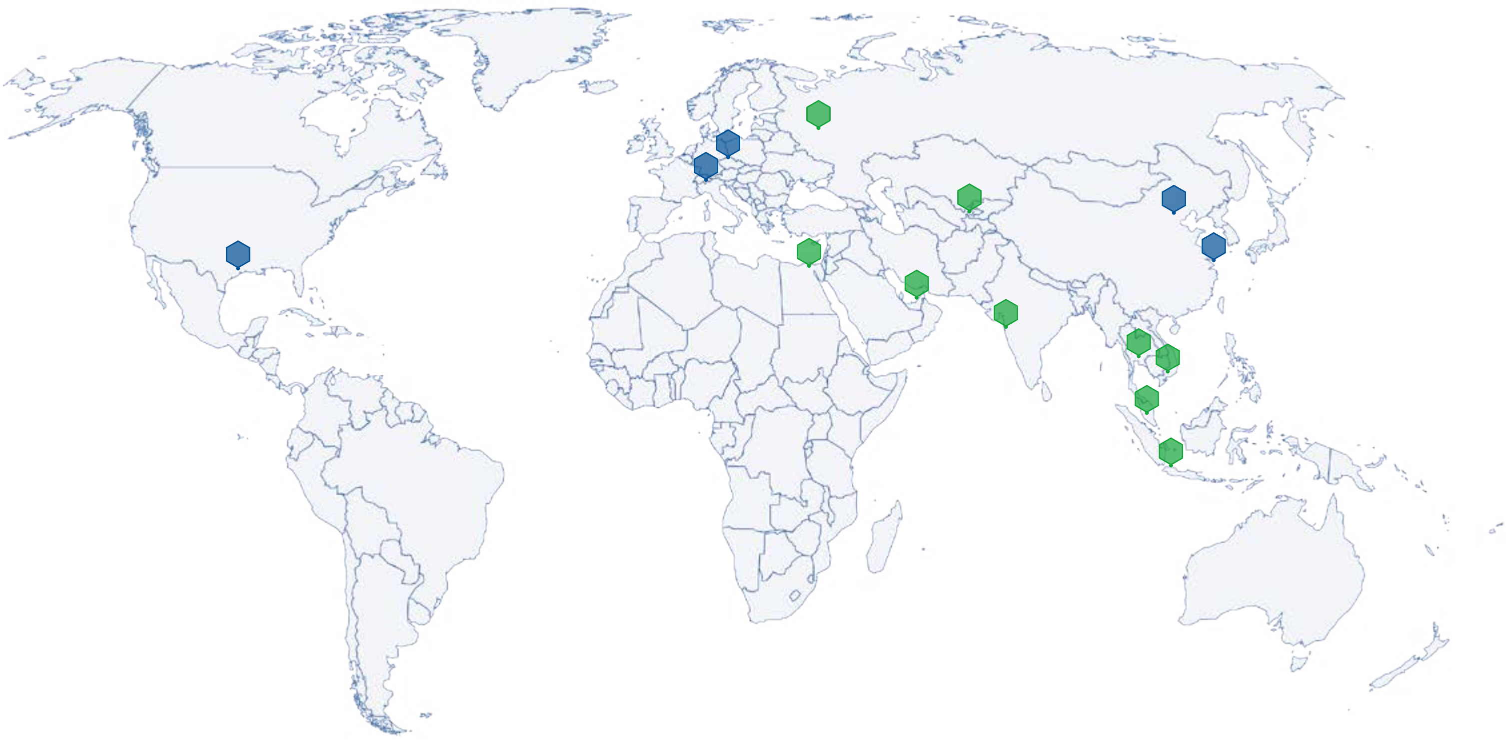
PLANTS FOR
A NEW PLANET.
SINCE 1921.

Casale in the world



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