Where energies make tomorrow

Pure.rGas™ by T.EN

# Pyrolysis Gas Product Purification for Steam Cracker Integration

Technip Energies is committed to defining solutions to make the circular economy a reality. Thus, we have been developing a resilient and flexible purification and upgrading train for pyrolysis gas produced from plastic waste. Our technology enables to offer to the market a licensed process that allows integration within steam cracker for final olefins, butadiene and aromatics recovery.

Mechanical plastic recycling has certain shortcomings, such as its inability to handle all types of plastic waste and to ensure virgin quality of recycled products.

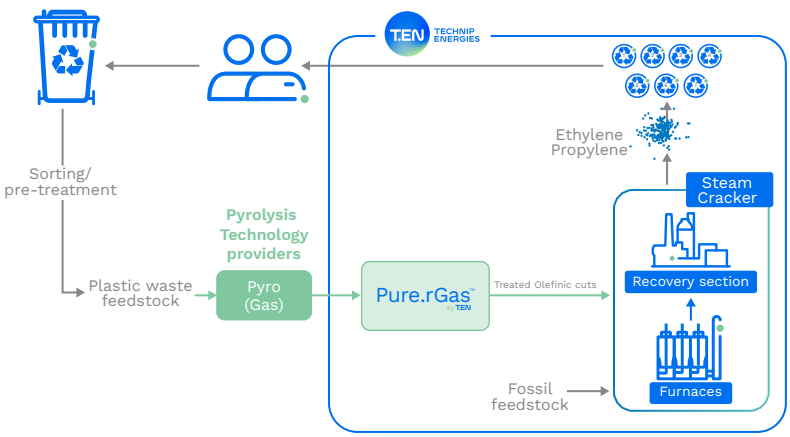
Pyrolysis of plastic-rich waste can overcome these limitations and thus ensures true circularity once the associated products can be successfully processed in steam crackers.

## Pyrolysis Gas technologies: Key differentiators and benefits

Among all the advanced recycling techniques using concept of pyrolysis of plastic waste in the absence of oxygen, the ones exporting product gas present some significant differentiators for integration with a steam cracker or refinery. The best in class pyrolysis gas technologies offer a high light olefins content which allows a cracker integration directly within the recovery section of the plant. The by-pass of furnaces enables:

- An attractive carbon footprint
- A plastic based feedstock that can act as olefins capacity adder and not only as fossil feedstock replacement.

## A true circular economy thanks to Technip Energies' Pyrolysis products purification trains




Pure.rGas purification and upgrading train ensures adequate feed preparation that enables a safe cracker integration. The design is flexible to different pyrolysis technologies and to any kind of crackers (gas or liquid cracker / front-end or back-end hydrogenation scheme). The selected process scheme benefits from:

- Key Know-how brought by our unique expertise in both ethylene technology and Refinery Off Gas (ROG) treatment technology which faces similar purification challenges
- Processing steps already proven in industry at large scale, as demonstrated by our proven track records in ROG projects
- Well established relationships with the key adsorbent suppliers
- Flexibility and resilience towards potential pyrolysis gas product fluctuations
- Multiple synergies with cracker

For the benefit of operating companies, customized solutions leading to define the best integration scheme for a given ethylene plant are optimized on a case by case basis.

# Plastic Pyrolysis based gas and olefins recovery: Feedstock definition, key challenge and purification strategy

Integration of pyrolysis gas products issued from plastic waste into existing steam crackers or standalone ethylene recovery units is a challenge that needs to tackle the dual concern of being able to capture the high value compounds while managing the presence of contaminants.

The high value compounds inherently present in the product gas are ethylene, propylene, butadiene and BTX. Paraffins will act as an olefins yield booster once recycled to extinction together with usual cracker recycles. Light end fraction is a mixture of methane, hydrogen, and nitrogen. At the same time, a various range of contaminants prone to induce negative effects on the steam cracker needs to be mitigated (NOx, CO, metals, chlorides, HCN, acid gases, oxygenates, sulfur compounds, ...).

The purification strategy consists of a dedicated multilayer contaminant removal scheme with several level of safeguard for key components like carbon dioxide, hydrogen sulphide, ammonia, chlorides, oxygenates, metals, ...

It maintains the operability of the steam cracker unchanged by allowing:

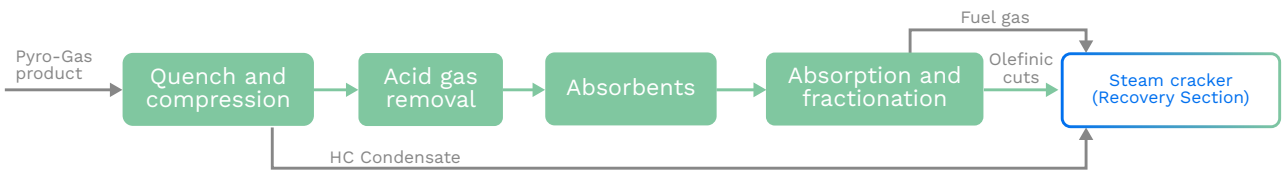
- the mitigation of fouling and corrosion issues
- a final on-specification product
- poison free operation of ethylene plant catalysts

# Ethylene plant safety: Primary driver for Pure.rGas

To ensure safe operation of the ethylene plant, a liquid absorption of light ends to fractionate the light components (including NO and CO) from the main olefinic streams is implemented. This feature is convenient for integration in any type of steam cracker arrangement:

- For front-end demethanizer scheme (back-end hydrogenation), the removal of nitrogen oxides (NOx) is mandatory before feeding the main cold box as one main concern with cryogenic recovery of ethylene is the hazard linked to the presence of NOx if mixed with butadiene and/or NH3. These compounds create solids (NOX gums/salts) at very cold temperature (especially below -100°C) which can then explode when reheated. The absorption used in the Pure.rGas purification train is based on a liquid absorption taking places in mild cryogenic conditions which eliminates such risk.
- For front-end deethanizer or depropanizer scheme (front-end hydrogenation), the acetylene converter is quite sensitive to runaways in case of CO fluctuations. By its nature the pyrolysis product gas will undergo some fluctuations due to the variability of the waste being processed. It is then a must to ensure the integration of a CO-free olefin product to mitigate such kind of risk.

# Pure.rGas by T.EN Overall Block Flow




By essence the purification train is centralized with the ethylene plant that will then receive three types of purified products:

- Fuel Gas fraction which contains the light end like methane, hydrogen, nitrogen, CO, $O_2$, NO, ...
- Olefinic liquid fractions (one or several cuts) that contains ethylene, propylene, butadiene, C5- paraffins
- Hydrocarbon condensate cut that contains the BTX fraction

**MAIN UTILITIES FROM/TO CRACKER**

- Power
- Cooling Water
- LP Steam/Condensate
- C3R Refrigerant
- BFW
- PA/IA/Nitrogen
- Service Water
- Regeneration gas
- Flare Releases

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