

TURNING GREEN INITIATIVES INTO PROFIT

WTE | November 2020



Presentation Outline

1. Introduction of WTE
2. Our Solutions
 - Superflox™ Technology: Flameless Waste Gas Combustion
 - RPS™ Technology: High-Efficiency Particle Separator for LNG & LPG Capture
3. Summary

WTE Introduction

INNOVATION AND ENTREPRENEURSHIP

WTE was founded by experienced entrepreneurs with a multidisciplinary technical background in major oil and gas companies, offshore oil & gas equipment manufacturing, and large-scale solar developments.

Since its establishment, the company has been committed to the development and application of new technologies and cooperating with manufacturers and technical experts across various industrial fields.

The business scope of WTE includes R&D and manufacturing of equipment with focus on efficiency and environment, engineering and turnkey solutions.



WTE Team

EXTENSIVE MULTI-DISCIPLINARY EXPERTISE

SUPERFLOX™

Advisory Board



**Jeroen
van der Veer**

Former CEO of Shell



**Koos
Breen**

Former CEO of Van Leeuwen



**Xander
Tiedemann**

Co-Founder of WTE & Hofung Tech

WTE TECH

Core Team



**Jan
van den Berg**

Founder & CEO



**Kees
Onstein**

CFO & CCO



**Wang
We**

Technical Director

WTE USA

Core Team



**Martijn
van Koolwijk**

CEO



**German
Ramirez**

COO



**Kristiina
Unnuk**

VP Business Development

WTE Locations



WTE Patented Technologies

TURNING GREEN INITIATIVES INTO PROFIT

WTE offers proprietary and patented technologies aimed at increasing operational efficiencies and lowering negative environmental impact.

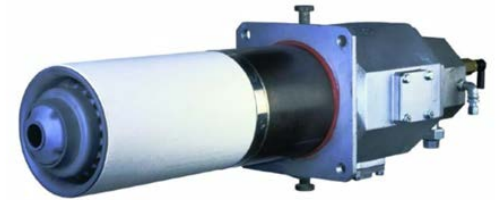
- **Superflox™ waste treatment technology** combines the Flameless Oxidation process with steam generation and proprietary gas management systems.

Maximum energy recovery | Zero emissions | Significant cost advantages

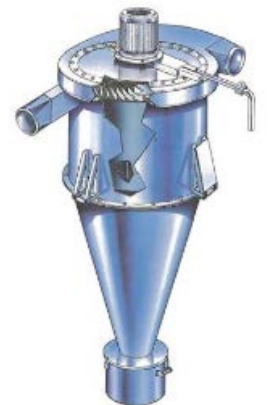
- **RPS™, or Rotational Particle Separator**, is based on the Joule-Thompson principle with the addition of the innovative cyclone-based LNG/LPG extraction process.

Minimum footprint | High efficiency LNG & LPG Capture

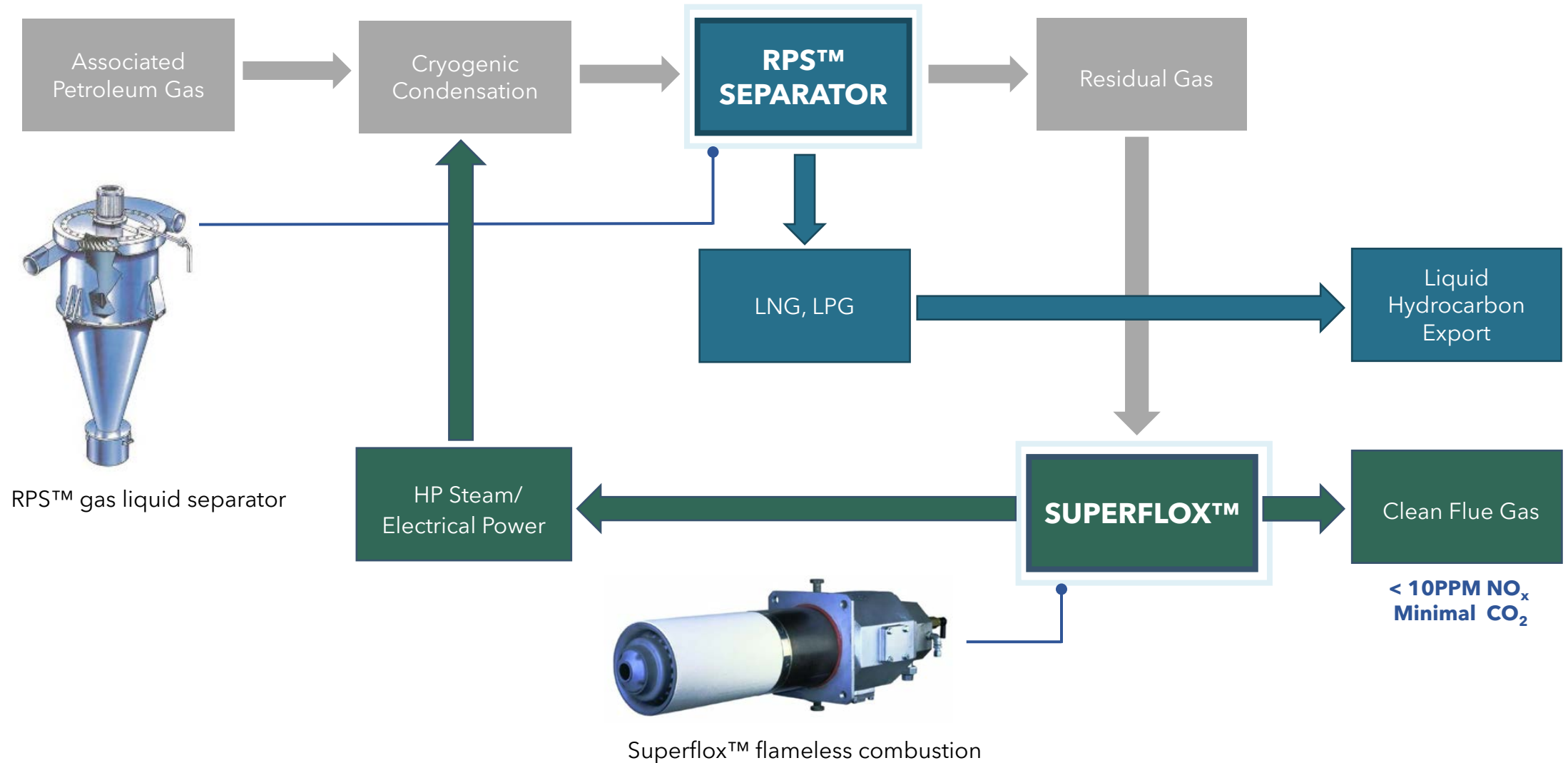
SUPERFLOX™



RPS™



APG Recovery With Minimum Emissions



SUPERFLOX™



SUPERFLOX™ Introduction

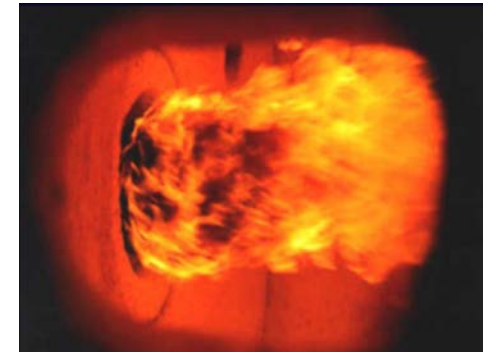
Superflox® is a proprietary technology, based on the well-established concept of Flameless Oxidation, (FLOX) discovered in Germany by Dr. Joachim Wünning in 1989.

A typical waste gas combustion process is associated with several inefficiencies:

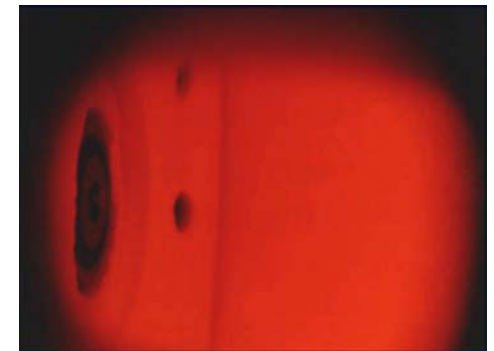
- High temperature combustion zone, resulting in formation of NO_x;
- Constant insertion of high-calorific gas (e.g. natural gas) is required to maintain the minimum heat content of the waste gas treated;
- Incomplete combustion resulting in formation of contaminants such as CO, SO_x and particle matter (PM).

In search for more efficient combustion technology, the phenomenon of flameless oxidation was observed, where under a certain set of conditions, full combustion of the fuel gas occurred while no flame was visible. It was also discovered in the process that the level of thermal NO_x emissions remained close to zero.

This discovery was the beginning of the Flameless Oxidation technology as a highly efficient and low-emission alternative to the conventional flame-based combustion technologies.



Conventional Flame



Flameless Combustion

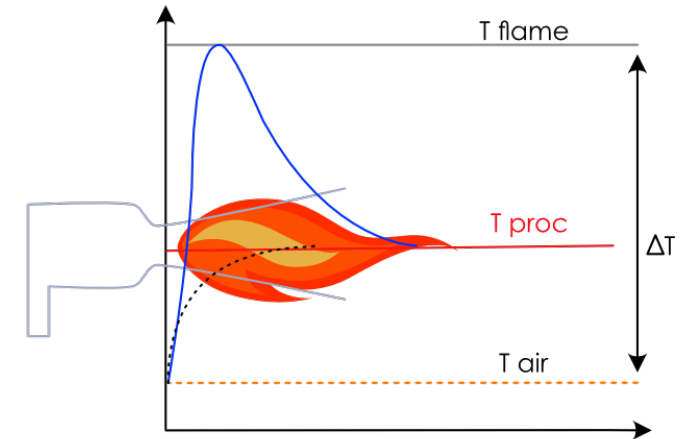
SUPERFLOX™ Key Characteristics

- Low calorific gases can be processed: minimum 1.5 MJ/m³.
 - Oxygen level in combustion chamber between 3% and 10%.
 - No risk of explosion.
 - Homogeneous gas composition and temperatures in process chamber.
 - Same gas composition conditions at burner tip and exit of furnace;
 - Minimum residence time of the gas in furnace (>0.5s) with no maximum;
 - High turn down ratio (40% - 120%).
 - Dedicated control oxygen levels at the exit of the furnace.
 - No pre-mixing of the fuel gas and combustion air.
 - Intrinsically safe process;
 - Intensive mixing of the separately introduced gas streams with high velocity injection into the combustion chamber.
 - Combustion chamber temperatures between 1500°F and 2000°F.
 - No formation of thermal NO_x
- 

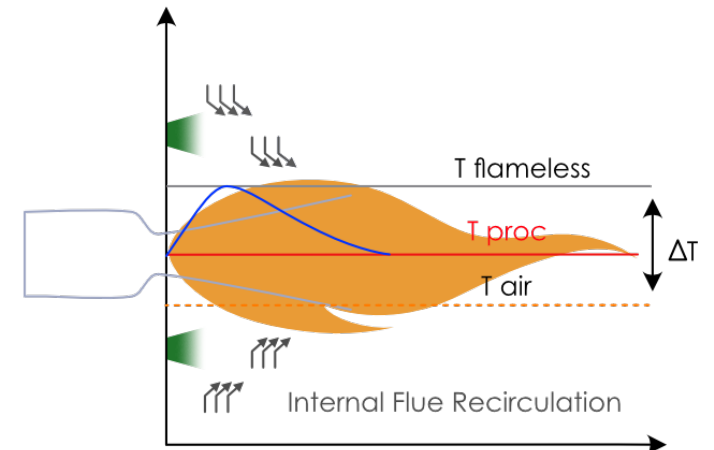
SUPERFLOX™ Advantages

COMBUSTION CONDITIONS	FLAME BASED	FLAMELESS
Fuel gas/Combustion air inlet	Pre-mixed	Separated
Minimum energy content Fuel Gas	>20 MJ/Nm ³	>1.5MJ/Nm ³
Combustion temperatures	>2700 °F	<2000 °F
Additional Fuel Gas/NG required	yes	No, only for start-up
Oxygen level	High (15-20%v)	Low (3-10 %v)
NO _x emissions	>200 ppmv	<25 ppmv

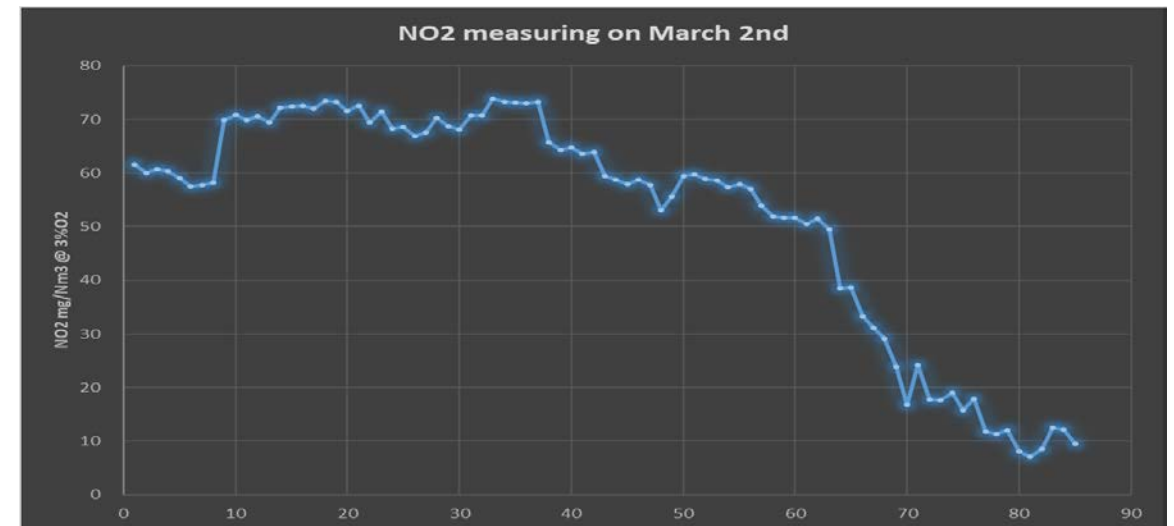
Conventional Flame



Flameless Combustion



SUPERFLOX™ On-site Testing



SUPERFLOX™ Summary

PROFIT, SAFETY, ENVIRONMENT



Effective for wide-range hydrocarbon content (1.5 – 20%v CH₄); no natural gas needed



Homogeneous and complete combustion



Zero thermal NO_x emissions and reduction of CO₂



Potential eligibility for carbon credits and offsets, creating an additional revenue stream



Maximal energy recovery



Significantly smaller footprint than other similar installations (e.g. thermal oxidizers)



Flexible and inherently safe operations

RPS™ Technology



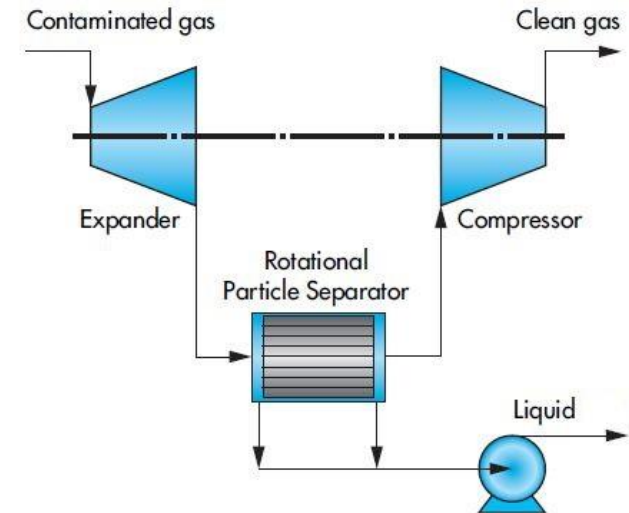
RPS™ Introduction

Many processes require the separation of micron sized particles from a gas stream. Techniques employed to do the job are scrubbers, fabric filters, electrostatic separators and multi-cyclones.

There is still a drive, however, to develop new technologies to overcome certain inefficiencies, e.g.:

- scrubbers are sizeable and fail to remove micron sized particles,
- fabric filters and electrostatic precipitators are limited to dry and/or chargeable particulate matter and involve large installations, and
- cyclones in industrial installations that are subject to large volume flows fail to collect micron sized particles.

A new development which overcomes several of the afore-mentioned limitations is the Rotational Particle Separator, or RPS.



RPS™ Process Description

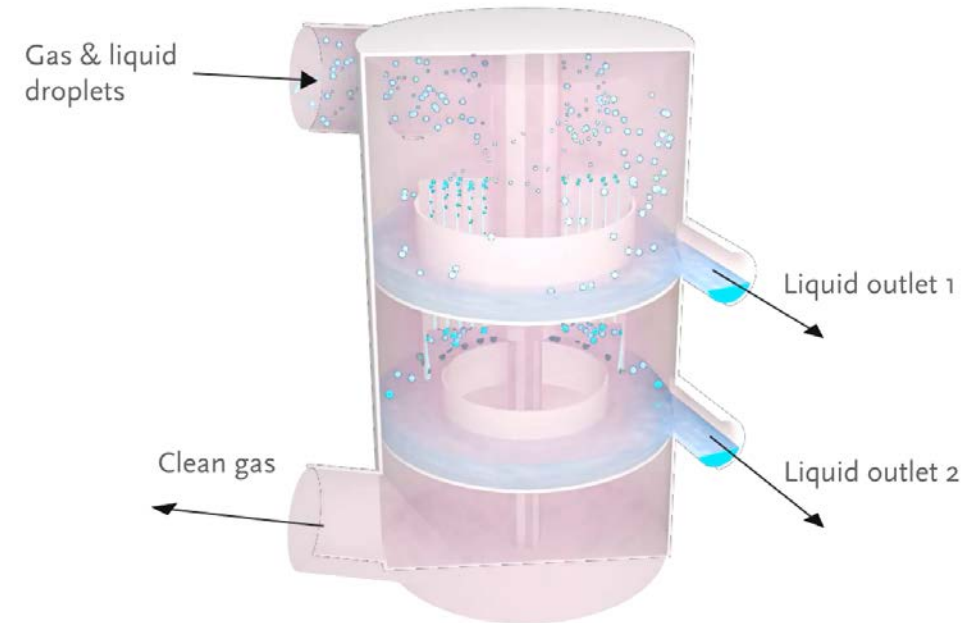
WTE's technology is based on two innovative and proven ideas for enabling gas-gas separation.

Principle 1 – Cryogenic Condensation

- Fast-cooling of mixture into the two-phase region by expansion (Joule-Thomson principle). When the temperature and pressure decreases, the gas mixture rapidly goes from the gas phase into the gas- liquid two-phase area, and small droplets are formed in a very short time. One of the components becomes a mist of fine droplets. The other component remains a gas.

Principle 2 - Rotational Particle Separation:

- At the core of it is a rotating cylinder consisting of a multitude of axially oriented channels of small diameter. Solid or liquid particles of micron and sub-micron size are separated from a carrier fluid flowing through the channels by the action of the centrifugal force. As a result, they form a film of particle material, which is collected via respective outlets.



<https://youtu.be/y7CxFx0didI>

Click on image or use the link for a video explaining the principle of RPS™

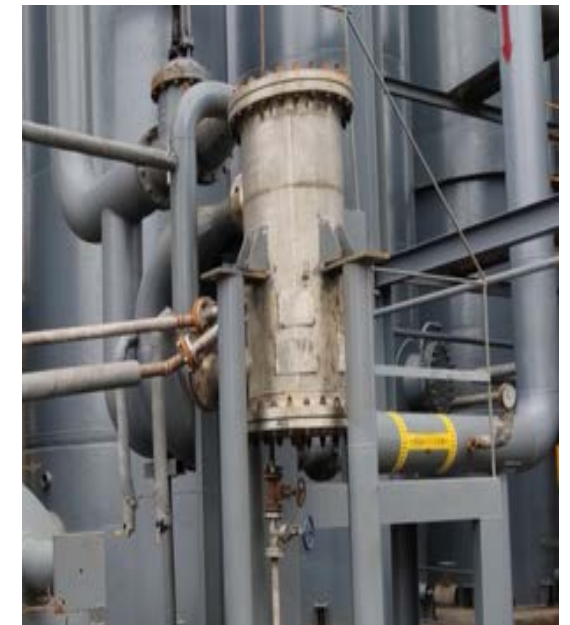
RPS™ Advantages

- 100% removal of all particles >1 micron.
- Small size equipment, small footprint (85% reduction in size).
- Ability to operate at very high pressures (up to 2900 PSI).
- Strongly reduced energy consumption.
- Improving the equipment production capacity.
- Protecting the activity and life of possible used catalysts.
- Prevention of liquid collection within the compressor.
- Improving synthesis efficiency and reducing side reactions.

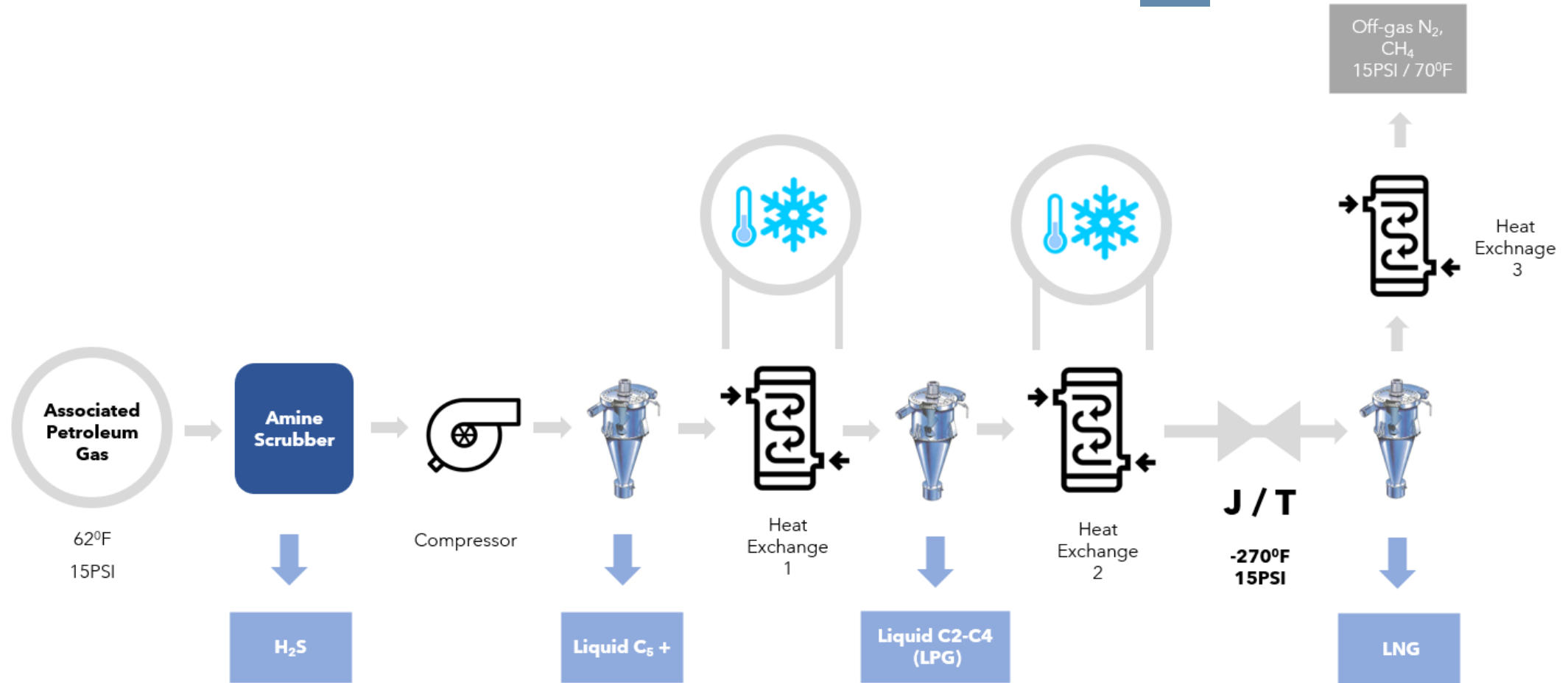
	Fibre	Knitted Mesh	Vane	RPS™ Separator
Relative gas-capacity	1	5	6-15	20-50
Relative liquid capacity	1	5	10	20
Minimum Droplet size (µm)	<0.1	3-10	10-40	1
Separation K-factor*	0.05	0.1	1	10

* K-factor is the acceptable gas speed over the filter

	RPS-Separator	Packed Separator
D _{p, 50%}	1 µm	3.5 µm
Size, w x h	2.6 t x 7.2 ft	7.2ft x 18ft
Volume	39 ft ³	636 ft ³
Weight	1.8t	17t



RPS™ Process Example



WTE Technologies Summary

- Robust Proven Technology (German/Dutch)
- RPS™ separation & cryogenic condensation
 - Minimum footprint
 - High efficiency
 - Gas-Liquid separation
 - LPG + LNG capture
- Superflox™ – flameless clean off-gas combustion
 - Zero emission
 - Maximum energy recovery (steam/power)
 - Driver for cryogenic condensation
 - Stand-alone operation
- Strong Business case
 - Dealing with zero value waste gas and environmental cost
 - Generate minimal and clean waste
 - Value recovery
 - Zero environmental cost

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