

Making our world more productive



**CIRRUS<sup>®</sup>**

Flexible, compact and reliable cryo-technology for VOC abatement.

# VOC recovery and abatement.

When cryo-condensation is the best fit.



## Cryo-condensation is an effective, clean and safe technology

Not limited to specific solvent types, cryo-condensation is a proven technology for VOC recovery and abatement in a host of industries: from fine and specialty chemicals, to pharma, tank farms and terminals, and many others.

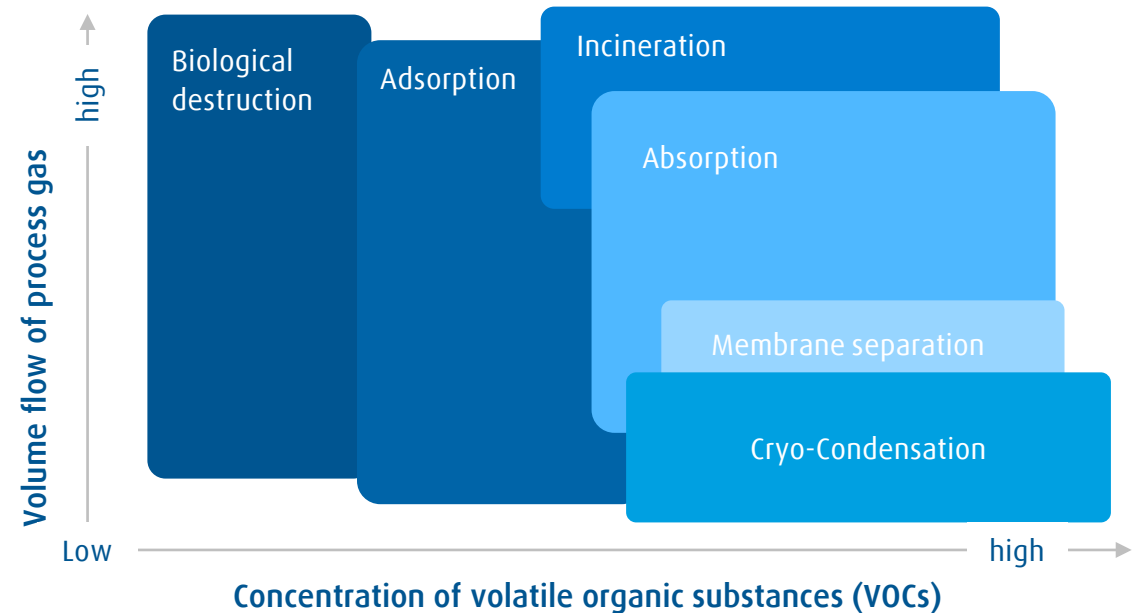
Ideal for low to medium flow streams with high VOC concentrations

Handles a wide range of VOCs

Nitrogen and solvents can be re-used

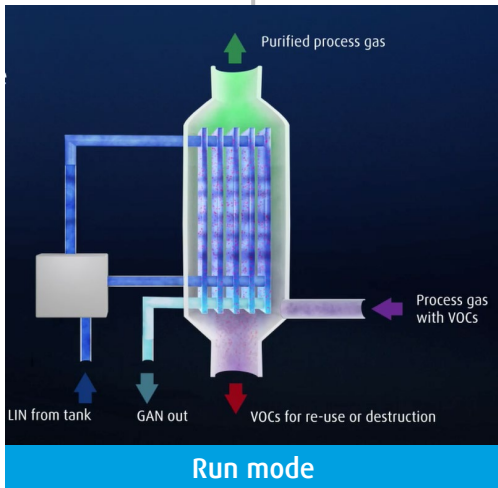
Clean and safe technology, not harmful to the environment

## VOC abatement technologies – application ranges



# Cryo-condensation by Linde.

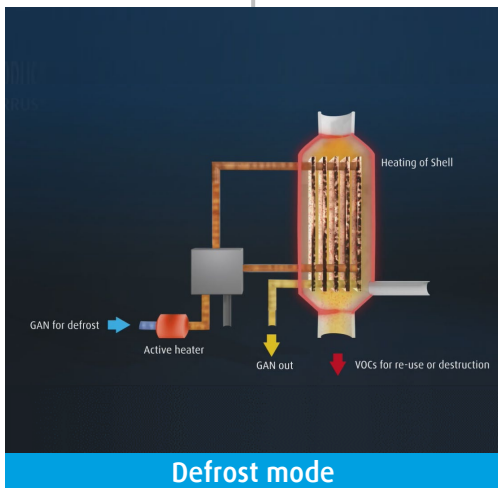
## CIRRUS® - operating principles.



## Condensing VOCs.

Cold Gas ensures a smooth heat exchange, avoiding localized overcooling or fast freezing

- Process gas enters the condenser from the bottom.
- Liquid Nitrogen (LIN) is pre-evaporated to generate cold gaseous nitrogen (GAN).
- Cold GAN passes through the thermo-plates of the condenser, cooling them down and condensing the VOCs, which are captured in the TM100 for further re-use or disposal.



## Handling ice/solid formation.

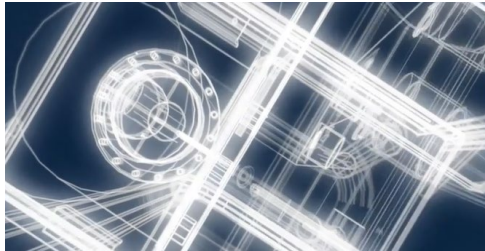
Automated to maximize performance, CIRRUS® defrost mode takes only two hours

- Process gas flow is shut down.
- Warm GAN passes through the thermo-plates and heats both plates and shell.
- Ice/solid melts and is captured in the TM100.
- Run mode starts automatically when defrost is finished.



### CIRRUS® removes up to 99% of VOCs

The Linde technology for VOC removal is flexible, compact and reliable. It's smart design saves space and money, while ensuring low power and maintenance costs. It runs in a fully automatic mode and is designed for expandability.

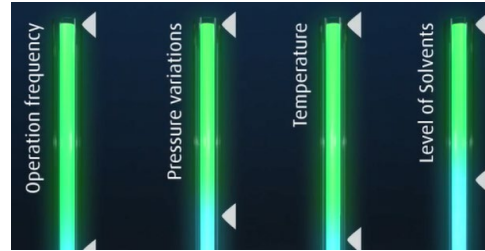


#### Smart design

Design of the condenser plates cooling avoids the need for additional equipment and saves time.

Smallest footprint in the market.

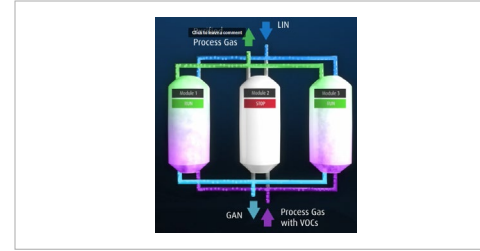
Absence of moving parts minimizes maintenance.



#### Maximum flexibility

CIRRUS supports batch, continuous and intermittent operations with varying flowrates.

It handles fluctuations in pressure, temperature and solvent concentration.



#### Modular, continuous operation

New modules can be easily added.

A built-in switching system ensures continuous operation by switching between modules.

Run and Defrost mode are triggered automatically.



#### Tailored to each process

Three different unit sizes to meet different process' needs.

Custom-design possible.

Suited to indoor and outdoor use.

Complete with gas supply scheme.

# CIRRUS®

The portfolio.



Nominal design limits	CIRRUS™ M50	CIRRUS™ M150	CIRRUS™ M500
Flow [Nm³/h]	50	150	500
Pressure [bar(g)]	5.5 (10)	0.5	0.5
Pressure drop* [mbar]	25 - 50	25 - 50	25 - 50
Process cooling [kW]	6	25	80
Design temperature [°C]	-196/+150	-196/+200	-196/+200



CIRRUS®

Proven results. Experts you can rely on.



## 25 years of experience with hundreds of installations worldwide

Linde is a trusted partner for your VOC handling needs: we support all steps in the project management cycle, from planning to installation and start-up, along with a gas supply system and attentive after-sales support. In addition, customers have the option of participating in test runs at our pilot plant or conducting trials at their own site.



CIRRUS M150 at Aesica Pharma in UK

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We are committed to minimizing the environmental impact of our production activities. We reviewed the options for solvent emissions control for one of our exhaust gas streams and Linde's cryo-condensation technology seemed ideally suited. One of the key advantages for our business is that by making use of the cold energy in the liquid nitrogen we already consumed, we achieve our environmental objectives with minimal additional running cost and energy consumption, so it is a very elegant and efficient solution.

Mike Battrum, Group Engineering Manager for Aesica, as published in Pharmaceutical Manufacturing.



# Thank you for your attention.

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