VOC Recovery System

During offshore and onshore loading, storage and transportation of crude oil onboard vessels or in oil terminals, crude oil vapours, also known as volatile organic compounds (VOC), are emitted to the atmosphere. The emissions vary between 0.1 kg VOC per ton of cargo to 2.8 kg VOC per ton (offshore loading in bad weather). When liquified, this will be equal to hundreds of barrels of oil. The emissions are a substantial source of lost financial value and destructive environmental impact.

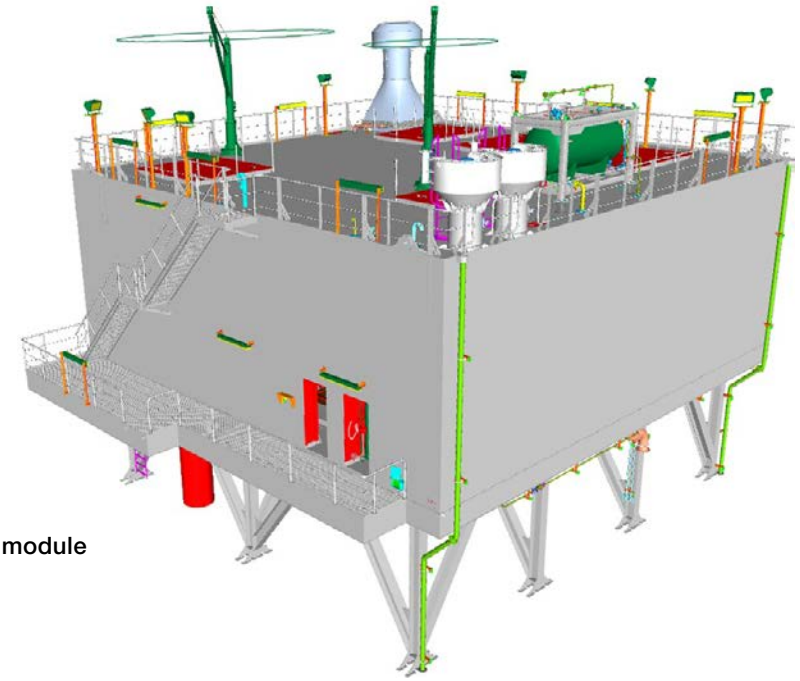
Wärtsilä's field proven system is mainly used during loading, but can also be used to reduce cargo tank pressure during laden voyage.

The VOC Recovery Unit is connected to the vent header on the tanker and the VOC gas is fed into the VOC recovery module, where it is treated by compression and condensation.

The liquefied gas is then fed into the VOC fuel tank. We have also developed a system for VOC recovery in offshore oil loading applications. It exceeds the Norwegian authorities' requirements for non-methane volatile organic compounds (NMVOCs) by reducing VOC emissions by 100 percent, including methane, which is not currently specified in the regulatory requirements.

Another application for the VOC technology is to install the VOC plant on a platform supply vessel (PSV) and connect a hose to the vapour connection on the manifold of the oil tanker loading crude. This is applicable especially to buoy loading and sea islands.

Since the VOC plant can be utilised at constant operation, the payback time for this solution is short.



VOC module

RECOVERY PLANT TECHNOLOGY

- Cleaning from particles in a scrubber/KO drum
- Compression
- Condensation in two stages:
  - 1st stage condensation and drying: fresh/sea water
  - 2nd stage condensation: propylene
- Utility consumption depends on plant capacity, i.e. VOC emissions to be recovered.

Utility consumption		
Cooling water	m^3/h	320
Steam	kg/h	4000/4100
Air	Nm^3/h	55/60

THE PURPOSE OF THE PLANT

The VOC Recovery System can recover the emissions resulting from loading of oil tankers and use the liquified VOC (LVOC) as fuel for power and steam production onboard or the LVOC can be discharged to shore.

The process includes:

- Cleaning of the displaced gas from cargo tanks
- Compression
- Condensation and separation in two stages

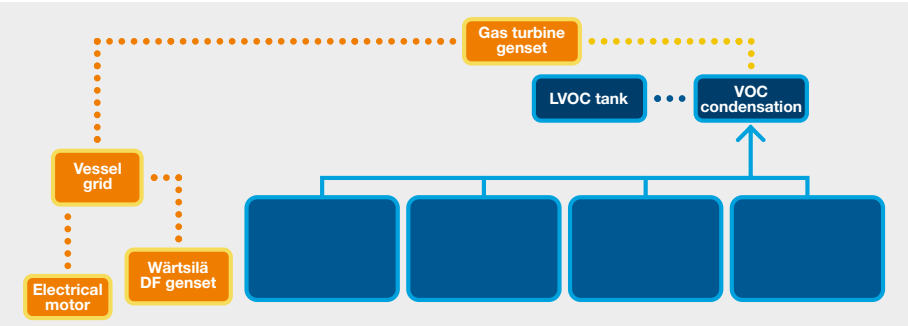
The final products are streams of unliquefiable gas (SVOC) and liquefied VOC (LVOC). The LVOC is stored onboard for further use.

The current projects use the VOC onboard. During loading, the SVOC feeds the gas turbines, or a boiler with turbo genset for production of electricity. Once the recovery ends and the laden voyage starts, the LVOC is mixed with LNG to fuel the main auxiliary engines and to generate electricity and inert gas (when offloading at terminals).

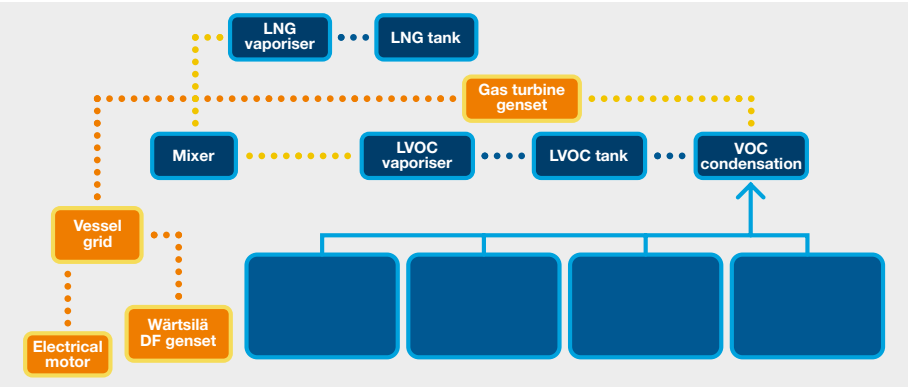
The VOC Recovery System allows a full recovery of the vented VOC gas during loading, replacing traditional fuel and thus reducing the overall carbon footprint of shuttle tankers.

For the PSV solution, the VOC is delivered to shore, either to a petrochemical plant or simply reinjected into the crude oil.

Item	Description	Qty.	Unit weight	Dimension (L x W x H)
1	VOC recovery module (deck house)	1	300 ton	15 m x 15 m x 5.5 m
2	Knock out drum skid	1	5.5 ton	4 m x 5.5 m x 5 m
3	LVOC storage tank (deck tank)	1	110 ton dry	Ø 5.87 m x 20 m
4	LVOC feed pump skid	1	0.7 ton	2 m x 1.5 m x 1.5 m
5	LVOC absorber unit	2	0.4 ton	4 m x 2 m x 0.5 m
6	Fuel treatment unit (deck house)	1	80 ton	12 m x 9 m x 4 m



Emission captured



Emission transformed to fuel – 30-40% of fuel converted from waste

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