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Vapour Recovery Units

VRUs
Vapour
Recovery
Units

We recognize two main vapour control solutions

Vapor Recovery Units
(VRUs)

Vapour Combustion Units
(VCUs)

Even if a Vapour Combustion Unit is capable to active is goal, limiting the emissions this way means to burn everything at high temperatures, this invokes high noise level, intrinsic temperature risks in explosive find proximity, complete loss of the products themselves.
That's why we our activity is focused in managing Vapour RECOVERY Units.

A good working VRU is always worth its guiding investment.
A VRU operating in optimal configuration will recover in average 1‰ of the processed products, sending back VOC's to tanks as real gasoline. This means potentially thousands of liters per day.

The profit coming from recovered gasoline is usually much higher than the electric power and plant maintenance expenses, so as far as money is concerned, respecting laws with low VOC's emission level turn itself in a good business.

Let's see the main points of interest in keeping a low emission level:

- AIR + Volatile Liquids = Volatile Organic Compounds(VOCs)
- VOCs + Sunlite (UV) + Combustion Products (Nox) = OZONE

Ozone is to be considered primary constituent in SMOG;

Ozone has harmfull effects on Human Health and can damage vegetation;

CE estimate that storage and distribution of gasoline contributes in excess of 500,000 tons/year (more than 5%) to the total communities VOC emissions;

Tipical sources of VOCs emission

Refinery plants

Storage Tanks and their process VENTS

Transportation Operations

Distribution

Factors affecting Vapour composition:

Loading method
Unloading method
Temperature
Vapour pressure
Pressure

VRUs Process Theory:

Adsorption via fresh gasoline spraying
Absorption via Activated Carbon
Regeneration of Carbon Beds via VACUUM Process

The “MAGIC” in Adsorption / Absorption:

ABsorption

generally it refers to when atoms, molecules, or ions entering some bulk phase: gas, liquid or solid material, under certain conditions.
For instance, a sponge absorbs water when it is dry.

ADsorption

is similar; but refers to a surface rather than a volume: adsorption is a process that occurs when a gas or liquid solute accumulates on the surface of a solid or a liquid (adsorbent), forming a molecular or atomic film. It is different from absorption, in which a substance diffuses into a liquid (or solid) to form a solution.

We consider universally accepted the carbon adsorption/absorption vapour recovery process

PROS:
- Worldwide acceptance as the standard for gasoline vapour recovery
- Many years of proven and reliable experience
- Highest emission control efficiency, meets all emission standards
- Lowest capital investment and operational costs
- Relatively simple to operate and maintain, no extreme expertise required
- Near ambient pressure and temperature operation, no vapour holder and no refrigeration required
- Reduced electric power consumption with optimization process

CONS:
- Accurate measurement of recovered product requires special equipments

ACTIVATED CARBON is the
"CORE"
of a vapor recovery system

Activated Carbon Structure

Activated carbon is highly microporous, it contains billions of pores of different dimensions:

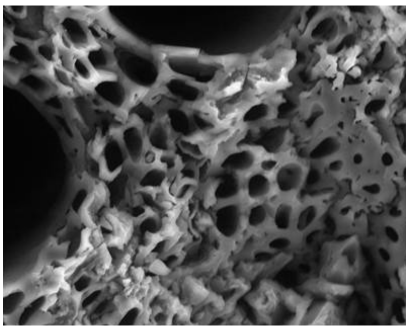
- Micropores < 20 angstroms
- Mesopores 20 to 500 angstroms
- Macropores > 500 angstroms

An amstrong = 0.0000001 millimeter

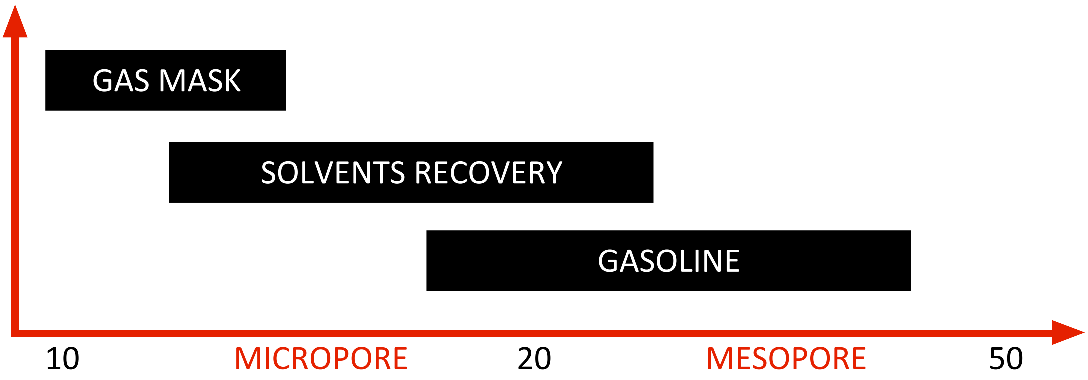
An average human hair is 500,000 angstroms in diameter

EXTREMELY HIGH SURFACE AREA

500 to 2,500 m^2 per Gram



Pores size affects activated carbon appliances



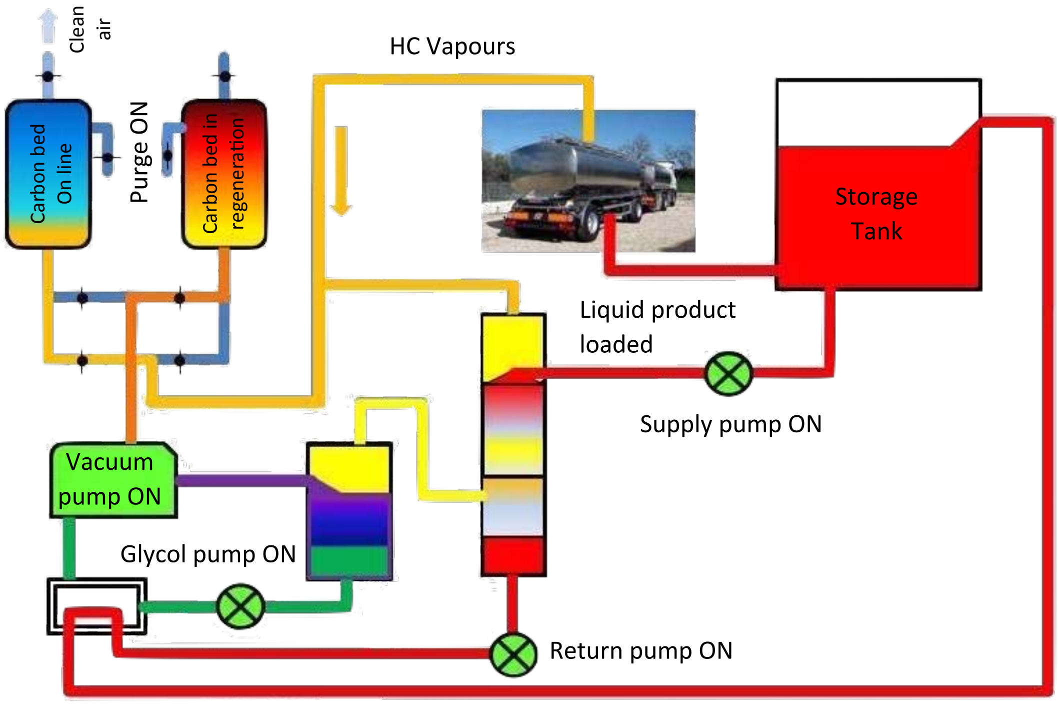
Key properties for Hydrocarbon Recovery:

- High Adsorption capacity
- Low retentivity
- Uniform particle size
- Thermal/chemical stability
- Long service life

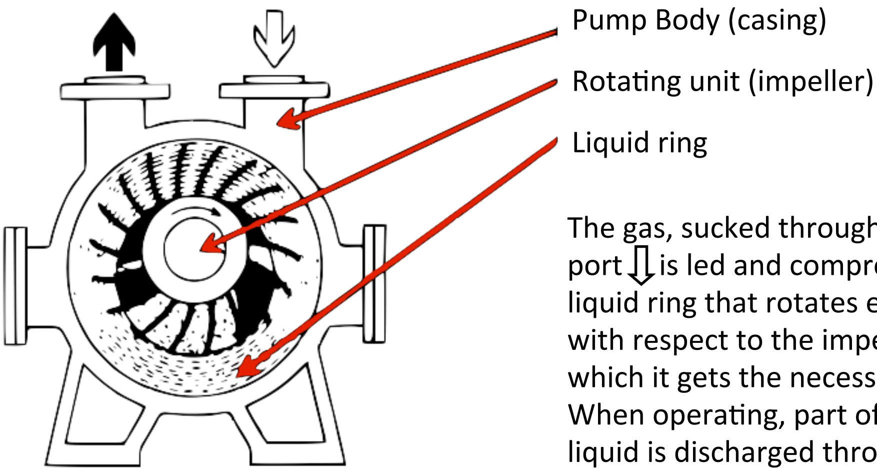
Here we are to the real process, how it works?

- A VRU could be considered as a filter: The filter processes the HC vapour and air stream coming from the loading bays, keeps the hydrocarbon vapours and lets the cleaned air to pass trough.
- The "adsorption" process, which is a process that occurs when a gas (HC vapours) accumulates on the surface of a solid (activated carbon), is carried out by the activated carbon which is inside the carbon beds.
- The adsorption process is exothermic and, therefore, it releases heat in a similar way as condensation
- HC vapours reach the VRU pushed by the pressure of liquid which is filling the tank.
- During the adsorption process, the filter gets saturated to the point which it is not capable to adsorb any more vapours .
- The VRU unit has two carbon beds to ensure uninterrupted service. AS VOCs are being adsorbed in the on-line carbon bed, the second bed is being regenerated.
- During regeneration, Hydrocarbons are removed from the activated carbon by pulling a deep vacuum on the bed by a vacuum pumping device and are sent to the next step in the process.
- Hydrocarbon vapors and condensed hydrocarbon liquids from the regeneration process are discharged from the vacuum system into a separator vessel.
- Typically, a liquid ring vacuum pump or a dry pump, sometimes combined with a positive displacement pump, is used to provide the necessary vacuum level for regeneration.
- The separator vessel is necessary to separate the seal fluid from the recovered hydrocarbon vapors and condenses hydrocarbon liquid. The seal fluid is cooled and returned to the vacuum system.
- If a dry vacuum pump is used there is no need for a separator
- The non-condensed hydrocarbon vapors, mixed with a small amount of air, flow from the separator vessel to the portion of the process where the actual recovery occurs.
- The actual recovery is accomplished in a packed absorber column, which uses the product from the storage tank as absorber fluid.
- Hydrocarbon liquid is collected in the bottom of the absorber tower and is pumped to liquid storage.
- Air and the uncondensed hydrocarbons are recycled back to the on-line carbon vessel.
- Applications include gasoline vapours, sweet crude oil vapours, certain chemicals including light alkanes, propane and heavier; light alkenes including butene and heavier and light aromatics including benzene

VRU functioning schema

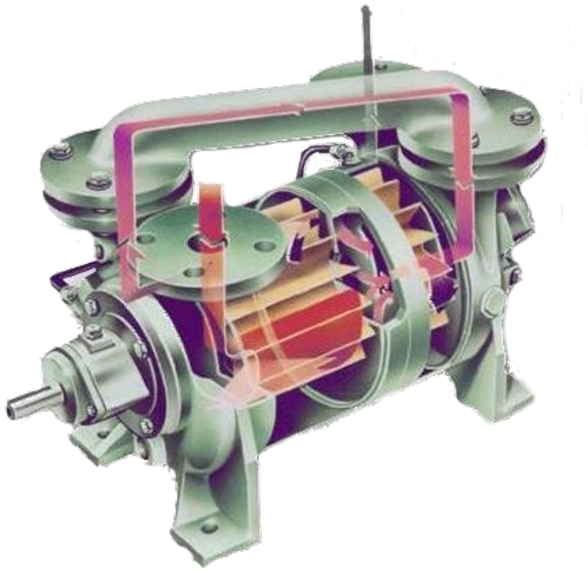


Liquid ring Vacuum pump details



The gas, sucked through the suction port ⇩ is led and compressed by the liquid ring that rotates eccentrically with respect to the impeller from which it gets the necessary energy. When operating, part of the service liquid is discharged through the discharge port 🡅 together with the compressed gas. A proper make-up of fresh liquid guarantees correct operation and performances.

Liquid ring Vacuum pump section view



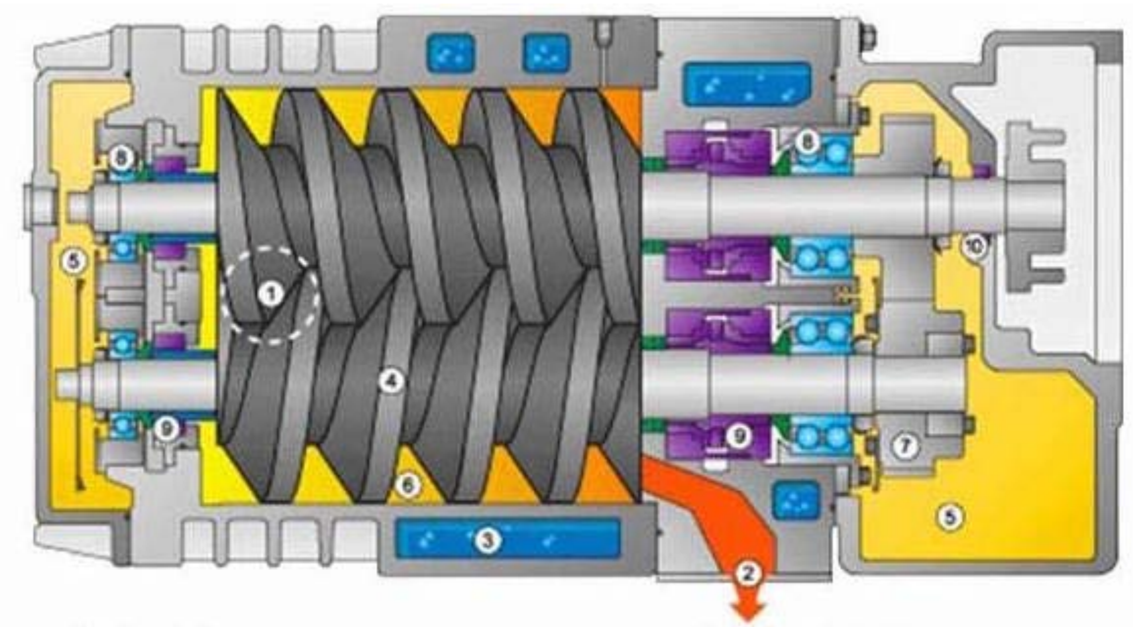
- To reach deep vacuum a dual stage pump is used. The discharge of the first stage is the suction of the second one. Both rotors are installed on the same shaft.

Dry vacuum pump

Dry vacuum pump does not need any glycol or a separator. All heat of compression stays in the pumped gas.

Dry vacuum pump section view

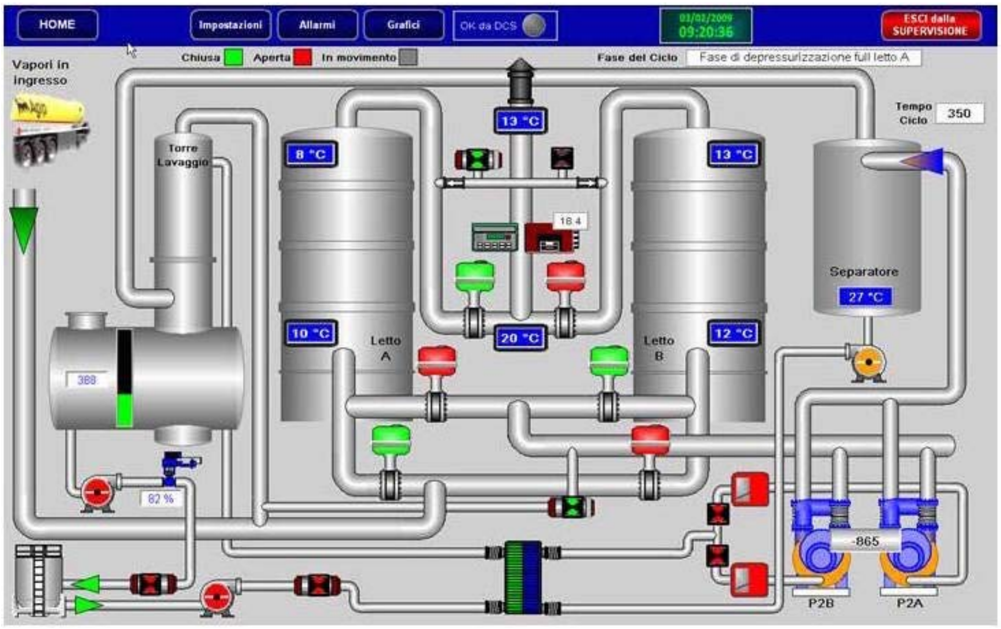
The pump operates on screw technology. Entering gases are trapped between flights of screws and moved axially down a short straight path to the exhaust where they are discharged.



1. Inlet
2. Exhaust
3. Water Jacket
4. Screw
5. Oil
6. Gas Path
7. Timing Gears
8. Bearings
9. Shaft Seals
10. Oil Seal

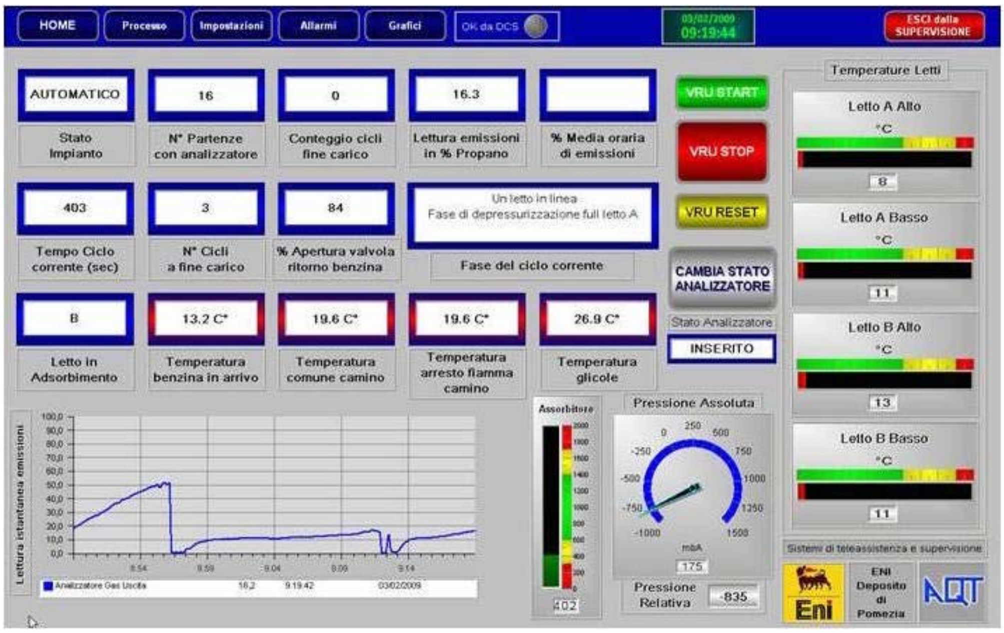
VRU remote management

The VRU would be remotely managed. The unique SCADA system gives a complete and detailed view, main job functions control, with no need to reach the filed for usual operations.



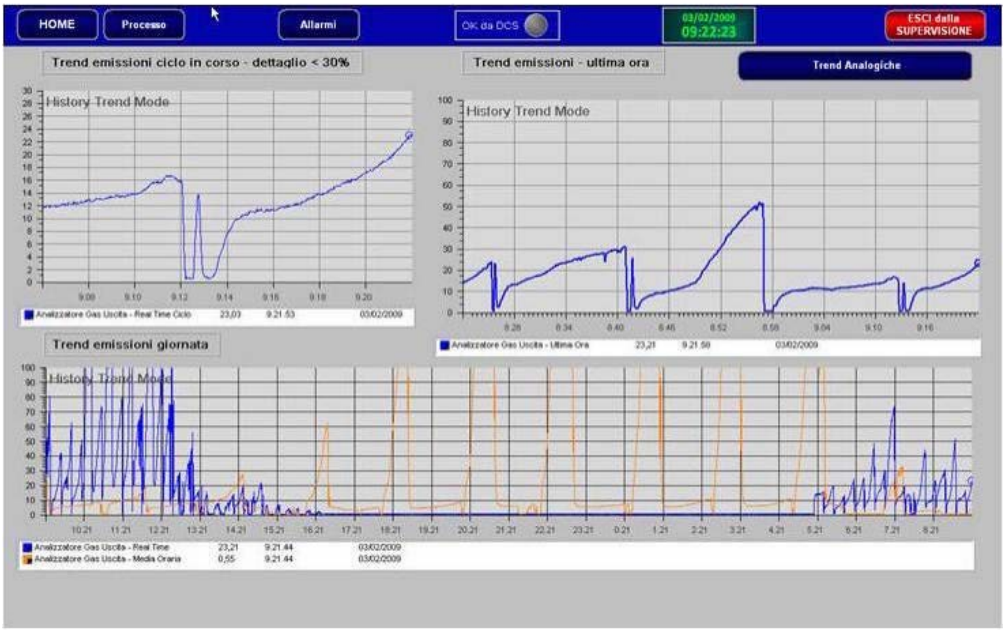
VRU remote surveying

The whole VRU's working parameters at a sight. A deep and historical structured ALARM and WARNING system advises operators of any unattended condition and helps identifying the causes of problems.



VRU trending utilities

Historical data storage is extremely useful. It involves reporting and deploydata analyzing tools used by the technicians to optimize VRUs performances



VRU setting multiple screens

SCADA system, via password protected data screens, lets the technicians (and deeply trained personnel) to immediately adjust the process parameters, in order to optimize the working cycle.

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