VENDOR :	PROJECT :	CATALOG UNIT :
cadabco	VAPOR RECOVERY SYSTEM	MINIVAC

VAPOUR RECOVERY UNIT

PROCESS DESCRIPTION

MINIVAC

CATALOG UNIT :	MINIVAC
CADABCO Document Name :	3000-PD-01

Cadabco – Head Office
Sofia 1186, Bulgaria
German, Manastirska vodenica Str. 8
Phone: +359 887 687 873

Table of Contents

Introduction 3

Process Description 4

Design Basis 6

- Design Vapour Profile 6
- Recovered Product Calculation 7
- Implementation 7
- Modification of the Underground Tank 7
- Modification of the Vent Line of the Underground Tank 7
- Installation of MINIVAC 7

Installation Figures 8

VENDOR :	PROJECT :	CATALOG UNIT :
Cadabco	VAPOR RECOVERY SYSTEM	MINIVAC

Introduction

Many service stations in the world today are equipped with:
Stage I Vapour Recovery System in which the vapours from the underground tanks of the service station are balanced back to the tank truck and the vapours in the truck are recovered by a Vapour Recovery Unit at the Storage Terminal.
Stage II, the recovery of the vapours from filling of the cars, back to the underground tank of the service station is not as widely implemented. Stage II returns the vapours from the car tanks back to the underground tank by means of a controlled vacuum system, whereby an amount of vapours, equivalent of the loaded liquid, is sucked from the opening of the car tank and pumped back to the underground tank. Stage II will evidently reduce the emissions of hydrocarbon vapours to atmosphere during filling of cars and will as such increase the concentration of the hydrocarbon vapours present on top of the liquid product in the underground tanks.

In cases where the vapours from the underground tanks at the service stations cannot or not economically be returned to the truck tank during filling of the underground tank, a dedicated small recovery system (**MINIVAC**) can be installed at the service station to recover the vapours during filling of the underground tank as well as any excessive vapours from incomplete balancing between car and underground tank. Most balancing systems are not able to achieve better recovery efficiencies than 65 to 70% from the car tank.

Cadabco introduces a new, simple and very innovating Vapour Recovery System (**MINIVAC**) to the market based on adsorption on activated carbon and regeneration by vacuum. The recovered hydrocarbon components are re-injected into one of the gasoline grades in the underground tank system. This Recovery System is able to reduce the emissions from the service station operations better than 99%.

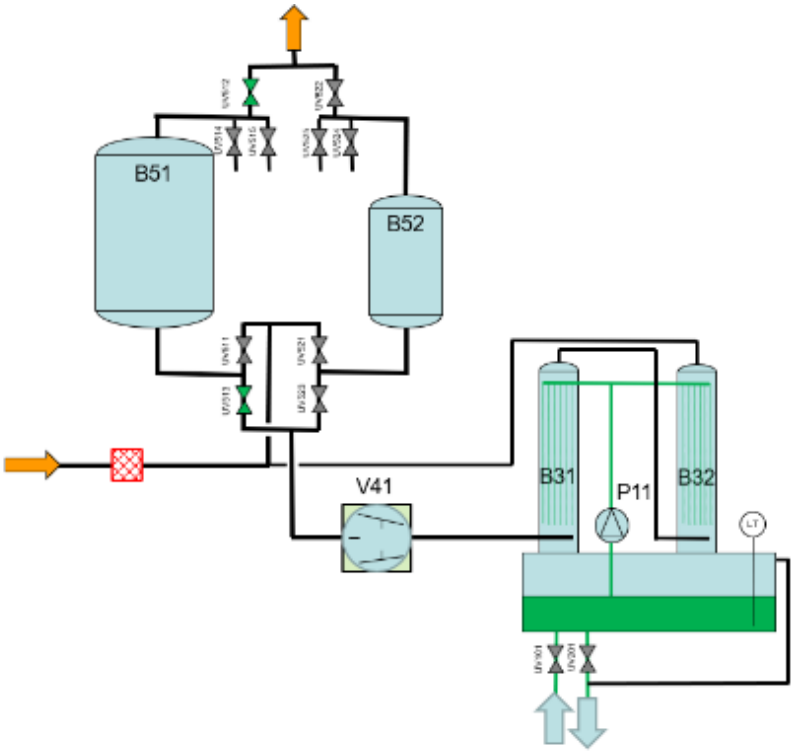
VENDOR :	PROJECT :	CATALOG UNIT :
adabco	VAPOR RECOVERY SYSTEM	MINIVAC

Process Description

The **MINIVAC** Process proposed is based on adsorption on activated carbon and regeneration of the saturated carbon by the dry vacuum technology. During re-filling of the car at the service station an amount of air with gasoline vapours will be sucked from the tank opening and returned to the underground tank. If exactly the same amount of vapour is returned as is loaded in liquid form, then no excessive vapour will be emitted from the underground tank to atmosphere. In practice however, the returned amount of vapour will not be equal and some emissions may occur. The vent line of the underground tank is now connected to an activated carbon resulting in removal of the hydrocarbons from the excessive air and reduction of the emissions to atmosphere.

At a certain moment the underground tank will need to be filled up by delivery of product by means of tank trucks. During emptying of the truck, the vapours present in the underground tank will be pushed out through the carbon bed, where the hydrocarbon components will be adsorbed, whilst the clean air is vented to atmosphere.
Any excessive vapour from car re-filling during this period is also treated by the system.

Once the truck is emptied, the carbon bed needs to be regenerated. This will take around 1 to 2 hours.



The regeneration of the activated carbon bed is manually started as soon as the truck was disconnected. The regeneration process is automated and will, after have completed the process, leave the carbon bed online to enable any excess vapour from the underground tank pass and be cleaned before being vented to atmosphere. During regeneration, the carbon bed inlet and outlet will be closed and the line to the vacuum pump will be opened. The pressure in the carbon bed will decrease and hydrocarbons will come off the surface of the carbon. These highly concentrated hydrocarbon mixture will be pushed through a re-absorber column where they will be re-absorbed and returned to the underground tank.

The absorbent used for the regeneration will be stored in a buffer tank during the regeneration cycle. The level metering of the buffer tank will indicate the quantity of product recovered during the cycle

Design Basis

The Recovery System is designed to recover the vapours from the underground tank during the emptying of one tank truck in addition to the emissions from normal breathing and excess vapours from the re-fuelling of cars in the period between two truck emptying operations. The truck volumes may vary in different regions of a country as well as the time between two truck loads and the number of cars that pass through the service station between two truck loads.

The total volume of vapour determines the volume of activated carbon in the adsorber vessel as well as the capacity of the vacuum pump required for regeneration.

Design Vapour Profile

The usual truck volume is around 30m3 of liquid product. This implicates that 30m3 of vapour will be pushed out from the underground tank during filling.
The time between two truck emptying operations depends on the throughput of the service station. In principle the volume loaded in the cars during the period between to trucks is proportional to one truck volume. Vapour balancing (Phase II), if implemented on this service station, will significantly reduce the total volume of vapour to be treated and will increase the hydrocarbon concentration considerably (HC concentration 25% without Phase II and 40% with Phase II installed). In case Phase II is not installed there will be air intake during car re-fuelling. This air will slowly saturate to around 25% and will as such push out around 25% of the ground tank volume between ground tank fillings. If Phase II is installed, the vapours returning from the car tank will be nearly saturated and little emissions will occur between two underground tank fillings.

In either case, however, the total mass of hydrocarbon vapours loaded on the carbon is similar.

The Vapour Recovery System will be designed for 30m3 of vapours pushed out during truck emptying and 25% of 30m3 of vapours between two underground tank fillings.
The total amount of vapour is therefore 40m3 with a concentration of 40% by volume.

Recovered Product Calculation

The composition of the vapours emitted from the underground tank is mostly C3, C4, C5 and C6. The average mole weight is around 65kg/kmole. The molar volume of the vapour at 30°C is 20.2 m3/kmole. The density of the recovered product in liquid form is around 680 kg/m3. The total amount of liquid product produced per truck load of gasoline is therefore:

V_{rec} = 30m3 x 40% concentration x 65kg/kmole / 20.2m3/kmole / 680kg/m3 = 0.0568m3
V_{rec} = 56.8 Litres of product recovered

The CADABCO Vapour Recovery Unit will recover at least 99% of the emitted vapours.

The amount of liquid product recovered from one single truck emptying operation will therefore be 99% x 56.8 Ltrs = 56 Ltrs of liquid product. This product is returned to the underground tank.

Implementation

To implement a **MINIVAC** on a service station, a number of modifications need to be made to the different equipment and pipelines.

Modification of the Underground Tank

A 2" liquid return connection needs to be provided to return the recovered liquid product back to the underground tank. The product pump on the underground tank will be used to supply a small amount of gasoline to the **MINIVAC** before regeneration of the carbon bed to fill the buffer tank. The required line size is 1".

Modification of the Vent Line of the Underground Tank

The Vent Line to atmosphere of the underground tanks must be foreseen with a pressure/vacuum breathing valve to maintain a certain minimum pressure in the underground tank and to enable the vapours to pass through the carbon bed of the Vapour Recovery System. A 2" branch connection must be created to connect the **MINIVAC**.

Installation of MINIVAC

The Service Station Vapour Recovery Unit (**MINIVAC**) needs to be installed on a flat concrete foundation (2.5 m x 2 m). The Unit is connected to the vent pipe, just below the pressure/vacuum breathing valve. One 1" lines is installed to supply gasoline to the **MINIVAC** before regeneration cycle. One 2" line is installed to return the product to the underground storage after regeneration cycle.

The **MINIVAC** is fully automated. The start will be initiated by manual push button. The stop is automatic after the regeneration phase is completed.

The **MINIVAC** need only one power feed cable. The maximum power requirement is 4 kW for 1 to 2 hours per truck load.

VENDOR :	PROJECT :	CATALOG UNIT :
adabco	VAPOR RECOVERY SYSTEM	MINIVAC

Installation Figures

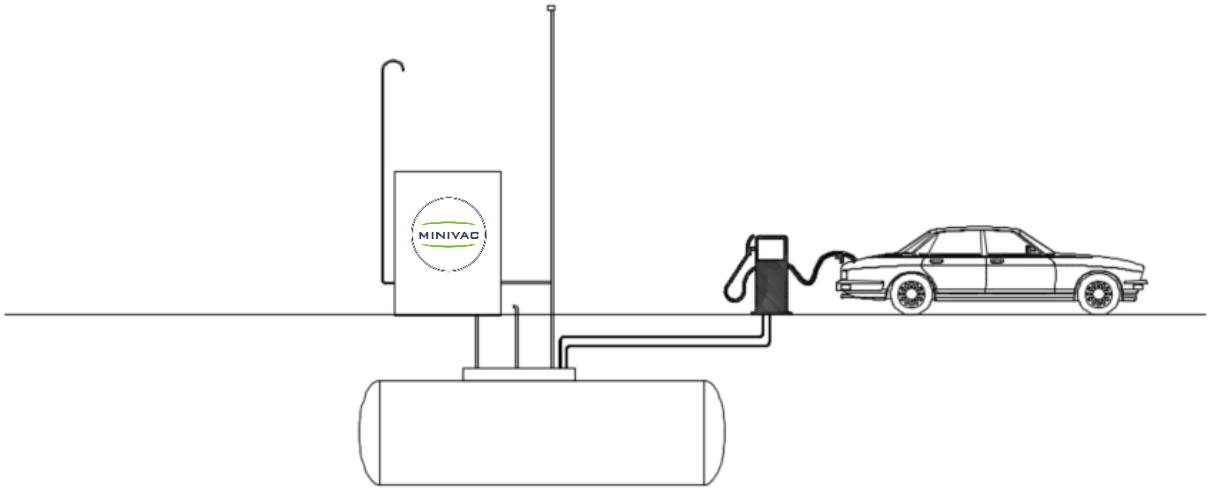


Figure 1 - Normal Car Re-Fuelling operations

Any excess vapour from the car tank flows through the carbon bed, where the hydrocarbons are removed. The cleaned air goes to atmosphere

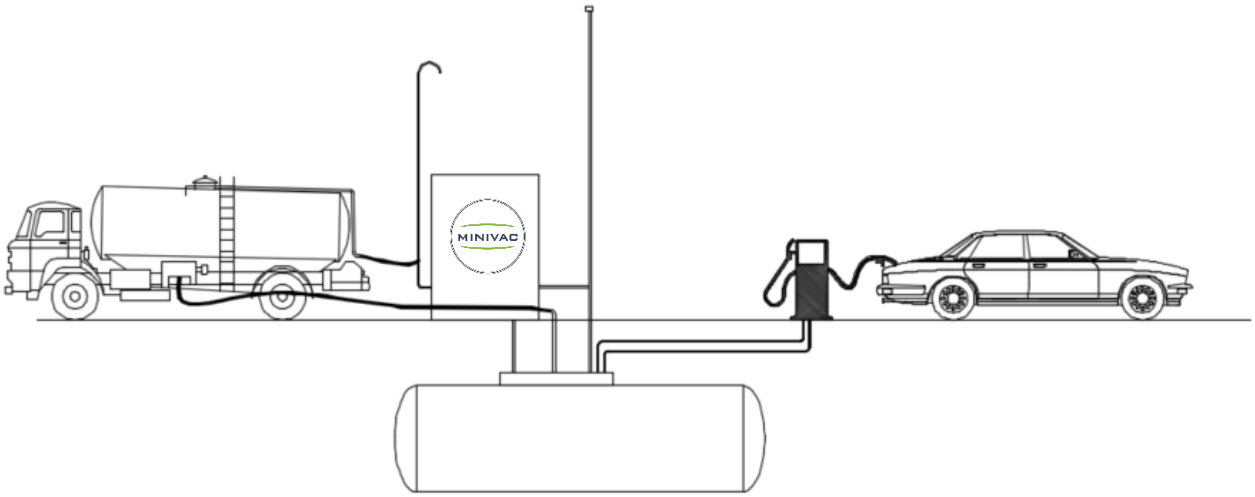


Figure 2 – Tank filling by Truck

The vapours pushed out from the underground tank by the liquid passes through the carbon bed. The hydrocarbons are removed and the cleaned air goes to atmosphere. The cars can continue their filling operation

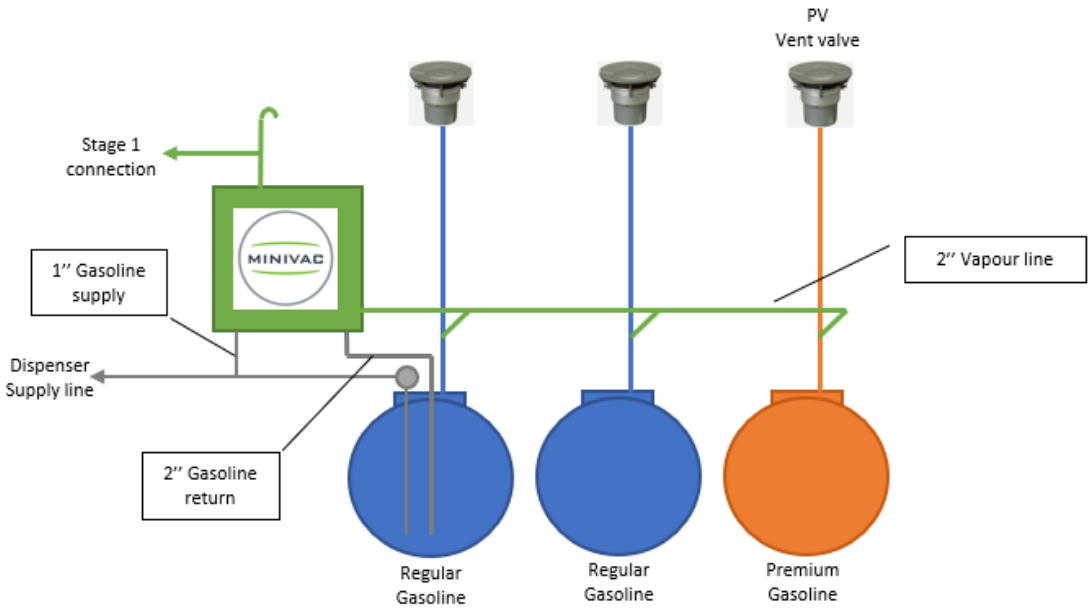


Figure 3 – Piping connections

Customer will be responsible for the supply of the following items:

- Flat concrete for the **MINIVAC**
- Power feed cable to the **MINIVAC** control panels
- Piping connection to the **MINIVAC**
- Installation of the HMI touch panel (inside building)
- Installation of the communication cable between **MINIVAC** and HMI
- Lightning protection if required
- Grounding grid.

The engineering project for the implementation of the **MINIVAC** on the terminal shall provide for safe working conditions and sufficient access to the **MINIVAC** for maintenance purposes.