

Vacuum Sewerage System - Palm Jumeirah, Dubai



Corodex Electromechanic
Bringing Engineering Solutions to Life



System Highlights

World's Biggest Vacuum Station

Over 2000 Villas Connected

900 Collection Chambers

40km of Vacuum Sewer Line

Savings over traditional gravity system

INTRODUCTION

In August 2002 Nakheel the Master Developer of Palm Jumeirah Island awarded Corodex Electromechanic the Vacuum Sewerage System contract for to-be the eighth wonder of the world.

The Vacuum Sewerage System, supplied by Roediger Vacuum GmbH, supports more than 2,000 villas, having 900 collection chambers and 40 km of vacuum sewer line to a central Roovac vacuum station, which is installed underground in the utilities building on Palm Jumeirah.

The vacuum station for the Palm Jumeirah Development, with a capacity to connect 23,000 persons, is the largest single vacuum station in the world.

The design of the vacuum sewerage system conforms with European Standard EN 1091 and the design guidelines of the German Wastewater Association.

SCOPE OF WORK

Design, supply, installation, commissioning, operation, and maintenance of a Vacuum Sewerage System for Palm Jumeirah Island.

SYSTEM GENERAL INFORMATION

Vacuum sewerage systems are wastewater collection systems. An air stream generated by differential air pressure drives the wastewater toward a vacuum station.

A vacuum sewer system consists of: i) A vacuum station, where the vacuum is generated, the wastewater is collected, then pumped to a wastewater treatment facility. ii) A vacuum pipeline system, typically consisting of a branched network of vacuum sewer pipe, and collection chambers with sumps and interface valve units.

Wastewater flows by gravity from a house/villa into a collection chamber's sump. After a given quantity (batch) of wastewater

accumulates in the sump, an interface valve automatically opens.

The batch volume plus an additional volume of air flows through the open valve and is transported to a centralized vacuum station.

Vacuum sewer pipes are arranged with high and low points in a specific elevation profile. Batches of wastewater come to rest at low points in the pipe. When air is introduced through an upstream interface valve, the wastewater is pushed plug-wise over subsequent high points toward the vacuum station.

Wastewater and air are driven to a collection tank (vacuum tank) at the vacuum station. Vacuum generators (vacuum pumps) maintain vacuum in the tank and sewer pipe. Conventional sewage pumps forward collected wastewater from the collection tank through a force main to wastewater treatment plant.

SPECIFICATIONS VACUUM SEWER LINES



Vacuum sewer line with inspection point

- > Comprised of High Density Polyethylene pipes (HDPE).
- > Pipe diameters- from 90 mm up to 250 mm.
- > Division valves are capable of sustaining a vacuum of 80 KPa.
- > Valves are made from ductile iron with internal & external epoxy coating.

VACUUM COLLECTION CHAMBERS

- > Made of PE with a wall thickness on the least 6mm.

VACUUM INTERFACE VALVES

- > Minimum size of 75 mm diameter.
- > Capable of passing solids with a minimum size of 75 mm diameter.
- > The interface valves are complete with controller, rubber coupling, plastic tubing, sensor piping connections, and monitoring connections.

CONTROLLERS

- > Open the interface valve only if there is a minimum vacuum of 22 kPa available.
- > Slide-attached to the valve body and exchangeable within 1 minute.
- > The air-admission time is adjustable in a wide range (up to 15 seconds) by turning of a screw or similar method.

VACUUM STATION

- > Comprise all mechanical and electrical works including pipe-work, vacuum vessel, vacuum pumps, sewage discharge pumps, control panel, odor control equipment, ventilation, air conditioning and lighting.
- > Includes four vacuum tanks, sixteen vacuum pumps, six non-clog sewage pumps and two control panels.

VACUUM VESSEL

- > Manufactured of steel with internal and external epoxy coating.
- > Equipped with lifting lugs and all required process connections.
- > Constructed from not less than 9mm thick steel plate; thus, it provides flanged manhole access of minimum 600mm diameter to permit man entry for inspection and maintenance.
- > The minimum vessel capacity is calculated under consideration of the maximum switch-on-frequency of the aggregates of 12 to 15 times per hour.

VACUUM PUMPS

- > Minimum one duty and one stand-by vacuum pumps were installed.
- > The pump controls incorporate auto and manual duty change-over facilities.
- > Operated by pressure switches attached to the vacuum vessel.
- > Interlocked with an emergency floating switch inside the vacuum vessel to prevent sewage from being drawn into the vacuum pumps.

SEWAGE DISCHARGE PUMPS

- > Minimum one duty and one stand-by sewage pumps were installed.
- > Suitable for operation under negative pressure without cavitation.
- > Pumps are dry pit, centrifugal impeller type capable of passing solids of a minimum shere size 80 mm diameter.
- > Controlled by analog capacitive level measurement installed inside the vacuum vessel.



Collection Chamber

ELECTRICAL CONTROL PANEL

- > The operation of all pumps is controlled by programmable logic controller.
- > The vacuum pumps are controlled by monitoring the vacuum inside the vacuum vessel with adjustable pressure switches.
- > The sewage pumps are controlled by capacitive level measurement in the vacuum vessel Telemetry.

SPECIAL FEATURES

- > Automatic air admission controllers used for flushing lines with air are available. Air admission is either controlled by vacuum strength or by a timer. These controllers are used to prevent excessive hydrostatic head loss, or to increase flow velocity during low flow periods.
- > Controllers automatically adjust the ALR (air to liquid ratio) with changing vacuum levels.
- > Designs of sewer pipe profiles is based on flow, line length, topography, pipeline material and ground stability. The saw-tooth profile provides excellent



Valve

momentum transfer from air to water.

- > Inspection pipes along vacuum sewers permit manual aeration, connection of pressure gauges and isolation by introduction of an inflatable ball.
- > No steel, stainless, or metallic component in contact with wastewater or ground water.
- > The atmospheric, passenger load chambers neither need breather lines for ventilation of valves and controllers nor air inlets on the gravity lines. The plastic covers are provided with a locking mechanism with a special key.
- > Flood-proof, heavy traffic chambers are provided with plastic covers and cast iron frames and covers on top of concrete support rings.
- > Insulation layer of styrofoam in the valve chamber protects the interface valve unit from extreme (hot and cold) temperatures.
- > Standard sumps are compact and have a self-cleansing shape.
- > Collection chamber is compact and can easily be carried and installed by two persons.
- > The sensor pipe is connected to the suction pipe. It is self-cleansed every time the valve cycles and grease built-up is prevented.
- > Valves are connected with



Vacuum Station with Vacuum Tanks

- rubber couplings and quick release clamps, and valves can be exchanged within seconds.
- > Vacuum clean-out lance, that is attached to the vacuum service connection in the valve chamber, removes large clogging objects that are retained in the sump.
- > DN 200 diameter gravity drain lines provide a large, adjustable, self-cleansing and inexpensive emergency storage volume.
- > Polyethylene pipes are electro-fusion-welded to ensure airtight conditions.
- > Vacuum Interface valves are membrane/diaphragm type which ensure total closing or complete opening of the valve even under

unstable pressure conditions.

- > Vacuum Interface Valves are activated pneumatically without any need of energy or electricity at each valve.

GENERAL ADVANTAGES OF VACUUM SEWERAGE SYSTEM

Construction & Installation

- > Small diameter plastic pipes (HDPE)
- > Shallow & narrow trenching
- > Uphill transportation possibility.
- > No need for manholes or lift stations.
- > Easy change of direction, crossing over or under obstacles (flexible pipeline construction).
- > Vacuum sewer may cross water protection areas because exfiltration cannot occur.
- > No need for electrical power at collection chambers.
- > Fast construction, minimal traffic disturbance, and environmental impact.
- > Low construction costs.



Control Panel



Collection Chamber

Operation & Maintenance

- > No line flushing because of self-scouring flow velocity.
- > No operator contact with wastewater.
- > No exfiltration of wastewater.
- > No infiltration of ground water, vacuum sewers are tightness tested.
- > No septicity because the wastewater in vacuum sewers is continuously aerated.
- > Pinpoint leak detection.
- > Reliable, durable components that are easy to service.
- > Low operation & maintenance costs.

- > Minimal environmental impact
- > Cleaner, safer maintenance
- > Eliminates leakages & contamination
- > More efficient sewage treatment
- > Easy avoidance of obstructions
- > Greater freedom in network planning



A typical Collection Chamber installation outside a villa in Palm Jumeirah

Additional Advantages

- > No natural fall required
- > Smaller pipes
- > Rise without pumping
- > Water & sewer in the same trench
- > Cost of inspection chambers eliminated
- > Electrical connections confined to central station

CHALLENGES	SOLUTIONS
✍ Low population density (more than 50 ft. of sewer pipe length per connected household (equivalent dwelling unit = EDU) & more than 50 EDU's connected.	✍ Small pipe diameters and shallow trenches allow cost-effective installations for areas with low population density.
✍ Terrain with insufficient slope for gravity transport (flat terrain)	✍ Saw-tooth profile allows pipe installation inside shallow trench.
✍ Obstacles to be crossed	✍ Obstructions can easily be by-passed.
✍ High ground water table	✍ Vacuum lines are installed in shallow trenches above ground water table.
✍ Rocky ground	✍ Deep excavations are avoided.
✍ Unstable ground	✍ No requirement for trench-supporting equipment as trenches are very shallow.
✍ High flow variation	✍ Vacuum systems can handle peak- and low-flow periods. Completely sealed system. No odour emissions during low-flow periods.
✍ Water protection areas	✍ No danger of exfiltration of sewage to the ground water.
✍ Need for water conservation eg. arid climate	✍ Vacuum sewer lines are self-cleaning due to high velocity; thus no requirement to flush the lines with water.

Schematic Drawing of Vacuum Sewerage System

