SEWERAGE SYSTEM

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Abstract – This paper This study compares the vacuume sewarage system to the traditional sewarage system and shows how the vacuume sewarage system is designed for a specific low-lying environment. The analysis of the vacuume sewarage system with the traditional sewarage system is included in the project's initial study. This demonstrates how the vacuume sewarage system is more practical and efficient than the traditional sewarage system. The design of a hoover system is therefore required in the second phase. We'll decide on a certain low-lying location. will gather all available geographic and local information. Following the selection of the location and data collection, the site is analysed, and the design of the vacuume sewarage system is applied. A variety of parameters are taken into consideration while designing vacuum separation, including sawsooth profiles, valve pits, collecting chambers, vacuum maintenance, vacuum speed, self-cleaning velocity, silting velocity, scouring velocity, and gap between suction timings. Following thorough analysis, a well-thought-out hoover storage system is created. Additionally, the relevant outcomes must be attained.

1.INTRODUCTION

Most people associate sewage systems with gravity-based subterranean pipe networks that move waste up a gradient and into a treatment facility. The most popular method for moving sewage has historically been using these gravity sewers, particularly in places with high population densities. Because they transport both sewage and storm water, these gravity sewer systems frequently make up the sewer infrastructure and are hence referred to as combined sewers. Other ideas that centre on separating stormwater from sewage are starting to surface nowadays. The vacuum drainage system, which is regarded as an alternate sewage collection system, is one intriguing choice.

A mechanical sewage transfer system is vacuum drainage. Vacuum drains employ variations in air pressure to transfer wastewater, as opposed to gravity flow. In order to operate vacuum pumps, the collecting system must have a vacuum, or negative pressure, maintained by a central power source. To maintain vacuum, the system usually needs a closed vacuum/gravity interface valve at each inlet to seal the tubes. When a certain volume of sewage builds up in the catch basins, these valves, which are housed in the valve wells, open. The outflow is forced towards the vacuum station by the pressure differential that results between the atmosphere and the vacuum.

Water is drawn into the vacuum tube by the pressure differential between the valve well and the network, and then it is carried to the collection tank next to the central vacuum cleaner. In a vacuum, draft air expands and employs a conveyance mechanism. Due to gravity and friction, the carried sewage momentarily halts in the pipe network profile's depressions its route to the hoover station's collection tank.

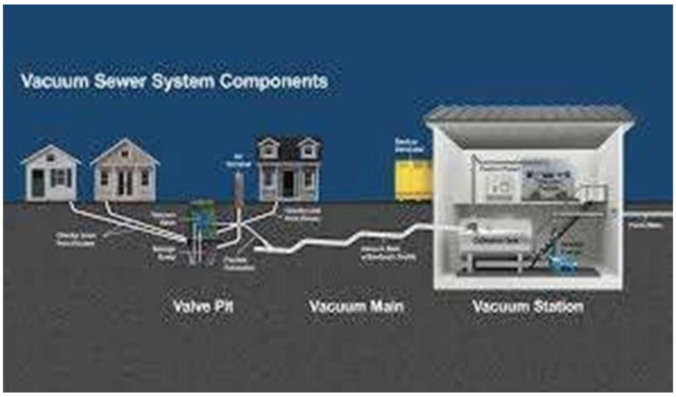


Figure vacuum Sewerage System

2. LITERATURE SURVEY

Abdelsalem Elawwad, Mostafa Rageb, Hisham Abdel-Halim (2015):
Globally, an estimated 2.5 billion people still lack access to better sanitation. The majority of jobless people reside in developing nations, primarily in rural areas. In developing nations, the most often utilised rural drainage technique is traditional gravity drainage. There are, however, a number of negative social, economic, environmental, and technical aspects to this system. An excellent substitute for conventional gravity drains would be a hoover drain. 33

rural communities in Egypt—a nation regarded as developing—that have this kind of population make up the sample. Utilising SPSS and STATISTICA software, statistical analysis is carried out. The population and area factors are most affected by the annual investment, operation, maintenance, and total costs calculations.

Katarzyna miszta-kruk (2015):
Based on seven distinct system investigations, this article offers an evaluation of the dependability of the pressure, vacuum, and gravity drainage system components. Both conventional (gravity) and non-traditional large-scale drainage systems are covered in this article. The data gathered during three to five years of studying actual sewage systems served as the basis for the research and evaluation. This study outlines the most susceptible system components and the most typical failure case types based on the analysis. This yielded a reliability estimate for each highlighted element in the form of computed failure rates (λ) and determined the length of identified failure events. It is possible to determine the likelihood that an object will operate by analysing the data in accordance with the functions of the items that are most likely to fail.

Mc Graw-hill Education (2008):
This document's goal is to give readers access to current information about Alternative Collection Systems (ACS). It is intended for planners as well as practitioners, and local governments can use the information when deciding what infrastructure to invest in. This kind of review paper is supported by the high level of development of ACS technologies. Given that the US Environmental Protection Agency and the WEF have recently recognised the benefits of decentralised technology and decentralised wastewater management in providing smaller metropolitan areas with affordable wastewater infrastructure, the timing of this work is especially poignant.

Informed infrastructure (2019):
When it comes to hoover drainage technology as a practical substitute for municipal sewage collection, some public construction officials and engineers give it second thought. Empty sewers have a number of benefits, such as lower installation costs, less interaction with raw sewage, and near infiltration (which therefore reduces costs for the treatment plant). However, concerns have been voiced regarding upkeep and long-term use (OandM). How long does a vacuum drain with pumps and valves last? Does it need ongoing care as the system becomes older? Are the parts dependable and simple to use? When spending tax resources, these are crucial considerations to consider. An important test case regarding the longevity and dependability of hoover sewers is the city of Ocean Shores, Washington.

Aquate (2019):
Vacuum systems function best in locations with thick soil, flat areas with high water levels, and sewer networks that have issues with infiltration. Flovac hoover systems offer a low-maintenance, dependable and efficient sewage network at a lower cost and with less environmental impact than low-pressure solutions and conventional gravity sewers. Since the 1960s, hoover drainage systems have been recognised as an affordable and sustainable option in over 40 nations.

3. METHODOLOGY

3.1 SELECTION OF SITE

The vacuum and pressure pipe length should be minimised while choosing the location of the vacuum stations. The location is independent of the system's features as well as the unique topographical and functional attributes of every project. The pumping station needs to be situated 500 mm above the 100-year flood level or built in a way that makes it possible to guarantee both operation and maintenance even in the event of flooding. The hoover plant's design shouldn't prevent the system from growing further. It is necessary to set aside enough room in order to install a new vacuum pump, new vacuum tube or bigger vacuum containers.

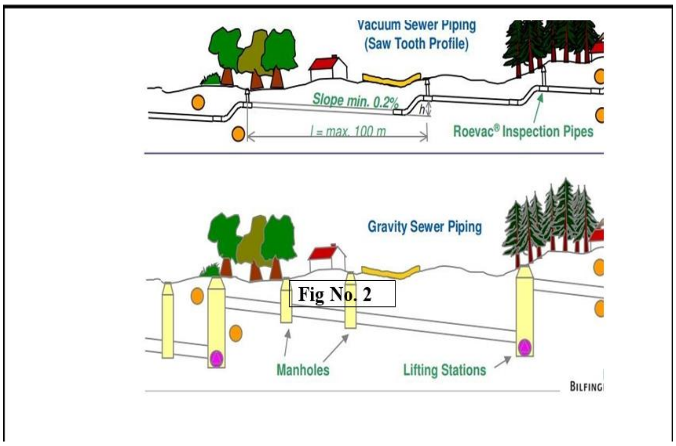


Fig No. 2

3,2 Vacuum station:

The vacuum station is the central component of the vacuum drainage system. The technical components located in the middle section include vacuum and sewage pumps, control cabinets, and electronic components used for communication, data collecting, and monitoring. Usually, the only point system that requires electricity is this one. For usage with vacuums, several models have been designed. Because of the design's flexibility, the arrangement can be modified to fit a variety of settings. The placement needs to be carefully chosen because the station's noise and odour emissions can have an impact on nearby residents and, in turn, the approval of the hoover system. It is necessary to consider both the position at the lowest point in the service area and the distance from nearby buildings.

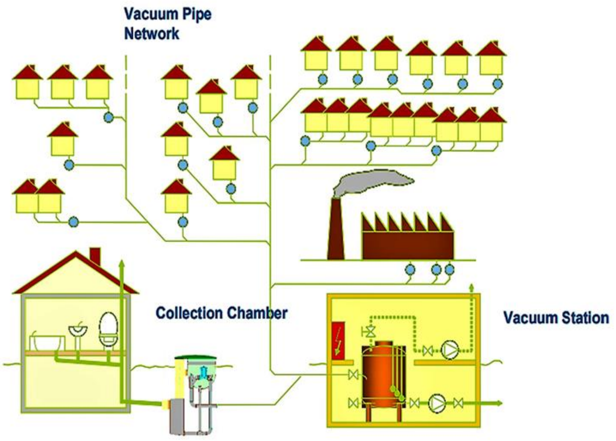
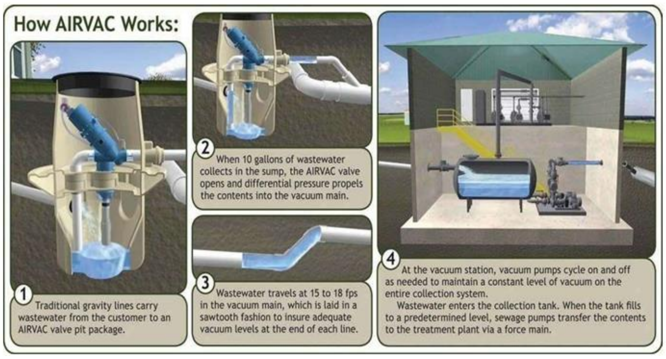


Figure:Vaccum Station

3.3 Working

A vacuum tank and vacuum pump keep the continuous vacuum needed for this sewage system to function. Gravity moves sewage from each property to a collection chamber nearby, where a vacuum connection valve that is automatically operated opens when a predetermined level of liquid is reached.Sewage is forced into the system by the pressure differential between the atmosphere and the vacuum sewer pipe, and the valve eventually closes to let more air enter the system.

With each interface valve action, the mixture of air and sewage is forced down the pipeline until frictional losses cause the liquid to stagnate at the bottom of the saw profile. This process is repeated until the wastewater eventually enters the vacuum vessel inside the vacuum pumping station.
Waste water collects there and is sent through the rising pipeline's outlet by the drainage pump. a vacuum pump in the station to remove air from the top of the vessel and maintain a constant vacuum level in the system.



Traditional gravity lines carry wastewater from the customer to an AIRVAC valve pit package.

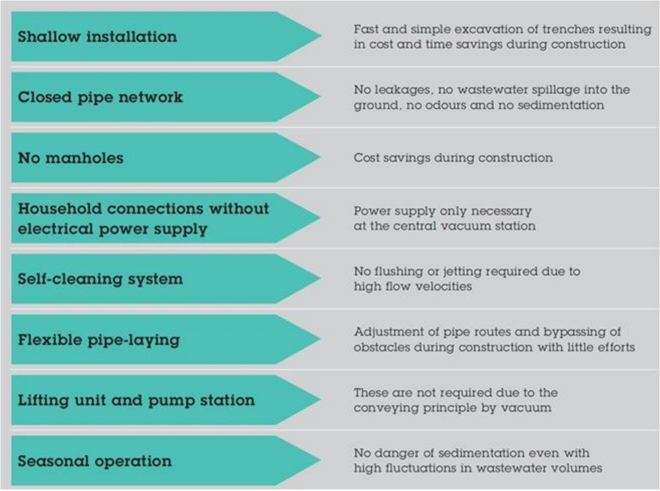
When 10 gallons of wastewater collects in the sump, the AIRVAC valve opens and differential pressure propels the contents into the vacuum main.

Wastewater travels at 15 to 18 fps in the vacuum main, which is laid in a sawtooth fashion to insure adequate vacuum levels at the end of each line.

At the vacuum station, vacuum pumps cycle on and off as needed to maintain a constant level of vacuum on the entire collection system.
Wastewater enters the collection tank. When the tank fills to a predetermined level, sewage pumps transfer the contents to the treatment plant via a force main.

Figure: Working

3.4 General technical advantages of vacuum sewer systems:



Shallow installation	Fast and simple excavation of trenches resulting in cost and time savings during construction
Closed pipe network	No leakages, no wastewater spillage into the ground, no odours and no sedimentation
No manholes	Cost savings during construction
Household connections without electrical power supply	Power supply only necessary at the central vacuum station
Self-cleaning system	No flushing or jetting required due to high flow velocities
Flexible pipe-laying	Adjustment of pipe routes and bypassing of obstacles during construction with little efforts
Lifting unit and pump station	These are not required due to the conveying principle by vacuum
Seasonal operation	No danger of sedimentation even with high fluctuations in wastewater volumes

Advantages	Disadvantages
Considerable savings potential in investment costs for construction	Expert design is needed
Shorter construction period	Needs energy to maintain vacuum
Shallow and narrow trenches	Skilled operators are required ,training necessary
Less water is needed for transport to centralized treatment facility	System is more vulnerable to vandalism due to more accessible.
Flexible pipeline construction independent from topography.	Network length is limited.
No manholes are required .	Valves are sensitive to faults and flushable objects.
One central vacuum station replaces several pumping stations; only one point of electricity consumption.	False user behaviour can limit the performance

3.5 Flow Calculation:

Dry Weather Flow:
(1000 x 250) / (24 x 60 x 60) = 2.89 Lit/Sec daily flow per capita (usually 200-280 lpcd)
Peak Flow:
(4 x 2.89) = 11.56 Lit/Sec peak factor (usually 3-4)
Pipeline:
Total length of Sewage = 800m
Flow per House = 11.56/200 = 0.057 Lit/house
Lateral Pipe = 110mm
Main Pipe = 160mm (As per standards mentioned in ISEKI Design Manual)
Vacuum Pump:
Capacity (Qv) = (3.6 x Qp x R x 1.5)
= 3.6 x 11.56 x 6 x 1.5
= 374.54 Cubic m/ hour So, Need to provide 2 pumps.

Vacuum Pump Downtime:
$T = (3.14 \times (0.162 \times 150) + (0.112 \times 650)) \times 0.7 / 4 \times 2 \times 375$
$= 32$ Sec < 5 Min ok
Collection Vessel :
$Vo = 15 \times 60 \times DWF$
$= 15 \times 60 \times 2.89$
$= 2.601$ cu.m
$Vt = 3 \times 2.601$
$= 7.803$ cu.m
So Approximately Vt = 8cu.m
And by considering depth of chamber as 1.5m. So Dia. Is 1.85m.

No deep excavation under rocky ground conditions:

4. RESULT

For better understanding of project, we have selected a area of a society and designed the vacuum sewerage system for it. Details are as follows:

Location - Olive Blue Skky Society,Near Moze College Wagholi,Pune
Population - 1000 persons
No. Of Houses - 200
Pump Capacity - 374.54 Cubic m/ hour
Number of pumps - 2 pumps.
Lateral Pipe = 110mm of Length 650m
Main Pipe = 160mm of Length 150m. ……(As per standards mentioned in ISEKI Design Manual)
Collection Vessel - depth of chamber as 1.5m. So Dia. Is 1.85m.

5. CONCLUSION

A number of factors and service conditions determine whether hoover drainage is the best option when it comes to sewage collection systems. The information provided in the figures is meant to offer decision-makers and other stakeholders in the wastewater services production process enough knowledge to decide whether vacuum drainage is a viable alternative in a particular service region.

Recent decades have seen a rise in interest in hoover sanitation due to advancements in technology, enhanced user experience, and a paradigm change towards integrated water management. Important facets of the design, development, and use of vacuum drainage systems are covered in this handbook. The technology's advantages and disadvantages are discussed, along with an approximation of the approximate costs of separate parts, maintenance, and vacuum sewer operation. Application, investment, and operational costs must all be evaluated in light of the specific circumstances in each location as they may differ greatly. Comparing hoover drainage to other drainage technologies, however, does offer some cost savings. Vacuum drainage's potential application as a transport technique in integrated water supply schemes is discussed.

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