Universe Scientific Publishing

Analysis and Countermeasures: Oil Pollution Causing Pipeline Blockage and Urban Waterlogging

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***Abstract**:* In recent years, the problem of urban waterlogging has become more and more serious during the process of rapidly advancing urbanization in China, including the world climate change, low-level standards of design and construction of rainwater canals and the increase of hard coverage, leading to different severe factors. Meanwhile, the urban water-logging is becoming even serious due to the blockage, and hetero-pipe insertion of drainage pipe. Another major cause of pipeline blockage, namely to be massive oil in the kitchen waste, was further investigated. Furthermore, foreign advanced measures should be reasonably introduced. In terms of urban construction, large-capacity underground storage system and a new type of rainwater treatment system which is promoted in Germany, namely "watershed seepage canal system", were adopted. The waste classification management and oil-water separator could make contributions to source control. The combination of municipal systems and technology can effectively solve the problems of blockage in the urban drainage system and urban water-logging.

***Keywords**:* Urban Water-Logging; Sewer Pipeline; Pipe Blockage; Edible Oil

1. Introduction

With the rapid advancement of urbanization and the continuous improvement of people's living standards, various urban problems and hidden dangers have gradually emerged, including urban problems in recent years, which have become one of urban problems after population, traffic congestion and environmental pollution. It has been seriously disturbed people's normal work and life [1].

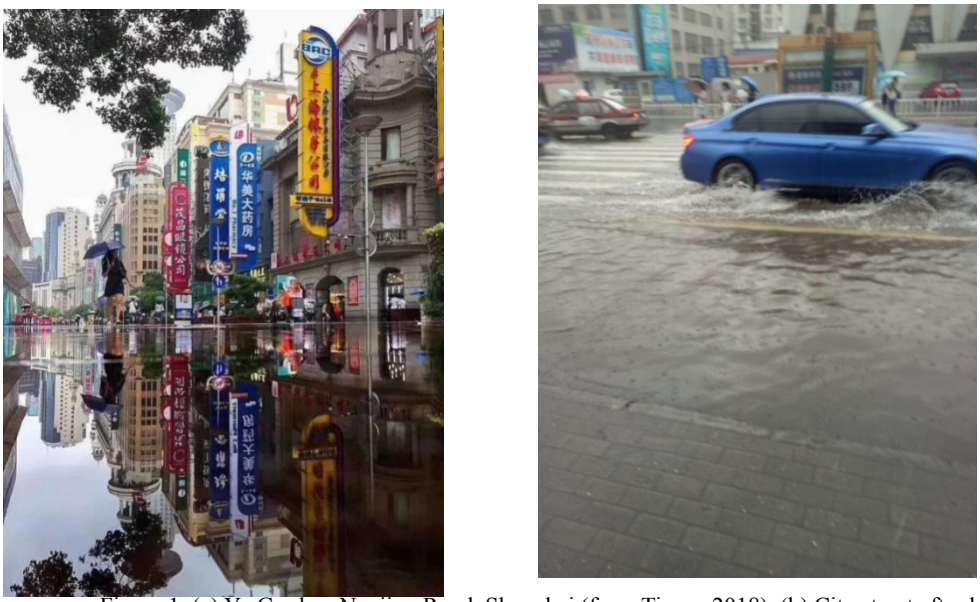

Figure 1. (a) Yu Garden, Nanjing Road, Shanghai (from Times, 2018), (b) City street after heavy rain

Figure. 1(a) is a photo about a clear reflection after rain near the Yu Garden of Nanjing Road in Shanghai published by Times in 2018, entitled "desolation of urban beauty and hidden dangers of thinking". On the surface, there is nothing new in this picture. Calm and tidy modern street, noble and classical architecture, peace water reflection of the same beautiful ground scenery and highly symmetric picture composition, all of these add the beauty of this photo. However, the real underground is not so calm, neat and beautiful as the ground. It has been already turbulent and dirty! The mirror was produced by collected water in the photo to reflect the social problem which is worthwhile pondering by all of us. We are

pursuing the life of modern urbanization, but we have ignored the municipal construction of civilized urbanization [2]. Over the years, large-scale urban construction has been made light of underground but heavy of above-ground, with high-rise buildings on the ground and skyscrapers piled up with reinforced concrete. Whereas the ground is fragile, a sudden rainstorm can present us serious of strange scene, like "cars in the water, people walk in the sea, garbage in the water spinning jump"...Figure 1(b) is a picture of a small city where I live. After experiencing a rainstorm, cars are speeding through the water. Alas, we still remember the flood in Beijing in one year. How can smaller cities survive in the floods when some of the fastest-growing big cities being so? [3]

2. Results

According to incomplete statistics, more than 500 cities in China have almost experienced urban waterlogging disasters. In some low-latitude cities, due to being close to the sea, rainstorms and floods occur frequently, "flood streets" have become a "required course" for these cities several times a year. Different from the previous floods caused by rural levee breaches, flood disasters have also brought huge economic losses to our modern cities. What is the root cause of this serious urban waterlogging problem? We analyze the reasons from scientific and objective factors: (1) **Climate change and urban rainfall heat island effect:** Severe changes in the natural ecological environment will bring about an increasing greenhouse gases, which will lead to elnino and other phenomena those change the global climate and correspondingly cause a significant increase in extreme weather changes in most Chinese cities; At the same time, with the gradual acceleration of urbanization in China, the urban heat island effect will also make the urban rainfall sometimes significantly greater than the suburban area. (2) **Increased hard cover to prevent rainwater from permeating on site:** In modern urban construction, impermeable materials such as granite, marble and cement are widely used to lay the ground. The ground is seriously hardened, and it is difficult for some rainwater to permeate from the surface to the ground quickly. The underground runoff is constantly decreasing, while the surface runoff is increasing. It is difficult for rainwater to flow quickly towards low-lying areas along the hardened pavement, which is easy to cause flooding. (3) **The storm sewer system, low construction standards and management does not reach the designated position:** While the city constructing in the new area, full consideration and implementation of rain sewage diversion in the old city reconstruction and units' interior rain sewage pipeline reconstruction still exist obvious hysteresis, resulting in the rain pollution in many cities confluence drainage patterns, while the new water pipe is performed practically with no function. In those areas where the combined drainage system is adopted, the main drainage pipes and canals discharge sewage during the non-rainy season, in this time the flow is small and the velocity is low, the impurities in the sewage are easy to precipitate, the pipes and canals are not cleared in time before the rainy season. And the drainage capacity of pipes is obviously insufficient or fragile in case of sudden rainstorm or prolonged rainfall [4].

Once experts said, the drainage system in the old city of Qingdao was the best in China, and this best drainage system was built by the German experts, more than one hundred years ago. At that time, the German experts design the damage system with rain sewage diversion idea, however, we did not totally learn German expert technical a train of thought when building perfect solid pipeline system and piled out a kingdom of hardened cements. Has been experienced more than 100 years, Qingdao's old city is difficult to cope with its modern urban development and its subsequent drainage system has not been scientifically designed and applied. So what is the reason for the continuous occurrence of "having a view of the sea from your doorstep"? We still need to look at the root cause. One of the most important reasons why heavy rainfall can't pass through underground pipelines smoothly, leading to increased surface runoff and eventually causing flooding is that the drainage pipes are blocked and obstructed. Pipeline blockage is mainly due to the partial catering, construction, medical treatment and other units discharge household garbage, medical sewage, site mud, and even illegal construction waste dumping. In addition, there are often different pipes inserted inside the drainage pipeline, such as water supply pipeline, telecom cable pipeline, communication pipeline, monitoring pipeline, etc., which cause the reduction of effective over-water area of the drainage pipe network. At the same time, a lot of garbage is attached to the pipeline (as shown in Figure 2), which will also lead to serious obstruction of the drainage system [5].

Figure 2. Various foreign bodies attached to groundwater pipelines: (a) deposition, (b) scaling, (c) roots, and (d) foreign body invasion.

Practice has proved that the biggest scourge of clogged pipes is the large amount of grease in kitchen waste. With the daily growing development of catering industry, restaurants on both sides of municipal roads and even ordinary communities are discharging more and more domestic sewage and greasy kitchen garbage (as shown in Figure 3).Especially in northern and central plains region, their tastes are salty, heavily spicy and the eaten hutch waste is rich in oil, if the oil along with the water drains into the river by a complex biochemical reaction in water, which will produce a series of complex aldehyde, acid has a fetid substances. Such the bad odor sending out into the air will not only pollute the atmosphere and influence the living environment, but also consume oxygen, water and the eutrophication in water body breeding ground for mosquitoes, flies and other insects, thus to cause water pollution. What's more, these oils in the cooler weather situation will condense into a solid adsorption on the inner wall of the pipe near the tube wall and slowly accumulate over a long period, making the pipe wall thickening, drainage pipeline corrosion and causing the original drainage area water will slowly decrease, plus the eat hutch garbage will directly into the pipeline and inspection wells, making the drainage pipe network in the long term to jam. As a result, the water cannot pass through the pipes, only can run on the road surface, when time is longer, will lead to urban flooding [6].

(a) (b)

(c) (d)

Figure 3. The status of several different sewage pipes in kitchen waste: (a) heavy oil dishes, (b) oily sludge, (c) residual oil from stir-fried vegetables, and (d) drainage pipes clogged with massive, solidified oil.

3. Discussion

Taking Changsha City as an example, the city collects nearly 640 tons of food and kitchen waste every day, including nearly 60,000 tons of waste oil. In Germany, the United States of American and Japan, there are already mature methods to deal with the food oil pollution that causes waterlogging. Table 1 gives the comparison of without and with oil & water separator as experimental examples. The different effects were found without and with oil & water separator.

Table 1. Comparison of without and with oil & water separator as experimental examples.

Entry	Total Volume of waste water containing waste oil (L)	Proportion without oil & water separator (L)	Proportion with oil & water separator (L)	Percentage of oil in waste water with oil & water separator
Example 1	100	16:84	1.0:99.0	1.190%
Example 2	100	20:80	0.5:99.5	0.625%
Example 3	100	22:78	0.4:99.6	0.513%
Example 4	100	19:81	0.8:99.2	0.988%
Example 5	100	25:75	1.2:98.8	1.600%
Example 6	200	21:79	0.5:99.5	1.266%
Example 7	300	20:80	0.7:99.3	1.725%
Example 8	400	22:78	0.6:99.4	2.077%

For example, in Hamburg, Germany, the city has a large capacity of underground storage, which has a strong capacity to dispatch water; Such large-scale underground water storage can not only ensure smooth drainage in flood season, but also realize reasonable utilization of rainwater. And the new rainwater treatment system popularized in Germany -- "depression infiltration canal system", that is, the short-term storage of rainwater in low-lying grassland and the long-term storage in infiltration canal ensure that as much rainwater as possible can be infiltrated, thus greatly reducing stormwater runoff and timely replenishing groundwater. This is an effort from the construction side of the city and let the rainwater seep down, not just drain through the pipe, so this idea is well worth adopting. Figure 3 displays a planar design drawing of oil and water separation system. Figure 4. shows outline design drawing of oil and water separation system [7].

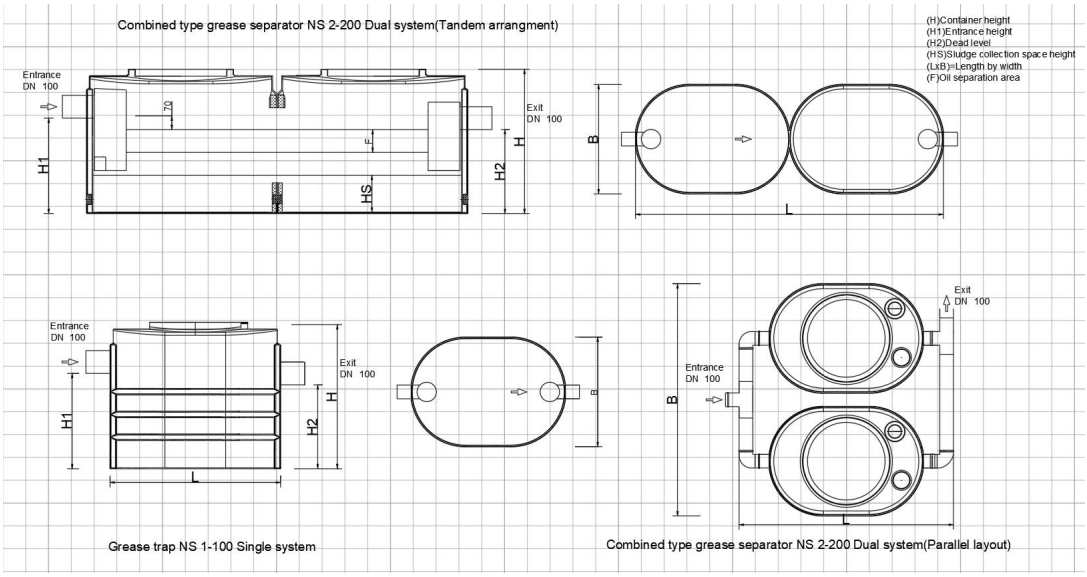

Figure 3. A planar design drawing of oil and water separation system.

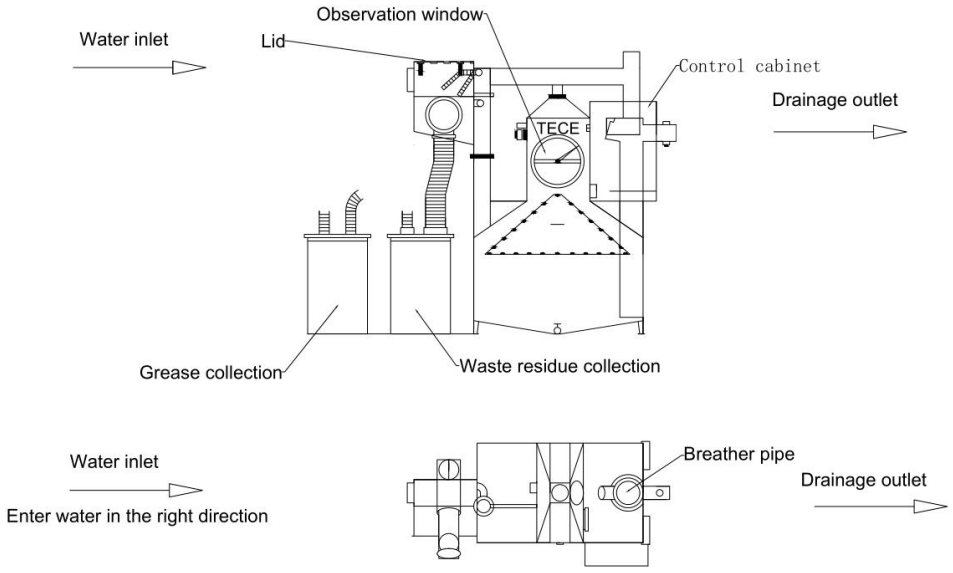

Figure 4. Outline design drawing of oil and water separation system.

On the other hand, it is to solve the problem of pipeline blockage at the source. Garbage, foreign matters, kitchen waste water and oil cannot be discharged into the pipeline at liberty. In Germany, apart from garbage classification management, grease separators are installed in catering kitchens, slaughterhouses, oil plants and even households to solve the problem of grease blocking the drainage pipes in catering garbage. Once this grease separator is put into use, according to the density of

biomass, it can produce deposition and stratification. The lowest layer is the household waste decomposition into the form of organic matter sludge, which can be pumped away, the use of high temperature anaerobic digestion process to produce methane, so as to make compressed vehicle gas be used. In the middle layer is waste water, which can be drained away through a drainage pipe. In the top class, sebum separation recycling processing can be made into industrial mix oil or biodiesel and realize resource recycling which can bring considerable economic benefits [7].

4. Summery

At the same time, it will not produce any biomass waste, and the kitchen waste that is eaten has no impact on the drainage pipe, even when it becomes waste, it means that it is transformed into resources and integrated. Therefore, it is a combination of getting rainwater into the groundwater as much as possible; and keeping drains open so that rainwater can be drained out in time. In this way, our city will not be afraid of rainstorm or flood disaster, so that our home "sea" into a real river and lake.

Acknowledgements

This study was funded by University level innovation project of Jiangsu University in 2022. We are grateful to Professor Can Kang for supervision. We are grateful to Dr. Zhengbin Qi, Technology Transfer Center, Hannover Institute of Technology, Germany and Dr. Fugui Yin, Institute of Subtropical Agriculture, Chinese Academy of Sciences, for their summer internship guidance and investigation of some reference materials. We are grateful to Dr. Jing Yuan for her proof-reading.

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