# Advanced Technology Based VOCs Management Plan for Oil Terminal

**Huan Peng, Zhiyao Huang***

Hunan Petrochemical Vocational and Technical College, Yueyang, 414100, China

**Keywords:** Industrialization; Energy; Oil terminal; Emission reduction; VOCs governance scheme

**Abstract:** With the rapid development of industrialization, the volatile organic compounds (VOCs) emission from the oil terminal, as an important energy transfer hub, has become increasingly prominent. VOCs not only pollute the environment, but also pose a threat to human health. Therefore, the treatment of VOCs in oil terminals is particularly important. According to the actual situation of VOCs emission from oil terminal, this paper puts forward a set of treatment scheme based on advanced technology. The scheme comprehensively uses various technical measures such as source emission reduction, process control and terminal treatment, aiming at effectively reducing VOCs emissions from oil terminals and improving ambient air quality. Through the implementation of this scheme, it is expected to achieve significant emission reduction effect and provide strong support for the green and sustainable development of oil terminals.

## 1. Introduction

Under the background of the continuous growth of global energy demand, the oil terminal, as an important link to support the energy supply chain, has been expanding its operation scale [1]. However, it is followed by the problem of VOCs emission in the process of oil loading, unloading and storage [2]. VOCs emissions not only aggravate air pollution, lead to photochemical smog, ozone layer destruction and other environmental problems, but also cause potential harm to human health, such as causing respiratory diseases and damaging the nervous system [3]. Therefore, effective treatment of VOCs emission from oil terminals is of great significance for protecting the ecological environment, maintaining public health and promoting sustainable economic and social development [4].

In addition, with the increasing awareness of environmental protection in the international community and the increasingly strict related laws and regulations, VOCs governance in oil terminals has also become an inevitable choice for enterprises to fulfill their social responsibilities and enhance their competitiveness [5]. By implementing advanced VOCs treatment technology, oil terminal enterprises can not only reduce environmental risks, but also improve resource utilization efficiency and achieve a win-win situation of economic benefits and environmental benefits [6]. The main purpose of this study is to put forward a scientific and feasible treatment scheme for VOCs emission from oil terminals. Through the comprehensive application of advanced technology and management means, the aim is to achieve the effective control and emission reduction targets of VOCs emission from oil terminals.

## 2. Present situation of VOCs emission from oil terminal

(1) Terminal operation and VOCs emission

As an important hub connecting oil tankers and inland oil depots, the daily operation of oil terminals involves a large number of oil loading, unloading, storage and transshipment activities [7]. During these activities, VOCs will inevitably be emitted due to the volatility of oil products. The leakage of equipment on the dock and the escape of pipelines are also important sources of VOCs emission.

In recent years, with the increasing throughput of oil terminals, VOCs emissions have also shown an increasing trend year by year. This not only aggravates the air pollution around the wharf, but also poses a serious threat to the health of the surrounding residents. Therefore, it is urgent to

  DOI: 10.25236/icmmct.2024.032

effectively control VOCs emissions from oil terminals.

(2) Analysis of emission sources and characteristics and environmental impact

The emission sources of VOCs in oil terminals mainly include loading and unloading operations, storage tank breathing, equipment leakage and fugitive emissions [8]. These emission sources have different characteristics:

Discharge from loading and unloading operations: This is one of the main sources of VOCs emission from oil terminals. In the process of loading and unloading, the fluctuation of oil level and the volatilization of oil and gas will produce a lot of VOCs emissions. This kind of emission is instantaneous, high concentration and difficult to control.

Breathing emission from storage tank: VOCs will be emitted from storage tank through breathing valve due to temperature change and pressure change during oil storage. This kind of emission has the characteristics of persistence, low concentration and easy to be affected by environmental factors.

Equipment leakage and fugitive emission: The equipment and pipelines on the wharf may leak or escape due to aging and wear, resulting in the emission of VOCs. This kind of emission has the characteristics of concealment, unpredictability and quantification.

The impact of VOCs emission from oil terminals on the environment is mainly reflected in the following aspects: air pollution, greenhouse effect, human health hazards and ecological environment damage (as shown in Table 1).

Table 1 Influence of VOCs emission from oil terminal on environment

| Impact category | Main performance |
|---|---|
| Air pollution | VOCs are important precursors of photochemical smog, which aggravate air pollution, reduce atmospheric visibility and increase ozone concentration. |
| Greenhouse effect | Some VOCs emissions aggravate global warming. |
| Harm to human health | Many components in VOCs are toxic to human body, and long-term exposure may cause respiratory diseases and nervous system damage. |
| Ecological environment destruction | VOCs emission may affect plant growth and destroy ecological balance. |

## 3. Summary of governance technology

### 3.1. Overview of governance technology and typical case analysis

At present, a variety of treatment technologies have been developed to solve the VOCs emission problem in oil terminals. These technologies can be roughly divided into three categories: source emission reduction technology, process control technology and terminal treatment technology [9]. Source emission reduction technology mainly reduces the generation of VOCs by improving the process and optimizing the equipment; The process control technology focuses on reducing the leakage and escape of VOCs during oil transportation; The terminal treatment technology is to capture and treat VOCs that have been discharged into the atmosphere.

In many oil terminals, there have been many cases of successful application of VOCs treatment technology. For example, a large oil terminal successfully reduced VOCs emission during loading, unloading and storage by adopting advanced loading and unloading technology and tank design; Another oil terminal installed ldar system, which effectively reduced VOCs emission caused by equipment leakage. These successful cases provide valuable experience and reference for other oil terminals.

### 3.2. Problems and challenges of existing technology

Although a variety of VOCs treatment technologies have been applied to oil terminals, there are still some problems and challenges in their practical application. First of all, there are differences in the applicable conditions and treatment effects of different technologies, and the choice of which technology needs to be comprehensively considered according to the actual situation of the terminal.

Secondly, the investment cost of some advanced technologies is high, which may increase the economic burden of enterprises. In addition, the operation, maintenance and management of technology is also a big challenge, which requires professionals to operate and maintain to ensure the stable operation and governance effect of technology. Finally, with the continuous tightening of environmental protection laws and regulations and the continuous progress of technology, the existing governance technologies may face the need of upgrading, and how to maintain the advanced nature and adaptability of technology is also a problem that needs attention in the future.

## 4. Governance scheme design

In view of VOCs emission from oil terminals, the overall idea of this treatment scheme is to combine "source emission reduction, process control and terminal treatment" to form a full-chain, multi-level treatment system. Firstly, by improving the process and optimizing the equipment, the generation of VOCs is reduced from the source; Secondly, strengthen monitoring and management in the process of oil transshipment to prevent the leakage and escape of VOCs; Finally, the VOCs that have been discharged are efficiently collected and treated to ensure that they meet the discharge standards. As shown in Figure 1.

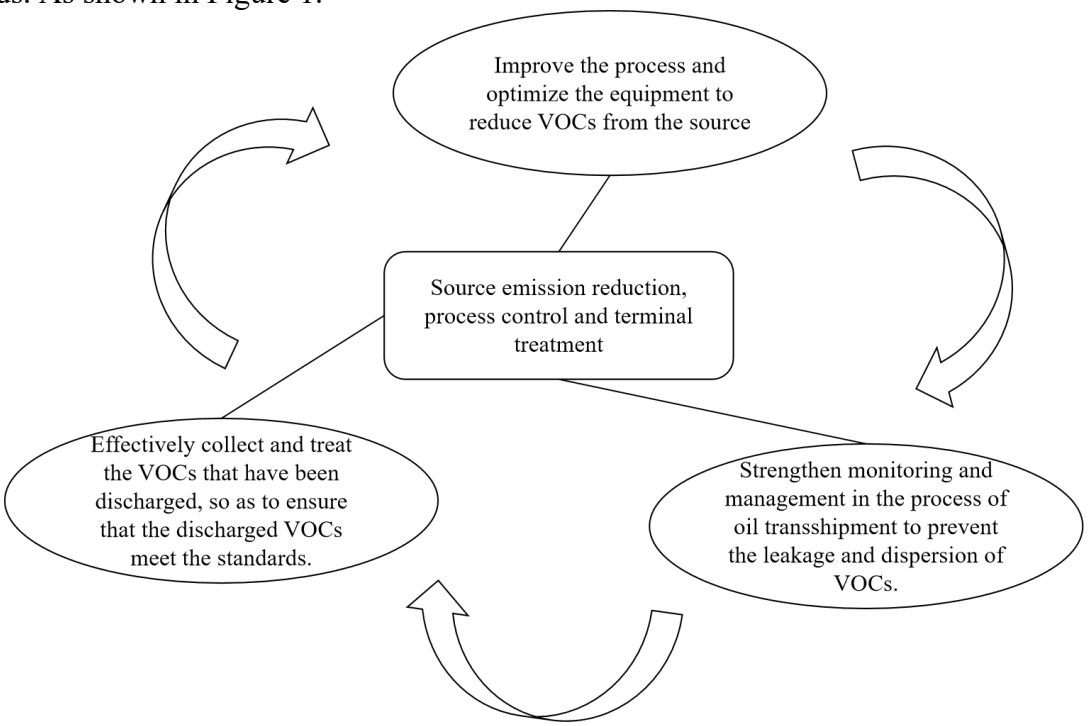


Figure 1 Thoughts on treatment scheme of VOCs emission from oil terminal

(1) Source emission reduction strategy

To improve the loading and unloading process, a closed loading and unloading system should be adopted to reduce the volatilization of oil during loading and unloading. At the same time, the loading and unloading operation process should be optimized to shorten the exposure time of oil products and reduce VOCs emissions.

To optimize the design of storage tanks, low volatile storage tanks such as floating roof tanks should be chosen to reduce the respiratory emissions of storage tanks. Additionally, the existing storage tank should be retrofitted by installing a breathing valve control device to further reduce VOCs emissions.

Use of environment-friendly materials: In dock construction and equipment renewal, materials and coatings with low VOCs volatility are preferred to reduce the release of VOCs.

(2) Process control technology

To ensure the airtightness of oil products during transportation, closed system operation should be implemented, such as using sealed oil pipelines, gas collection hoods, etc., to prevent VOCs

from leaking into the atmosphere.

Establishing a regular leakage detection system involves conducting regular inspections of equipment, pipelines, etc., on the dock, and timely discovering and repairing leakage points to reduce the unorganized emissions of VOCs.

Intelligent monitoring system: utilizing sensors and monitoring technology, it monitors the VOCs concentration in various areas of the dock in real time, achieving excessive warning and rapid response.

(3) Terminal treatment method

Adsorption recovery technology: the discharged VOCs are adsorbed by adsorbents such as activated carbon, and then recovered through desorption process to realize the recycling of resources.

Catalytic combustion technology: under the action of high temperature and catalyst, VOCs are oxidized and decomposed into harmless small molecular substances, such as carbon dioxide and water.

Biofiltration technology: VOCs are transformed into harmless substances by microbial degradation. This method is suitable for treating VOCs with low concentration and atmospheric volume.

## 5. Implementation plan and effectiveness evaluation

### 5.1. Governance implementation plan

Pre-preparation: Investigating the current situation of VOCs emission from oil terminals and clarifying the governance objectives and requirements are essential steps. Formulating a detailed governance scheme and implementation plan, including investment budget, technology selection, and project progress, is crucial.

Regarding technology implementation, it is important to gradually promote the implementation of source emission reduction, process control, and terminal treatment technology according to the requirements of the treatment plan. Ensuring that all technical measures are put in place and achieve the expected results is imperative.

Establishing a professional operation and maintenance team to regularly inspect and maintain the governance facilities is essential for effective operation and maintenance. Additionally, carrying out technical training to improve the skill level of operation and maintenance personnel is necessary.

Continuous monitoring is key. Using an intelligent monitoring system to monitor the VOCs concentration in each area of the terminal in real-time ensures the continuous and stable treatment effect.

### 5.2. Expected emission reduction and environmental benefits

Through the implementation of this treatment plan, it is expected to achieve significant VOCs emission reduction effect. See Table 2 for details.

Table 2 Expected emission reduction effect and benefit of VOCs treatment scheme for oil terminal

| Implementation of governance plan | |
|---|---|
| Governance goal | Significant VOCs emission reduction effect |
| Influencing factor | Wharf scale, throughput, and types of oil products |
| Emission reduction | |
| Expected emission reduction | Tailor-made emission reduction plan according to specific factors |
| Environmental benefit | |
| Air quality improvement | Reduce VOCs emission and improve air quality |
| Risk reduction of photochemical smog | Reduce the risk of photochemical smog caused by VOCs |
| Ozone pollution reduction | Reduce ozone pollution and improve the atmospheric environment |
| Human health protection | Reduce the harm of VOCs to human health |
| Economic benefits | |
| Recycling of resources | Realize the effective use of resources and reduce costs |

| | |
|---|---|
| Cut down on energy consumption | Take energy-saving measures to reduce energy consumption |
| Economic benefit improvement | Through environmental governance and resource management, we can achieve a win-win situation of economic benefits and environmental protection |

Table 2 describes in detail the expected emission reduction effect and the environmental and economic benefits brought by the implementation of VOCs treatment scheme for oil terminals. Through targeted emission reduction measures, not only the environmental quality can be significantly improved, but also the economic benefits can be improved.

### 5.3. Risk assessment and management

Technical risk assessment: Conducting risk assessment on the selected governance technologies is essential. It involves identifying potential technical risk points and formulating corresponding preventive measures and emergency plans.

Management and policy risk response: Establish and improve the operation management system and operation procedures of governance facilities to ensure the stable operation of facilities and discharge up to standard. At the same time, we should pay close attention to the changes in relevant laws and policies, and adjust the governance strategy in time to meet the new requirements.

Safety risk assessment: Evaluate the safety risks that may be involved in the treatment process, such as the identification and control of hazards such as fire and explosion. We need to formulate a safety management system and emergency plan to ensure the safety and controllability of the governance process.

## 6. Conclusions and suggestions

### 6.1. Research summary

In this study, the problem of VOCs emission from oil terminals was deeply analyzed and discussed. Through field investigation, data collection and collation, technical comparison and evaluation, the following main conclusions were drawn:

(1) As an important energy transfer hub, the VOCs emission of oil terminal cannot be ignored. The emission sources mainly include loading and unloading operations, tank breathing and equipment leakage, which pose a serious threat to the environment and human health.

(2) At present, some experience and technology have been accumulated in the treatment of VOCs in oil terminals, but there are still many problems and challenges, such as technical applicability, investment cost, operation and maintenance, etc.

(3) The treatment scheme put forward in this study comprehensively applies various technical measures such as source emission reduction, process control and terminal treatment, aiming at achieving comprehensive control of VOCs emission from oil terminals. Through the implementation of this scheme, it is expected that significant emission reduction effects and environmental benefits will be achieved.

(4) The implementation of the governance plan needs the joint efforts of the government, enterprises and society. The government should strengthen supervision and policy guidance, enterprises should actively fulfill their social responsibilities, increase investment, and society should participate in supervision and support extensively.

### 6.2. Policy and enterprise suggestions

Based on the above conclusions, this study puts forward the following suggestions to the government and enterprises:

(1) The government suggested that

We need to formulate stricter VOCs emission standards for oil terminals and strengthen supervision to ensure that enterprises meet the emission standards.

We need to introduce preferential policies and financial subsidies to encourage enterprises to adopt advanced VOCs governance technology and reduce governance costs.

We need to strengthen the monitoring and information disclosure of VOCs emissions from oil

terminals to improve public participation and supervision.

We need to promote the green development, transformation, and upgrading of the oil terminal industry and guide enterprises to develop in the direction of low carbon and environmental protection.

(2) Enterprise suggestions

We need to establish the concept of green development, incorporate VOCs governance into the long-term development plan of enterprises, and increase investment.

We need to actively introduce and develop advanced VOCs governance technology to improve governance efficiency and effectiveness.

We need to strengthen the internal management of enterprises, establish a sound VOCs emission monitoring and reporting system, and ensure that the data are true and reliable.

We need to strengthen communication and exchanges with the government, industry associations, and experts, and jointly promote the improvement of VOCs governance level in oil terminals.

## References


[1] Jiang Xufeng. Reasonable treatment plan for VOCs emissions from refined oil terminals [J]. China Aviation Weekly, 2021 (2): 50-51

[2] Xiao Jing, Guo Ruili, Wang Bing, et al. Characteristics and Source Analysis of VOCs Pollution during the Summer Ozone Heavy Pollution Period in Puyang City [J]. Environmental Science and Management, 2023, 48 (1): 122-127

[3] Tang Yu. Technical Plan for VOCs Treatment Process Transformation of a Terminal Natural Gas Separation Plant in a Bohai Oilfield [J]. Cleaning World, 2021, 37 (5): 2

[4] Lin Qingyuan. Innovation and Industrial Application of Oil and Gas Recovery Technology in Oil Storage Tank Areas [J]. Chemical Management, 2023 (17): 71-73

[5] Ouyang Jianfeng. Discussion on VOCs emission control technology for finished oil terminals [J]. Anhui Chemical, 2020, 46 (3): 5

[6] Zhao Jianliang, Zhou Yong, Li Yongwu, et al. Discussion on VOCs treatment process measures and plans for gasoline storage tanks [J]. Shandong Chemical, 2022, 51 (14): 3

[7] Yang Zhengshan. Exploration of VOCs treatment technology for refinery oil storage and transportation systems [J]. Contemporary Petroleum and Petrochemical, 2023, 31 (9): 30-35

[8] Zhang Gangfeng. The VOCs emission reduction experience in the Japanese ink industry is worth learning from [J]. Shanghai Environmental Science, 2023, 42 (1): 6-8

[9] Liang Lingyu. Current Status and Emission Reduction Strategies of Volatile Organic Compounds in Industrial Coating Processes in Jinzhong City [J]. Shanxi Chemical Industry, 2023, 43 (5): 256-258