



# ГУБКИНСКИЙ УНИВЕРСИТЕТ

ДАЙДЖЕСТ  
НАУЧНО-ТЕХНИЧЕСКИХ ПУБЛИКАЦИЙ  
ПО НАПРАВЛЕНИЮ:

СЖИЖЕННЫЙ  
ПРИРОДНЫЙ ГАЗ

2 КВАРТАЛ  
2021



## О нас

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## Параметры составления дайджестов

I. Период составления дайджеста / Digest compilation period:

1 апреля – 30 июня / April 1 – June 30

II. Ключевые слова / Key words:

СПГ, сжиженный природный газ, LNG, liquefied natural gas

III. Источники

Журналы:

1. Applied thermal engineering;
2. Chemical and petroleum engineering;
3. International journal of refrigeration;
4. Brazilian journal of chemical engineering;
5. Measurement science and technology;
6. Вестник МГТУ Станкин;
7. Safety Science.

## I. Производство / Production

### 1.1. Подготовка газа / Gas Pretreatment

#### 1.1.1 Статьи / Articles

##### 1. DESIGN AND OPTIMIZATION OF LNG VAPORIZATION COLD ENERGY COMPREHENSIVE UTILIZATION SYSTEM BASED ON A NOVEL INTERMEDIATE FLUID VAPORIZER

**Authors:** Yao S.G., Shen X.Y., Yang Z.M., Feng G.Z., Xiao M.

**Journal:** Applied thermal engineering, volume: 190

**DOI:** 10.1016/j.applthermaleng.2021.116785

**Abstract:**

In this paper, a novel type intermediate fluid vaporizer with LNG vaporization cold energy utilization was proposed and applied to 9200TEU container LNG power ship. Considering the different LNG vaporization parameters of the ship's main and auxiliary engines and the requirements of shipping for power generation, seawater desalination, cold storage and air conditioning, a comprehensive utilization system of LNG vaporization cold energy was constructed with a novel intermediate fluid vaporizer. Through the simulation and analysis of the scheme, and based on the cascade utilization of cold energy, the design scheme was optimized from the perspective of process arrangement and refrigerant selection. Finally, the parameter matching optimization of the determined optimization design scheme was carried out by using genetic algorithm. The results showed that the overall exergy efficiency of the optimal design scheme of the cold energy cascade utilization system of the ship LNG built in this paper based on the novel intermediate vaporizer was 51.09%, the net output electric power of the system was 342.228 kW, and the net profit of the system was about US \$224,300 per year, and the cost was recovered in 7 years.

##### 2. USING DYNAMIC SIMULATION IN LNG PRODUCTION UNITS DESIGN ON THE EXAMPLE OF A PROPANE PRE-COOLING UNIT

**Authors:** Razyapov T. E., Zhedyaevskiy D. N., Fedorova E. B., Rudenko S. V., Nozikov N. D., Fedoseev P.O.

**Journal:** Chemical and petroleum engineering, volume: 57, number: 1-2, pp.: 36-43

**DOI:** 10.1007/s10556-021-00891-3

**Abstract:**

The article presents the features of using dynamic simulation in LNG production design. Benefits, as well as potential areas of application at various stages of domestic projects in order to increase their competitiveness are revealed. General principles of dynamic simulation using software suites are described. The results of dynamic simulation of a propane pre-cooling unit for natural gas and the response of the model to emergency transient modes are also presented.

## 1.1.2. Патенты / Patents.

### 3. DEMISTING SYSTEM OF LNG GASIFIER



**Authors:** Xu Ying, Meng Xiangwei, Cheng Jinliang, Li Xueying, Luo Can, Zhang Wanli, Zhang Anqi

**Publication number:** 213299609

**Publication date:** 28.05.2021

**Abstract:**

The utility model discloses an LNG (Liquefied Natural Gas) vaporizer demisting system which mainly comprises a cold mist collecting and processing device, the cold mist collecting and processing device comprises a temperature sensor, a humidity sensor and a telescopic fence, the temperature sensor and the humidity sensor are mounted at the bottom of an LNG vaporizer, an air collecting opening is formed between the LNG vaporizer and the telescopic fence, and the air collecting opening is communicated with the temperature sensor and the humidity sensor. And a cold fog collecting pipeline is connected below the telescopic fence. The system can effectively monitor the generation of cold fog during LNG gasification within the range of the telescopic fence and remove the cold fog in time, and is different from the traditional treatment mode, the system can stop running when the LNG peak shaving station does not have a gasification task, and the system adopts a physical method to treat the cold fog, so that the energy consumption is further reduced, and the energy consumption is reduced. The whole system is simple in structure and low in investment, and the economical efficiency problem of station yard investment can be considered when the cold fog problem is solved.

### 4. NOVEL INTEGRATED LNG GASIFICATION GAS SUPPLY SYSTEM



**Authors:** Zhou Jianqi, Wu Long

**Publication number:** 213272030

**Publication date:** 25.05.2021

**Abstract:**

The utility model discloses a novel integrated LNG (Liquefied Natural Gas) gasification gas supply system which comprises a moisture insulation box, a fixing hole, an explosion-proof junction box, a conveying pipe, a fixable supporting and protecting storage box structure, a protecting and warning heat preservation pipe structure, a shielding and replacing cover structure, an automatic odorizing machine, a stop valve, a pressure regulator, a flow meter, a water bath type reheater and a filter. A differential pressure sensor and a pressure sensor. Due to the arrangement of the fixing box, the LNG low-temperature storage tank, the vaporizer, the supporting rod, the bottom plate and the moisture-proof box, the moisture-proof box, the fixing box and the bottom plate are matched with one another in the using process, and electrical equipment can be protected conveniently in the using process; by arranging the protection pipe, the fixing plate, the connecting plate, the fixing pipe, the moisture insulation box and the conveying pipe, the conveying pipe can be protected through the protection pipe and the fixing pipe in the using process, and the situation that in the using process, the conveying pipe is corroded or damaged, and work is affected is prevented.

## 1.2. Технологии сжижения / Liquefaction Technology

### 1.2.1 Статьи / Articles

#### 1. THERMODYNAMIC INVESTIGATION AND OPTIMIZATION OF TWO NOVEL COMBINED POWER-REFRIGERATION CYCLES USING CRYOGENIC LNG ENERGY



**Authors:** Dokandari DA., Khoshkhoo R.H., Bidi M., Mafi M.

**Journal:** International journal of refrigeration, volume: 124, pp.: 167-183

**DOI:** 10.1016/j.ijrefrig.2020.12.019

**Abstract:**

The present study aimed to introduce two novel combined power-refrigeration cycles into optimal usage of liquefied natural gas (LNG) cryogenic energy and reduce exergy destruction due to high-temperature difference in the heat transfer process. The combined cycles include a compression-ejector refrigeration cycle and two low and high-pressure Rankine cycles in which the power required to drive the compression-ejector refrigeration cycle compressor is provided by the power generated by the two low and high-pressure Rankine cycle turbines. Increasing the utilizable cooling energy of LNG is considered as the benefits of the new combined cycles compared to direct LNG evaporation. A comprehensive thermodynamic analysis, along with optimizing both novel combined power-refrigeration cycles, was performed through the first and second thermodynamics laws and the constant area model assumption for the ejector. Analyzing the design parameters demonstrated that the maximum energy efficiency, exergy efficiency, and the highest refrigeration increasing ratio (RIR) increase in both novel combined power refrigeration cycles as increasing the pump discharge pressure and decreasing turbine outlet pressure of the low-pressure Rankine cycle. The maximum thermal efficiency and exergy efficiency were 77.3% and 23.7% in cycle I and 87.5% and 23.9% in cycle II, respectively, through performing optimization in the boundary set for the design parameters. Finally, the highest obtainable cooling energy to direct the evaporation of LNG ratio in the two cycles I and II was 62.6% and 73.9%, respectively.

#### 2. DESIGN AND OPTIMIZATION OF ENERGY-EFFICIENT SINGLE MIXED REFRIGERANT LNG LIQUEFACTION PROCESS



**Authors:** Santos L.F., Costa C.B.B., Caballero J.A., Ravagnani M.A.S.S.

**Journal:** Brazilian journal of chemical engineering

**DOI:** 10.1007/s43153-021-00111-8

**Abstract:**

The optimal design of single mixed refrigerant (SMR) natural gas liquefaction process is decisive for upgrading the liquefied natural gas (LNG) value chain and can be achieved using process simulators and derivative-free optimization techniques in simulation-optimization frameworks. The process work consumption can be reduced by modifying process flowsheet and manipulating refrigeration cycle thermodynamic conditions and refrigerant composition. The goal of this paper is the design of energy-efficient SMR liquefaction process for LNG production using simulation-optimization approach, in Aspen HYSYS(R) and MATLAB(R), that considers more decision variables to be optimized with a Nelder-Mead simplex algorithm and small flowsheet modifications, such as hydraulic turbines and flash separators in between compression stages. The present approach resulted in liquefaction process with network duty of 750.2 kJ per kg of natural gas, which is considerably smaller than those reported in the literature.

## 1.2.2. Патенты / Patents.

### 3. SYSTEM AND METHOD FOR PREPARING LNG AND CO-PRODUCING METHANOL, LIQUID AMMONIA AND HYDROGEN BY PURIFYING COKE



**Authors:** Wang Gui, Guan Jie, Hao Chenghao, Zuo Yongfei, Fan Hui, Zhang Chao, Zhang Tao, Zhao Pusheng **Publication number:** 112961711

**Publication date:** 15.06.2021

**Abstract:**

The invention provides a system and method for preparing LNG and co-producing methanol, liquid ammonia and hydrogen by purifying coke oven gas, and belongs to the field of coke oven gas purification. A pre-washing tower is arranged as a supergravity rotating device, so that the coke oven gas subjected to benzene removal can be subjected to primary impurity removal in the pre-washing tower through a supergravity rotating technology, and harmful substances such as dust, benzene, tar, naphthalene, ammonia and sulfur in the coke oven gas subjected to benzene removal are deeply removed; the problems that sulfur and ammonia in the coke oven gas exceed the standard to affect stable operation of a system, tar and naphthalene in the coke oven gas can cause blockage of a compression system, and the operation cost is increased due to the fact that a desulfurization adsorbent for fine desulfurization loses efficacy in advance due to abnormal coarse desulfurization are solved. The coke oven gas does not need to be desulfurized after being returned to the coke oven through pretreatment, so that the investment and desulfurization waste liquid can be reduced. CH<sub>4</sub>, CO and H<sub>2</sub> are separated out through coke oven gas cryogenic separation to serve as feed gas to synthesize methanol and liquid ammonia and output hydrogen, and the effect of quality-divided utilization of coke oven gas is achieved.

### 4. LNG PURIFICATION DEVICE



**Authors:** Ji Wei, Wang Fuchao

**Publication number:** 212955029

**Publication date:** 13.04.2021

**Abstract:**

The utility model provides an (Liquefied Natural Gas) purification device which comprises a box body, a first partition plate and a second partition plate are arranged in the box body and divide an inner cavity of the box body into three chambers which are communicated with one another, the chambers are a filter chamber, a desulfurization chamber and a drying chamber in sequence, and a primary-efficiency filter screen, a medium-efficiency filter screen and a high-efficiency filter screen are arranged in the filter chamber. Wherein an alcohol amine solution is arranged at the bottom of the desulfurization chamber, a circulating spraying device is arranged at the top of the desulfurization chamber, a material containing box is arranged in the drying chamber, and a drying agent is contained in the material containing box. The natural gas filter is compact in structure, the primary-efficiency filter screen, the medium-efficiency filter screen and the high-efficiency filter screen are arranged in the filter chamber, and the natural gas can be subjected to three-stage filtration through the structure; the sulfur removal chamber is used for removing hydrogen sulfide and carbon dioxide by circularly spraying an alcohol amine solution, so that the use of the alcohol amine solution is saved, and the production cost is reduced; the drying chamber is provided with the material containing box, the drying agent is placed in the material containing box, scattering of the drying agent is avoided, and convenience and rapidness are achieved.



## 5. LNG PEAK REGULATION OUTPUT SYSTEM



**Authors:** Wang Yaowu, Du Lixia

**Publication number:** 213018931

**Publication date:** 20.04.2021

**Abstract:**

The utility model discloses an LNG peak shaving output system which comprises an LNG storage tank and a gasification device, a main pipeline is arranged between the LNG storage tank and the gasification device, the LNG peak shaving output system further comprises a low-pressure pump, a high-pressure pump, a pump rear backflow device and an ejector, the low-pressure pump is arranged in the LNG storage tank, and the high-pressure pump is arranged outside the LNG storage tank. One end of the main pipeline is connected with the low-pressure pump, the other end of the main pipeline is connected with the gasification device, and the high-pressure pump is arranged on the main pipeline; the after-pump backflow device comprises an after-pump pipeline, one end of the after-pump pipeline is connected to the main pipeline, the other end of the after-pump pipeline is connected to the LNG storage tank, the jet device is communicated with the upper portion of the low-pressure pump and the upper portion of the LNG storage tank, and the jet device diffusion pipe is communicated with the high-pressure pump. According to the LNG storage tank, materials in the LNG storage tank can be output to the gasification device, the LNG flow is regulated and controlled according to the downstream requirement, the field requirement for frequent startup and shutdown is met, the working efficiency of a peak shaving station can be effectively improved, energy is saved, consumption is reduced, and the operation cost is reduced.

## 6. LNG AND CNG SHARED POINT SUPPLY DEVICE



**Authors:** Ma Keliang, Ma Cheng, Liu Xiaohui, Ning Jiangbo, Ma Tian

**Publication number:** 213272025

**Publication date:** 25.05.2021

**Abstract:**

The utility model relates to an LNG (Liquefied Natural Gas) and CNG (Compressed Natural Gas) shared point supply device, an LNG supply station and a CNG supply station are respectively arranged above the ground, the LNG supply station comprises a vaporizer, a first filter and a first heater which are sequentially connected, the CNG supply station comprises a second heater, a second filter and a high pressure reducer which are sequentially connected, the LNG supply station and the CNG supply station are jointly connected with a pressure reducing device, the pressure reducing device comprises a pressure reducer I and a pressure reducer II which are sequentially connected, the first heater and the high-pressure pressure reducer are connected with an inlet of the pressure reducer I, and baffles are arranged on the two sides, close to the LNG supply station and the CNG supply station, of the ground. The LNG supply system has the advantages that the LNG supply station and the CNG supply station are built in the same area, the shared decompression device is arranged between the LNG supply station and the CNG supply station, the number of connected pipelines is reduced, and the operation process is simplified; the baffle is arranged on the periphery of the point supply station, so that the protection effect is achieved.

## 1.3. Оборудование / Equipment

### 1.3.1. Патенты / Patents

#### 1. LNG (LIQUEFIED NATURAL GAS) SUPERCOOLING FILLING SYSTEM

**Authors:** Ma Jie, Yang Wanbo, Yuan Yibo, Zhang Hetao, Wang Yuqing

**Publication number:** 113007594

**Publication date:** 22.06.2021

**Abstract:**

The invention provides an LNG (Liquefied Natural Gas) supercooling filling system. The LNG supercooling filling system comprises an LNG tank car, a liquid nitrogen tank car and a liquid nitrogen-natural gas subcooler, the liquid nitrogen-natural gas subcooler comprises a liquid nitrogen heat exchange pipeline and an LNG heat exchange pipeline, an inlet of the LNG heat exchange pipeline is connected with a liquid discharging opening of the LNG tank car, and a supercooling LNG filling pipe connected with a filling opening of a film type liquid tank is arranged at an outlet of the LNG heat exchange pipeline. An inlet of the liquid nitrogen heat exchange pipeline is connected with a liquid discharging opening of the liquid nitrogen tank car through a liquid nitrogen discharging pipe, and an outlet of the liquid nitrogen heat exchange pipeline communicates with the atmosphere. A flow regulating valve is arranged on the liquid nitrogen discharging pipe, and a temperature sensor is arranged on the supercooling LNG filling pipe. According to the LNG supercooling filling system, LNG in the LNG tank car is conveyed to the liquid nitrogen-natural gas subcooler, so that the LNG exchanges heat with liquid nitrogen and is cooled to obtain subcooled LNG, the subcooled LNG is injected into the film type liquid tank, and it is guaranteed that natural gas entering the film type liquid tank is liquid-phase natural gas in a saturated state or a subcooled state; and waste of natural gas resources, potential safety hazards and environmental pollution caused by the fact that gaseous natural gas is discharged due to the fact that the LNG in the film type liquid tank is overheated and evaporated to cause overlarge pressure are avoided.

#### 2. LIQUEFIED NATURAL GAS (LNG) GASIFICATION STATION LEAKAGE RESTRAINING AND ISOLATING DEVICE

**Authors:** He Jiangang, He Gongwei, Xiang Tongfei

**Publication number:** 213576808

**Publication date:** 29.06.2021

**Abstract:**

The utility model provides an LNG (Liquefied Natural Gas) gasification station leakage suppression partition device, which is characterized in that a partition device is arranged on the periphery of an LNG gasification station rain shelter, a water collecting tank is arranged on the periphery of a gas filling island, the water collecting tank is arranged below the partition device, the partition device comprises a water curtain plate, a water spraying port is arranged below the water curtain plate, the water curtain plate is communicated with a water pump through a pipeline, and the water pump is communicated with a water tank or/and the water collecting tank. When LNG leaks, the water curtain is sprayed in time, the purpose of blocking gas diffusion is achieved by reducing the volume concentration of LNG steam and preventing the LNG from forming a heavy gas effect, harm caused by leakage is reduced, and precious time is won for remedy.

### 3. DEMISTING SYSTEM OF LNG GASIFIER



**Authors:** Xu Ying, Meng Xiangwei, Cheng Jinliang, Li Xueying, Luo Can, Zhang Wanli, Zhang Anqi

**Publication number:** 213299609

**Publication date:** 28.05.2021

**Abstract:**

The utility model discloses an LNG (Liquefied Natural Gas) vaporizer demisting system which mainly comprises a cold mist collecting and processing device, the cold mist collecting and processing device comprises a temperature sensor, a humidity sensor and a telescopic fence, the temperature sensor and the humidity sensor are mounted at the bottom of an LNG vaporizer, an air collecting opening is formed between the LNG vaporizer and the telescopic fence, and the air collecting opening is communicated with the temperature sensor and the humidity sensor. And a cold fog collecting pipeline is connected below the telescopic fence. The system can effectively monitor the generation of cold fog during LNG gasification within the range of the telescopic fence and remove the cold fog in time, and is different from the traditional treatment mode, the system can stop running when the LNG peak shaving station does not have a gasification task, and the system adopts a physical method to treat the cold fog, so that the energy consumption is further reduced, and the energy consumption is reduced. The whole system is simple in structure and low in investment, and the economical efficiency problem of station yard investment can be considered when the cold fog problem is solved.

### 4. STABLE LNG VALVE



**Author:** Su Xiaocai

**Publication number:** 212928913

**Publication date:** 09.04.2021

**Abstract:**

The utility model discloses a stable LNG valve which comprises an LNG valve body, a valve rod is connected above the LNG valve body, an outer ring is arranged above the valve rod, an inner ring is arranged in the outer ring, the outer ring and the inner ring are connected through a plurality of connecting rods, and the two sides of the LNG valve body are connected with connecting pipes. A containing assembly is arranged below the connecting pipe and comprises a supporting block, a connecting block, a fixing screw piece, a connecting rotating rod and a supporting column, through arrangement of the containing assembly, the function that the device is convenient to place stably when not used is achieved through mutual cooperation of the inner structures of the containing assembly, stability is high, and when the device is used, the assembly is convenient to store and high in practicability. And the space is greatly saved, and the practicability is high.

## II. Хранение / Storage

### 2.1. Резервуары/ Containment Systems

#### 2.1.1 Патенты / Patents

##### 1. INTELLIGENT STORAGE TANK WITH LNG COMPOSITE SHELL UNDER PERMANENT FROZEN SOIL LAYER IN COLD REGION AND CONSTRUCTION METHOD



**Authors:** Xu Yan, Liu Haishui, Lu Zhaohong, Wang Zunce, Li Donggang, Guo Guanghui

**Publication number:** 112942943

**Publication date:** 11.06.2021

**Abstract:**

The invention provides an intelligent storage tank with an LNG composite shell under a permanent frozen soil layer in a cold region and a construction method. The intelligent storage tank comprises a monitoring system, a storage tank composite wall and a foundation treatment system, wherein the storage tank composite wall comprises an outer wall, an inner wall and a middle interlayer; the inner wall is formed by splicing a plurality of quadrilateral arched steel plates containing 9% of nickel; the middle interlayer is phase-change concrete, and the outer wall is formed by splicing a plurality of quadrilateral arched glass steel plates; the monitoring system comprises an optical fiber network, and the optical fiber network is connected with the inner wall of the storage tank composite wall through rivets; the optical fiber network of the monitoring system is fixed to the inner wall through rivets, and the optical fiber network of the monitoring system is externally connected with a data line used for transmitting information to a working room; the foundation treatment system comprises a hot rod inserted into foundation soil, and the hot rod is inserted into the foundation soil in a deep burying mode; and the hot rod is a seamless steel pipe containing carbon, and the heat transfer mode of the hot rod is one-way propagation from the underground to the ground. According to the storage tank and the construction method, the damage to the ecological environment can be reduced, and the phenomena of frost heaving and thaw collapse of the storage tank are prevented.

## 2. LNG STORAGE TANK COLD INSULATION STRUCTURE BASED ON METAL REFLECTION TYPE HEAT PRESERVATION LAYER AND INSTALLATION METHOD THEREOF



**Authors:** Fan Jiakun, Li Fangqiu, Chen Tuanhai, Xu Jiawei, Yang Fan, Yang Liang, Zhang Bochao, Huang Huan, Su Zhan, Wang Jiayin

**Publication number:** 112944202

**Publication date:** 11.06.2021

**Abstract:**

The invention relates to an LNG storage tank cold insulation structure based on a metal reflection type heat preservation layer and an installation method thereof. The LNG storage tank cold insulation structure comprises an outer tank, an inner tank coaxially arranged in the outer tank and a tank top covering the top of the outer tank and the top of the inner tank, an annular containing space is formed between the outer tank and the inner tank, and the metal reflection type heat preservation layer is installed in the annular containing space. The storage tank cold insulation structure has a better cold insulation effect, the problems that the cold insulation function of an LNG storage tank is reduced due to perlite sedimentation and the like can be completely eradicated, meanwhile, an installation technological process of the heat insulation layer of the LNG storage tank is optimized, the construction period of the LNG storage tank is shortened, and the problem of environmental pollution caused by perlite filling is solved.

## 3. LARGE LNG (LIQUEFIED NATURAL GAS) STORAGE TANK PROVIDED WITH VERTICAL-ANNULAR PARTITION PLATES



**Authors:** Zhao Yi, Li Hongnan, Cui Miao

**Publication number:** 112963726

**Publication date:** 15.06.2021

**Abstract:**

The invention provides a large LNG (Liquefied Natural Gas) storage tank provided with vertical-annular partition plates, and belongs to the field of civil engineering. The vertical partition plate and the annular partition plate are additionally arranged on the basis of an existing storage tank, and a heat preservation layer is made of a rock wool plate. The vertical partition plate is of an L-shaped structure, the vertical part of the vertical partition plate is welded to the side wall of an inner tank of a storage tank, and the horizontal part of the vertical partition plate is welded to a bottom plate. The annular partition plate is welded on the side wall of the inner tank of the storage tank and is welded with the vertical partition plate on the side wall. The vertical-annular partition plates are mounted in the inner tank of the storage tank, so that the structural rigidity can be increased, the stress can be effectively reduced, the liquid sloshing is reduced, the hydrodynamic pressure is reduced, and the overall safety of the large LNG storage tank structure is greatly improved. The storage tank has the advantages of wide application range, low manufacturing cost, easiness in construction and the like, and is suitable for being vigorously popularized and applied in the industry.

#### 4. VISUAL DETECTION INTEGRATED DEVICE IN LNG (LIQUEFIED NATURAL GAS) STORAGE TANK



**Authors:** Fu Zihang, Hou Hailong, Wang Xiulin, Yang Yuxia, Yang Hongwei, Yao Huichao, An Dongyu, Duan Pinjia, Xing Nan, Wu Jianhong

**Publication number:** 213333667

**Publication date:** 01.06.2021

**Abstract:**

The utility model relates to an LNG (Liquefied Natural Gas) storage tank internal visual detection integrated device which comprises an installation hole reserved in the tank top of the LNG storage tank, a cable device is installed outside the tank top of the LNG storage tank, the first end of the cable device is arranged in the LNG storage tank through the installation hole, and a magnetic fixing block is arranged at the end of the first end of the cable device. The magnetic fixing block is adsorbed at the bottom of the tank body of the LNG storage tank; the second end of the cable device is connected with a power supply and control system arranged outside the LNG storage tank; the cable device is located in the LNG storage tank, a detection device is arranged on the cable device, and visual detection of the interior of the LNG storage tank is achieved through the detection device. According to the utility model, three-dimensional laser imaging and visible light imaging can be carried out on the interior of the storage tank under the condition of no parking, the internal condition of the storage tank can be visually observed and monitored, the deformation caused by temperature stress in the storage tank can be observed, the corrosion condition in the storage tank can be visually observed, and the ice settling amount and the like of the storage tank can be observed.

#### 5. LNG STORAGE TANK AND LNG STORAGE TANK COMBINED EQUIPMENT



**Authors:** Lu Liping, Zhao Wenbin, Rui Xuan, Zheng Zuzhong, Ye Xu, Ma Yacheng, Wu Dingfan, Ma Xiaoyu, Chen Hailin

**Publication number:** 112797308

**Publication date:** 14.05.2021

**Abstract:**

The invention provides an LNG storage tank and LNG storage tank combination equipment, and relates to the technical field of liquefied natural gas storage. The storage tank comprises a tank body and a hoop-shaped frame; the tank body comprises a first side wall, a second side wall, a third side wall and a fourth side wall, and the first side wall, the second side wall, the third side wall and the fourth side wall are sequentially connected and jointly define a cubic storage cavity; the hoop-shaped frame is installed in the storage cavity, and the four edges of the hoop-shaped frame abut against the first side wall, the second side wall, the third side wall and the fourth side wall in a one-to-one correspondence mode. According to the LNG storage tank, the space utilization rate can be increased, and the structural strength can be improved.

## 6. CONSTANT-TEMPERATURE LNG STORAGE TANK



**Authors:** Wu Baoyong, Zhang Baoliang, Chen Guanghui, Lu Xiangmin, Wang Dajun

**Publication number:** 213207255

**Publication date:** 14.05.2021

**Abstract:**

The utility model discloses a constant-temperature lng storage tank which comprises a lng storage tank body, a lng internal storage tank body, a hydraulic valve, an air inlet hole, a gasification hole, a fixing groove, a drain hole, a filter, a fixing block, a conveying pipe, a fixing ring and a refrigerating machine, and has the beneficial effects that the temperature of the tank body is reduced, the lng stability is improved, and the safety in the storage process is improved.

## 7. LNG TRANSPORTATION STORAGE TANK



**Authors:** Qu Gongjin, Ge Lianghua, Hu Chunyan, Xie Xianxiao, Yang Fei, Bai Yudong

**Publication number:** 213236965

**Publication date:** 18.05.2021

**Abstract:**

The utility model discloses an LNG (Liquefied Natural Gas) transportation storage tank which comprises a storage tank body, the fixed seats are fixedly welded to the two sides of the bottom of the storage tank body; the interior of the connecting plate is slidably connected with a fixed seat; the fixing mechanism comprises fixing rods, placing grooves, fixing screw rods, bolts and limiting plates, the placing grooves are formed in the two sides of the surface of the top of the connecting plate, the fixing screw rods are inserted into the placing grooves in a threaded mode, and the ends, located in the connecting plate, of the fixing screw rods are in threaded connection with the fixing bases; by means of the storage tank fixing device, the problems that when the storage tank and a transport vehicle are installed, the storage tank and the transport vehicle are unstable, and large hidden dangers are likely to be caused are effectively solved.

## 8. ANNULAR DEVICE FOR PREVENTING OUTER WALL OF LNG STORAGE TANK FROM FROSTING



**Authors:** Qi Xiaobiao, Fan Duoqiang, Chen Xiaoshuang, Lan Tianlin, Du Yongheng, Shao Jianchuan, Wei Na, Yao Xianhong

**Publication number:** 213236972

**Publication date:** 18.05.2021

**Abstract:**

The novel annular device for preventing the outer wall of the LNG storage tank from frosting comprises a three-way valve, a nitrogen channel, a self-operated regulating valve, a pressure gauge I, a breather valve, the outer wall of the LNG storage tank, a filling port, an annular layer, a discharging port, a pressure gauge II, a supporting rod, an air inlet and a nitrogen cylinder. The device has the advantages that the two nitrogen inlets are evenly distributed in the annular layer in the circumferential direction, and it is guaranteed that nitrogen in the annular layer is sufficient and even; three pressure gauges are uniformly mounted on the annular layer, so that pressure monitoring is more accurate, proper nitrogen pressure in the annular layer is ensured, and the cold insulation effect is prevented from being influenced by overlarge or undersmall pressure; according to the device, perlite is adopted as a heat insulation material, and nitrogen is filled into the stainless steel annular layer to ensure that the annular layer is in a micro-positive pressure state, so that the problem of frosting of the outer wall of the storage tank is solved, moisture regaining of the perlite is prevented, and the cold insulation effect of the LNG full-capacity tank is enhanced.

## 9. LNG STORAGE TANK CONTAINER CONVENIENT TO TRANSPORT AND INSTALL



**Authors:** Yu Zhipeng, Li Jijia

**Publication number:** 213009770

**Publication date:** 20.04.2021

**Abstract:**

Storage tank container convenient to transport and install comprises an tank body, an outer fixing frame is arranged on the outer side of the tank body, the outer fixing frame and the LNG tank body are of an integrated structure, an outer cross beam is arranged in the middle of the two sides of the outer fixing frame, and a fixing groove is formed in the lower end of the outer cross beam; an upper supporting plate of the side supporting mechanism is installed in the fixing groove through bolts, the side supporting mechanism comprises an upper supporting plate and a lower supporting plate, a plurality of universal wheels are fixed to the lower surface of the lower supporting plate, a plurality of hydraulic cylinders are fixed between the upper supporting plate and the lower supporting plate, and two supporting seats are arranged at the lower end of the LNG tank body. Sliding grooves are formed in the lower ends of the two supporting seats, directional rolling wheel mounting seats are mounted in the sliding grooves, and a plurality of directional rolling wheels rolling in the length direction of the LNG tank body are mounted on the directional rolling wheel mounting seats. The utility model has the advantages of simple structure and reasonable design, is convenient for transportation and installation, can reduce the difficulty of position adjustment during installation, and shortens the installation time.



## 10. LNG UNLOADING AND PRESSURIZING STORAGE TANK PRESSURIZING INTEGRATED PRY



**Author:** Wan Lugu

**Publication number:** 212986764

**Publication date:** 16.04.2021

**Abstract:**

The utility model provides an LNG unloading pressurization and storage tank pressurization integrated pry which comprises a pry body, an LNG storage tank and a liquid phase pipeline. An LNG loading arm and a storage tank loading arm are arranged on the pry body; the liquid-phase pipeline comprises an LNG loading pipe; the LNG loading arm is connected with an LNG loading pipe; the LNG loading pipe is connected with an LNG storage tank; the LNG loading pipe is connected with an LNG unloading pipe in parallel; an emergency cut-off valve and a check valve opposite to the loading direction are arranged on the LNG unloading pipe; the LNG storage tank is correspondingly provided with an immersed pump; a supporting assembly and a plurality of universal wheels are arranged at the bottom of the pry body. Sliding fixing plates are arranged on the two sides of the pry body, and sliding blocks are oppositely arranged at the two ends of each sliding fixing plate. Guide rails corresponding to the sliding blocks are arranged on the two sides of the pry body. And the sliding fixing plate is connected with the pry body in a sliding manner. The unloading pressurization and storage tank pressurization integrated pry is easy to install, convenient to maintain and better in using effect.

## 11. NOVEL LNG STORAGE TANK



**Authors:** Li Wenyi

**Publication number:** 212952215

**Publication date:** 13.04.2021

**Abstract:**

The utility model relates to a novel LNG storage tank, which relates to pressure container equipment and comprises a tank body, supporting legs supported on the ground are fixedly connected to the bottom of the tank body, an outlet is formed in the bottom of the tank body, a root valve is mounted at the outlet, and the root valve is a vacuum valve. The cold insulation device has the effect of reducing the difficulty of cold insulation operation on the storage tank.

## 12. LNG STORAGE TANK AND LNG STORAGE TANK COMBINED EQUIPMENT



**Authors:** Wang Jun, Zhang Peng, Shen Qiangsheng, Zhu Hongwei, Liu Yinjun

**Publication number:** 112849342

**Publication date:** 28.05.2021

**Abstract:**

The invention relates to the field of ships, and provides a double-lug LNG liquid tank for an power-driven ship. A reinforcing ring is welded at the position corresponding to the saddle in the tank body, so that the strength of the matched part with the saddle is increased, and the matched part with the saddle is prevented from being deformed and damaged; the fixed saddle matches the sliding saddle, so that the damage to the tank body caused by the displacement of the tank body due to ship bumping and thermal expansion and cold contraction is reduced; a pair of vacuum rings is additionally arranged in the tank body and is used for reinforcing the structure of the long cylinder body, so that the deformation resistance of the long cylinder body is improved; a swash bulkhead is mounted in the middle of the tank body, so that jolt is reduced, namely fluctuation of liquid in the tank body, and damage possibly caused by fluctuation is reduced; a double-lug structure is adopted, two half tanks are spliced, the storage capacity of the storage tank is effectively improved, the longitudinal partition bulkhead is constructed between two tanks, the transverse strength of the tank bodies is further improved, and deformation is prevented.

## 13. STORAGE AND TRANSPORTATION TANK CAPABLE OF PREVENTING LNG (LIQUEFIED NATURAL GAS) FROM ROLLING



**Authors:** He Jiangang, He Gongwei, Yang Nanyi

**Publication number:** 213272043

**Publication date:** 25.05.2021

**Abstract:**

The utility model provides a storage and transportation tank for preventing LNG (liquefied natural gas) from rolling, which is characterized in that the storage and transportation tank is rotatably connected with a frame, a plurality of rotating seats are arranged on the frame, the storage and transportation tank is arranged on the rotating seats, rotating rings are arranged on the rotating seats, the storage and transportation tank is fixedly arranged on the rotating seats by the rotating rings, and an offset correction device is arranged on the frame. According to the device, sloshing energy in the transportation process can be converted into rotating LNG kinetic energy, LNG layering is eliminated, rolling accidents are prevented, and the device is suitable for popularization and application.

#### 14. VACUUM PLUG FOR LNG (LIQUEFIED NATURAL GAS) BOTTLE



**Author:** Li Tianxiao

**Publication number:** 213177676

**Publication date:** 11.05.2021

**Abstract:**

The utility model discloses a vacuum plug for an LNG (Liquefied Natural Gas) bottle. The vacuum plug comprises a mounting seat, a plug seat and a plug body which are arranged on a bottle body, an accommodating groove is formed in one end of the plug seat; a through hole is formed in the bottom face of the containing groove, and the inner diameter of the containing groove in the central axis direction of the plug seat is gradually increased so that a first conical bin can be formed in the containing groove. The mounting seat comprises a fixing plate connected with the bottle body and a connecting part; the connecting part is screwed into the through hole in a threaded fit mode and connected with the fixing plate, and the connecting part is provided with a hollow bin. The inner diameter of the hollow bin is gradually reduced in the central axis direction of the hollow bin so as to form a second conical bin in the hollow bin; the plug body comprises a first sealing column used for being matched with the hollow bin, a second sealing column used for being matched with the second conical bin, a third sealing column used for being matched with the first conical bin and a fourth sealing column used for being matched with the containing groove. And the fourth sealing column, the third sealing column, the second sealing column and the first sealing column are connected in sequence. The valve seat and the mounting seat are convenient to disassemble and assemble, and the sealing performance between the valve body arranged in the valve seat and the valve seat is good.

#### 15. LNG (LIQUEFIED NATURAL GAS) FOUR-BLADE FUEL TANK



**Authors:** Li Jie, Sun Dawei, Zhang Xihua, Lyu Jian, Liu Yunde, Wang Shihui

**Publication number:** 213576771

**Publication date:** 29.06.2021

**Abstract:**

The utility model discloses an LNG four-blade fuel tank which comprises a tank body and a protection unit arranged on the side face of the tank body. The cross section of the tank body is in a four-blade shape, and four grooves are formed in the side face of the tank body. The protection unit is arranged on the side face of the tank body and comprises transverse stabilizing assemblies arranged on the left side and the right side of the tank body and longitudinal stabilizing assemblies arranged on the upper side and the lower side of the tank body. According to the device, the four-blade fuel tank can be arranged according to the space condition of a ship body, the space utilization rate is improved, the protection device arranged on the side face of the fuel tank is easy and convenient to install and convenient to maintain and repair, and meanwhile the stability of the fuel tank in the transportation process is guaranteed.

## 16. LARGE LNG (LIQUEFIED NATURAL GAS) STORAGE TANK PROVIDED WITH PARTITION PLATES AND REINFORCING MESHES



**Authors:** Zhao Yi, Li Hongnan

**Publication number:** 112963727

**Publication date:** 15.06.2021

**Abstract:**

The invention provides a large LNG storage tank provided with partition plates and reinforcing meshes, and belongs to the field of civil engineering. Reinforcing meshes, a vertical partition plate and an annular partition plate are additionally arranged on the basis of an existing storage tank, the thickness of the vertical partition plate is equal to that of the bottom of an inner tank, and a heat preservation layer is made of a rock wool plate. The vertical partition plate is of an L-shaped structure, the vertical part of the vertical partition plate is welded to the side wall of the inner tank and evenly arranged in the circumferential direction of the storage tank body, and the horizontal part of the vertical partition plate is welded to a bottom plate. The annular partition plate is uniformly welded on the side wall of the inner tank of the storage tank and are welded with the vertical partition plate on the side wall. The reinforcing meshes are vertically arranged in the storage tank, and the reinforcing meshes on the two sides of a middle reinforcing steel bar are symmetrically arranged relative to the center reinforcing mesh. According to the large LNG storage tank, the vertical-annular partition plates and the reinforcing meshes are installed in the inner tank of the storage tank, the structural rigidity can be improved, displacement of the large LNG storage tank is reduced, stress is effectively reduced, the reinforcing meshes increase damping during liquid sloshing, adverse hazards caused by violent liquid sloshing are avoided, meanwhile, the hydrodynamic pressure is reduced, and the large LNG storage tank runs more safely and stably.

## 2.2. Отгрузочные операции / Discharge Operations

### 2.2.1 Патенты / Patents

#### 1. LNG FILLING DEVICE WITH FRONT PLATFORM



**Authors:** Si Yue, Ru Ningning

**Publication number:** 213018875

**Publication date:** 20.04.2021

**Abstract:**

The utility model discloses an LNG (Liquefied Natural Gas) filling device with a front platform, which comprises a filling platform and a tank box platform, the filling platform is arranged on a shore line, the tank box platform is arranged behind the shore line and is connected with a rear supply station road, the filling platform is connected with the tank box platform through a connecting section, and a hose crane and a metering pry are arranged on the filling platform. The tank box platform is provided with a plurality of placement points and a filling pry; the filling pry comprises a filling pump, a pressurizing vaporizer and a heater, the LNG tank box is connected with the filling pump, the filling pump is connected with the metering pry, a liquid-phase pressurizing opening of the LNG tank box is connected with the pressurizing vaporizer, and an outlet of the pressurizing vaporizer returns to the LNG tank box; and the metering pry, the filling pry and the connecting pipeline are all connected with the heater. The LNG filling device has the advantages that the LNG filling device is arranged in the mode that the fixed platform is combined with the movable LNG tank box, the length of a conveying pipeline of the LNG filling device is shortened, the invalid LNG loss is reduced, a cold insulation circulating pipeline system is omitted, and the BOG production amount is reduced

## 2.3. Эффекты хранения / Storage Phenomena

### 2.3.1. Статьи / Articles

#### 1. INVESTIGATION OF MEASUREMENT UNCERTAINTIES IN LNG DENSITY AND ENERGY FOR CUSTODY TRANSFER



**Authors:** Wu T.Y., Kenbar A.

**Journal:** Measurement science and technology, volume: 32, number: 4

**DOI:** 10.1088/1361-6501/abdcdf

**Abstract:**

In the custody transfer of fuels such as liquefied natural gas (LNG), energy measurement accuracy is critical. The important elements in calculating transferred energy are the volume, the density and the superior calorific value (SCV). In this paper we have used a new approach to carefully study the various uncertainty factors contributing to two of these elements: the density and the SCV. For density, six methods were evaluated, namely the method of extended corresponding states, the Hiza method, the revised Klosek-McKinley method, the Groupe Europeen de Recherche Gaziere (GERG-2004) method, the GERG-2008 method, and the equation of state-LNG method, to estimate the modelling error in the density calculation. Other factors affecting LNG density estimation (LNG composition, reference densimeter, temperature and pressure) have also been investigated to derive the total uncertainty in LNG density estimation. For the SCV, the uncertainty has been analysed with consideration given to uncertainties in the composition and the SCV of LNG components. The expanded uncertainty in LNG energy during custody transfer is estimated to be 0.58% ( $k = 2$ ) after considering the uncertainties due to the membrane-type tank's unloaded LNG volume, SCV, density and their correlation effect.

### 3.2. Патенты / Patents

#### 2. LNG STABLE STORAGE DEVICE BASED ON INERT GAS



**Author:** Zeng Yu

**Publication number:** 213177658

**Publication date:** 11.05.2021

**Abstract:**

An LNG stable storage device based on inert gas comprises a first storage tank and a second storage tank. A vacuum cavity is formed between the first storage tank and the second storage tank; a plurality of groups of buffer plates are arranged in the second storage tank, and through holes are uniformly formed in the buffer plates; the gas distribution plate is horizontally arranged at the lower end in the second storage tank; the inert gas conveying pipe is communicated with the gas distribution plate; an air exhaust pipe is arranged on the first storage tank and extends into the upper end of the interior of the second storage tank; a heat exchange pipe is arranged in the heat exchange tank, and an input port and an output port are formed in the heat exchange pipe; the input pipe is connected with an input port of the heat exchange pipe, and the other end of the input pipe extends into the upper end of the interior of the second storage tank; the output pipe is connected with an output port of the heat exchange pipe, and the other end of the output pipe extends into the lower end of the interior of the second storage tank. According to the LNG storage tank, the constant air pressure in the storage tank can be kept, the LNG can be stably stored, the storage effect is excellent, the storage process is safer, and practicability is achieved.

### 3. INTERNAL PRESSURE ADJUSTING DEVICE OF LNG STORAGE TANK



**Author:** Wu Long

**Publication number:** 213040298

**Publication date:** 23.04.2021

**Abstract:**

The utility model discloses an LNG storage tank internal pressure adjusting device which comprises a transport vehicle body and a storage tank, and a pressure sensing device is arranged in the storage tank. Through mutual cooperation of a control valve, an exhaust pipe, a one-way valve, a cooling pipe, a food storage box, a heat preservation layer, a baffle, a supporting plate, heat dissipation holes and other parts, a driver can conveniently store food, the food can be stored for a long time, and the health of the driver is protected; the pressure of the inner side of the storage tank is reduced through the electric telescopic rod, the piston and the first temperature control device, LNG reaches the exhaust pipe through the control valve and then is exhausted into the cooling pipe from the exhaust pipe, natural gas in the cooling pipe brings away heat in the food storage box, a low-temperature environment is provided for food in the food storage box, and the food storage time is prolonged; LNG in the cooling pipe can be finally discharged into an automobile engine to be used as automobile fuel.

## III. Регазификация / Regasification

### 3.1. Патенты / Patents

#### 1. LNG GASIFICATION PRESSURE REGULATING PRY

**Authors:** Liu Jin, Zhao Zhou

**Publication number:** 213452862

**Publication date:** 15.06.2021

**Abstract:**

The utility model discloses an LNG gasification pressure regulating pry which comprises a supporting plate, a protective frame, a vaporizer, a gas leakage detection box structure, a pressure regulating pry protective maintenance plate structure, a gas inlet pipe, a protective sleeve, an exhaust pipe, a pressure regulating valve, a conveying pipe, a pressure gauge and a flow meter, and the protective frame is connected to the middle position of the upper surface of the supporting plate through screws; the vaporizer is connected to the left side of the interior of the protective frame through screws; the gas leakage detection box structure is arranged in the middle of the upper surface of the protective frame; the pressure regulating pry protective maintenance plate structure is arranged in the middle of the upper part of the front surface of the protective frame; the air inlet pipe penetrates through the protection frame and is in threaded connection with the lower portion of the left side of the vaporizer. According to the utility model, the fixing plate, the protective net, the protective shell, the detection ball, the sealing plate and the locking screw are arranged, so that the function of detecting the air leakage of the pressure regulating pry is increased; and through the arrangement of a tight plate, a hinge, a connecting rod, a protective piece, a locking piece, a mounting screw and a handle, the pressure regulating pry can be maintained conveniently.

#### 2. INTEGRATION OF CONTAMINANT SEPARATION AND REGASIFICATION SYSTEMS

**Authors:** David W. Maher, Chad C. Rasmussen, Richard Perry Connell

**Publication number:** 20210131613

**Publication date:** 06.05.2021

**Abstract:**

Methods and systems for cryogenically separating contaminants and regasification of LNG utilizing common refrigeration equipment and/or fuel. An integrated system includes: a component for separating contaminants from an input feed stream; a heat exchanger coupled to a first line, wherein: the first line is coupled to the component for separating contaminants, and the heat exchanger cools a first feed stream of the first line; and a LNG regasification system comprising a vaporizer, wherein: the vaporizer heats a LNG stream of the LNG regasification system, and the heat exchanger functions as the vaporizer. A process includes: separating contaminants from an input feed stream with a component for separating contaminants; cooling a first feed stream with a heat exchanger, wherein the heat exchanger is coupled to the component for separating contaminants; and heating a LNG stream with a vaporizer of a LNG regasification system, wherein the heat exchanger functions as the vaporizer.



## IV. Инфраструктурные решения / Infrastructure Solutions

### 4.1. Статьи / Articles

#### 1. A QUANTITATIVE LNG RISK ASSESSMENT MODEL BASED ON INTEGRATED BAYESIAN-CATASTROPHE-EPE METHOD

**Authors:** Wu J.S., Bai Y.P., Zhao H.H., Hu X.F., Cozzani V.

**Journal:** Safety Science, volume: 137

**DOI:** 10.1016/j.ssci.2021.105184

**Abstract:**

Increasing quantities of natural gas are transported as liquefied natural gas (LNG) worldwide, and LNG is also proposed for use as a clean fuel for ships and trucks. This scenario raises concerns for the safety of LNG bunkering and storage at ports, due to the potentially severe accidents that may arise from LNG leakage. In this paper, an integrated quantitative risk assessment model for LNG bunkering and storage at ports based on BayesianCatastrophe-EPE (Energy transfer theory, Preliminary hazard analysis and Evolution tree) method was proposed. The energy-based EPE model was used to derive Bayesian network (BN) causal structure, and the catastrophe theory was employed to deal with experts' judgment to determine the conditional probability tables of BN. The proposed BN-based risk assessment model can provide a novel perspective to identify hazards and risks, and to assess the evolution process of LNG accidents from causes to consequences. The results of scenario analysis of typical LNG accidents demonstrate the soundness and applicability of the proposed model. Moreover, sensitivity analysis was implemented to identify critical hazards and quantify the correlations between each element considered in LNG accidents. The proposed risk assessment framework is of great significance to widen the technical tools available to support safety assessment and loss prevention of LNG bunkering and storage at ports.

#### 2. АНАЛИЗ И ОЦЕНКА РИСКОВ СПГ-ТЕРМИНАЛАС ПОМОЩЬЮ ДИАГРАММЫ РИСКОВ

**Авторы:** Драпак К.А., Крылов Е.Г., Капитанов А.В.

**Журнал:** Вестник МГТУ Станкин, номер: 2 (57), стр.: 37-43

**УДК:** 681.5:622.276

**Аннотация:**

Рассмотрены особенности эксплуатации технологических установок газоперерабатывающих производств с повышенным риском, приведена методика анализа и контроля рисков СПГ-терминала с использованием метода LOPA. Описана оценка вероятности отказов по требованию с учетом обеспечения полноты безопасности для высокотехнологичных автоматизированных систем. Составлена диаграмма рисков на основе вероятности возникновения инцидента и нанесённого ущерба предприятию или оборудованию.

## 4.2. Патенты / Patents

### 3. LNG LEAKAGE EMERGENCY COLLECTION SYSTEM



**Authors:** Xu Yilong, He Lin

**Publication number:** 213452852

**Publication date:** 15.06.2021

**Abstract:**

The utility model discloses an LNG leakage emergency collection system which comprises an LNG collection area, an LNG flow guide pipe, a detachable filter cartridge structure, a first LNG collection ditch, a separation pool, a partition wall, a rainwater ditch, a second LNG collection ditch, an LNG confluence pool, a water suction pump, a siphon and a supportable discharging frame structure. The other end is embedded in the upper end of the first LNG collecting ditch; the detachable filter cartridge structure is mounted on the LNG flow guide pipe; the first LNG collecting ditch is integrally formed in the right side of the upper end of the separation tank; and the partition wall is integrally arranged in the separation tank. The utility model has the beneficial effects that through the arrangement of the detachable filter cartridge structure, when the filter cartridge is used, sundries such as leaves can be intercepted through the inclined net, so that the filter cartridge can be protected.