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Design and Research of High Efficiency Combined Oil-water Separator for Marine Use

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Abstract: *With the development of the marine industry, the demand for marine power system oil-water separator is gradually increasing. Marine oil-water separator for industrial oil-water separator of a kind, in the operation of the ship generated by the marine oil will be processed by the oil-water separator, but the oil-water separator is not always in operation, it will be in the oil and water stored in a certain amount of automatic opening for processing, which makes the oil and water will be in operation, with the lowering of the liquid level deposited in the oil-water separator tank on the inner wall, which is gradually accumulated and thickened, the presence of oil will cause corrosion of the tank, and reduce the capacity of the tank, affecting the classification effect of the oil-water separator. The presence of oil will cause corrosion on the tank, and reduce the capacity of the tank, affecting the classification effect of oil-water separator. In order to solve the problem that the traditional oil-water separator is not efficient under high load conditions, this paper proposes an efficient combined oil-water separator device for marine use after a series of researches and experiments. The device can effectively remove the oil in the tank body wall, to achieve the maintenance of the oil-water separator, to ensure that the oil-water separator can be used efficiently.*

Keywords: *Marine Oil-Water Separator, Combined Design, Oil-Water Separation, Maintenance*

1. Introduction

With the increasing global emphasis on environmental protection, the requirements for wastewater treatment in the marine industry are also increasing. Wastewater generated during the navigation and operation of ships contains a variety of oily components that may pose a potential threat to the marine ecosystem[1]. Therefore, efficient separation and treatment of this wastewater has become an important task to ensure environmental sustainability and ecological balance. Marine oil-water separator, as a key part of marine environmental protection equipment, plays a vital role. Its main function is to efficiently separate the oily components from the wastewater to ensure that the discharged water meets stringent environmental standards and regulations. However, conventional oil-water separators commonly suffer from the problem of oil accumulation after long-term use[2-4]. This accumulation of oil will gradually lead to a decline in equipment performance, negatively affecting environmental protection and ship operations. The accumulation of oil contamination seriously affects the separation efficiency of the separator, and the internal deposition and build-up of these oily components prevents the separator from achieving the efficient separation function for which it was designed. This not only increases the difficulty of wastewater treatment, but may also have a negative impact on the marine ecosystem. In addition, the build-up of oil can lead to equipment failure and increased maintenance costs. Oil accumulated over a long period of time may block the piping and filtration system of the separator, affecting the normal operation of the equipment. Repairing and cleaning up these failures may require more frequent maintenance, which not only increases the cost of operating the vessel, but may also affect the vessel's normal operating schedule. More seriously, the problem of oil accumulation can lead to violations of environmental regulations, which can have serious legal consequences. Environmental regulations usually impose strict limits on the discharge of wastewater from ships. If the degradation of the performance of the oil-water separator leads to the discharge exceeding the standard, the ship may face serious consequences such as fines, scrutiny by law enforcement authorities, or even suspension of sailing. These problems will not only bring direct economic losses to shipping companies, but may also damage their industry reputation and affect future business development[5].

In view of these issues, solving the problem of oil pollution accumulation after long-term use of

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conventional oil-water separators is crucial to the environmental protection efforts and sustainable development of the shipping industry. This involves not only compliance with environmental regulations, but also the economic benefits and social responsibility of the business. To this end, there is a need to develop and adopt more advanced and efficient oil-water separation technologies that can reduce the accumulation of oil pollution, improve separation efficiency and reduce maintenance costs. At the same time, it also requires shipping companies to raise awareness of environmental protection and take proactive measures to regularly inspect and maintain oil-water separation equipment to ensure its continued efficient operation and reduce potential impacts on the environment. Through these comprehensive measures, the shipping industry can better meet the challenges of environmental protection and promote its progress towards more sustainable development[6].

2. Marine Oil-water Separator Operation Mechanism Analysis

In the backdrop of increasingly stringent environmental regulations, the maritime industry has seen a growing demand for wastewater treatment. Among these requirements, industrial oil-water separators stand as an integral part of the maritime wastewater treatment systems[7]. The design and operational mechanisms of shipboard oil-water separators directly correlate to the environmental impact of vessels during their navigation at sea. However, the currently utilized shipboard oil-water separators suffer from certain issues, with the accumulation of oil residues inside the tanks being a significant concern.

Shipboard oil-water separators usually activate automatically, processing only when the oil-water mixture reaches a specific quantity. This operational method leads to the gradual accumulation of oil residues on the inner walls of the separator tanks during operation, resulting in the formation of an oil residue layer. The presence of this oil residue layer can give rise to a series of problems. Primarily, it leads to a decline in the efficiency of the separator[8] . Due to the presence of the oil residue layer, the separator's separation efficiency diminishes, failing to meet the anticipated standards for oil-water separation and thereby contravening environmental regulations.

Furthermore, the accumulation of oil residues could also damage the tank's structure. This affects the tank's susceptibility to corrosion and decreases its capacity, eventually impacting the overall performance and lifespan of the oil-water separator[9]. Hence, the current operational mechanisms and designs exhibit certain shortcomings concerning long-term stable operation and compliance with environmental standards.

To address this issue, this article proposes an innovative shipboard high-efficiency combined oil-water separator. This separator employs advanced technology aimed at minimizing oil residue accumulation to the greatest extent while optimizing separation efficiency. Unlike conventional oil-water separators, this combined separator features a more adaptable operational mechanism, capable of intelligent start-stop functions as needed, thus preventing unnecessary accumulation of oil liquid[10].

3. Marine High-Efficiency Combined Oil-Water Separator Design

As shown in Figures 1 to 3, a structural schematic of a marine high efficiency combined oil-water separator demonstrates its complex and efficient design. The design is expanded and explained in more detail below.

3.1 Design of Combined Cover and Control Mechanism

As shown in Figure 1, a control disc is rotationally connected to the inner wall of the combination cover. The control disc is driven by a control member provided above the combination cover. A hollow disc is fixedly connected to the bottom of the control disc, and a telescopic column is connected to the inner wall of the hollow disc through an inner diameter adjustment assembly. A scraping rod is connected to the bottom of the combination cover through an elastic limiting member, the end of the telescopic column is fixedly connected to the side wall of the scraping rod, the bottom of the scraping rod is fixedly connected to a collection box, and the side wall of the scraping rod is fixedly connected to a scraping strip that is set in an arc shape.

3.2 Limit and Drive Mechanism

As shown in Figure 2, a limit outer ring is provided at the bottom of the combination cover, and a

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limit triangular block is connected to the inner side wall of the limit outer ring through a guide post. The limiting triangular block is connected to the limiting outer ring through a resisting spring set on the outer side wall of the guide post. The control member includes a control rotary column fixedly connected to the combination cover, a driving gear fixedly connected to the outer side wall of the control rotary column, and a toothed ring fixedly connected to the control disc that is mesh connected to the driving gear.

3.3 Inner Diameter Adjustment Assembly, Elastic Limiting Element and Wiper Strip Design

As shown in Figure 3, the inner diameter adjusting assembly includes a rotating disc rotationally connected inside the hollow disc, and a control column is fixedly connected to the top of the rotating disc. A plurality of linkage rods are rotationally connected to the outer side wall of the rotating disc, a telescopic opening is opened in the outer side wall of the hollow disc, and the telescopic column extends inwardly through the telescopic opening and is rotationally connected to the linkage rods. The elastic limiting member includes a rectangular moving port opened at the bottom of the control disc, a sliding column fixedly connected to the inner wall of the rectangular moving port, the top of the scraping bar penetrating into the rectangular moving port and slidingly connected to the sliding column, and the scraping bar connecting to the inner wall of the rectangular moving port through the telescopic spring socketed on the outer side wall of the sliding column. The scraping bar is provided with a resistive heating column for heating, and a plurality of vertically set downflow slots are provided on the side wall of the scraping bar.

The purpose of this structural design is to realise a highly efficient oil-water separation process and to ensure stability and controllability of the separation effect through the synergistic action of various components.

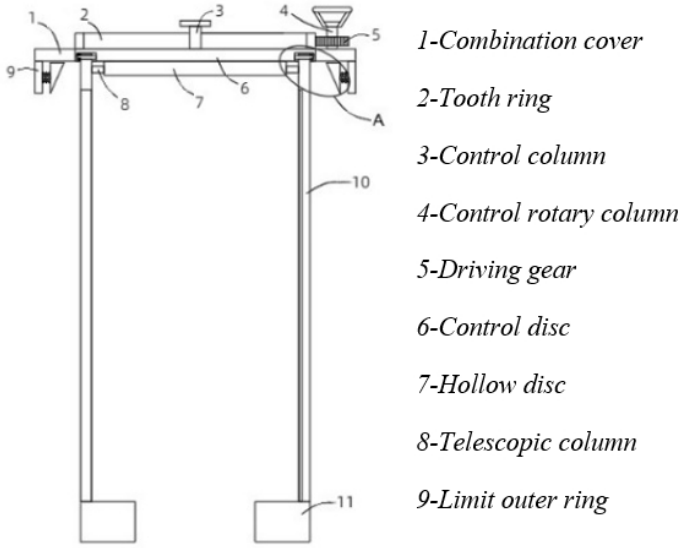

Figure 1: Schematic structure of marine high efficiency combined oil-water separator.

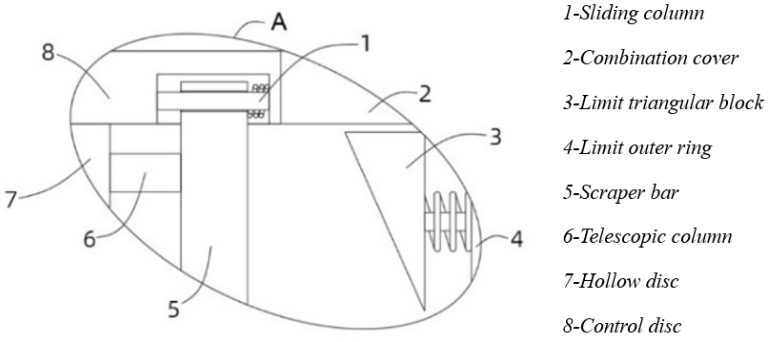

Figure 2: Schematic diagram of the enlarged structure at A.

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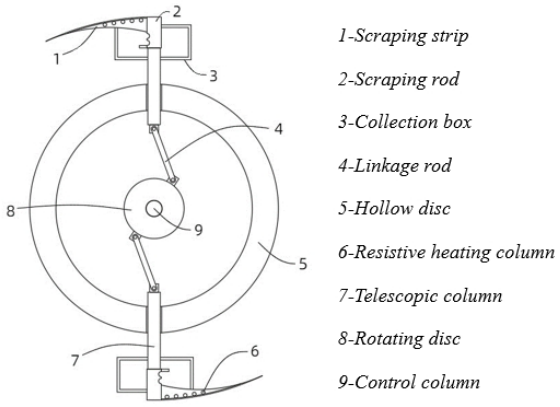

Figure 3: Schematic structure of the hollow disc.

4. Research and Analysis

The bottom of the combination cover is provided with a limit outer ring, and the inner side wall of the limit outer ring is connected with a limit triangle block through the guide column, in which the limit triangle block will realise the contact along the mouth of the can body when it is pressed down to ensure the stability of the combination cover, and the limit triangle block is connected with the limit outer ring through the resisting spring which is set on the outer side wall of the guide column.

The inner wall of the combination cover is rotationally connected to a control disc, and the two are rotationally connected through bearings, and the control disc is driven by a control member set above the combination cover, furthermore, the control member includes a control rotary column fixedly connected to the combination cover, a drive gear is fixedly connected to the outer wall of the control rotary column, and a ring of teeth connected with the drive gear is fixedly connected to the control disc, so as to be able to achieve the rotation of the control disc by using the control rotary column, thus making it possible to operate the control disc by using the control rotary column to achieve the control disc. The control disc has a ring fixedly connected to the drive gear, so that the control rotary column can be used to achieve the rotation of the control disc, thus making the operation more labour-saving.

The bottom of the control disc is fixedly connected to a hollow disc, the inside of the hollow disc is hollow, and the inner wall of the hollow disc is connected to a telescopic column through an inner diameter adjustment component, furthermore, the inner diameter adjustment component includes a rotating disc rotatingly connected to the inside of the hollow disc, and the top of the rotating disc is fixedly connected to a control column, so as to achieve rotation of the rotating disc by using the control column, and the outside wall of the rotating disc is rotatingly connected to a plurality of linkage levers, and the outer wall of the hollow disc is opened with a retracting port, and the retracting column runs through the retracting port. The outer side wall of the hollow disc is opened with a telescopic opening, and the telescopic column extends inwardly through the telescopic opening and is rotationally connected with the linkage rods.

The bottom of the combination cover is connected to a scraping rod through an elastic limit member, furthermore, the elastic limit member includes a rectangular moving port at the bottom of the control disc, a sliding column is fixedly connected to the inner wall of the rectangular moving port, the top of the scraping rod extends through the rectangular moving port and is slidingly connected to the sliding column, the scraping rod is connected to the inner wall of the rectangular moving port by the retracting spring set on the outer wall of the sliding column, and the stability of the scraping rod during movement is ensured by the retracting spring set on the sliding column. The telescopic spring is set on the sliding column to ensure the stability of the scraping rod when it is moved.

The end of the telescopic column and scraping rod side wall fixed connection, scraping rod bottom fixed connection with the collection box, scraping rod side wall fixed connection with a curved set of scraping strip, scraping strip is set up for heating the resistance of the heating column, scraping rod side wall is set up with a plurality of vertical set of downstream groove, downstream groove set up to make the melted oil can be quickly entered into the collection box.

After research and analysis, it can be seen that when the marine oil-water separator is used for many

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times, it is necessary to clean up the oil contamination layer of the inner wall, open the tank lid of the oil-water separator, press down on the restriction triangular block set at the bottom of the combination lid, use the restriction triangular block to realize the stability of the tanks with different inner diameters, and reasonably adjust the inner diameter adjustment components according to the different tank diameters, and the rotating disc rotation will make the linkage rod drive the telescopic column connected to it to move outward. Connected to the telescopic column to move outward, thus changing and combined cover through the sliding column sliding connection of the scraping rod to move, set in the scraping rod on the scraping strip will be in contact with the oil layer on the wall of the tank body, at this time through the control of turning the control rotary column, so that the driving gear and the role of the ring drive the control disc to rotate, set in the control disc on the scraping rod will be driven by the scraping strip to rotate, to achieve the oil in the tank body wall on the eradication, the oil is shovelled out, and the oil is shovelled out, and the oil is shovelled in the tank body wall. The oil dirt on the scraping bar will gradually melt in the heating and flow into the collection box, thus realising the effective treatment of the oil dirt on the inner wall of the tank and ensuring that the oil-water separator can be used efficiently.

5. Conclusion

With the continuous global concern for environmental protection, the requirements for wastewater treatment in the marine industry are gradually increasing. The oil content in wastewater poses a potential threat to the marine ecosystem, making marine oil-water separators particularly important as a key component of environmental protection equipment. However, conventional oil-water separators suffer from the common problem of oil accumulation, which may lead to a decline in equipment performance and adversely affect the environment and ship operations. By analysing the reasons affecting the performance of oil-water separators, it was found that their operating mechanism leads to the accumulation of oil inside the tank, forming an oil contamination layer, which in turn reduces the efficiency of the equipment, damages the tank structure, and increases maintenance costs. This accumulated oil contamination layer has a negative impact on the separator in a number of ways, including reduced separation efficiency and damage to the tank structure. As a result, existing oil-water separator designs have limitations. To address these challenges, this paper presents an efficient combined oil-water separator for marine applications. The design takes into account the problem of oil accumulation, and through an innovative structure and operating mechanism, it is able to handle oil-water mixtures more efficiently, reduce the accumulation of oil pollution, and improve the separation efficiency. Specifically, effective treatment of oil contamination is achieved through regular cleaning of the oil contamination layer on the inner wall of the tank, using components such as linkage rods, telescopic columns and scraper bars. This design ensures the long-term stable operation of the oil-water separator, reduces the negative impact on the environment and ship operations, and lowers maintenance costs.

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