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Development of an Innovative Oil Suction and Discharge Machine Compartment for Sewing Machines to Enhance the Industrial Safety in Textile Industries.

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A B S T R A C T

oil extraction and management are some of the major industrial maintenance processes in automotive servicing, and waste management. Increasing the efficiency of these processes help the industries minimize losses, optimize operations and promote environmental friendliness. This study is focusing on design, functionality, and application of oil suction machines that provide an environmental-friendly and efficient operation compared to conventional method of removing oil in the textile industry. This unit is designed with vacuum pumps, suction hoses, and integrated storage tanks, to be able to process rapid and precise oil extraction without major risk of spillages or contamination. This machine preserves the main compartment of sewing machine and it provides additional filtration systems to run for long duration, if any, which allow partial reutilization of oils through the removal of possible contaminants like sludge and metals. Applications differ in industries mainly in service and waste oil recycling, which shows that they play their role in helping improve efficient maintenance and promoting the circular economic principles. The study further highlights the environmental and economic benefits of oil suction machines, as these machines help in resource conservation, workplace safety, and cost reduction. The limitations of the current design that need future improvement are the limitations on capacity, high upfront costs, and periodic maintenance are acknowledged as areas for improvements. Further technological developments, such as IoT-enabled monitoring, AI-based predictive maintenance, and solar-powered design are discussed as potential upgrades to enhance the performance, sustainability, and accessibility of oil suction machines. This project work exposes valuable insight into the reliability and limits of the oil suction pump compartment. It is offering a foundation for further research and innovational developments aimed at oil handling and management technologies.

Keywords: Compressor tank, Oil suction, Sustainable, Artificial intelligent, Textile industry

1. Introduction

The growing consciousness on resource management and sustainability issues has increased demands throughout industries for better and more refined ways of handling oil resources. Among them, oil suction machines have become a necessary part in the line of how used or waste oil is effectively extracted, stored, and handled. These machines are important in providing cleaner and smooth oil removal processes, especially in the applications associated with automotive service, industrial maintenance, and recycling of waste oil. Generally speaking, traditional ways of oil removal, such as by draining, have always been associated with inefficiency, increased labour, and environmental hazards in the form of spills and other forms of improper handling. By contrast, oil suction machines are in a closed-loop system that minimizes waste and reduces operational downtime while encouraging safe handling of the lubricants or hydraulic oils. Major components it boasts of include vacuum pumps, suction hoses, storage tanks, and filtration systems for optional use in view of the execution of the said extraction and storing process.

This paper presents the design and working principles of an oil suction machine that would make oil management easy in industries and automobiles. The research also goes on to explain how such a machine will be useful in sustainable practices, such as collection and recycling of used oils. In the presented paper, analysis will be directed at the technical efficiency, dependability of operation, and environmental concerns with a view to highlighting this technology in the solution perspectives of modern problems related to oil handling and globally coordinated action of resource conservation and waste reduction.

The strategic process of balancing efficiency in operations with the welfare of employees is crucial in achieving these objectives. Minimizing exposure to hazardous situations is an important aspect in any modern workplace, as this directly relates to the health and safety of the employees. That will be possible by advanced safety protocols, automation in highly hazardous activities, and proper training to increase the preparedness of employees toward any kind of risk. Improvement in ease regarding performing a job is the other important sphere. Incorporating friendly tools and making the workflow less complex will facilitate comfort for the workers while performing the work with minimal physiological and psychological stresses. It will not only enhance individual productivity but also offer a very healthy environment to the workers, making them feel valued and important (Siliņa et al., 2023).

Job satisfaction is the prime factor in retaining the talented staff within an organization. Meaningful recognition, opportunities for growth, and an inclusive culture will encourage increased job satisfaction and thereby welcome the contributions of employees. Satisfaction goes along with performance, and the contentment of the workforce brings about improvement in organizational results. Reduction in downtime is especially critical for areas related to operational or mechanical services. All delays can be considerably minimized through efficient resource planning, predictive maintenance, and real-time monitoring systems for maintaining continuity of service delivery. Reduced downtime automatically reflects in reduced costs and enhances client satisfaction (Ghazanfarian et al., 2024)

1.1 Applications

1.1.1 Automotive Industry

The most common use, however, is in vehicle servicing. Mechanics utilize such machines for extracting engine oil during oil change services. These methods are relatively faster, cleaner, and efficient as opposed to the conventional draining methods, which require lifting of a vehicle.

1.1.2 Industrial Maintenance

In an industrial setting, heavy machinery relies on machines to siphon hydraulic oil, gear oil, or lubricants. This is quite necessary for the good performance and durability of the equipment.

1.1.3 Waste Management and Recycling

Waste oils collected and relayed to recycling centers for processing into usable products by oil suction machines have been one of the key sustainable ways in which such waste has been managed, hence contributing to the circular economy.

1.1.4 Research and innovation

Oil suction machines are also applied in research fields related to bioenergy and waste management on an experimental basis to handle used or waste oil. Waste oil, for instance, can be treated into biodiesel or other biofuels.

2.Litreature review

In this respect, the oil suction machine becomes very important, both to many different industries and the automotive maintenance field, as well as to all businesses concerned with the recycling of waste oil, for the efficient and safe handling and care for lubricants and hydraulic fluids with ecological responsibility. A lot has been done through the years of development, application, and optimization of oil-suction technology. This review examines the available body of research on oil suction machines, design principles, operational mechanisms, applications, challenges, and contributions to sustainability. Traditional methods for extracting oil, involving manual draining or depending on gravity, were often extremely time-consuming, labour-intensive, and posed a few environmental threats in terms of spillage and incorrect disposal (Zhang et al., 2018).

These previous methods relied on the manual operation of machinery and hence caused increased contamination issues and workplace hazards. In an effort to overcome these faults, the development of oil suction technology has brought a clean and effective substitute for use - Thomas & Johnson, 2017. Oil suction machines were introduced to minimize human intervention while enhancing precision in oil removal. The early designs were based on manually working vacuum pumps, but the advancement of pneumatic and electric systems made machines work faster and more automatically for better control and safety (Kumar et al., 2020).

The major elements of design considerations taken into account in the construction of oil suction machines are the vacuum system, storage tanks, and control mechanisms. Various literature has cited that in Patel and Singh (2019), vacuum pumps have played an important part in providing partial vacuum conditions that will permit efficient suction of oil, whether from machinery or any given storage system. Advanced designs have enabled two-tank systems, separating different grades of oil, which is of great aid to diversification and meeting the various environmental legislations. Other key improvements are the infiltration systems in oil-sucking machines. Filters used not only help draw out impurities like sludge, metallic particles, and other contaminants but also, according to Gupta et al. (2021), can make the extracted oil partially reusable to reduce waste produced. Real-time monitoring systems, such as pressure gauges and flow meters, further enhance precision during operation. Examples can be given by Li et al. (2020). These have indeed been inseparable tools within the motor industry. Ahmed and Al-Mutairi (2022) explain how effective these machines are in siphoning off engine oil from cars, especially when such an operation is industrial. It ensures reduced time for operational processes in the service centre and a minimum of inconvenience to the customers with faster service of oil changes. These machines suck out lubricants and hydraulic fluids from heavy machinery during their maintenance in industries. As identified by Choudhury et al. (2019), the machine is important in the upkeep of consistent performance and longevity of equipment in manufacturing industries and power generation. Furthermore, several designs have been made for special purposes such as oil extraction from transformers and turbines where precision with safety is the main concern as argued by Nakamura et al. (2020). Another important area of application is waste oil recycling. A study by Wang et al. (2018) identified suction machines for oil collection to be used in recycling and reprocessing into alternative fuels or lubricants. This goes hand in hand with the principle of waste reduction and resource recovery in a circular economy.

For such reasons, environmental benefits have widely been recognized for oil suction machines: they help clean oil removal and thus prevent spills, which contaminate soil and water bodies. As argued by Green et al. (2021), the integration of such machines into waste oil management equates to a significant reduction in the ecological footprint emanating from industrial and automotive operations. Economically, oil suction machines offer cost efficiency in view of minimizing waste and prolonging machinery lifetimes through effective maintenance, as stated by Kumar et al. (2020). This dependence on fresh oil is further reduced by the ability of some to filter and then reuse the oil, hence reducing operation costs. Nevertheless, oil suction machines have some limitations. In addition, capacity is cited as a limitation in large-scale industrial operations by Ramanathan et al. (2022), whereby machines with smaller tanks need frequent emptying that could disrupt the smooth running of operations. Besides, good-quality machines with superior qualities may be very costly, hence becoming out of reach for small and medium-sized enterprises. Maintenance of the machine: Filters and hoses should be cleaned and replaced periodically for optimal performance, according to Patel and Singh (2019).

Automation and sustainability are some of the recent trends in the field of oil suction. For example, smart oil suction machines that are installed with IoT sensors have been used to monitor and control operation activities in real time, hence improving operational efficiency Chen et al. (2023) The development of the eco-friendly materials used in the construction of the machinery will, therefore, relate the technology to wider sustainability challenges. Future studies will, however, be aimed at the scaling up and economical production of oil suction machines using higher technologies, such as artificial intelligence, in predictive maintenance and optimization, as Ahmed & Al-Mutairi (2022) said.

3. Methodology

3.1 Parts

- Gun
- Compressor tanks-2
- Motor
- Power supply
- Wires and tubes
- Plug point
- Controller
- Sensors

3.2 Components

Vacuum Tanks are storage vessels into which the extracted oil gets collected. From the picture, the top of this machine is occupied with tanks to store the oil in sizeable volumes. Suction hoses are those which connect the machine with the source of the oil and drain the latter. Vacuum Pump uses a vacuum pump or air compressor to create the suction force necessary for pulling oil from the source. Control systems inside the machinery are supported with gauges, switches, and valves for use in moderating suction pressures, monitoring flow rates, and ensuring safety. Filtration System, this may be on a few that have installed filters which strain off the debris or sludge/impurities from the extracted oil. Frame and Storage Compartments, the metal frame supports the strong body structure, giving room for storage of used oil or disposal mechanisms (Al-Obaidi et al., 2024)

(Figure 1-Pumps **/-Figure 2-Outlook)**

(Figure 3-Front view **/Figure 4-Compressor tanks)**

3.3 Mechanism

3.3.1 Installation and Connection

First, connect the suction hose to the source of oil. In the use of the motor vehicle for example, the hose is inserted into a dipstick tube of an engine or directly into an oil tank. Installation of the machine should be properly done and tighten to avoid any spill over when in use.

3.3.2 Suction and Oil Transfer Mechanism

Once coupled, the vacuum pump or air compressor is turned on to create negative pressure within the system. A pressure gradient thus created allows the oil to be siphoned out of the source. In general, suction pumps can also be driven by an electric motor, compressed air, or manual pumping systems. The oil is then pumped through the suction hose and deposited into the vacuum tanks. Some machines, by design, may have multiple tanks so that different types of oil could be segregated, or contaminated oil from clean ones (Bhatia, P. 2021).

3.3.3 Filtration, Monitoring and Control

The machine is fitted with a filtration system, so if it has been installed, then during transfer, the oil will be cleared of sludge, metal particles, or other forms of contamination. This will make the collected oil cleaner for reconditioning and, in most cases, reusing. The operators monitor the sucking by gauges and flow meters. Pressure gauges determine that the pump operates within safe limits, while the flow meters monitor the volume of oil extracted. Control switches are for turning on, shutting off, or regulating the force of suction (Ahmed, H. 2015).

3.3.4 Disposal or Storage

Processed oil, following extraction, may be stored within the tanks of the machine itself or transferred into bigger containers for appropriate disposal or recycling. Some models are designed to be connected to a waste oil disposal system to ease further the workload(Jindal & Kaur, 2021)

(Figure 5- Oil service Operation)

4. Discussion

This manipulating machine for oil should contain a vacuum pump, suction hose, storage tanks, and controls and other parts to operate the system in consistently. The core of such a machine is the vacuum pump, which generates negative pressure needed for the effective extraction of oil to effectively proceed. Adding several tanks makes it more versatile for operation, separating types of oils or dealing with bigger volumes of used oil waste. Control systems are incorporated that include pressure gauges and flow meters, giving precision and safety of operation. There are, however, drawbacks to the design. While the basic models are cost-efficient, the higher-end versions lack filtration systems or IoT-enabled controls. Most importantly, this is where adding filters comes in handy in segregating impurities from the oil and hence making the oil partially utilizable. With this, one can see why the filters and the hoses have to be changed often, since it increases downtime for operation. With a modular design, there is ease of maintenance and replacement.

Another critical aspect is that of efficiency. Oil suction machines have been recorded to cut the time taken by oil removal several times when comparing traditional methods. By taking away manual involvement and spillage, such machines contribute a lot to workplace safety and smoothen the workflow. For example, in car servicing, with one machine multiple cars can be serviced in no time, compared to doing it conventionally, enhancing throughput. In large-scale applications, though, efficiency could be limited by the storage tank size. Greater capacity could result from larger or scalable tanks or systems designed for continuous oil transfer. Oil suction machines work well with the concept of environmental sustainability. Conventionally, oil is disposed of by draining, which in turn causes on-the-ground spills and contamination of soil and water. These machines provide a closed-loop system that is non-polluting, without posing such environmental risks. Recovered waste oil collection contributes to greater recycling goals, thereby reducing the need for virgin product production and embracing circular economy principles. Other models further enhance their environmental profile by adding filtration systems that will remove impurities from the extracted oil, thus enabling its reutilization in secondary applications or even its reprocessing into alternative products, such as biodiesel, which reduces waste and further lowers the environmental footprint of industrial and automotive operations. Notwithstanding such benefits, there is a critical evaluation that needs to be done about the sustainability of the machine itself. Construction materials and the energy consumed by the vacuum pump could be an addition to its carbon footprint. Innovations in eco-friendly materials and energy-efficient pumps could make the technology more sustainable. Besides, more compact models with solar power might be further extended to more remote or resource-constrained areas.

From an economic point of view, oil suction machines save money by making operations efficient and not wasteful. For instance, quick oil removal in automotive servicing means smaller service times, higher customer throughput and, therefore, profitability. Similarly, the machinery elongates the life of equipment through regular proper maintenance in industries, hence reducing repair costs. However, a high cost of an advanced oil suction machine may be discouraging in most small and medium-scale industries. Low-range machines are devoid of various features required for their good performance, whereas high-range models with sophisticated control and filtration mechanisms are expensive. The cost-to-benefit ratio is better when time is considered; however, it is difficult to make the machines more affordable at an initial level. Government subsidies or leasing models would encourage wider adoption, particularly in developing regions for industrial advancements.

While oil suction machines boast a lot of strong points, the limitations are still there. In fact, one big limitation is regular maintenance of the machine itself is required to omit the blockages of the system. Indeed, filters and hoses and vacuum pumps must be periodically cleaned or even replaced, aside from disrupting the operations. IoT and AI can be further used in the development of self-cleaning filters or predictive maintenance systems. Other limitations involve capacity: machines with small storage tanks make the overall efficiency low in large-scale industrial applications where there is a frequency of emptying. This could have been avoided by designing scalable systems or mechanisms for continuous transfers to larger storage units.

Advanced technology in the form of oil-suction machines encompasses even future scope for improvement at all ends and moments in time. IoT-enabled machineries do help in all cases for enhancing total operation efficiency based on real-time control and monitoring aid. For example, these sensors can further be used to continuously monitor, in real time, the level of oil, flow rates, and pressures for accurate regulation that prevents overloading of any part of the system. Going up a notch from that, though, would include predictive maintenance or process optimization via artificial intelligence. AI algorithms, in turn, could analyse running data in order to predict things-like filters or hoses-to replace before those do fail and decrease downtime to enhance the profit in the company.

5. Conclusion

The performance assessment of oil suction machines reveals their critical role in modern industrial automotive, and environmental applications in sustainability. In addition, they offer great value to various industries through streamlining the processes of oil removal, reducing wastes, and hence contributing toward sustainability goals. But full exploitation of this potential is yet to come, as these machines need to overcome the challenges in terms of capacity, maintenance, and affordability. Emphasis on design innovation, such as modular elements, filtering systems of new generations, and IoT integration, might make oil suction machines much more functional and user-friendly. Furthermore, efforts toward greener and cheaper equipment will make sure that wider diffusion of them turns them into one of the cornerstones of sustainable practices of waste management in the future. By using this machine, we can cutoff LKR 1920,000 per year. Generally, there should be four employee who working on that process in manually and one employee need to be paid LKR 40000.00 per Month. Therefore, it is a more economical feasible pathway to think about economical sustainability. Also, it has generally gained the oil change mechanism in manually around 1 hour, but by using this machine compartment it is gaining half of hour to finish the oil cleaning service to reduce the down time of the production.

6. References

1) Ahmed, H. (2015). Mechanics of Materials assignment (By Preston University Islamabad campus).

2) Bhatia, P. (2021). A framework to aid decision making for smart manufacturing technologies in Small-and Medium-Sized Enterprises. In Nancy Diaz-Elsayed, Ph.D., Ashok Kumar, Ph.D., & Jose Zayas-Castro, Ph.D., USF Tampa Graduate Theses and Dissertations [Thesis].https://digitalcommons.usf.edu/etd/9660

3) Hasanbeigi, A., Lynn Price, China Energy Group, Environmental Energy Technologies Division, & Lawrence Berkeley National Laboratory. (2012). A review of energy use and energy efficiency technologies for the textile industry. Renewable and Sustainable Energy Reviews, 16, 3648–3665. https://escholarship.org/uc/item/4531h558

4) Hasanbeigi, A., Price, L., China Energy Group, Energy Analysis and Environmental Impacts Department, Environmental Energy Technologies Division, & Lawrence Berkeley National Laboratory. (2015). A technical review of emerging technologies for energy and water efficiency and pollution reduction in the textile industry. In Lawrence Berkeley National Laboratory [Journal-article]. http://www.elsevier.com/open-access/userlicense/1.0/

5) Jindal, H., & Kaur, S. (2021). Robotics and automation in textile industry. International Journal of Scientific Research in Science Engineering and Technology, 40–45. https://doi.org/10.32628/ijsrset21839

6) Siliņa, L., Dāboliņa, I., &Lapkovska, E. (2023). Sustainable textile industry – wishful thinking or the new norm: A review. In Journal of Engineered Fibers and Fabrics, Journal of Engineered Fibers and Fabrics (Vols. 19–1, pp. 1–27) [Review-article]. https://doi.org/10.1177/15589250231220359

7) Ghazanfarian, J., Iranian Journal of Engineering Education -Ijee, & The Academy of Sciences Islamic Republic of Iran. (2024). IMPROVING THE EFFECTIVENESS OF THE MECHANICAL ENGINEERING CURRICULUM BY COMBINING GLOBAL, LOCAL AND FUTURE-ORIENTED PERSPECTIVES. Iranian Journal of Engineering Education, 26(No.102), 1–20. https://doi.org/10.22047/ijee.2024.456100.2078

8) Al-Obaidi, A. S. M., Husaeni, D. F. A., Setiyo, M., &Nandiyanto, A. B. D. (2024). The role of mechanical engineering in industry: Review and bibliometric analysis. Mechanical Engineering for Society and Industry, 4(3), 308–317. https://doi.org/10.31603/mesi.12619