Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 6, No.3, June : 2024

CCTV LENS WIPER WASHER UNIT

Mamta Koban Professor, Dept. Of Electronics and Telecommunication Engineering, AISSMS Institute Of Information Technology, Pune.
Mugdhesh Dhaware Electronics and Telecommunication Engineering, AISSMS Institute Of Information Technology, Pune.
Amit Durugkar Electronics and Telecommunication Engineering, AISSMS Institute Of Information Technology, Pune.
Yash Shinde Electronics and Telecommunication Engineering, AISSMS Institute Of Information Technology, Pune.

ABSTRACT
Mostly all the industrial plants especially the oil and gas industries and the petroleum industries are very widely spread industries. The area where these industries are situated in presumed to be in thousands of acres. In these industrial plants there are CCTV'S mounted on the poles one after other with some distance of kilometres between them, and the major responsibility is to not let the dust getting accommodated on the shield of the CCTV lens. Our project mainly focuses on the automated cleaning of these CCTV camera's.
The project involves setting up a washer unit which will contain a 0.5 HP pump, motor, approximately 10 to 25 Liters tank, stainless steel tube and a nozzle to execute the shield cleaning operation. Overall, the CCTV cleaning mechanism would get much easier and convenient.

Keywords:
Oil and Gas Industries, Petroleum Industries, CCTV, Lens, Tank, Pump, Motor, Nozzle, Tube.

I. Introduction
Security is a major and the most primary concern in the world, since today's era is Fastly emerging in the new and the way latest technologies. Concerning the security part the medium for maintaining security i.e. the CCTV cameras are being manufactured and also keeping in mind the future situation or the future demand of the society the manufacturers gave every variety possible while the manufacturing the CCTV cameras. The variety of camera's being manufactured is:

- Weather Proof Camera
- Explosion Proof Camera
- Pan Tilt Zoom (PTZ) Camera

In India there are several industrial plants situated overall away from the human settlements. There are many industrial plants whether it be manufacturing or processing or shipping the area in which these plants are located or situated are spread in large areas. These industrial plants are presumed to be situated in thousands of acres. Especially the oil and gas industries and also the petroleum industries are the most widely spread industrial plants. The petroleum and oil and gas industries are prominently located in the below mentioned locations:

1. Eastern Offshore (with 6.73% share of oil)
2. Gujarat (with 19.63% share of oil)
3. Nagaland (with 0.39% share of oil)
4. Rajasthan (with 4.06% share of oil)

Such industrial plants have CCTV camera's mounted on the poles with a distance of few kilometre's between the poles to avoid any kind of theft or any sort of uncertain activity taking place in the industrial plant. Due to the surroundings in the industrial areas these CCTV camera lenses get affected i.e. either the dust gets accommodated on the shield of lens or in some case there might be excess moisture on the shield of lens. This problem might result in blur CCTV footage and hence when the CCTV footage gets blur then there is high chance of any uncertain activity happening around.

Therefore, our project aims to develop a washer unit which will be containing a 0.5 HP pump, Motor, 10-to-25-liter tank, Stainless steel tube, Nozzle's, CCTV Camera is integrated with wipers. By assembling this washer unit our focus is to clean the camera whenever the operator finds the footage blur and as and when the operator will operate this cleaning mechanism through the control room through a button.

II. Literature

Hyundai's Self-Cleaning ADAS Camera, Rob Stumph [1]

Now-a-days most of the car brands in the market have adopted various camera cleaning mechanisms which will not let the car drivers do the same job manually. Therefore, this article published is about one of such car brands which has adopted an automatic camera probably the ADAS (Advanced Driver Assistance System) camera cleaning mechanisms. This camera is probably used to get the backside view of the car whenever the driver is supposed to reverse the car according to the requirements. Therefore, considering the project workflow we have made a survey with this article wherein we have studied the automatic ADAS camera cleaning mechanism for the Hyundai car. We have examined the previously used ADAS camera cleaning mechanism and we also have compared the older or in other words the previous adopted mechanisms by which the advanced driver assistance system camera was cleaned to maintain a clear camera visibility. Hence the basic thought proposed through this article is to build an automatic ADAS camera cleaning system which would help to avoid some sort of unusual accidents. Previous thought of the car automaker was to implement a process where in if the ADAS camera lens gets dirty because of dust or if excess moisture settles on it then the driver should press a button then the nozzle below the ADAS camera will spray water and then the integrated small wiper with the camera would clean the dust or the moisture settled on the lens. The latest mechanism of Hyundai car works in such a way that if the camera lens gets accommodated with dust or moisture then automatically the lens rotates and gets cleaned itself. This automatic cleaning mechanism of the ADAS camera marks a significant advancement in maintaining clear camera visibility for the automobile vehicles rather in the sector of automobile industry.

Windshield wiper wash system (For Aero plane) [2]

Clear visibility is of utmost importance in aviation, whether it is for windshields or CCTV cameras. To address this concern, aircraft, helicopters, and private jets employ efficient mechanisms that reduce human effort. The wiper washer system designed for aerospace vehicles is adaptable to various types of aircraft.

This article presents a theoretical formulation of the mechanism used to clean windshields in aircraft, helicopters, and private jets. The design of this mechanism considers climatic conditions suitable for its operation, ensuring effective cleaning when dust or moisture accumulates on the windshield. The core components of this system include a specialized nozzle used to clean the windshield promptly, mitigating potential hazards caused by obscured vision. Statistics on air accidents highlight the importance of such systems, with India witnessing approximately 0.87 accidents per million departures in 2022, a significant improvement compared to previous years when the rate was 4.35 accidents per million departures.

Innico.R, Karthish Durai.A.M, Poovalingam.M, "Cleaning of Solar Photovoltaic Panels" EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal (February 2023) [3]

This paper delves into the cleaning mechanisms for solar photovoltaic panels, which are utilized both for household and commercial purposes. Commercially mounted solar panels, often positioned at heights, are susceptible to dust accumulation, necessitating cleaning mechanisms. The focus of this paper is on the mechanism employed to clean solar panels using wipers when dust accumulates on the photovoltaic surface. The wipers' motion is facilitated by the SMPS coupler, a vital component in the cleaning system designed for solar photovoltaic panels.

The publication primarily addresses the cleaning process for solar panels when dust settles on them. The project designers emphasized cleaning for dust particles as the primary concern, given that solar panels in elevated locations, such as rooftops, are prone to dust and debris accumulation due to wind. The use of the SMPS coupler enables the wipers to clean the solar panels effectively when dust settles on their surfaces.

First ever 40x zoom PTZ camera, Jose Antunes, 29 March, 2024 [4]

KY-PZ540 Series PTZ Cameras with 40x zoom at NAB 2024 (Booth C4720). As the company's first PTZ cameras to incorporate this focal depth, the KY-PZ540 and KYPZ540N with integrated NDI HX3 capabilities are designed with JVC's 4K imager. The cameras also feature JVC's renowned Variable Scan Mapping technology, which dynamically scans the 4K sensor to produce a seamless and lossless image transition up to 40x in full resolution HD. The cameras are, according to the company, "ideal for large event spaces and instances when the need to zoom in from a distance is essential." With AI-powered advanced SMART auto tracking functionality and NDI-supported IP-based remote operation capabilities, the KY-PZ540 and KY-PZ540N PTZ cameras are unveiled for the first time at NAB 2024.

First ultrasonic lens cleaning chipset, Texas Instruments [5]

In this article we studied about a new and different mechanism of cleaning the camera lens, which works very efficiently and is a very reliable mechanism. In this process new ultrasonic lens cleaning technology is introduced to clean the camera lens. Utilizing the ULC1001 digital signal processor and DRV2901 piezo transducer driver, both equipped with a proprietary algorithm, facilitates the self-cleaning process for the cameras. This self-cleaning algorithm simply reduces manual effort which would be required to clean the camera lenses and somehow it also gets very hectic and tough for the human to clean the lens properly whereas this self-cleaning proprietary algorithm cleans the lens until and unless the footage is visible clearly to the human eye.

Havells Catalogue [6]

In this catalogue we had got an overview of various architectures and designs of the motors with integrated pumps. The main purpose behind referring this catalogue was to browse out the motors which have integrated pumps in them and which are explosion proof i.e. the motors will not be affected by the external harm or any external unexpected explosion happening in the premises. Our main concern with the motors was that the motor which would be selected should have IP66 rating. Here in IP means "Ingress Protection". This ingress protection is a primary and most important protection standard which mostly emphasizes on the motors or pumps being completely explosion proof. Ingress Protection (IP) ratings classify the degree of protection provided by enclosures against the intrusion of solid objects (like dust) and liquids. The IP rating typically consists of two digits; the first indicates protection against solids, and the second indicates protection against liquids. Ingress Protection (IP) ratings are a standardized system used to define the level of protection provided by enclosures against the intrusion of solid objects, such as dust and dirt, as well as liquids like water.

Trans-techno [7]

An IP65-rated motor with an inbuilt pump offers a robust solution for applications requiring both motorized operation and fluid pumping capabilities, while also demanding protection against dust ingress and water jets. The first digit signifies that"6" indicates that the motor is completely protected against dust ingress. This means that the motor enclosure is dust-tight, preventing any harmful deposits from entering and affecting its operation. Also, the second digit signifies that "5" indicates that the motor is protected against water jets from any direction. While it's not submersible like higher IP ratings, it can withstand powerful water jets, making it suitable for applications where exposure to water is expected but not constant immersion.

Siemens (impeller.net) [8]

Simo gear geared motors showcase significant advantages, such as high-power density, refined torque levels, and high efficiency. When combined with Simo gear, the Samanic's G110M comes fully pre-configured from the factory. This new inverter, with a protection rating up to IP66, allows for versatile use of the compact system and expands its functionality. The Samanic's G110M, a modular system, is easy to install, commission, and operate. Installation is simplified by pluggable connections for all inputs and outputs, reducing cabling by daisy-chaining 400 VAC, 24 VDC, and communication signals. Additionally, the inverter features comprehensive and user-friendly diagnostic tools, along with an integrated braking resistor. Its built-in functions, such as "Quick Stop" and limit switch capability, make it particularly well-suited for conveyor applications.

Windshield wiper washer motor used for vehicle [9]

A disclosed system and method for sealing a pressure area in a washer pump involve creating designed interference and contact points between multiple adjacent walls. These walls are configured to form a serpentine channel and are integrally melded into both the pump housing and the motor housing. When fluid pressure increases in the pressure area, at least one of these walls becomes biased and engages with one or more corresponding walls in the mating housing, forming at least one seal to effectively close off the pressure area. The walls may feature bevelled edges to create a "point contact," which enhances the sealing capability. This approach minimizes or eliminates the need for an O-ring between components like the pump housing and the motor housing.

Residential Purpose Wiper Washer Unit [10]

WAS-WASPT is a wash kit designed for PTZ cameras and camera housings with wipers. The kit includes a water tank with an integrated pump, available in capacities of 5 or 23 liters, and can deliver water up to 30 meters. The WASPT series allows remote control of This extensive range of washers and tanks ensures efficient cleaning for enhanced camera visibility. In the 11m (36ft) and 30m (98ft) delivery versions the lack of liquid in the tank is signalled following the automatic stop of the pump (except for 11m (36ft) version of WAS series). Pumps with 30m (98ft) delivery are available only in 230Vac or 120Vac. With the use of the antifreeze liquid the minimum operating temperature goes down to -25°C (-13°F). Products with 5m (16ft) or 11m (36ft) delivery heads have an IP66 level of protection. The WASPT0V23L11M00 washer pump with tank of 23l (6gal) and delivery head 11m (36ft) is certified "Lloyd's Register Marine Type Approval", also in conjunction with the DTWRX card.

Peter Electronics [11]

The Overdrive iE3/3E3 series is a range of variable frequency drives (VFDs) designed specifically for controlling pumps, featuring IP66/IP66S ingress protection ratings. These VFDs are available in power ratings ranging from 0.37 kW to 7.5 kW, catering to a variety of pump applications. The document outlines the technical specifications of the VFDs, including input voltage and frequency, output voltage and frequency, motor power range, and ambient operating temperature range. It also provides details about the enclosure protection rating (IP66/IP66S), indicating resistance to dust ingress and powerful water jets. The VFDs in this series offer a range of features to enhance pump control and efficiency, including variable frequency operation, soft start and stop functions, overload protection, and motor parameter settings. They are designed for easy installation and integration into pump systems, with user-friendly interfaces and programming options.

India Mart [12]

India MART is India's leading online B2B marketplace connecting buyers with suppliers, offering a comprehensive platform where businesses can discover products, negotiate deals, and transact securely. With millions of supplier listings spanning diverse industries, India MART enables buyers

to search for products, compare prices, and submit RFQs, while providing sellers with a powerful platform to reach a wide audience, manage leads, and streamline sales processes. Through its digital marketplace, secure payment solutions, and mobile app accessibility, India MART revolutionizes B2B commerce, empowering businesses to thrive in the digital economy.

Ingress Protection rating [13]

the wiper and washer pump. The Ingress Protection (IP) rating is a standard defined by the International Electrotechnical Commission (IEC) to classify the degrees of protection provided by enclosures of electrical equipment against the intrusion of solid objects, dust, accidental contact, and water. The rating typically consists of the letters "IP" followed by two digits. The first digit ranges from 0 to 6 and indicates the level of protection against solid particles, with 0 meaning no protection and 6 signifying complete protection from dust. The second digit ranges from 0 to 9, indicating the level of protection against liquids, where 0 means no protection and 9 signifies protection against high-pressure, high-temperature water jets. This rating system helps consumers and manufacturers understand the durability and suitability of electronic devices in various environmental conditions.

Electric Motor Protection rating [14]

The Ingress Protection (IP) rating of a motor indicates its level of protection against water and solid particles like dust. This rating, typically displayed on the motor nameplate, is essential for selecting an electric motor, as it confirms that the enclosure can safeguard the motor from its operating environment. IP ratings are specified by the International Electrotechnical Commission (IEC) standards, while the National Electrical Manufacturers Association (NEMA) provides a comparable enclosure rating system.

Polycase [15]

IP ratings are a system of electrical enclosure ratings based on the IEC 60529 standard that specify the protective qualities of an enclosure. An IP rating is a two-digit number in which each digit represents the level of protection that the enclosure offers against environmental hazards. IP65 ratings have the following protective qualities:

• Completely dust-tight (no ingress of dust, objects or airborne debris permitted)
• Protected against splashing, falling, or dripping water
• Protected against hose-directed water, from any direction, using a nozzle of 6.33 mm or smaller at relatively low pressures

IP65 enclosures offer solid and reliable protection, and they’re used for many different indoor and outdoor applications.

IP66 ratings have the following protective qualities:

• Completely dust-tight (no ingress of dust, objects, or airborne debris permitted)
• Protects against splashing, falling, or dripping water
• Protects against hose-directed water, from any direction, using a nozzle of 12.5 mm or smaller at higher pressures.

III. Implementation

Since our Problem Statement is to discuss the challenges faced in maintaining clear visibility of CCTV cameras in outdoor environments due to environmental factors such as dust, rain, and pollution.

Also, we aim to enhance the efficiency and maintenance of CCTV wiper washer units by integrating optical fibre technology and junction boxes, ensuring optimal camera visibility in various climatic conditions.

For every project there are some generalized steps or in the other way every activity has some typical methodology or a work flow assigned according to the execution. In the similar manner for our washer unit setup, we also have a generalized methodology as mentioned below:

Firstly, while starting with the project, we got an idea about the project which means we studied the problem statement deeply and, we researched some factors i.e. we searched out for some similar projects that whether they are available in the market and if yes then what are the drawbacks within the developed project and what could be the changes in the developing design. This primary survey helped us very much while developing the rough sketches for the assembly arrangement of the hardware apparatus involved in our washer unit setup. On the first survey we also examined and analysed the cost which is being consumed while developing the project and also we again analysed the cost for the project which were already developed , and with this we had a thought of including some modifications which are not included in the previous developed projects since we were concerned with avoiding the drawbacks being faced with the previously developed washer units and all this thought process indirectly resulted in the reduction of cost , which was one of the advantage with this project.

1). For the second phase of our literal survey, we started collecting some virtual data which would be helping us while developing the final drawing for the hardware arrangement of our project. The collected data gave us an idea about the proper hardware arrangement which would not consume much space and, we got a briefing about the working process with that arrangement. Then we developed a new mechanism with approximately 90% of the same hardware arrangement and this thought of our project team helped us to understand the obstacles faced by the water flowing from the stainless-steel pipe with our thought of arrangement. Also consulting with some people who previously developed the design we finally collected the appropriate data which further helped our team with the other designing aspects.

2). Now coming to the literature survey parameter, for this project we mainly consulted the people who worked on site to mount the developed hardware of washer unit. From these people we noted down the parameter's which would affect the enclosure box the water tank and somehow the connections. The noted parameters were as follows:

a). The climatic conditions.

b). The surrounding (Whether dusty or moist).

c). The material used for the hardware development.

The above three parameters made us think for the good quality material also we were much concerned about the appropriate camera type to be used in that respective area where in the washer unit setup will be mounted. The oral literal survey helped us to think more practically. We also gathered some data virtually which helped us in developing the arrangement in such a way that it will not exceed the pole height limit and also it won't damage the cameras since those were the primary component in the project.

3). In this phase we had an eye on the proper component selection and along with the component selection we also studied the specification of the selected components. The components involved in our project were the 0.5 HP pump,

Motor, Relay, Junction box, Enclosure set, Spray nozzle, Tank and Mounting hardware.

Hardware Specifications:

The setup includes a 0.5 HP pump responsible for pumping water upwards through a stainless-steel pipe towards the CCTV camera lens.

The pump's power is approximately 372 watts. A motor is also part of the assembly, working alongside the pump to push water into the CCTV enclosure. The junction box contains and connects all the components, acting as a central hub.

For water storage, a stainless-steel tank with a capacity of 10 to 25 Liters is used to prevent corrosion from adverse weather conditions. A 5 to 10 feet long stainless-steel pipe serves as the conduit for water flow, chosen for its corrosion-resistant properties.

Nozzles in the system monitor water pressure, regulating the flow onto the lens shield during the cleaning process.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 6, No.3, June : 2024

IV.Block Diagram

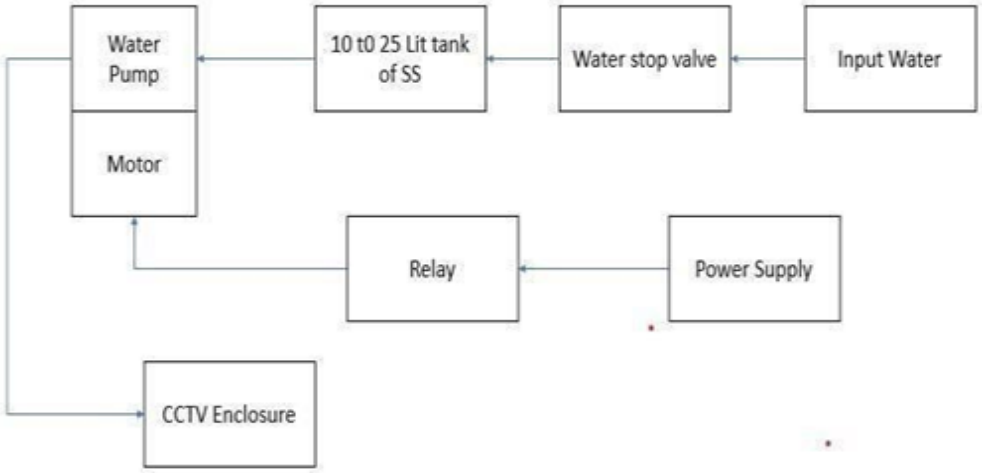

Fig 1. Block diagram (Washer unit)

1). Input Water: The input water in this mechanism is being supplied through underground medium. For this project to supply the water towards the tank the operator has to transfer the water from the water storage area through the underground pipeline towards the tank as per the capacity i.e. 10 liters or 25 Liters and then as and when the tank gets filled properly with the water then the respective operator has to close the valve of the tank to avoid the excess or the unnecessary waterflow from the tank.

2). 10-to-25-liter tank of SS: The tank is an ovular shape tank which is being used to store the water according to the tank capacity and is being used to clean the lens shield as and when the shield gets dirty. The tank is built by using the stainless-steel material which also helps to avoid the material corrosion due to the adverse atmospheric conditions. The primary concern of building the tank in stainless steel material is protect the tank and the water from the material corrosion.

3). Water Pump and Motor: The pump and the motor are coupled with each other using a coupler. If the pump and the motor are not coupled with each other than the water would not be pumped upwards to the CCTV camera enclosure. Hence in this setup the coupling of the motor and the pump is very important. The technical specifications of the pump are, it has the power of 0.5 horse power which is 372 watts approximately and this power of pump helps the water to get pumped up to the height of 5 to 10 feet towards the CCTV camera.

4). Relay and Power Supply: To execute this whole setup as expected this relay and the power supply arrangement helps a lot. Mainly in other terms it can be said that to operate the pump and the motor which are coupled with each other the relay and the power supply arrangement plays a very important role.

5). CCTV Enclosure: Basically, the CCTV enclosure is nothing but the lens shield upon which the nozzle is being mounted through which the water is being sprayed up on the shield as the dust/debris gets accommodated on the CCTV camera lens shield.

Comparison of normal CCTV camera and PTZ (IP) camera:

Table 1. Comparison between CCTV camera and PTZ camera

CCTV Camera	PTZ Camera
Closed-circuit television camera system	Pan-Tilt-Zoom camera system
Mostly fixed, limited mobility	Mobile with pan, tilt, and zoom capabilities
Surveillance in fixed areas	Surveillance in dynamic environments, tracking, and monitoring

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 6, No.3, June : 2024

Typically, manual control	Remote control for pan, tilt, and zoom operations

V. System Design

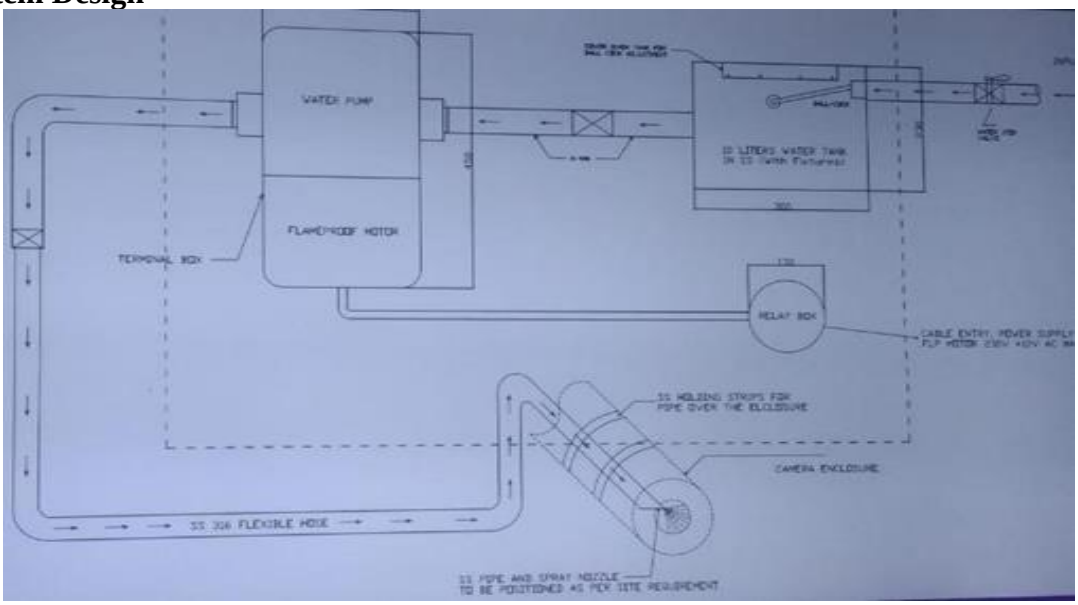

Figure 2. System design (Washer unit)

In this photograph we had developed the system design which is briefly illustrating the entire water flow or in other terms this design is explaining the entire work flow of our project i.e. how the water will be filling and how it will be passing through the tank towards the coupled 0.5 HP pump and the motor which is being operated with relay and with the power supply and how the water flow will be approaching the mounted CCTV camera lens shield. The whole design flow is explained as below:

The water input for this system comes from an underground source. To fill the tank, the operator transfers water from the storage area through an underground pipeline, filling the tank to its capacity of either 10 or 25 liters. Once the tank is filled, the operator must close the tank valve to prevent excess or unnecessary water flow. The project includes an ovular- shaped stainless-steel tank, holding 10 to 25 liters of water. It's used for storing water as per capacity and for cleaning the lens shield when dirty. Stainless steel construction prevents material corrosion, ensuring durability and protection against adverse atmospheric conditions.

The pump and motor are connected via a coupler, crucial for pumping water to the CCTV camera enclosure. The pump has a power of 0.5 horsepower, approximately 372 watts, enabling water to be pumped up to 5 to 10 feet toward the CCTV camera. If the pump and motor aren't coupled, water wouldn't be pumped upward effectively.

To execute this whole setup as expected this relay and the power supply arrangement helps a lot. Mainly in other terms it can be said that to operate the pump and the motor which are coupled with each other the relay and the power supply arrangement plays a very important role. Relay along with the power supply is acting as the most crucial component in this project.

VI. Results

Table 2. Performance matrix of CCTV Wiper Washer Unit

Test Case	Water Pressure (bar)	Flow Rate (lit/min)	Cleaning Time (min)	Efficiency	Power Consumption (kW)
TEST 1	3	8	1	85 %	0.39999
TEST 2	5	10	2	80 %	0.08335

TEST 3	7	12	3	75 %	0.18667

Calculations:

Test 1:

Pressure = 3 bar = 300,000 Pa (1 bar = 100,000 Pa) Flow Rate = 8 lit/min = 0.1333 lit/sec (1 lit = 0.0167 cubic feet)

Efficiency = 85%

Power= (300,000 Pa×0.1333 lit/sec / 0.85) ×10−3 kW Power= (39.999 kW) ×10−3 kW

Power= 0.039999 kW

Test 2:

Pressure = 5 bar = 500,000 Pa

Flow Rate = 10 lit/min = 0.167 lit/sec

Efficiency = 80%

Power = (500,000 Pa × 0.167 lit/sec /0.80) × 10−3 kW

Power = (83.35 kW) × 10−3 kW Power = 0.08335 kW

Test 3:

Pressure = 7 bar = 700,000 Pa

Flow Rate = 12 Liters/minute = 0.2 Liters/second Efficiency = 75%

Power = (700,000 Pa × 0.2 lit/sec /0.75) × 10−3 kW

Power = (186.67 kW) × 10−3 kW

Power = 0.18667 kW

VII.Hardware Box

Fig (3.1) Hardware Box

Fig (3.2) Camera

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 6, No.3, June : 2024

Fig (3.3) Camera with Wiper

The photographs illustrate the final arrangement of our project in which we have displayed the hardware setup and we also have displayed the configured camera which requires internet protocol configuration. The complete process of final working is such that the PTZ camera also called as the IP camera needs to be configured into a software by entering the respective IP address assigned to each camera separately (Eg: 172.188.19.87) After the camera configuration is done then is the camera focusing in the right direction and if the side terminals of the camera are rotating properly is being checked. After checking all these parameters then it is perfectly ensured that the camera configuration is 100% completed and then finally after the camera configuration process then we connected the hardware connection which involves the connection between the TB's and then the power supply unit since these connections ensure the proper working of the motor and the other mechanism.

VIII.Conclusion

We were finally successful in developing a cleaning mechanism just through a button which is being operated from the main location i.e. the control room. Our mechanism mainly consisted of relay, tank, motor and pump coupling and the other connections were housed in the explosion proof junction box which protected the connections from any sort of unexpected activity. While developing the enclosure design of the project we were primarily focused on how would the enclosure be as compact as possible and also how the enclosure weight would be reduced. Considering these points for the enclosure we developed such a enclosure set for our project which was very compact and was weighing less and also it was occupying the necessary space while being mounted. We also successfully developed the junction box architecture which protects the connections made for the washer unit. While developing the design of the junction box our prime focus was on the usage of appropriate material of Ingress Protection rating 66 (IP-66) which would protect the connections from getting exposed to the unusual explosion and also the junction box avoids the further damage to the washer unit mechanism. Overall, we completed the total development of the CCTV lens wiper washer unit with the proper consideration of the material and its protection rating and other parameters.

IX. References

[1] R. Stumph, "Hyundai's Self- Cleaning ADAS Camera," [Online].
[2] W. w. w. system, "Windshield wiper wash system," collins aerospace. [Online].
[3] K. D. Innico.R, "Cleaning of Solar Photovoltaic Panels," [Online].
[4] J. D'Amico, "NAB 2024: JVC Unveils Its First Ever 40x Zoom PTZ Camera Series," [Online].
[5] Jake Hertz, "Texas Instruments Announces First Ultrasonic Lens Cleaning Chipset," [Online].
[6] "Havells Catalogue," [Online]. Available: https://www.havells.com/HavellsProductImages/Havells India/Content/dam/havells/.
[7] "Trans techno," [Online]. Available: https://www.transtecno.com/en-en/news/-ip66-dc- ac-electric-motors/.

[8] S. (Impeller.net). [Online]. Available: https://impeller.net/magazin/siemens-presents- Simo gear-geared-motors-with-integrated- sinamics-g110m-inverter/.
[9] "Windshield wiper washer motor used for vehicle.," [Online]. Available: https://patents.google.com/patent/US5833441A/e n.
[10] "Polycase," [Online]. Available: https://www.polycase.com/techtalk/ip-rated- enclosures/ip65-vs-ip66.html.
[11] R. P. W. W. Unit., "Residential Purpose Wiper Washer Unit.," [Online]. Available: https://www.videotec.com/cat/en/products/washin g-systems/was-washing-systems/was-waspt/.
[12] "Peter Electronics," [Online]. Available: https://www.peter-electronic.com/wp/en/wp-content/uploads/sites/2/vfd-pump-versidrive-i-e3- 3e3-ip66-ip66s-0-37-7-5kw-data-sheet-en.pdf.
[13] "India-mart," [Online]. Available: https://m.indiamart.com/.
[14] E. M. P. rating. [Online].
[15] "Polycase," [Online]. Available: http://www.polycase.com/.