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DIESEL ADDITIVE SKID

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Abstract:

The paper presents the process of automating, designing, fabricating and manufacturing an 'Additive Diesel Skid' for the pumping of anti-static agents into the diesel transportation trucks at the fuel filling stations. At present the whole process is done manually by measuring the exact amount of anti-static from a storage drum and then adding it directly to the diesel transportation truck.The design solution consisted of having pumps and a control panel that automatically calculates the right amount of anti-static that has to be added to the diesel. The process involves the selection of the right tank and then the designing of the frame and pipe work. The components involved in the project were all tested and approved by the Australian and New Zealand Standards. Inspection and testing of the whole project setup was done by an external agency. The whole setup was designed by using AutoCAD and also Navisworks Freedom. The addition of the right amount of anti-static agent to be added was done by a specific injection device.

Key Words: Additive Skid, Sandpiper Bump, Anti-Static Agent & Fuel Control System

1. Introduction

In today's fast-moving, highly competitive industrial world, companies must be flexible, cost effective and efficient if they want to survive. Automation plays an increasingly important role in the world economy and in daily experience. Automation is the use of control systems and information technologies to reduce the need for human intervention in the production of goods and services. The current project involves the process of automating, designing, fabricating and manufacturing of an 'Additive Diesel Skid' for the pumping of anti-static agents into the diesel transportation trucks at the fuel filling stations. At present the whole process is done manually by measuring the exact amount of anti-static from a storage drum and then adding it directly to the diesel transportation truck. The manual process for transportation of diesel is time and cost consuming due to its demand. In order to save time and cope with the market needs, the pumping of anti-static to the diesel transportation trucks needs to be automated.The design solution consisted of having pumps and a control panel that automatically calculated the right amount of anti-static that has to be added to the diesel. The process involves the selection of the right tank and the designing of the frame and pipe work

2. Diesel Additive Skid:

The additive skid is a setup which contains various components that aids in the pumping and injection of anti-static agents into diesel. When fuels are moved through distribution systems such as pipelines, they can build up a static charge. In order to safely pump and move fuels from place to place, conductivity improvers are often added to help dissipate this static charge buildup. Conductivity improvers are also referred to as anti-stats or antistatic agents, and their use is increasing as sulfur (which acts as a natural static charge dissipater) is removed from diesel fuels. The main part is the additive tank along with its unique additive pump.

The additive tank is made of high grade steel with a protective coating which helps prevent corrosion. The tank is also provided with an emergency vent which operates only if the pressure exceeds the safety limit. The main primary pump used is the Sandpiper S15 pump which operates due to differential air pressure. The outer casing of this pump is also made with high grade steel which is especially made for the suction of oils.

The additives added to make up the various anti –static agents where from different companies such as 'Lubrizol' and 'Innospec'. Each chemical added to make the anti-static agents were based on its 'Flash Point' and 'Pour point'. 'Flash Point' refers to the lowest temperature within which any vapors of the liquid can ignite whereas 'Pour Point' refers to the temperature at which the liquid becomes semi – solid and losses its flow characteristics. The anti-static agents used here are very specific and can only be used for the diesel grade made by BP (British Petroleum).

The main component that controls the precise injection of anti- static agents is the 'Fusion 4 MSC-A' from Honey well. This electrical component is specifically used for accurate adding of any chemicals into petroleum products. The Fusion 4 comes with a LCD panel which is used as a display and for programming the injection rate. The whole additive skid setup sits on a frame that supports the entire weight .The frame is fabricated by using 'Parallel Flange Column' and' Universal Flange Column ' which are structural steel bars capable of withstanding high load.

Figure 1: Diesel Additive Skid

3. Methodology:

The operational block diagram is shown in Fig. 2. The Block diagram explains the process in a sequential way.A block diagram is a diagram of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks.A block diagram provides a quick, high-level view of a system to rapidly identify points of interest or trouble spots. Because of its high-level perspective, it may not offer the level of detail required for more comprehensive planning or implementation.A block diagram is especially focused on the input and output of a system.Block diagrams use very basic geometric shapes: boxes and circles. The principal parts and functions are represented by blocks connected by straight and segmented lines illustrating relationships.

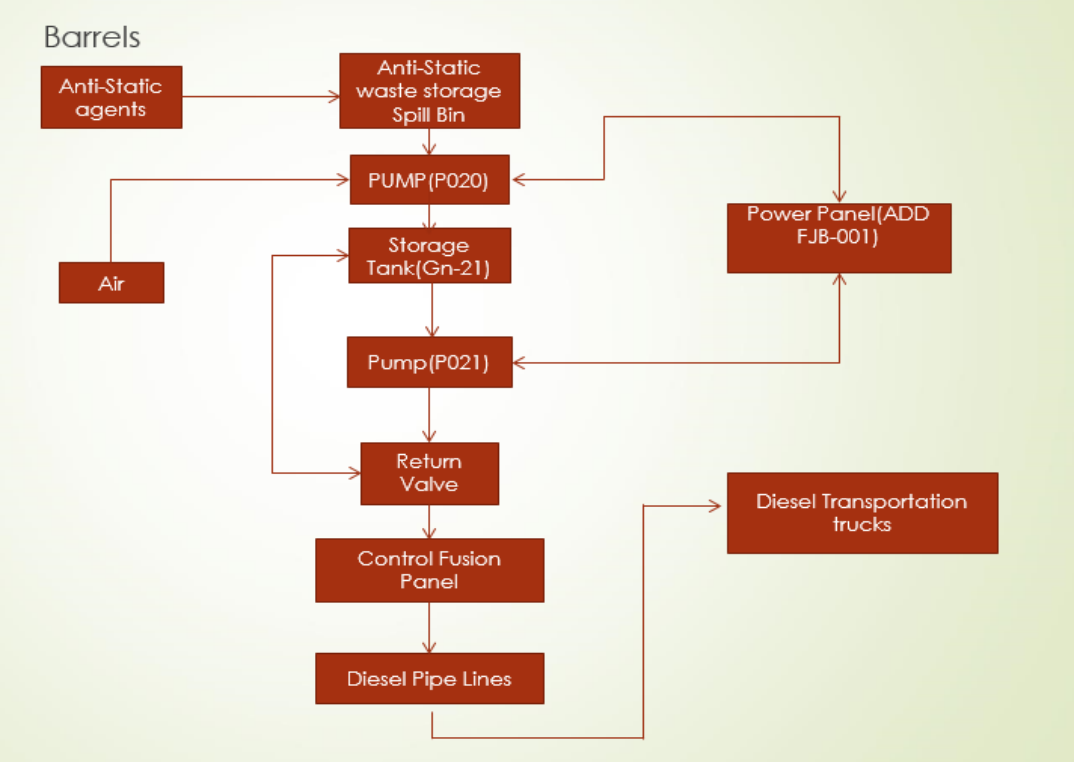

Figure 2: Block Diagram

The Anti- Static agents, stored in barrels are kept on the spill bin. The spill bin is used to store anti-static agent if it leaks from the barrel. A hose from the spill bin is connected to the inlet pipe which is directly connected to the 'PUMP 1'.The anti-static agent is then sucked from the pumped and stored in the Tank. Based on the requirements the parameters are set in the 'Control Fusion Panel 'Then the anti-static is sucked from the storage tank using 'PUMP 2' and goes directly to the diesel lines. The excess, goes back to the tank via the return valve .The Control Fusion Panel controls the mixing and then directly stops the suction until the requirements are made. The mixture is then stored in the diesel trucks ready for transportation.

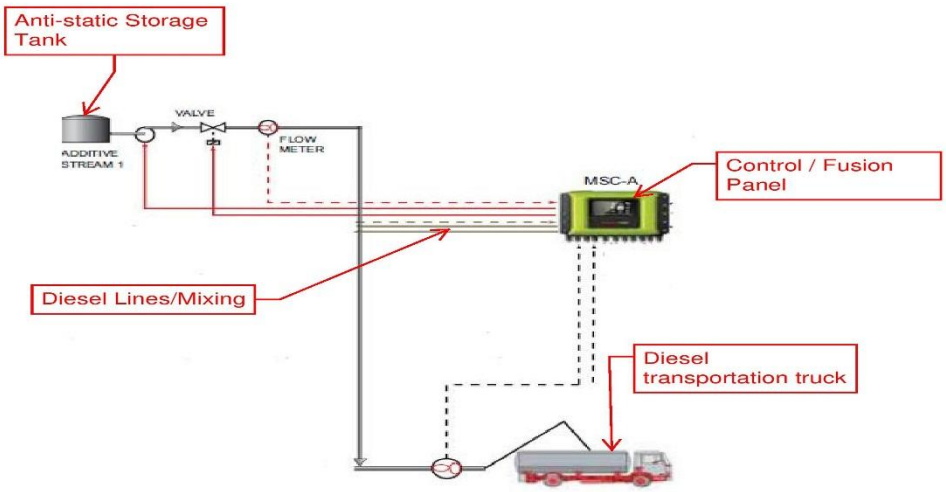

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Figure 3: Flow chart

The Rough flow chart of the additive skid working is shown in Fig. 3.This flow chart gives a better understanding of the diesel additive skid.

4. Hardware:

4.1 Lifting Lugs:

The lifting lugs were used for moving the skid .The Lifting plan consisted of designing spreader beams which can carry a maximum load of 4000 Kg and had adjustable lengths.

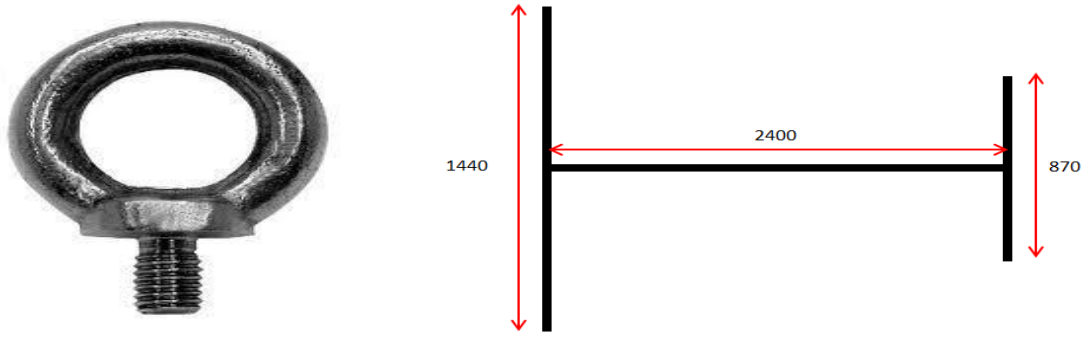

Figure 4: Design of Lifting Lugs

The perfect balance for lifting was done by calculating were the center of gravity of the skid. The I Bolts were made up of stainless steel and was manufacture to withstand a load of 5 Kg .There were totally four bolts welded onto the corners of the skid frame. Chains of suitable lengths were used to secure its position onto the cranes for moving.

4.2 Pipes and Valves:

The entire piping for the skid were designed following the Australian/New Zealand standards of pipes.The Australian and New Zealand standards specify the thickness,pressure rating,size,grade of material and the type of liquids that the pipe can withstand .All the pipe work used for the skid were stainless steel as it is least corrosive.The pipe work inclued reducers,flanges,ellbows etc. The pipes alingment were designed to able the maximum flow of the anti-static agents.

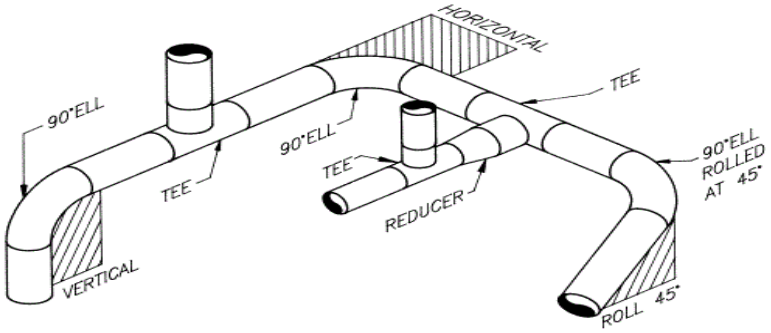

Figure 5: Design of pipes and valves

A pulley belt mechanism is used to transmit the rotational motion. The final output speed becomes twice that of the speed of the motor by using a 1:2 ratio pulley as shown in Fig 7

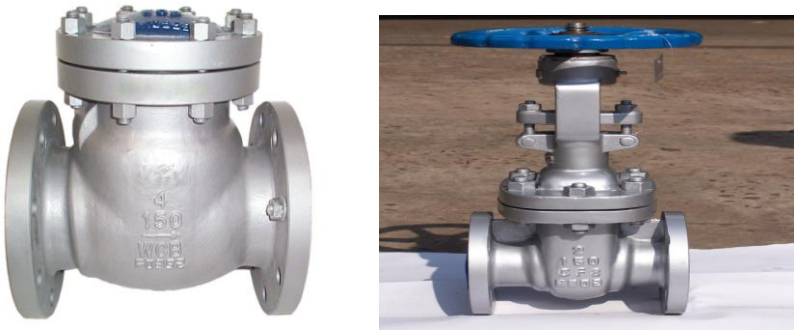

Figure 6: (a) Gate Valve b) Check Valve

The valves also are designed and fitted with accordance of the Australian/New Zealand standards. These standards specify the flow rate, pressure rating, temperature, flow direction, fire and corrosion proof etc. The Gate valves are used so that the flow is bi-directional flow whereas the Check valves are used for uni-directional flow. All valves bought from various suppliers must be certified and testing for the required pressure.

4.3 Overall Design:

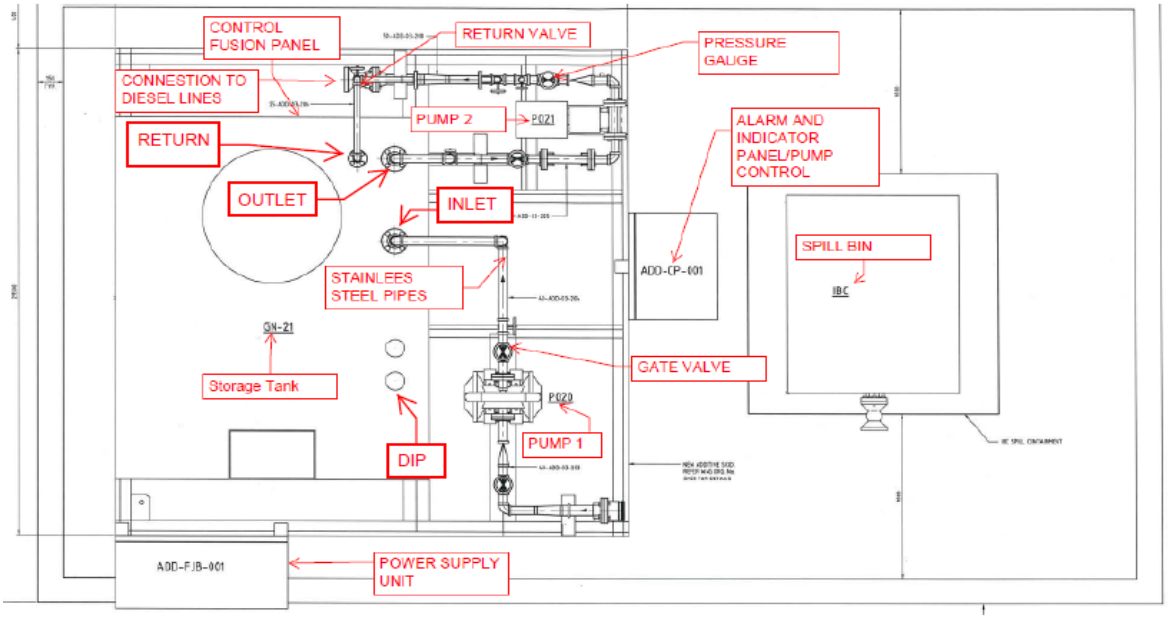

Figure 7: Overall design of system

The storage tank was designed and manufactured by 'DTE Group'. The tank has a storage capacity of '4000 Liters'. The basic tank structure weighs roughly about 600 Kg and rest on the skid frame. The tank is manufactured specifically for handling flammable liquids and consist for three nozzles namely the 'Inlet', 'Outlet' and the 'Return' nozzle. The storage tank was designed and manufactured by 'DTE Group'. The tank has a storage capacity of '4000 Liters'. The basic tank structure weighs roughly about 600 Kg and rest on the skid frame. The tank is manufactured specifically for handling flammable liquids and consist for three nozzles namely the 'Inlet', 'Outlet' and the 'Return' nozzle. The tank also is provided with a 'Dip' in order to monitor the level of liquid in the tank. The Spill Bin was bought by a local vendor. The Spill Bin is made of basic Stainless Steel and is used to collect any wastage anti-static agents that may leak from the anti-static barrels stored on the top of the Spill Bin.

5. Control System:

5.1 Fusion 4 MSC-A (Multi Stream Controller –Additive)

Figure 8: Fusion 4 MSC-A

In this project we used the 'Fusion 4 MSC-A' from Honeywell.The Fusion 4 Multi Stream Controller-Additive (MSC-A), is a hazardous area of intelligent additive injection controller, utilizing state-of-the-art microprocessor technology for high accuracy additive injection applications, in the global oil storage and distribution industry. The MSC-A is designed to control up to 12 individual additive streams. It can operate in any product transfer application, such as road tanker loading, rail-off loading or pipeline transfer, where multiple products need to be accurately combined.Users can choose between 'Station' and 'Modular' formats. 'Station', comprises of pre-integrated additive injector panels with the Fusion4 MSC-A, on a free-standing frame, providing rapid installation and commissioning whereas the 'Modular' arrangement provides the additive injector panels and the MSC-A individually for flexible field installation.

Fusion4 MSC-A is a state-of-the-art control center that monitors all aspects of the injection operation. It continually reviews peripheral system data to pace the injection of additives into the transfer lines. It also monitors alarms, runs calibration sequences, collates and stores critical transaction and alarm data, and seamlessly disseminates this information to third-party systems via multiple communications and Ethernet ports. The precision injector assembly features a solid stainless steel block design, housing a mini oval gear meter, solenoid valve, integral check valve, needle valves and inlet strainer, all machined directly into the control block to improve the precision, traceability and security of additive operations. Users benefit from comprehensive monitoring of critical operational parameters, transaction traceability, calibration security, enhanced diagnostic tracking and seamless integration.

5.2 Sandpiper S15:

Sandpiper S15 pump is very unique as it does not require any electric power for its use. The pump works on the principle of differential air pressure for suction. The main advantage is that the pump can save power and also cost, since it does not require maintenance. The pump has a capacity of zero to four hundred and one liters per minute. The pump has a maximum operating pressure of 8.6bar or 125 psi. The whole outer body of the pump is made with high grade 'Stainless Steel'. The pump is specifically designed for pumping oil of various viscosity. The pump is also designed with a protective coating to give it chemical as well as corrosive resistance.

Air-Operated Double Diaphragm (AODD) pumps are powered by compressed air or nitrogen. The main directional (air) control valve (1) distributes compressed air to an air chamber, exerting uniform pressure over the inner surface of the diaphragm (2). At the same time, the exhausting air (3) from behind the opposite diaphragm is directed through the air valve assembly(s) to an exhaust port (4).As inner chamber pressure (P1) exceeds liquid chamber pressure (P2), the rod (5) connected diaphragms shift together creating discharge on one side and suction on the opposite side. The discharged and primed liquid's directions are controlled by the check valves (ball or flap) (6) orientation. The pump primes as a result of the suction stroke. The suction stroke lowers the chamber pressure (P3) increasing the chamber volume. This results in a pressure differential necessary for atmospheric pressure (P4) to push the fluid through the suction piping and across the suction side check valve and into the outer fluid chamber (7).Suction (side) stroking also initiates the reciprocating (shifting, stroking or cycling) action of the pump. The suction diaphragm's movement is mechanically pulled through its stroke. The diaphragm's inner plate makes contact with an actuator plunger aligned to shift the pilot signaling valve. Once actuated, the pilot valve sends a pressure signal to the opposite end of the main directional air valve, redirecting the compressed air to the opposite inner chamber.

Figure 9: Sandpiper Pump

5.3 Level Indicator- Endress Hauser R1A16:

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Figure 10: Level Indicator

The level of anti-static agents in the additive tank can be measured using a level indicator as shown in Fig.10The level indicator used in this project is the Endress Hauser R1A16. The indicator records an analog measuring signal and shows this on the display. The LC display shows the current measured value digitally and as a barograph with limit value violation signaling. The indicator is looped into the 4 to 20 mA circuit and obtains the required energy from there. The RIA16 field indicators monitor measurement signals and display them with high resolution and accuracy. The indicators feature one Open Collector output for monitoring a limit value. They permit universal installation and are particularly suitable for use in the field or in mobile rigs.

5.4 Emergency Relief Valve-Treloar DN200

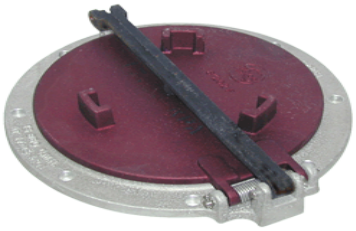

Figure 11: Treloar DN200 Emergency Relief Valve

Emergency vents are installed on aboveground storage tanks as a code requirement. Emergency vents provide high capacity pressure relief if the tank is exposed to fire. When the internal tank pressure reaches the opening pressure of the vent, the weighted cover moves up on the center pin allowing air to escape. When the internal tank pressure falls, the cover automatically lowers back onto the body and is automatically reset. In the absence of sufficient emergency relief a tank rupture could occur, with disastrous effect on life and property and the environment. The Emergency Relief vent used in this project is 'Treloar DN200' and can be seen in Fig 11 the Treloar emergency vents are used on above ground bulk plant and storage tanks. The emergency vent is an auxiliary to a free vent or pressure-vacuum vent. It acts to relieve excess internal pressure created by overheating, fire and over-pumping etc. Emergency vent comes in three emergency relief settings being 17.5kPa, 24kPa and 45kPa.

6. Results and Discussion:

The diesel additive skid is finally constructed and it is successfully tested. The final setup is shown in figure 12

Figure 12: Work Setup of diesel additive skid

The whole construction of the additive diesel skid was inspected and tested in accordance with the specified Standards.

The Inspection and Testing Plan was carried out making sure all specifications were met. Each component was tested according to manufacturing specifications. The whole setup was tested by using low grade diesel to ensure the pumps were in working conditions. The additive skid was transported to the Client's requested location and again the skid was tested on site.

The whole installation of the additive skid was documented and a manufactured data report was created based on each step involved towards the completion of the skid. The final result was achieved which was automating the adding of anti-static agents into diesel transportation trucks. The whole projected was fabricated and built within the time line given in the client's contract.

The additive skid was designed with a modular structure to aid in the injection of anti-static agents into multiple diesel transportation trucks simultaneously. In future more additive lines pumping the required anti-static agents can be used to meet the requirements of the industries. This is possible mainly due to the 'Fusion 4 MSC-A' which can handle six outlets for aiding in the mixing of the anti -static agents with the diesel.

7. References:

1. https://www.honeywellprocess.com/en-US/explore/products/terminal-operations/loading-and-unloading/additive-injection-systems/Pages/additive-pump-skids.aspx>
2. http://www.sandpiperpump.com/content/s15
3. www.galvanizeit.org/Finspection-course/Fgalvanizing-process
4. www.treloar.com./Fdetails.asp/Prod ID101
5. www.eaton.in/Eaton/ProductsServices/FHydraulicsProductsbyName
6. J. Boro and D. Deka, "A Review on Biodiesel", Journal of Biobased Materials and Bioenergy, vol. 6, no. 2, (2012), pp. 125–141.
7. A. Ulusik, "Advantages and disadvantages of biodiesels", Energy EducSciTechnol, vol. 28, no. 1, (2011), pp. 221–226
8. D. H. Qi, H. Chen, L. M. Geng and Y. Z. Bian, "Effect of diethyl ether and ethanol additives on the combustion and emission characteristics of biodiesel-diesel blended fuel engine", Renewable Energy, vol. 36, (2011), pp. 1252–1258