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Design and Fabrication of Hybrid Petrol Tank

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Abstract - *The life line of our automobile industry is its energy source –petroleum products like petrol and diesel. But these are nonrenewable sources of energy; it means that they will not last forever. Every drop of crude fuel count, so it should be practice not to waste these precious energy sources. But since gasoline could be a terribly volatile fuel thus throughout its use in vehicles heaps of fuel gets wasted in style of physical change emissions. If these emissions could be checked through proper means then a lot of fuel can be saved. Although Evaporative emission control systems are integrated into most of the vehicles it provides as an assist rather a solution. This High-density polyethylene material is light weight and could radiate less heat inside a closed environment which makes this more effective material for fuel tank. The heat radiation characteristics is studied and compared in extensive environments which could match the real time scenario. This analysis work is devoted to the study of physical change gasoline emissions and factors on that it depends. This research work is dedicated to the study of evaporative petrol emissions and factors on which it depends. In order to overcome this problem, we have planned to reduce the heat transfer from outside environment to inside the petrol tank by using HDPE material.*

***Key Words*: Carbon canister, Evaporative emission, Purging, Resistance Thermometer Sensor, Conduction test, Convection test, PID control, Fuel tank, Coating and Adhesion.**

1. INTRODUCTION

A vehicle's fuel tank is vital in terms of safety, performance, and dependableness. A good equipment in a very low volume vehicle relies on the proper choice or construction of the tank, tank location among and attachment to the vehicle, correct venting, spillage and escape dispersion, and care, even on the little things like fuel hoses and fittings. Note that wherever a production vehicle is fitted with its original fuel tank or alternative equipment parts in their original locations. The primary objective of this project is to use life cycle style tools to guide the development of fuel tank systems. All the commercial passenger cars and bikes available in India have to comply with the design and safety regulations put forth by Government of India to regularize the Automobile market through The Automotive analysis Association of Asian country (ARAI). These rules additionally embody the look demand for fuel tank. Unless the fuel tank does not meet these minimum requirements, it cannot be installed in an automobile. Thus, the fuel tank we have a tendency to ar work are initial analyzed for the prevailing style, once it is analyzed it will be modified either to increase the capacity of the tank or to extend the strength of the fuel tank or each. Once the first analysis of the present style is completed, the subsequent modifications and changes in the design will be undertaken. Further the new style with modifications are analyzed in compliance with ARAI rules and it should accommodate identical.

1.1 A Coating of Stainless Steel

It is vital to understand that chrome steel may be a solid material and not a special coating applied to standard steel to convey it "stainless" properties. Conventional steels and, indeed, several other metals, are often coated or "plated" with white metals such as chromium, nickel or zinc to protect their surfaces or to provide other surface characteristics. While such coatings have their own edges and ar still wide used, the danger exists that the coating can be penetrated or damaged in some way, such that its protective effect is undermined. The appearance of chrome steel will, however, vary and can rely upon the means it's created and finished.

1.2 High-Density Polyethylene (HDPE)

High-density synthetic resin (HDPE) or synthetic resin high-density (PEHD) could be a thermoplastic chemical compound made from the chemical compound olefine. It is typically known as "alkathene" or "polythene" once used for pipes. With a high strength-to-density quantitative relation, HDPE is used in the production of plastic bottles, corrosion-resistant piping, geomembranes and plastic lumber. HDPE is usually recycled, and has the number "2" as its resin identification code. HDPE is known for its large strength-to-density ratio. The density of HDPE will vary from 930 to 970 kg/m3. Although the density of HDPE is simply marginally above that of low-density synthetic resin, HDPE has little branching, giving it stronger intermolecular forces and tensile strength than LDPE. The distinction in strength exceeds the distinction in density, giving HDPE a higher specific strength. It is additionally tougher and additional opaque and might stand up to somewhat higher temperatures (120 °C/ 248 °F for brief periods). High-density synthetic resin, unlike polypropylene, cannot withstand normally required autoclaving conditions. The lack of branching is ensured by AN applicable selection of catalyst (e.g., Ziegler-Natta catalysts) and reaction conditions. The physical properties of HDPE will vary reckoning on the molding method that's wont to manufacture a selected sample; to a point a deciding issue are the international standardized testing strategies used to spot these properties for a selected method.

2. METHODS TO CONTROL EVAPORATIVE EMISSION

Fig -1: Carbon canister and its working

Carbon Canisters square measure devices found in vehicles designed to decrease the quantity of pollution the vehicle creates whereas at an equivalent time increasing its fuel potency. Even once the vehicle's engine is turned off, hydrocarbons square measure made. This occurs within the style of fuel vapor rising within the fuel tank. Carbon Canisters trap that vapor rather than allow it to escape the fuel tank, feeding it back into the engine. Carbon Canisters are rectangular shaped boxes that sit apart from the fuel tank next to the throttle in most vehicles. There is an input port and an output port, with the two ports side by side. There square measure 3 chambers within the canister, running in sequence from the intake to the outtake. The interior of the canister is stuffed with charcoal or carbon pellets. The input of the canister connects to the gas tank's vent port, whereas the output connects to the purge valve within the facet of the vehicle's manifold.

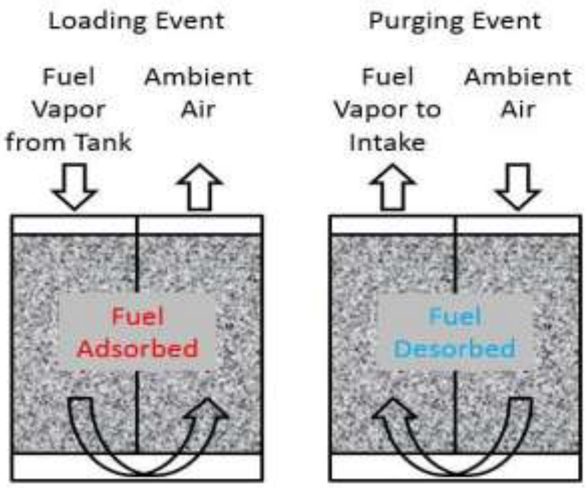

Fig -2: Loading and Purging event

When the vehicle is shut off, there's a pressure imbalance inside the fuel tank caused by fuel being siphoned out, however no air being let back in to require up the empty space. The lower pressure within the tank promotes a bigger rate of evaporation, lease a number of the fuel become a gas. Eventually the tank's internal pressure equalizes, at which point the gas leaves the tank through the vent port and goes into the carbon canister. It's unfree there by the properties of the carbon inside the canister, keeping it from escaping into the air. When the vehicle's engine starts, the sudden suction created along the intake manifold opens up the purge valve and pulls all the gaseous fuel out of the canister and burns it in the engine. The canister goes unused till the automobile is turned off once more.

3. TESTING THE FUEL TANK FOR LEAKS

The best means is to immerse it in water (just the highest of the tank) and blow within the priming tube to ascertain wherever the leaks square measure. If there are leaks do the following, as appropriate:

- **Cap Openings:** With a wide file, finish the tank openings until they are perfectly flat and smooth. A block of wood (so it's flat) with sandpaper may also be used.
- **Caps:** Be sure to check inside the caps carefully. I have discovered defects below the cap seal that caused leaks (see the pic below).
- **Tube Openings:** With brake cleaner or mineral spirits, thoroughly clean the tube inserts and their openings. Using RTV ("blue") from the machine elements store, LIGHTLY coat the inside of openings and the outside of the tubes and insert them into their respective openings. If you employ an excessive amount of RTV it would plug the openings/tubes that require to be clear, like the priming tube. Make sure the priming tube is lined up properly. Let things sit for every day so as to completely cure.
- Retest your tank for leaks. Make sure the priming tube is not restricted or blocked with RTV or bits of tank material. If it is, you'll be able to use a length of wire to clear it.
- Another way to discover leaks in the fuel system is to just fly the engine a dozen hours. Dust in the air will stick to the oil mixed in the fuel where the leaks are. There square measure typically multiple leaks within the same tank.

4. RTD SENSOR

Fig -3: Resistance Thermometer Sensor

Resistance thermometers, additionally referred to as resistance temperature detectors (RTDs), live} sensors want to measure temperature. Many RTD parts contains a length of fine wire wrapped around a ceramic or glass core however alternative constructions are used. The RTD wire may be a pure material, usually Pt, nickel, or copper. The material has associate degree correct resistance/temperature relationship that is employed to supply a sign of temperature. As RTD parts area unit fragile, they're typically housed in protecting probes. RTDs, that have higher accuracy and repeatability, area unit slowly commutation thermocouples in industrial applications below 600 °C.

Resistance thermometers area unit created during a range of forms and provide larger stability, accuracy and repeatability in some cases than thermocouples. While thermocouples use the See motion result to get a voltage, resistance thermometers use electrical phenomenon and need an influence supply to control. The resistance ideally varies nearly linearly with temperature per the Callendar-Van Dusen equation.

The Pt detective work wire must be unbroken freed from contamination to stay stable. A Pt wire or film is supported on a former in such some way that it gets negligible differential enlargement or alternative strains from its former, however in all fairness resistant to vibration. RTD assemblies made of iron or copper are utilized in some applications. Commercial Pt grades exhibit a temperature constant of resistance zero.00385/°C (0.385%/°C) (European basic Interval).[6] The sensing element is typically created to own a resistance of a hundred Ω at zero °C. This is outlined in BS nut 60751:1996 (taken from IEC 60751:1995).

4.1 Temperature

- If method temperatures area unit between −200 and five hundred °C (−328.0 and 932.0 °F), associate degree industrial RTD is that the most well-liked possibility. Thermocouples have a variety of −180 to two,320 °C (−292.0 to 4,208.0 °F),[8] therefore for temperatures on top of five hundred °C (932 °F) they're the sole contact temperature measuring device.

- **Response time:** If the method needs a really quick response to temperature changes (fractions of a second as opposition seconds), then a thermocouple junction is that the most suitable option. Time response is measured by immersing the sensing element in water moving at one m/s (3 ft/s) with a sixty-three.2% step amendment.

- **Size:** A standard RTD sheath is three.175 to 6.35 mm (0.1250 to 0.2500 in) in diameter; sheath diameters for thermocouples are often but one.6 mm (0.063 in).

- **Accuracy and stability requirements:** If a tolerance of two °C is suitable and also the highest level of repeatability isn't needed, a thermocouple junction can serve. RTDs area unit capable of upper accuracy and might maintain stability for several years, whereas thermocouples will drift among the primary few hours of use.

5. WIRING CONFIGURATIONS

5.1 Two-wire configuration

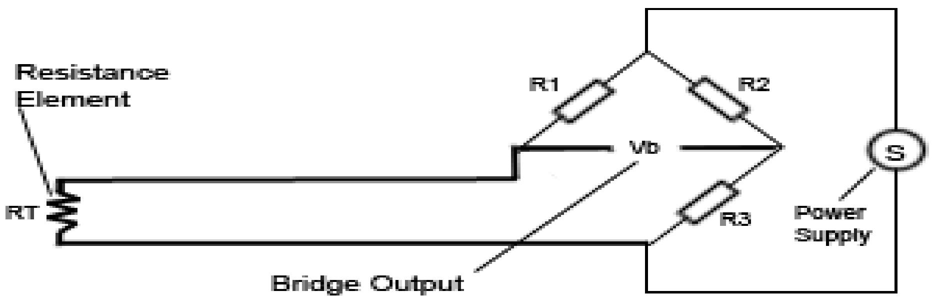

Fig -4: Two-wire configuration

The simplest resistance-thermometer configuration uses two wires. It is only used when high accuracy is not required, as the resistance of the connecting wires is added to that of the sensor, leading to errors of measurement. This configuration allows use of 100 meters of cable. This applies equally to balanced bridge and fixed bridge system. For a balanced bridge usual setting is with R2 = R1, and R3 round the middle of the vary of the RTD. So for instance, if we tend to measure between zero and a hundred °C (32 and 212 °F), RTD resistance can vary from a hundred Ω to 138.5 Ω. We would choose R1 = 120 Ω. In that method we tend to get a tiny low measured voltage within the bridge.

5.2 Three-wire configuration

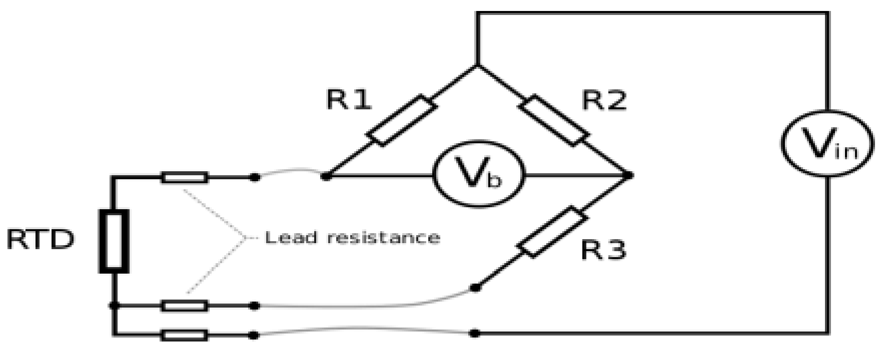

Fig -5: Three-wire configuration

In order to attenuate the results of the lead resistances, a three-wire configuration may be used. The recommended setting for the configuration shown, is with R1 = R2, and R3 round the middle of the vary of the RTD. Looking at the bridge circuit shown, the drop on the lower mitt aspect is V_rtd + V_lead, and on the lower mitt size is V_R3 + V_lead, so the bridge voltage (V_b) is that the distinction, V_rtd - V_R3. The drop because of the lead resistance has been off out. This continuously applies if R1=R2, and R1, R2 >> RTD, R3. R1 and R2 will serve the utilization of limiting this through the RTD, for instance for a PT100, limiting to 1mA, and 5V, would counsel a limiting resistance of approximately R1 = R2 = 5/0.001 = 5,000 Ohms.

5.3 Four-wire configuration

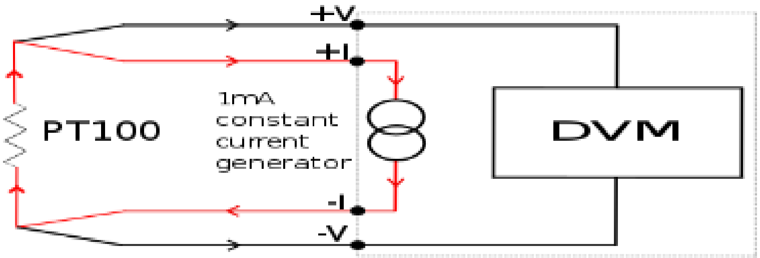

Fig -6: Four-wire configuration

The four-wire resistance configuration will increase the accuracy of activity of resistance. Four-terminal sensing eliminates dip within the activity leads as a contribution to error. To increase accuracy any, any residual electricity voltages generated by completely different wire varieties or screwed connections ar eliminated by reversal of the direction of the one mA current and the leads to the DVM (digital voltmeter). The electricity voltages are made in one direction solely. By averaging the reversed measurements, the electricity error voltages are off out.

6. CLASSIFICATIONS OF RTDS

The highest-accuracy of all PRTs square measure the quality atomic number 78 Resistance Thermometers (SPRTs). This accuracy is achieved at the expense of sturdiness and value. The SPRT parts square measure wound from reference-grade atomic number 78 wire. Internal lead wires square measure sometimes made up of atomic number 78, while internal supports are made from quartz or fused silica. The sheaths square measure sometimes made up of quartz or typically Inconel, depending on temperature range. Larger-diameter atomic number 78 wire is employed, which drives up the cost and results in a lower resistance for the probe (typically 25.5 Ω). SPRTs have a wide temperature range (−200 °C to 1000 °C) and are approximately accurate to ±0.001 °C over the temperature range. SPRTs are only appropriate for laboratory use.

7. TEMPERATURE CONTROLLER

As the name implies, a temperature controller - often called a PID controller is an instrument used to control temperature. The temperature controller takes associate degree input from a temperature detector device associate degreed has an output that's connected to a bearing element like a heater or fan.

To accurately management method temperature while not intensive operator involvement, a temperature control system relies upon a controller, which accepts a temperature sensor such as a thermocouple or RTD as input. It compares the particular temperature to the specified management temperature, or setpoint, associate degreed provides an output to a bearing component.

Fig -7: Temperature Controller

8. ON/OFF CONTROL

An on-off managemental is that the simplest sort of temperature control device. The output from the device is either on or off, with no middle state. An on-off controller can switch the output only the temperature crosses the setpoint. For heating management, the output is on when the temperature is below the setpoint, and off above setpoint. Since the temperature crosses the setpoint to alter the output state, the process temperature will be cycling continually, going from below setpoint to above, and back below. In cases wherever this sport happens speedily, and to prevent damage to contactors and valves, an on-off differential, or "hysteresis," is added to the controller operations. This differential need that the temperature exceed setpoint by an explicit quantity before the output can close up or on once more. On-off differential prevents the output from "chattering" or creating quick, continual switches if the cycling above and below the setpoint occurs very rapidly. On-off management is typically used wherever a particular management isn't necessary, in systems which cannot handle having the energy turned on and off frequently, where the mass of the system is thus nice that temperatures amendment extraordinarily slowly, or for a temperature alarm. One special kind of on-off management used for alarm may be a limit controller. This controller uses a latching relay, that should be manually reset, and is employed to close up a method once an explicit temperature is reached.

9. PROPORTIONAL CONTROL

Proportional managements square measure designed to eliminate the sport related to on-off control. A proportional controller decreases the common power provided to the heater because the temperature approaches setpoint. This has the result of fastness down the heater in order that it'll not overshoot the setpoint, however can approach the setpoint and maintain a stable temperature. This proportioning action are often accomplished by turning the output on and off for brief time intervals. This "time proportioning" varies the quantitative relation of "on" time to "off" time to manage the temperature. The proportioning action happens at intervals a "proportional band" round the setpoint temperature. Outside this band, the controller functions as associate on-off unit, with the output either totally on (below the band) or totally off (above the band). However, at intervals the band, the output is turned on and off within the quantitative relation of the measure distinction from the setpoint. At the setpoint (the point of the proportional band), the output on:off quantitative relation is 1:1; that's, the on-time and off-time square measure equal. If the temperature is clear of the setpoint, the on- and off-times vary in proportion to the temperature distinction. If the temperature is below setpoint, the output are on longer; if the temperature is simply too high, the output are off longer.

10. PID CONTROL

The third managementler kind provides proportional with integral and spinoff control, or PID. This managementler combines proportional control with 2 extra changes, that helps the unit mechanically complete changes within the system. These changes, integral and spinoff, square measure expressed in time-based units; they're conjointly brought up by their reciprocals, RESET and RATE, severally. The proportional, integral and spinoff terms should be severally adjusted or "tuned" to a specific system victimization trial and error. It provides the foremost correct and stable management of the 3 controller varieties, and is best employed in systems that have a comparatively tiny mass, those that react quickly to changes within the energy intercalary to the method. It is suggested in systems wherever the load changes typically and therefore the controller is predicted to compensate mechanically because of frequent changes in setpoint, the number of energy on the market, or the mass to be controlled. OMEGA offers variety of controllers that mechanically tune themselves. These are known as autotune controllers.

11. COATING OF FIBERS

Methods for monitoring wetting, adhesion and cleaning:

When coating natural and artificial fibers, wetting and adhesion to the surface further because the coating thickness area unit decisive factors for top product quality. Our measuring instruments are used in the quality control of fiber-coating processes in order to avoid air pockets and irregular or unstable coating.

Typical fiber-coating applications

- Pre-coating of carbon, glass and natural fibers for embedding in fiber-reinforced composites
- Hair dyeing and temporary coating to make combing easier
- Temporary protection of fibers before weaving (sizing)

- Water-repellent coating on technical textiles
- Coating on glass fibers to improve elasticity and breaking strength

12. WETTING AND ADHESION

The wetting and adhesion between fiber and coating result from the interaction of the 2 parts at the interface. A combination of strategies between contact angle activity for the fiber and activity of the physical phenomenon for the coating is thus ideal.

The wet ability of the fiber by the coating can be measured directly in the form of the contact angle between the components involved. If, on the opposite hand, fiber and coating liquid are investigated separately, the two products can be matched to one another. A rule of thumb says that the coating provides optimum wetting once its physical phenomenon is a smaller amount than the surface free energy of the solid.

The surface polarity of the 2 phases is additionally determined so as to calculate the adhesion within the sort of work of adhesion. The adhesion is stronger and has higher long-run stability a lot of similar the pro-rata polar forces of the 2 phases at the surface.

For uniform fibers like hair, carbon and glass fibers, we tend to advocate that the contact angle and surface free energy be determined employing a single-fiber torsiometer. With irregular fibers, it is advisable to use an optical contact angle measuring instrument with microscope lens and picolitre dosing.

The physical phenomenon of the liquid coating is set victimization the ring or plate methodology. Our tensiometers use this method of measurement with fully automatic or semiautomatic sequences.

12.1 Coating Thickness

Surfactants scale back the physical phenomenon within the coating tub. When a fibre moves through the bathtub quickly, the surface tension at the point of exit is higher, as fewer surfactant molecules remain on this newly formed surface. As a result of the distinction in tension, a force acts on the fibre, a process known as the Marangoni effect. This result is specifically wont to increase the coating thickness.

Surfactant molecule clusters (micelles) within the coating tub diminish the result, as molecules quickly migrate from the micelles to the new surface and scale back the physical phenomenon. The critical micelle concentration (CMC) of the surfactant can be measured precisely and fully automatically with our Force Torsiometer – K100 in order to guarantee the use of surfactant with the right concentration.

12.2 Coating Dynamics

Coating processes usually run at high speed. Our mobile severally stationary Bubble Pressure Torsiometers – BPT Mobile and BP100 do the suitable measurements of the dynamic physical phenomenon. These area unit capable of mensuration the worth of the physical phenomenon many milliseconds when a brand-new surface has been made and so realistically represent the method conditions.

12.3 Glass-reinforced plastic (fiberglass)

Glass-reinforced plastic (GRP) may be a material or fiber-reinforced plastic product of a plastic bolstered by fine glass fibers. Like graphite-reinforced plastic, the composite material is commonly referred to as fiberglass. The glass may be within the sort of a cut strand mat (CSM) or a plain-woven material.

As with several alternative composite materials (such as bolstered concrete), the two materials act together, each overcoming the deficits of the other. Whereas the plastic resins area unit sturdy in compressive loading and comparatively weak in durability, the glass fibers are very strong in tension but tend not to resist compression. By combining the 2 materials, GRP becomes a material that resists both compressive and tensile forces well. The two materials are also used uniformly or the glass is also specifically placed in those parts of the structure that may expertise tensile masses.

13. WORKING

13.1 Conduction test in steel tank

In empty fuel tank, how much the amount of heat is conducted in inner side and outer side of the fuel tank is to be measured. the conduction test in empty fuel tank is measured for about 30minutes. RTD sensor is placed inner side of the fuel tank which measures the inner temperature of the fuel tank. Another RTD sensor is placed outer side of the fuel tank which measures the outer temperature of the fuel tank. Temperature controller is connected to RTD sensor which displays inner and outer temperature range.

Inner RTD sensor connected with temperature controller. Displayed temperature range in the temperature controller is taken as initial temperature. The temperature reading is taken for 30 minutes time interval. For outer temperature range in the temperature controller is taken as same as previous procedure taken for inner temperature. The temperature reading is taken for 30 minutes time interval. The fuel level is measured another way which is taken by 5liter capacity of petrol cane. When the petrol is poured into the 5liter capacity cane we can analysis the amount fuel evaporates in the steel petrol tank. The RTD sensors which connected inside the steel petrol tank will show the inner temperature while taking the evaporation of petrol it shows every temperature between the time interval for evaporation test. With inner temperature reading we are able to measure the amount fuel evaporate for the particular temperature. The outer temperature and inner temperature will be various for interval of time the evaporation petrol depends on the amount of heat travels from outer surface of the petrol tank to inner side of the petrol tank.

Fig -8: Conduction test in steel tank(a)

Fig -9: Conduction test in steel tank(b)

13.2 Conduction and Convection test in fuel tank

Two litre petrol is filled in the petrol tank in order to measure the amount of evaporation in the fuel tank. When specific amount of heat radiated into the fuel tank, the temperature is measured through the controller where it is connected to RTD sensor. The amount of fuel is calculated by discharging into the beaker after the interval of time. This process is repeated up to the maximum interval of time. The temperature inside the fuel tank and the amount of petrol is evaporated in the fuel tank is also calculated. This process is taken for inner temperature of the fuel tank.

Fig -10: Conduction and Convection test in fuel tank

Following data shows the results obtained in the conduction test for steel tank

Sl. No	Tank type	Fuel tank capacity (Full/Usable Reserve)	Fuel Tank Material	Fuel level	Time (min)	Inside Temperature(°C)	Outside Temperature(°C)
1	Discover 125cc	9.5 Liters	Stainless steel	Empty	30	34	39
2	Discover 125cc	9.5 Liters	Stainless steel	empty	60	41	44
3	Discover 125cc	9.5 Liters	Stainless steel	Empty	90	48	53
4	Discover 125cc	9.5 Liters	Stainless steel	Empty	120	55	57
5	Discover 125cc	9.5 Liters	Stainless steel	Empty	150	58	61
6	Discover 125cc	9.5 Liters	Stainless steel	Empty	180	61	68

Fig -11: Conduction test for steel tank

Fig -12: Conduction test for steel tank(a)

Fig -13: Conduction test for steel tank(b)

Fig -14: Conduction test for steel tank(c)

- Initial temperature: 30(°C)
- Initial quantity of petrol: 2500ml
- Final quantity of petrol collected:2473ml

14. STAINLESS STEEL E202

Fig -15: Appearance of stainless steel E202

Mechanical properties are mentioned below,

Properties	Metric
Tensile strength	515 MPa
Yield strength	275 MPa
Elastic modulus	207 GPa
Poisson's ratio	0.27-0.30
Elongation at break	40%

Fig -16: Mechanical properties of stainless steel E202

Sl.No.	Vehicle Model	Fuel tank capacity (Full/Usable Reserve)	Fuel Tank Material	Fuel level	Time (min)	Inside Temperature(°C)
1	Steel tank	10litres	Stainless steel	2.5l	30	34(°C)
2	Steel tank	10litres	Stainless steel	2.5l	60	39(°C)
3	Steel tank	10litres	Stainless steel	2.5l	90	42(°C)
4	Steel tank	10litres	Stainless steel	2.5l	120	44(°C)
5	Steel tank	10litres	Stainless steel	2.5l	150	45(°C)
6	Steel tank	10litres	Stainless steel	2.5l	180	46(°C)

Fig -17: Conduction test for stainless steel

- Initial temperature:33(°C)
- Initial quantity of petrol: 2500ml
- Final quantity of petrol collected:2488ml

15. CAD MODEL

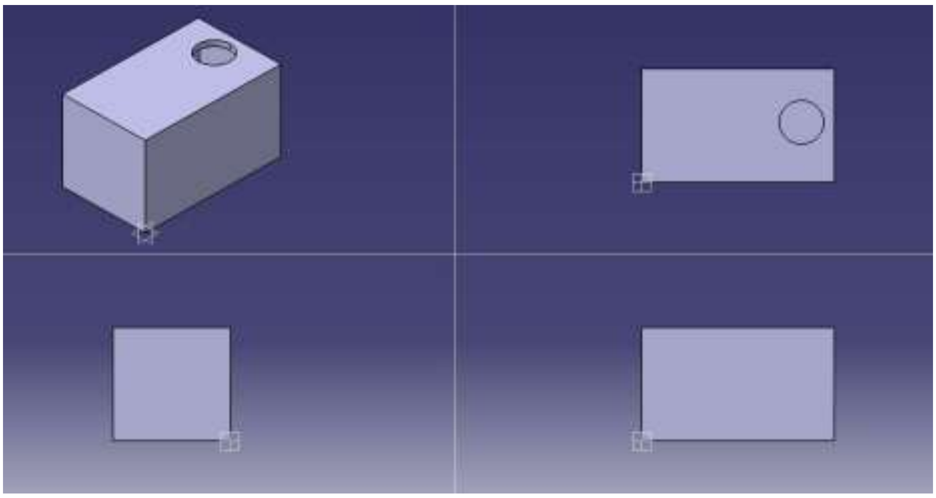

Fig -18: CAD model of fuel tank

16. CONCLUSION

The inner and outer temperature for both discover 125cc petrol tank and stainless steel are measured. When the heat travels from outer surface of the tank to inner surface of the tank, where we can measure the amount of fuel evaporated inside the tank. From the above tables the inner, outer temperature for both the tanks and also the amount of fuel to be evaporated are mentioned. From this project we have concluded that the weight of the petrol for discover tank and stainless-steel tank are much more differ for 5%. The another important one is that the amount of fuel evaporated in steel tank is 30% and for stainless steel is 10%. Here we can see the 20% difference between these two tanks. More loss of evaporation is occurred in steel tank when compared to stain less steel which are coated with the fibers. We concluded that the stainless steel with T glass fiber coating have more strength to withstand heat compared to steel tank.

17. REFERENCES

[1] https://www.finishing.com/502/26.shtm

[2] www.aalco.co.uk/datasheets/Stainless-Steel-201201L202204_97.ashx

[3] https://www.azom.com/article.aspx?ArticleID=6780

[4] www.ril.com

[5] www.jains.com/Pipefittings/hdpe pipe.html

[6] https://www.omega.com

[7] https://www.indiamart.com/proddetail/rtd-sensor-3957156988.html

[8] www.tempsens.com/rtds.html

[9] www.thermometricscorp.com/rtd.html