# Design and Testing UniKL MIAT CF 700 AFT Fan Turbofan Fuel Tank with Indicator

**Muhd Zulfadhli Muhd Zaimi, Muhammad SyahmiNazran, RoslanBasit**

***Abstract: This project is to describe designing and testing UniKL MIAT CF 700 Aft turbo fan fuel tank with indicator system. The original fuel tank engine tends to run out fuel in a short time of period when engine ground run is conducted. As an alternative to this problem, a new bigger design of the fuel tank will be design and will be tested with simulation to overcome this problem. The main objective is to design new bigger fuel tank with indicator and to test the design with the hydrostatic test in simulation program.***

***Keywords: UniKL MIAT CF 700, bigger fuel tank.***

## I. BACKGROUND

Gas turbine engine is crucial for the aircraft to fly. Hence, it is important for the technician and the engineer to maintain the engine to fly in accordance to the maintenance manual. The CF700 aft turbo fan engine that is owned by UniKL MIAT is for training purposes. The current fuel tank for the engine is relatively small and the engine trainer does not have any indicator to indicate how much fuel remaining in the tank. Usually after a short period of time when the trainer engine runs out of fuel during training it will disrupt the practical session[1]. Hence, the new design of a bigger fuel tank with an indication system would help the instructor to run the trainer engine for a longer duration and to observe the level of fuel left for the engine to run before fuel depletion. The scope of this study would be the designing of the new fuel tank and testing the fuel tank with fuel quantity indicator. When the new design is produced, later it will be test with simulation to determine the suitable material for the fuel engine tank and fuel quantity indicator. From the observation of the current fuel tank, the fuel tank is consumed by the engine is in large amount because of the small fuel tank and without any indication that supposed to be on the fuel tank. The expectation of this research is to design and to test the bigger fuel tank engine with fuel quantity indicator.

## II. METHODS

Begin with the sketching of the new fuel tank design with rough dimension earlier in 3.3.3 that stated the dimension of the new fuel tank which is 100cm (Length) x 60cm (Width) x 70cm (Heights). Then we initiate "CATIA" V5 program to start designing on the computer. Next, Under Mechanical Design option, select part design before start to sketch.

Under tool options, select parameter and measure to define the unit that would be use for designing. In this case, we will use Centimeter (CM) as a default unit for the sketching later. After that, rename the part design to the intended part that will be design. Then we start to design with select the sketch command as the starter and select the axis that we want to start the drawing. Then construct using line command and create a square box with the area surface of 100 cm x 60 cm.

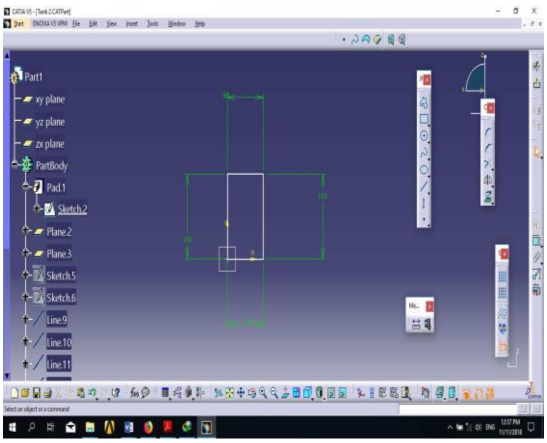

**Fig. 1 The sketch of the fuel tank design**

Next, we will exit the workbench, and use pad command to make the sketch into 3 Dimension object. The input that the pad command needed is 70 cm to define the height of the fuel tank.

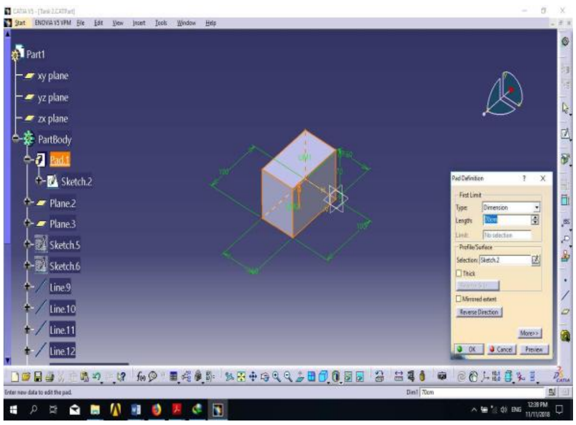

**Fig. 2 The pad definition of the fuel tank design**

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After that, Select plane definition from the original axis. Then, select sketch plane and construct a box design again. Constraint the side of the box from the original geometry. Then, use plane definition and use the previous plane as the reference distance.

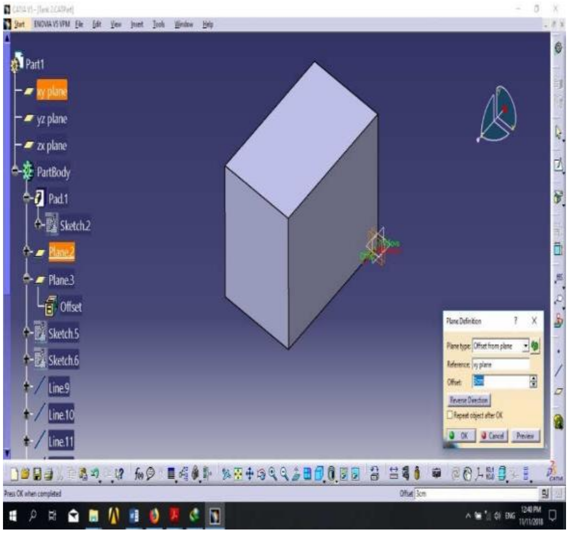

**Fig. 3 The plane definition**

Select new plane axis and coincidence each side of the line from the previous box. Next, select axis sketch command and choose the point definition Then, select each edge of the box to construct the point repeatedly. Open line command and connect all the previous point connected in edge of the box. Open multi section solid removal and select the previous both planes. Choose the upper surface.

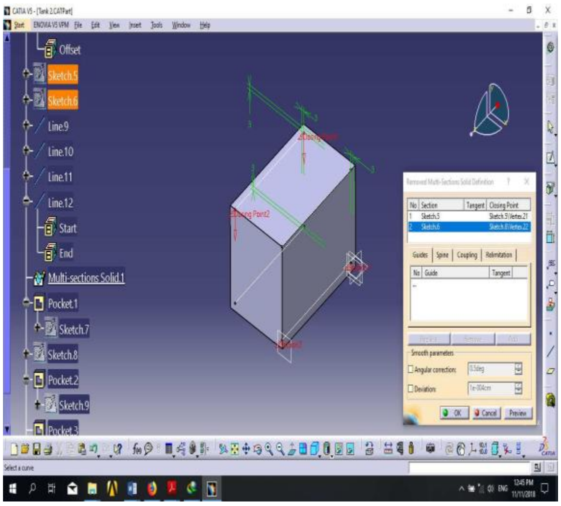

**Fig. 4 The multi section solid definition**

Select the sketch command, construct a hole with the diameter 3 cm. Constraint it with 12 cm away from the length and 13 cm from the width to get a centreline for the hole. Exit workbench, then use pocket command and set the input is 3cm. Then, select the same surface. Define the constraint from the previous axis of the circle and the distance of the circle is 2.25 cm from another 3 cm circle. Then, select command circular pattern and set the complete crown, with diameter of 0.4 cm and select axis at the circle of 3 cm.

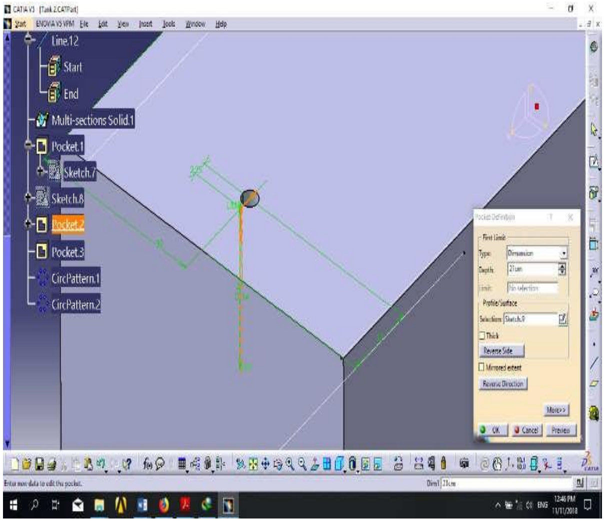

**Fig. 5 The pocket command definition**

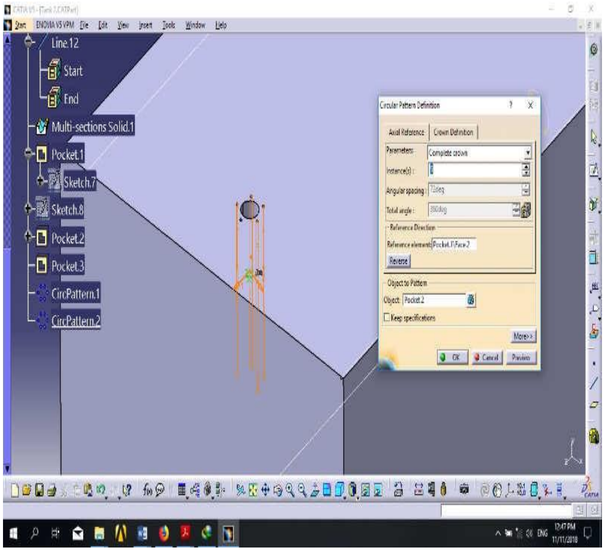

**Fig. 6 The complete crown definition**

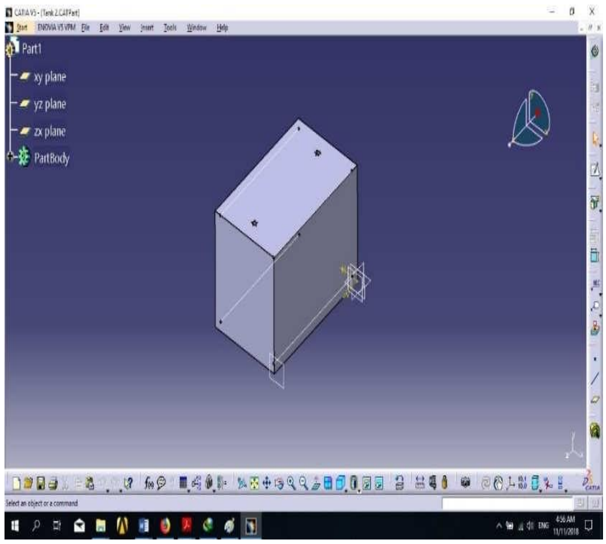

**Fig. 7 The finish product of the fuel tanktime**

## III. RESULTS

Hence, the data that I have based on the log book itself are:

**Table. 1 The engine CF 700's log book data**

| Date | Detail | Time Operations (Hour) |
|---|---|---|
| 17/8/2017 | Performed ground operation run test. Normal start and Normal engine parameters, No defects | 0.30 |
| 17/8/2017 | Performed ground operation run with instrument for training, during start cycle, fluctuation in indication system was noted. Due to GPU failure. A voltage fluctuates caused fuel flow indication needle to fluctuate and deflect very sharp. Fuel flow indication is connection in operation. | 0.30 |
| 17/8/2017 | Performed additional run up operation with instructor, all systems check. The system is operation satisfactory | 0.30 |
| | **1.30** | |
| 6/9/2017 | Oil state: Slightly above add 3 quarts.<br>Uplifted 2 quarts of turbo 2380 engine oil.<br>The engine ground run carried<br>out found satisfactory | 0.20 |
| 26/9/2017 | Weekly engine ground run carried out found satisfactory. | 0.30 |
| 11/10/2017 | Oil state:<br>FullEngineground run carried out found satisfactory | 0.20 |
| 16/11/2017 | Oil state:<br>FullEngineground run carried out found satisfactory | 0.15 |
| | **2.55** | |
| 21/11/2017 | Engine ground run carried out found satisfactory. Oil state: Full | 0.15 |
| 23/11/2017 | Engine ground run carried out found satisfactory. Oil state: Full | 0.20 |
| 8/2/2018 | Engine ground run carried out found high idle rpm 56%. Idle adjustment to 33 counter clockwise turns. Now idle rpm is approximately 51%. Engine needs further adjustment and rigging. Oil state after run: Full | 0.15 |
| | **3.45** | |
| 15/5/2018 | Engine ground run carried out found satisfactory.<br>Oil State: Slightly above, Add 1 quarts | 0.15 |
| 29/5/2018 | Engine ground run carried out found satisfactory.<br>Oil State: Slightly above, Add 1 quarts | 0.10 |
| 26/6/2018 | Replenished ¼ quarts of turbo 2380 engine oil.<br>Engine ground run carried out found satisfactory. | 0.20 |
| | **4.45** | |

From the data gather above, roughly the fuel tank could withstand about 15 minutes to 20 minutes before the engine run out the fuel. This problem would interrupt the training session and it is takes time to refuel the fuel engine. From this observation, it is necessary to design a new fuel tank engine.

**The new fuel tank design assembly**

After going through the design drawing in chapter methodology, the parts that had been design will undergo the assembly process where the part design will be combining to make it one product which is the indicator system.

In the figure below is the top view cross sectional area.

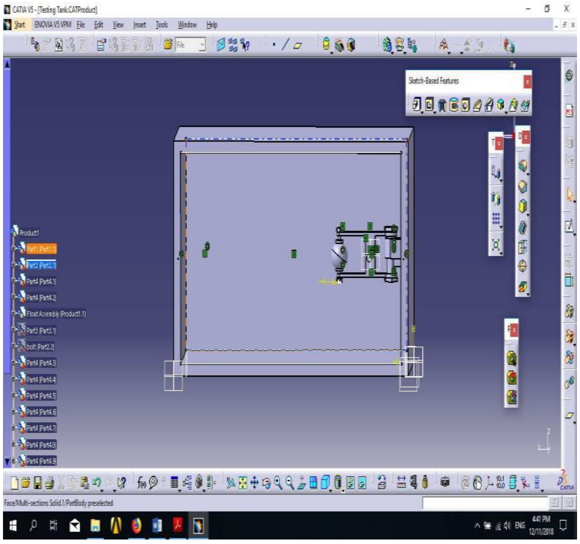

**Fig. 8 The open top view of the fuel tank**

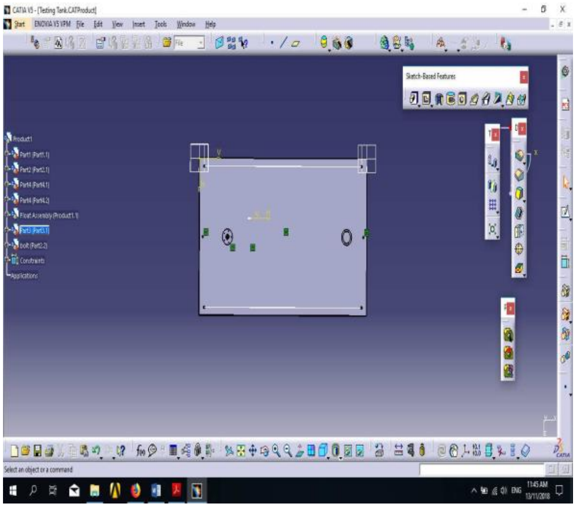

**Fig. 9 The close top view of the fuel tank**

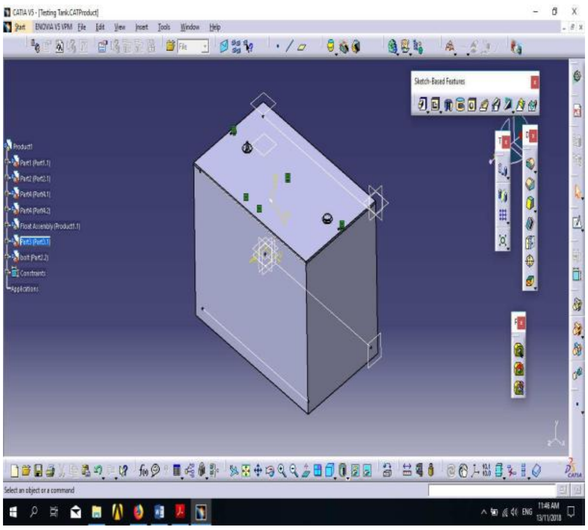

**Fig. 10 The isometric view of the fuel tank**

**The indicator design assembly**

Later before the fuel tank is completed, the fuel tank has indicator system the parts that had been design will undergo the assembly process where the part design will be combining to make it one product which is the indicator system.

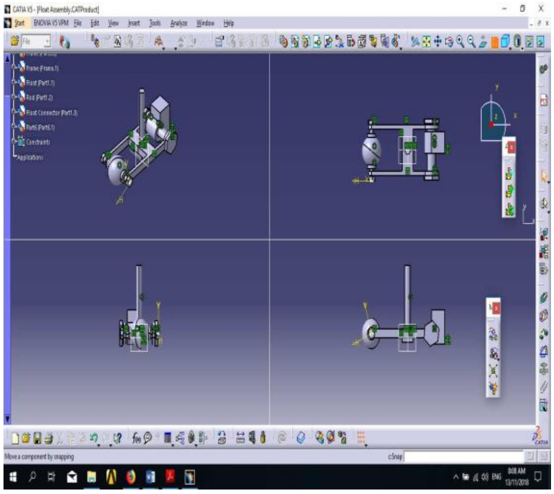

**Fig. 11 The orthographic view of the float indicator design**

**The design of the new fuel tank test**

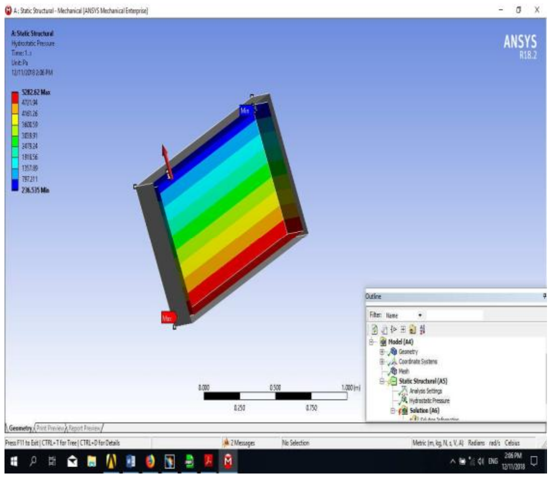

**Fig. 12 The hydrostatic pressure test new fuel tank design**

On the figure above shows a serial of color that indicates the level of pressure that act on the fuel tank. These colors are staged blue to red to shows which red is most effected by the pressure where else the blue is most less effected by the pressure on the fuel tank.

**Table. 2 The original fuel tank test**

| Pressure (Pa) |
|---|
| 5286.20 (MAX) |
| 4721.94 |
| 4161.26 |
| 3600.29 |
| 3039.91 |
| 1918.56 |
| 1357.89 |
| 797.21 |
| 236.535 (MIN) |

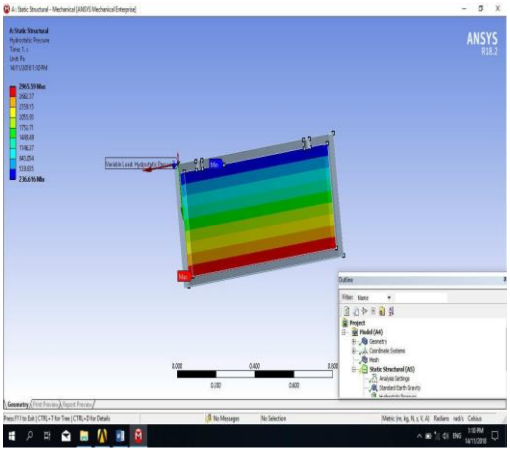

**Fig. 13 The hydrostatic pressure test on the original fuel tank**

On the figure above shows a serial of color that indicates the level of pressure that act on the fuel tank. These colors are staged blue to red to shows which red is most effected by the pressure where else the blue is most less effected by the pressure on the fuel tank.

**Table. 3 The original fuel tank test**

| Pressure (Pa) |
|---|
| 2965.59 (MAX) |
| 2662.37 |
| 2359.15 |
| 2055.93 |
| 1752.71 |
| 1449.49 |
| 1146.27 |
| 539.835 |
| 236.616 (MIN) |

Based on the table on 4.2.1 and 4.2.2 shows that the value of the pressure that exerted at the equilibrium state at the given point due to the force of gravity. Hydrostatic pressure increases in proportion to the depth measure from the surface because of the increasing weight of fluid exerting downward force from the above. Hence, below shows the comparison of the pressure between the new fuel tank design and the old tank design.

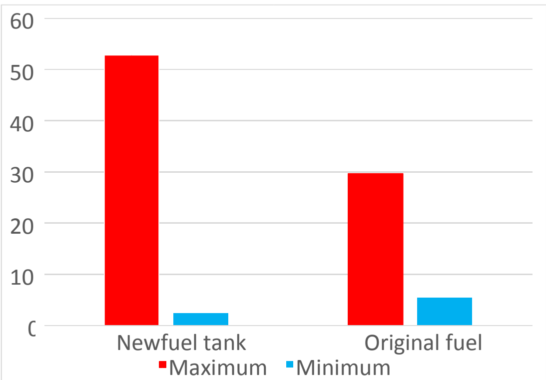


**Fig. 14 The comparison of the pressure between new fuel tank design and the original fuel tank design**

From the chart above stated that the maximum pressure value of the new fuel tank design is 5286.20 Pa which is greater from the original fuel tank design which is 2965.59 Pa. This shows that the bigger of the fuel tank, the bigger pressure that the fuel tank can accommodate.

**The factor of safety**

Apart from the design and the testing of the fuel tank, the are other consideration to take care after the design the new fuel tank. The material that use for the testing is AISI 1008 Low carbon steel. Here are the mechanical properties of the AISI 1008 Low carbon steel.

**Table. 4 Mechanical Properties of AISI 1008 Low Carbon Steel**

| **Mechanical Properties** | **Metric** |
|---|---|
| Hardness, Brinell | 95 |
| Hardness, Knoop (Converted from Brinell hardness) Hardness, Rockwell B (Converted from Brinell hardness) | 145 |
| Hardness, Vickers (Converted from Brinell hardness) | 131 |
| Tensile Strength, Ultimate | 340 MPa |
| Tensile Strength, Yield | 285 MPa |
| Elongation at Break (In 50 mm) | 20.0% |
| Reduction of Area | 45.0% |
| Modulus of Elasticity (Typical for steel) | 190-210GPa |
| Bulk Modulus (Typical for steel) | 140 GPa |
| Poisson's Ratio (Typical for Steel) | 0.27-0.30 |
| Machinability (Based on AISI 1212 steel. as 100% machinability) | 55 |
| Shear Modulus (Typical for steel) | 80.0 GPa |

From the table about that we can say that the Tensile strength of the material AISI 1008 Low carbon steel has excellent welding properties which is earlier later to fabricate. This metal offers a good balance of toughness, strength and ductility.

Hence, a calculation of the Factor of safety for the fuel tank design based on the maximum pressure we get on the testing.

**= 1.5**

**= 5286.20 × 1.5 = 7929.3**

***h*** **= 340 = 340,000**

Hence from the value above that we get, we can relate to the type of material that we use for the fuel tank. The metal that we use is AISI 1008 Low carbon steel. Based on the AISI 1008 Low carbon steel tensile Strength which is 340 MPa, we could say that the factor of safety is 7929.3 Pa. Hence, the tensile strength of the metal is strong enough to withstand the pressure inside the fuel tank, so the fuel tank does not deform after the pressure has been applied.


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## IV. CONCLUSIONS

In my conclusion, what I can conclude is from the analysis the material that I use for testing is safe for fuel tank fabrication in the future. This is proven by the calculation of the factor of the safety. The design of the new fuel tank is tested in simulation to find the maximum pressure inside the fuel tank itself. The design that have been created is about 5 times bigger in volume than the original fuel tank.

For the recommendation and the future work of this research projects, it is highly recommended that designing and analysis can be adapted for other aircraft parts or even social science domains of aviation[2-21]. The students can use the design that have been provided for the fabrication of the fuel tank[22]. Other than that, the students could fabricate the fuel tank and fuel indication system as their base project for their final year project. Besides that, the students could use the design as their references for future use. The students also could fabricate the fuel tank with the mobility.

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