International Journal of Scientific & Engineering Research, Volume 5, Issue 12, December-2014
ISSN 2229-5518

ADVANCEMENTS IN JET ENGINES

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Jet engines are the one of the engines used in aeroplane or aircrafts. In starting jet engines were of high weights and that produces low thrust.Nowdays there are various types of jet engines are available. The jet engines can be made more efficient by using ceramic composite materials that weighs far less than metal alloys that they will replace. The major advantage of this type of jet engine that they can be operated for higher temperature, nearly 1400k in combustion chamber. This engine will reduce 15% of fuel that was consumed earlier and significantly reduces carbon emission from the engine. This engine can save nearly $1 million per year per aeroplane.

There are two main types of jet engines for aviation; 1-low bypass turbofan (consider to be turbojet) and high bypass ratio turbofan. Both the engines are working well presently, but their fuel consumption could be reduced and thrust could be increased. For this an engine is taken in which high pressure core exhaust and the low pressure bypass stream of a convectional turbofan are joined by a third outer flow path that can be opened and closed in response to flight conditions. For take-off ,the third stream is closed off to reduce the bypass ratio this will send more airflow to high pressure core to increase thrust and during cruise conditions the third bypass system is opened to increase bypass ratio and reduce the fuel consumption it will reduce nearly25% of fuel consumption.

Introduction

In present age we need a jet engine which should have high fuel efficiency and low weight. The weight of the engine is mainly reduced by using carbon composite materials. The recent advancement in jet engines the improving its combustion conditions. One of the jet engine is developed by developing ionic thrusters.there are many advancements in ramjet based on their fuel injector methods. The engines can be made which have lower emission of carbon and NOx products. The engine would have greater fuel efficiency than the previous one and it would be compatible.

KEYWORDS:

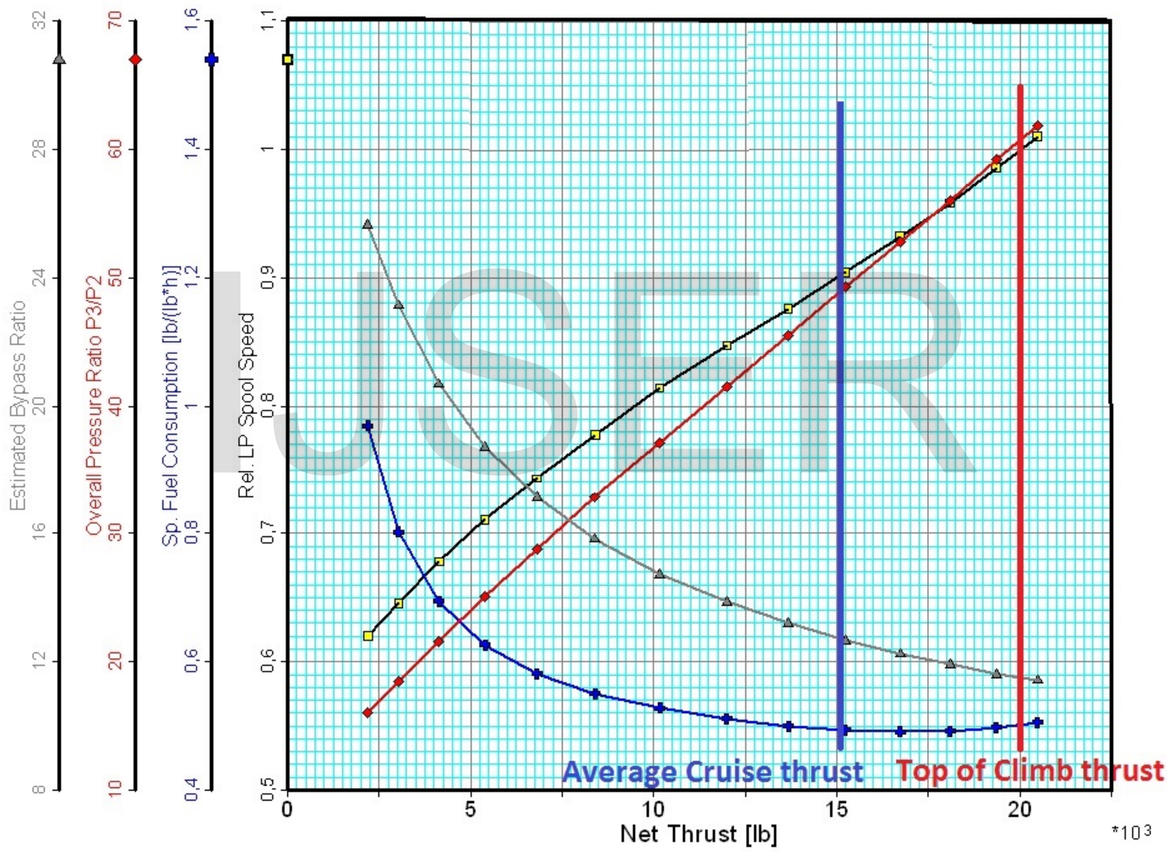
LEAP Engines, Bypass ratio, Turbofan Engine, Fuel to air Ratio, Fan Blades.

EFFICIENT TUROFAN ENGINE:

This engine is made of higher stiffness carbon fibre and new epoxy resin. The leading edge material is being modified from titanium to a steel alloy to further enhance the blade’s strength. These carbon composite materials has strength as our current composite fan blades.it has fewer, thinner blades it will enhance the airflow and makes for a lighter and more efficient fan that will help with the engine's performance and fuel burn.

The fan blades are the fourth generation composite fan blade design ,that will incorporate improved aerodynamics .this engine would have max thrust of 100,000 lbs.it has 133 inch diameter composite fan and 16 composite fan blades .it would have next generation 27/1 pressure ratio and it have 11 stage high pressure compressor ,a third generation TAPS(twin annular pre swirl) combustor for greater for greater efficiency and low emissions and matrix composite (CMC) material in combustor and turbine. It most efficient turbofan engine till now.

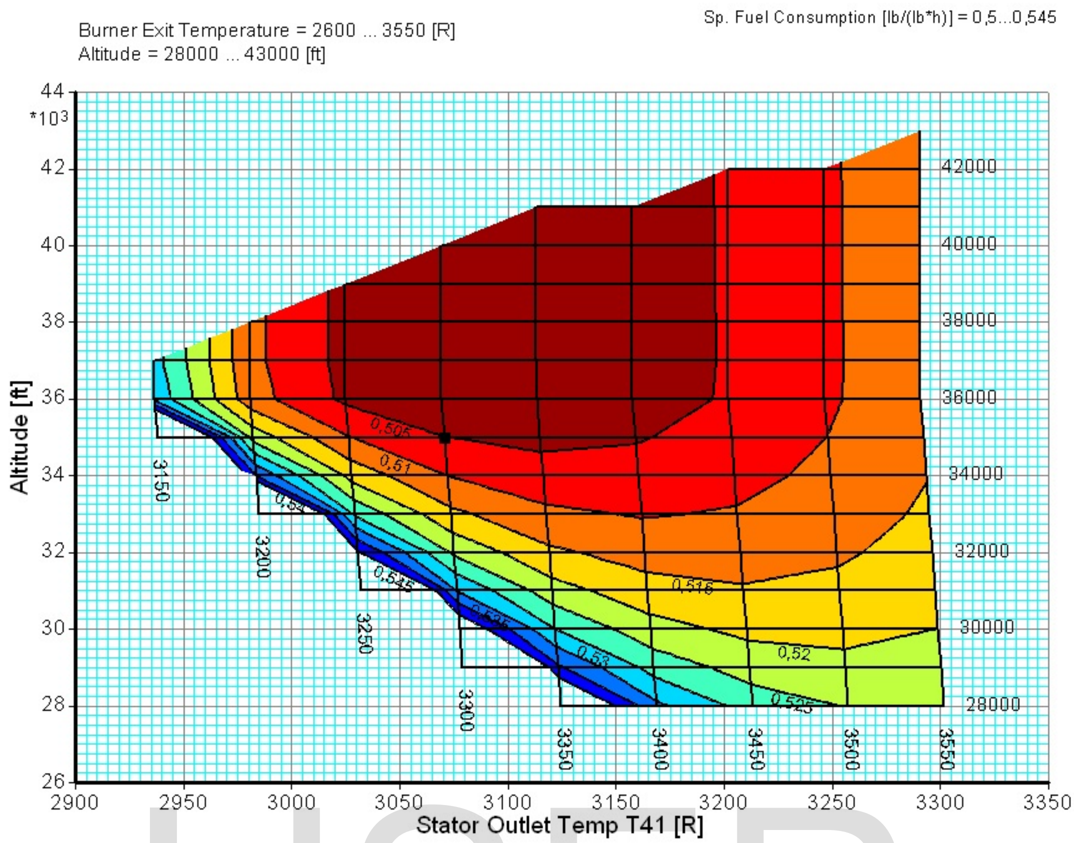
I has 10% better SFC than previous one.it has 5% better SFC than any other twin-aisle engine. This is quietest engine ever produced turbofan engine .It has the lowest NOx engine emissions than any turbofan.



SOME COMMON CHARECTERSTICS OF THIS ENGINE:

Altitude(ft.)	Mach no	Net thrust(lb.)	SFC	Bypass ratio	Overall pressure ratio p3/p2	L.P.T Inlet temperature(c)	Engine mass flow	Propulsive efficiency	Core efficiency

							rate		
33000	0.85	21936	0.50	11.5	61	929	1623	.79	0.61
37000	0.85	15000	0.49 0	12.3	52	825	1295	0.82	0.60



Bypass ratio of all bypass engines varies as the engines are throttled and moves from thicker to thinner air. It is the value for the engine and it stays the same, nothing could be falser, it varies all the time. Even the value they give us is given a bit arbitrarily, they can give us the value for Top of Climb i.e. the point where the engine is the most stressed aerodynamically or the value for max Take-off thrust at standing still at sea level (Static SLL) where the engine is working he hardens from a mechanical point of view. The lighter load on the engine the higher bypass ratio and vice versa. Look at the engine throttle diagram in the graph, the bypass goes from 11.5 at max thrust to 25 at min thrust at M0.85 and 33000 feet. Thrust 53000-74000 lbf

Bypass ratio 10-11

Inlet mass flow 2400-2670 lbm/sec.

Most derated engine (and therefore lowest price and longest on wing life because it spins the slowest and has the lowest temps) 53000 lbf, bypass 11 and mass flow 2400 lbm/sec, hence then 74000/10/2670 for the top version. All these values are probably. The pressure ratio of 50 has nothing to do with any of these values; it is the highest value they achieve for the 74000 lbf engine at Top of Climb, the T1000 pressure ratio at TO is around 40-43, 40 for the 54klbf and 43 for the top engine. The same goes for when they give you their fuel efficiency, which they very very seldom reveal other than a fussy X% better than some old engine. Now the big question is at what flight regime and from what version of the old engine, is it installed in the nacelle .As we can see above the TSFC varies between 0.3 at sea level and Take-off power up to almost 0.6 when climbing and then settles down to 0.49 at the coldest/densest flight level of around FL380, this is all uninstalled.

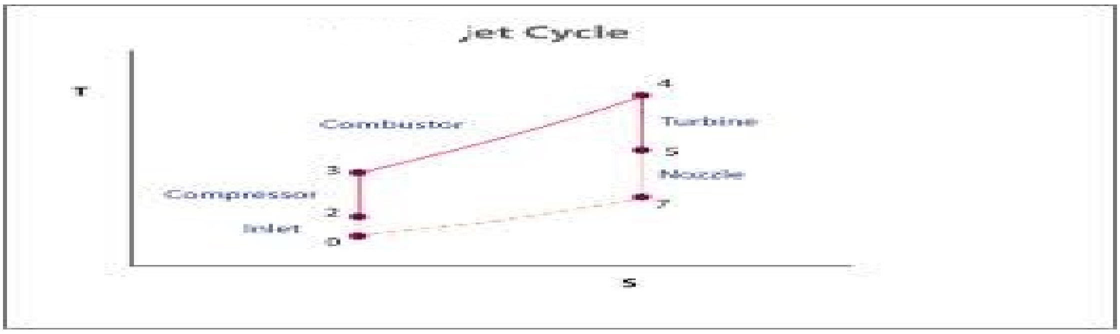
Leap Engines

The leap engines (Leading Edge Aviation Propulsion) are one of the advanced jet engines.i.e turbofan. We can use the three dimensional woven resin transfer moulding (3d-DWRTM) that dramatically reduces the engine's weight, while providing a more durable blade .This ultra-light weight material will support the higher temperatures, found in the high-pressure that provides thermal efficiency. This high temp capability is paired with state of art cooling and coating technology to keep the temperature profile of the metal in control.

The ceramics will decrease the amount of energy to cool off the engine parts. In current engine they operate at temp above the melting point of nickel metal alloy, used in chamber .to keep them from melting engine uses secondary air to cool these parts and keep the engine safe. But in leap engine this secondary air is not needed to cool the parts rather it can be used for generating extra thrust. IN this the ceramic matrix composites will replace only some of the parts .Further reducing losses that would allow engine to run at higher possible speed to get more thrust from a given amount of fuel, It would make engine lighter.

Fuel;

This engine would improve fuel efficiency by 15% over the current engines .leap's high bypass architecture, debris rejection system, light weight composite fan blades and advanced 3D air foil, they will give high compressor and turbine efficiency .emission of CO2 and NOx is reduced .It delivers 15% lower CO2 and 50% lower NOx engine and 40% reduction in noise foot prints vs. today's aircraft having turbofan engine.it has high bypass ratio.



Compressor eff, =TO3 ((po4/po3)0.2857-1)/TO4-TO3, AT PO4/PO3=0.9176, TO3=382.3 K, TO4=744.3K,

Since the engine made of carbon composite materials we can take higher value of TO4 as engine can withstand for higher value of TO5 ,Eff compressor $1/TO4-TO3,as T04 increases compressor efficiency increases ,we can get high compressor efficiency from this engine.

Fuel-air ratio (f) =Mf/Ma=(1-b)(Cph*TO5-Cpc*TO4)/(Nb*Q-Cph*TO5), At TO5=1559k,TO4=774K, f=0.0244(1-b) (case 1)

From energy relation;

Cph (1+f-b)(T05-T06)=Cpc(TO3b-T03)+Cpc(1-b)(TO4-T03b)

1.147(1+0.0244-1.0244b)*380=1.005(165.7+226-226b)

b=o.2406, from case 1 f=0.0185

Case 2, where TO5=1600K, T04=780'

1.147(1.0254-1.0254b)*421=393.65-227.13b

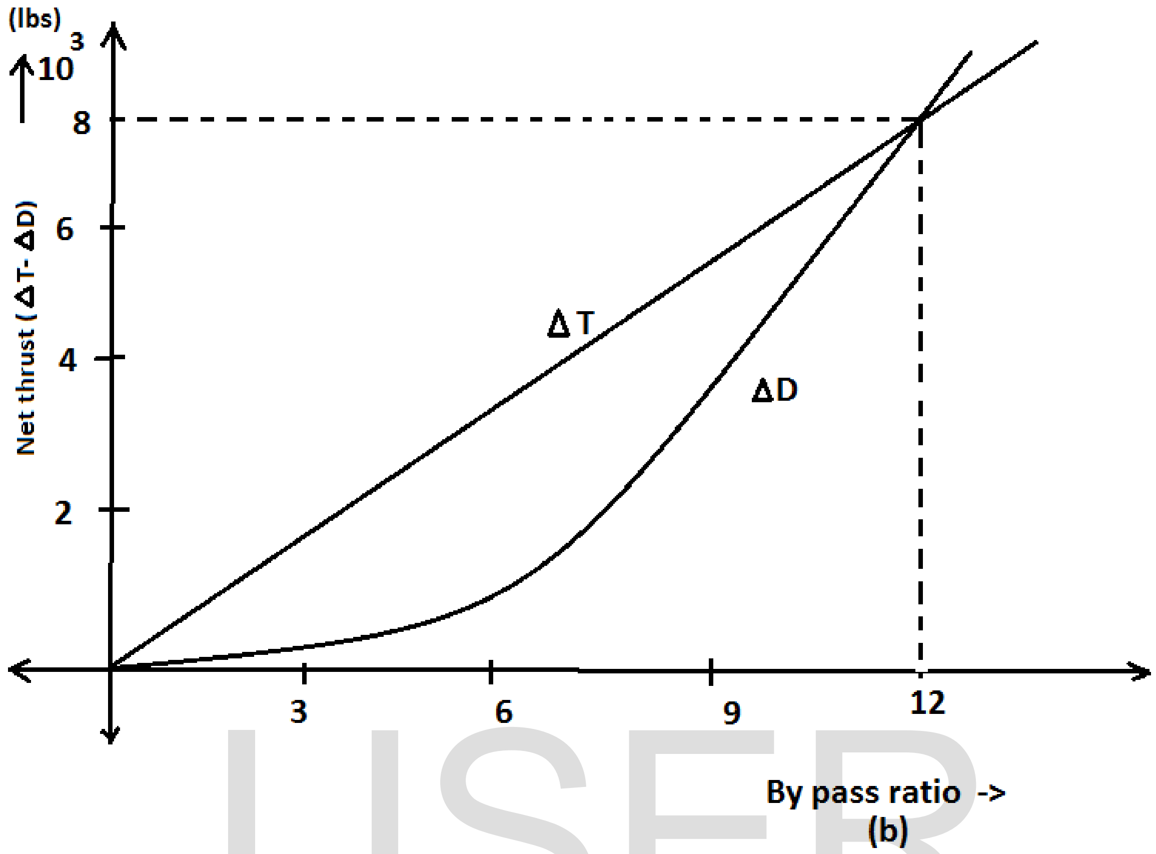
b=0.3787,   f=0.0244(1-b) =0.0244(1-0.3787)

f=0.0157

The mass of fuel used in case 2 is less than compared to case 1,so by this engine which is able to withstand higher value of TO4 and TO5 we will get higher fuel efficiency

Abbreviation	SFC	LPT	b	Ma	Mf	Cph	Cpc	T	D
Full name	Specific fuel consumption	Lower power turbine	Bypass ratio	Mass flow rate of air	Mass flow rate of fuel	Constant pressure co-efficient for hot gases	Constant pressure co-efficient for cold air	Thrust	Drag

Secondly, the engine is made of carbon composites the bleed air (b) which is used for



cooling the parts can be used for generating extra thrust. The net thrust of the engine can be varied by variation in bypass ratio, from the above graph it could be seen that for high bypass ratio the value of thrust is high.i.e at bypass ratio (b) 11 the net thrust is 8*10000 lbs.

Conclusion:

By the various advancements in jet engines. The aircraft would have better engine as compared to present engines. The improvement in fuel efficiency of the modern engine will improve the performance of the engine. Due to advancements the other parameters such as thrust produced by the engine will also increase .these engines will helpful in saving fuel which is non-renewable resource and emission of NOx and CO2 products is being reduced by improvement in technology, so these engines would damage the environment till little extent only. The engines of light weights will to reduce the weight of the aircraft. The working conditions of engines would also be improved and stability of engine will increase .The engines produced will be highly stable and fuel efficient.

ACKNOWLEDGEMENT

Mr Basab Adhyapak, B.Tech, for unwavering guidance, helping and spending his precious time, editing our abstract and paper presentation.
I (Krishna Mohan Singh) deeply acknowledge the encouraging words and support. I would like to express to express my deep gratitude to professor Mr, Vinayak Malhotra and professor Mr, Sarvanan for their patient guidance .and useful critics for this research work.
Finally, I wish to thank my parents for their support and encouragement throughout my study.

REFRENCES

1- AERO0015-1 - MECHANICAL DESIGN OF TURBOMACHINERY pp. 1-54

2- **Robert Schafrik , Materials in Jet Engines: Past, Present, and Future pp. 26-63**

3- Ahmed F.El-Sayed,Aircraft Propulsion and Gas Turbine Engines ,chapter 2 and chapter 5

4- Bhaskar Roy ,Aircraft Propulsion Science of making thrust to fly, chapter 1

5- Kumar P. Bharani Chandra, Nitin K. Gupta, Narayan Ananthkrishnan, Ik Soo Park, and Hyun Gull Yoon. "Modelling, Simulation, and Controller Design for an Air-breathing propulsion System", Journal of Propulsion and Power, Vol. 26, No. 3 (2010), pp. 562-574.