

الآية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿ وَاضْرِبْ لَهُمْ مَثَلَ الْحَيَاةِ الدُّنْيَا كَمَا أَنْزَلْنَاهُ مِنَ السَّمَاءِ
فَاخْتَلَطَ بِهِ نَبَاتُ الْأَرْضِ فَأَصْبَحَ هَشِيمًا تَذْرُوهُ الرِّيَّاحُ ۚ وَكَانَ
اللَّهُ عَلَى كُلِّ شَيْءٍ مُقْتَدِرًا ﴾

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

الكهف الآية ﴿٤٥﴾

الإهداء

نهدي العمل لأبائنا وأمهاتنا

للأستاذة بقسم هندسة الطيران

إلى كل من علمنا حرفاً



شكر و تقدير



أولاً نشكر عز و جل الذي سخر لنا هذا العمل بفضله ومنه ، و أيضا الشكر موصول للأستاذ الفاتح مكي معروف الذي أشرف على هذا العمل بدعمه و نصائحه المتواصلة وعلى معاملته الكريمة ، و أيضا الشكر إلي كل من ساهم برأيه في إخراج هذا العمل من زملائنا بالدفعة ١٣ طيران ، وكل الشكر مع خالص الحب لأسرنا الكريمة و هي ترعى و تدعم بصبر بالغ ، سائلين الله عز و جل أن يجزيهم جميعهم خيراً و يجعل ذلك في ميزان حسناتهم والله والموفق



List of contents:

- الآية
- الإهداء
- الشكر و التقدير
- List of contents
- List of figures
- List of Tables
- List of Symbols
- Abbreviations
- Chapter one : Introduction
- Chapter Two : literature review
- Chapter three : The silent aircraft concept
- Chapter four: Review of the technologies for silent propulsion system
- Chapter five:Technologies optimisation(silent takeoff optimisation)
- Chapter six : Conclusion and recommendation

List of figures:

List of figures	Page No.
Chapter One : Introduction	
1.1 Background	1
1.2 Objectives of the project	2
1.3 Methodology	3
1.4 Project outlines	4
Chapter Two : Literature review	
2.1 Aviation and the Environment`	5
2.2 Basics of Sound	6
2.3 Noise Effects	7

2.4 Aircraft noise sources	7
2.5 histories in jet noise reduction work	12
Chapter Three : Silent Aircraft	
3.1 Silent Aircraft Concept	13
3.1.1 Aerodynamically smooth lifting surface	13
3.1.2 Hidden Trailing Edge	14
3.1.3 Ultra-high by-pass ratio turbofan engines	14
3.1.4 Distributed propulsion system Embedded In the Airframe	15
3.1.5 Power Assisted lift	15
3.1.6 Silent drag – wind milling Engine air-brake	16
3.1.7 Silent spoiler	16

Chapter four : Review of the technologies for silent propulsion system	
4.1 The Concept of Ultra high bypass ratio engine with variable area nozzle and noise reduction	17
4.1.1 Introduction	18
4.1.2 Influence of fan pressure ratio and bypass ratio on jet noise emissions and cycle performance	18
4.1.3 Cycle limits and trends in jet noise emissions and cycle performance for separate flow exhaust nozzle	19
4.1.4 Cycle limits and trends in jet noise emissions and cycle performance for mixed flow exhaust nozzles	20
4.1.5 Influence of engine technology level on noise reduction potential	21
4.1.6 Variable area nozzle	24
4.1.7 Nozzle design	24
4.1.8 Variable area nozzle performance	25
4.1.9 Conclusion	27

4.2.1 Distributed propulsion system with high aspect ratio nozzle: concepts	28
4.2.2 Introduction	29
4.2.3 Embedded propulsion system layout	29
4.2.4 Embodiment of ultra high bypass ratio engines in a blended wing body Airframe	30
4.2.6 Multiple small engines	33
4.2.7 Multiple fans driven by a common core engine	33
4.2.8 Evaluation of multiple fan \ engine propulsion system	35
4.2.9 Noise signature of multiple fans	37
4.2.10 Conclusion	37
4.3 High Aspect ratio nozzle	37
4.3.1 Nozzle performance	39
4.3.2 High aspect ratio nozzle and noise reduction	40

Chapter Five : Technologies optimization (Cases study)	
5.1 Introduction	42
5.2 Jet noise	42
5.3 Case study	45
5.3.1 Influence of fan pressure ratio and bypass ratio on jet velocity and jet noise emissions	45
5.3.2 Conclusion	50
5.4 Case study	51
5.4.1 Influence of high aspect ratio nozzle on jet noise emissions	51
5.4.2 Conclusion	56
Chapter six : Conclusion and recommendations	
6.1 Conclusion	57
6.2 Suggestions and recommendations	58

List of Tables:

List of tables		Page No.
Table (4.1)	Cycle Parameters of the Trent 500 engine and advanced engine technology (for baseline blended –wing-body suggested in lie beck et al. (1996)	20
Table (4.2)	Cycle Configuration leading to jet noise reduction 30 EPNL (dB)	23
Table(4.3)	the total area requirement for ultra high bypass ratio cycle and airframe dimensions at the corresponding location.	31
Table (4.4)	Comparison of propulsion system configurations A, B and D 1__4.	35
Table (4.5)	high aspect ratio nozzle performance	39
Table (4.6)	Preliminary distributed propulsion system configurations to enable a functionally-silent aircraft	41

Table (5.1)	Table (5.1) Cycle Parameters of the Trent 500 engine	46
Table (5.2)	The effect of fan pressure ratio and jet velocity on jet noise emissions	48
Table (5.3)	The effect of jet velocity on jet noise emissions from high aspect ratio nozzle	53
Table (5.4)	The effect of the jet area and the jet temperature on jet noise emissions from high aspect ratio nozzle	54

List of symbols:

Symbol	Quantity
OPR	Overall pressure ratio
BPR	Bypass ratio
ST	Specific thrust
$\dot{\eta}_{fan}$	Fan polytrophic efficiency
$\dot{\eta}_{LPC}$	Low-pressure compressor efficiency
$\dot{\eta}_{HPC}$	High- pressure compressor efficiency
$\dot{\eta}_{HPT}$	High-pressure turbine polytropic efficiency
$\dot{\eta}_{LPT}$	low- pressure turbine polytropic efficiency
T_{t4}	Turbine inlet temperature
Π_d	Inlet pressure recovery
Π_b	Combustor pressure ratio
Π_{nc}	Core nozzle pressure ratio
Π_{nb}	Bypass nozzle pressure ratio
FPR	Fan pressure ratio

(A_{rec})	The total rectangular area occupied by the fans
D_f	Fan diameter
N_f	Fan numbers
A_1	Propulsion system inlet
A_2	Fan inlet
A_{mix}	Mixer nozzle inlet
$\omega_2 \max$	Maximum span wise extent
CD	Discharge coefficient
C_{fg}	Gross Thrust coefficient
C	Speed of sound
D	Diameter (m ²)
V_j	Jet speed [m/s]
W	Acoustic power [w]
ρ	Density [$Kg\ m^{-3}$]

$\dot{m}$	Mass flow rate [$Kg\ s^{-1}$]
A	Jet area [m ²]
η	Polytropic efficiency[9]
γ	Ratio of specific thrust
T	Temperature [K]
R	Gas constant [$J\ Kg\ K$]
γ	Ratio of specific thrust
V_o	Flight speed [m/s]
M	Mach number

Abbreviations:

ENPL : Effective perceived noise level

BWB : Blended wing body

ST : Specific thrust

TSFC : Thrust specific fuel consumption

VAN : Variable area nozzle

Abstract

noise emitted by commercial aircraft has been one of the most critical environmental issue , such as large number of people effected by aviation noise .The International body ICAO sets the common rules for the level of noise & engine emission through Annex 16 to the Chicago Convention 1944.

Since the Most of aircraft noise is emitted by propulsion system, the major objective of this project is to review, study and optimisation of the recently techniques of design , that can achieve the concept of silent propulsion system (30 dB noise reduction).

Ultra high bypass ratio engines with the influence of fan pressure ratio on engine noise emission , in addition to the concept of distributed propulsion system with high aspect ratio nozzle are two basic branches of this project.

A300-600 powered by trent 500 was taken as case study for optimization the effet of fan pressure ratio on jet velocity as well as on jet noise emissions under normal takeoff flight conditions .Another case study was carried out for optimization the Influence of high aspect ratio nozzle on jet noise emissions .

The fan pressure ratio was adjusted , and the optimum jet area was estimated for (30 EPNL dB) reduction which can achieve the concept for silent propulsion system.

