

RÉPUBLIQUE ALGÉRIENNE DÉMOCRATIQUE ET POPULAIRE
MINISTÈRE DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE
SCIENTIFIQUE
ÉCOLE NATIONALE POLYTECHNIQUE
Département d'Automatique



End of Studies Project

In view of obtaining the State Engineering Diploma in Automatic Control

Modeling and Modern Control of Naturally Aspirated and Turbocharged Dual-Fuel Engines

Realized by:

HARKANE El Ghani
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Under the supervision of:

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M. BENBRAIKA **ENP**

Composition of the jury:

PRESIDENT: F. BOUDJEMA **ENP**
EXAMINER: H. ACHOUR **ENP**

Invited:

ZAAMTA Hichem **EMO Constantine**
KHEBRI Dirar **ENP**

Presented and publicly defended on **23/06/2025**

ENP 2025

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Mémoire de Projet de Fin d'Etudes

En vue de l'obtention du Diplôme d'Ingénieur d'État en Automatique

Modélisation et Contrôle Moderne des Moteurs Atmosphériques et
Suralimentés à Double Carburant

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الملخص

يهدف هذا البحث إلى دراسة وتقييم تقنيات التحكم في محركات الوقود المزدوج، سواء كانت الطبيعية أو المزودة بشاحن توربيني. يُعرض في هذا السياق منظور شامل حول تاريخ وتطور هذه المحركات، مع التركيز على مكونات عملية احتراق الوقود داخلها وخصائصه الأساسية.

يشمل العمل أيضًا شرحًا لمفهوم محركات الوقود المزدوج F4L912 يتم التطرق إلى المحرك النموذجي (ديزل/غاز طبيعي)، مع توضيح كيفية تحويل المحركات التقليدية لتحمل بهذا النمط، بما في ذلك نظام الحقن بالغاز والتحديات التقنية المرتبطة به. الهدف الأساسي من اعتماد الوقود المزدوج يتمثل في تقليل الانبعاثات وتحسين كفاءة استهلاك الوقود، مع تقديم تحليل لمزايا وعيوب هذا النوع من الأنظمة.

الكلمات المفتاحية : محركات الوقود المزدوج، احتراق الوقود، تحويل المحركات، تقنيات التحكم، الانبعاثات، كفاءة الوقود، المحركات الطبيعية و المزودة بشاحن توربيني

Résumé

Ce travail étudie les techniques de commande des moteurs à double carburant, qu'ils soient atmosphériques ou suralimentés. Il retrace l'évolution de ces moteurs, en analysant les caractéristiques de la combustion et les défis liés à la conversion des moteurs diesel vers une alimentation mixte diesel/gaz naturel. L'objectif est de réduire les émissions et d'améliorer l'efficacité énergétique. L'étude s'appuie notamment sur le moteur F4L912 et présente une analyse des avantages et des limites de cette technologie.

Mots-clés : moteurs à double carburant, combustion, conversion, commande, émissions, rendement, suralimentation.

Abstract

This work investigates control techniques for dual-fuel engines, whether naturally aspirated or turbocharged. It traces the evolution of these engines by analyzing combustion characteristics and addressing the challenges involved in converting conventional diesel engines to operate with a diesel/natural gas mixture. The objective is to reduce emissions and improve fuel efficiency. The study focuses in particular on the F4L912 engine and provides an analysis of the advantages and limitations of this technology.

Keywords : dual-fuel engines, combustion, conversion, control, emissions, efficiency, turbocharging.

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*To my beloved mother,
the light of my life and my greatest source of strength.*

*To my dear father,
for his support and guidance.*

*To my brother Oussama,
whose encouragement never failed me.*

*To my brothers and sisters,
for their affection and presence.*

*To all my family and friends,
for their unwavering support.*

Youcef

*To my dear mother,
To my dear father,
To my brothers and sisters,
To my dear grandparents,
To all my family and friends.*

El Ghani

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