

**IMPROVEMENT OF FUEL PROPERTIES VIA HYDROGENATION AND
RING OPENING: STUDIES ON TETRALIN/1,3-
DIMETHYLCYCLOHEXANE**



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A Dissertation Submitted in Partial Fulfilment of the Requirements
for the Degree of Doctor of Philosophy
The Petroleum and Petrochemical College, Chulalongkorn University
in Academic Partnership with
The University of Michigan, The University of Oklahoma,
and Case Western Reserve University

2007

502045

Thesis Title: Improvement of Fuel Properties via Hydrogenation and Ring Opening: Studies on Tetralin/1,3-Dimethylcyclohexane
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ABSTRACT

4581003063: Petrochemical Technology

Siraprapha Dokjampa: Improvement of Fuel Properties via Hydrogenation and Ring Opening: Studies on Tetralin/1,3-Dimethylcyclohexane. Thesis Advisors: Assoc. Prof. Thirasak Rirksomboon, Prof. Daniel E. Resasco, Prof. Somchai Osuwan, and Dr. Siriporn Jongpatiwut 102 pp.

Keywords: Hydrogenation/ Ring Opening/ Tetralin/ 1,3-Dimethylcyclohexane

Due to environmental concerns, the reduction of aromatics in gasoline and diesel fuel is focused on many countries around the world. However, the decrease in aromatic contents via the hydrogenation process ended up with low octane number gasoline. Although, in the case of diesel fuel, the reduction of aromatics is closely related to an increase in cetane number, the saturation of aromatics using the conventional two-stage process might not be able to approach fuel requirements for the near future. Recently, the opening of the naphthenic ring was introduced as one of the promising reactions for both cetane and octane number improvement which depends on the positions of the cleavage of the C-C bond. In this work, the hydrogenation of tetralin on Pt/Al₂O₃, Pd/Al₂O₃, and Ni/Al₂O₃ catalysts in a gas phase reaction was investigated. It was found that the product selectivities depend on the intrinsic properties of the metal and the cis- to trans-decalin isomerization. A selective catalyst toward the cis-decalin product with low isomerization activity is more preferred to maximize cis-decalin, which facilitates ring opening products in subsequent processes. In addition, the ring opening of 1,3-dimethylcyclohexane (1,3-DMCH) was also carried out on Ir catalysts and promoted Ir catalysts with K or Ni. It is postulated that only the cleavage of the C-C bond at the unsubstituted position of 1,3-DMCH is desired in order to yield high branched chain hydrocarbon products which are required for octane number improvement. It was found that the addition of K or Ni altered the metal dispersion and metal-support interaction. Consequently, the product distribution can be modified using appropriate ratios of Ir to K or Ir to Ni.

บทคัดย่อ

ศิริประภา ดอกจำปา : การปรับปรุงคุณภาพของเชื้อเพลิงโดยการเติมไฮโดรเจนของเตตระลินและการเปิดวงของ 1,3-ไดเมทิลไซโคลเฮกเซน (Improvement of Fuel Properties via Hydrogenation and Ring Opening: Studies on Tetralin/1,3-Dimethylcyclohexane) อ. ที่ปรึกษา : รศ.ดร. ชีรศักดิ์ ฤกษ์สมบูรณ์ ศ.ดร. แคนเน็ล อี ริชส์โก ศ.ดร. สมชาย โอสุวรรณ และ ดร. ศิริพร จงผาดิวุฒิ 102 หน้า

ในปัจจุบันนี้หลายประเทศทั่วโลกต่างเล็งเห็นถึงความสำคัญของพลังงานสะอาดเพิ่มมากขึ้น ซึ่งการลดความเข้มข้นของสารอะโรมาติกส์ในเชื้อเพลิงโดยการเปลี่ยนให้เป็นวงแหวนอิ่มตัวด้วยการเติมไฮโดรเจนก็เป็นอีกทางเลือกหนึ่งที่น่าสนใจ แต่เป็นที่ทราบดีว่าค่าออกเทนของวงแหวนอิ่มตัวมีค่าต่ำกว่าสารอะโรมาติกส์มาก ด้วยเหตุนี้การลดความเข้มข้นของสารอะโรมาติกส์ด้วยวิธีดังกล่าวส่งผลให้ค่าออกเทนในน้ำมันเบนซินลดลง แม้ในกรณีของน้ำมันดีเซลวงแหวนอิ่มตัวจะส่งผลดีต่อค่าซีเทน แต่การใช้เทคโนโลยีแบบดั้งเดิม (กระบวนการแบบ 2 ขั้นตอน) เพียงอย่างเดียวก็ไม่สามารถรองรับความต้องการของมาตรฐานน้ำมันในอนาคตได้ ดังนั้นการเปิดวงของวงแหวนอิ่มตัวจึงเป็นอีกแนวทางหนึ่งซึ่งส่งผลดีต่อทั้งค่าซีเทนและค่าออกเทน ซึ่งขึ้นอยู่กับตำแหน่งของการแตกวง งานวิจัยชิ้นนี้ได้แบ่งเป็นสองส่วน ส่วนแรกได้ศึกษาการทำให้อิ่มตัวของสารเตตระลิน ด้วยการเติมไฮโดรเจนบนตัวเร่งปฏิกิริยาได้แก่ แพลททินัม พัลลาเดียม และนิกเกิลบนอะลูมินา จากการศึกษาพบว่าการเลือกเกิดผลิตภัณฑ์ซีส-เดคคาลินหรือทราน-เดคคาลินขึ้นกับธรรมชาติของตัวเร่งปฏิกิริยาและปฏิกิริยาไอโซเมอร์ไรเซชัน การเลือกตัวเร่งปฏิกิริยาที่เอื้อต่อการเลือกเกิดผลิตภัณฑ์ซีส-เดคคาลิน และในขณะเดียวกันตัวเร่งปฏิกิริยาดังกล่าวต้องมีความสามารถในการเกิดปฏิกิริยาไอโซเมอร์ไรเซชันต่ำจะสามารถเพิ่มผลิตภัณฑ์ซีส-เดคคาลินซึ่งมีความสามารถในการแตกวงได้ดี กว่าในกระบวนการต่อไปได้ ส่วนที่สองได้ศึกษาการแตกวงของสาร 1,3-ไดเมทิลไซโคลเฮกเซนบนตัวเร่งปฏิกิริยาอิริเดียมและอิริเดียมที่มีการเติมโพแทสเซียมหรือนิกเกิล สำหรับการแตกวงระหว่างคาร์บอนสองตัวของสาร 1,3-ไดเมทิลไซโคลเฮกเซนในตำแหน่งที่คาร์บอนนั้นๆมีพันธะกับคาร์บอนอื่นเพียงสองตัวเท่านั้นที่ให้ผลิตภัณฑ์ที่ให้ค่าออกเทนสูง จากการศึกษาพบว่าการผสมอิริเดียมด้วยโพแทสเซียม หรือนิกเกิลทำให้เกิดการเปลี่ยนแปลงของการกระจายตัวของโลหะอิริเดียมและพันธะระหว่างโลหะอิริเดียมและตัวรองรับ ซึ่งส่งผลโดยตรงต่อการเปลี่ยนแปลงการเลือกเกิดของผลิตภัณฑ์ กล่าวคือการเติมโพแทสเซียมหรือนิกเกิลในปริมาณที่เหมาะสมบนตัวเร่งปฏิกิริยาอิริเดียมสามารถเลือกการแตกวงของวงแหวนอิ่มตัวในตำแหน่งที่ต้องการได้

ACKNOWLEDGEMENTS

I would like to acknowledge the organization and the generous guidance and assistance of the following individuals in completing this research project:

First of all, I would like to gratefully acknowledge the generosity of the Ph.D. Program from the Thailand Research Fund through the Royal Golden Jubilee Ph.D. Program (Grant No. PHD/0147/2547), the National Excellence Center for Petroleum, Petrochemicals, and Advanced Materials Thailand, and the Oklahoma Center for the Advancement of Science and Technology (OCAST), which have made grants to finance my research.

My PhD life might not be possible without the kind supervisions from Assoc. Prof. Thirasak Rirkksomboon and Prof. Somchai Osuwan. They always sincerely proffered many suggestions. I am also appreciative of the helpfulness, tireless guidance and patient demeanour of Dr. Siriporn Jongpatiwut. A special gratitude is expressed to my US advisor, Prof. Daniel E. Resasco. I still remember my first day at OU and his warm welcome. He contributed his unconditioned kindness and, more importantly, his innovative ideas to the thesis. My work might not be possible without the supervision from all of my advisors.

I especially extend my appreciation to Assoc. Prof. Sumaeth Chavadej, Asst. Prof. Sirirat Jitkarnka, and Assoc. Prof. Vissanu Meeyoo for their recommendations serving as committee members.

The first step of the experimental part might not have been initiated without the helpfulness of C. P. O. Poon Arjpru. I would like to express my sincere gratitude for his assistance. He usually encourages me to solve many problems. I also would like to express my thanks to other PPC, OU and ConocoPhillips staff.

I especially extend many thanks to two of my colleagues during my research overseas. Firstly, Phoung T. Do, who is more than a colleague. She also stayed by my side when I faced problems. The other one, González-Cortés Sergio was always ready to lend a hand. I appreciate their kindness. And I also would like to thank all of my lovely friends at OU and PPC.

Finally, I would like to express my gratitude for the inspiration from my family.

TABLE OF CONTENTS

	PAGE
Title Page	i
Abstract (in English)	iii
Abstract (in Thai)	iv
Acknowledgements	v
Table of Contents	vi
List of Tables	xi
List of Figures	xiii
List of Schemes	xviii
CHAPTER	
I INTRODUCTION	1
II LITERATURE REVIEW	4
2.1 Types of Aromatic Compounds in the Petroleum Fractions	4
2.2 Revolution of the Refining Process	4
2.3 Future Aspects	5
2.4 Hydrogenation of Aromatics	7
2.5 Ring Opening Reactions	10
2.5.1 Ring Opening of Naphthenic Molecules	10
2.5.2 Cetane Number of the Ring Opening Products	14
2.5.3 Prediction of Octane Number from Ring Opening Products	21
III EXPERIMENTAL	24
3.1 Materials	24
3.1.1 Hydrogenation of Tetralin	24
3.1.1.1 Catalyst Preparation	24

CHAPTER	PAGE
3.1.1.2 Reactants for Catalytic Activity Testing	24
3.1.2 Ring Opening of 1,3-Dimethylcyclohexane	24
3.1.2.1 Catalyst Preparation	24
3.1.2.2 Reactants for Catalytic Activity Testing	24
3.2 Catalyst Preparation	25
3.2.1 Catalysts for Hydrogenation Reaction	25
3.2.2 Catalysts for Ring Opening Reaction	25
3.3 Catalytic Activity Testing	26
3.3.1 Hydrogenation Reaction	26
3.3.2 Ring Opening Reaction	26
IV COMPARATIVE STUDY OF HYDROGENATION OF TETRALIN ON SUPPORTED Ni, Pt, AND Pd CATALYSTS	29
4.1 Abstract	29
4.2 Introduction	30
4.3 Experimental	33
4.3.1 Catalyst Preparation and Characterization	33
4.3.2 Catalytic Activity Tests	34
4.4 Results and Discussion	35
4.4.1 Kinetics Study	35
4.4.2 Trans/Cis Decalin Ratio	39
4.4.3 Isomerization of Cis-to-Trans Decalin in the Presence of Tetralin on Pt and Ni Catalysts	42
4.5 Conclusions	44
4.6 Acknowledgements	45
4.7 References	45

CHAPTER	PAGE
V	
TUNING THE SELECTIVE OF RING OPENING OF 1,3-DIMETHYLCYCLOHEXANE WITH THE ADDITION OF POTASSIUM OVER Ir/SiO₂ CATALYSTS	48
5.1 Abstract	48
5.2 Introduction	49
5.3 Experimental	51
5.3.1 Catalyst Preparation	51
5.3.2 Catalyst Characterization	51
5.3.2.1 Elemental Analysis	51
5.3.2.2 Chemisorption of CO	52
5.3.2.3 Temperature Programmed Reduction (TPR)	52
5.3.2.4 X-ray Photoelectron Spectroscopy (XPS)	52
5.3.2.5 Extended X-ray Absorption Fine Structure (EXAFS) and Near Edge X- ray Absorption Fine Structure (NEXAFS)	53
5.3.3 Catalytic Activity Measurement and Data Analysis	54
5.4 Results and Discussion	54
5.4.1 Characterization	54
5.4.1.1 Metal Dispersion and Particle Size of Ir Catalysts	54
5.4.1.2 Temperature Programmed Techniques	55
5.4.1.3 X-ray Photoelectron Spectroscopy	56

CHAPTER	PAGE
5.4.1.4 Extended X-ray Absorption Fine Structure and Near Edge X-ray Absorption Fine Structure	57
5.4.2 Catalytic Activity	61
5.5 Conclusions	65
5.6 Acknowledgements	66
5.7 References	66
VI RING OPENING OF 1,3-DIMETHYLCYCLO- HEXANE ON Ir CATALYSTS. MODIFICATION OF DISTRIBUTION BY ADDITION OF Ni AND K TO IMPROVE FUEL PROPERTIES	69
6.1 Abstract	69
6.2 Introduction	70
6.3 Experimental	73
6.3.1 Materials Investigated	73
6.3.2 Catalyst Characterization	73
6.3.3 Catalytic Activity Measurements	74
6.4 Results and Discussion	74
6.4.1 Characteristics of the Catalysts Investigated	74
6.4.2 Ring Opening of 1,3-DMCH on Monometallic Ir Catalysts	76
6.4.3 Reactions on Bimetallic Ni-Ir Catalysts	84
6.4.4 Reactions on K-Promoted Ir Catalysts	86
6.4.5 Impact of the Ring Opening and Hydrogenolysis Reactions on Octane Number and Ried Vapor Pressure of the Product Mixture	88
6.5 Conclusions	91

CHAPTER	PAGE
6.6 Acknowledgements	91
6.7 References	92
VII CONCLUSIONS AND RECOMMENDATIONS	94
REFERENCES	97
CURRICULUM VITAE	100

LIST OF TABLES

TABLE		PAGE
CHAPTER II		
2.1	Predicted cetane numbers of ring contraction products of the reaction pathway of acid-catalyzed ring opening of decalin (Santana <i>et al.</i> , 2006)	16
2.2	Predicted cetane numbers of ring opening products of the reaction pathway of acid-catalyzed ring opening of decalin (Santana <i>et al.</i> , 2006)	17
2.3	Predicted cetane numbers of alkane products of the reaction pathway of acid-catalyzed ring opening of decalin (Santana <i>et al.</i> , 2006)	18
2.4	Parameters values for octane number calculation (Ghosh <i>et al.</i> , 2006)	23
CHAPTER IV		
4.1	Characterization of the catalysts investigated	34
4.2	Tetralin hydrogenation activity on different catalysts Reaction conditions: 3540 kPa, 548K, H ₂ /HC=25, TOS=6 h	35
4.3	Kinetics parameters for the hydrogenation of tetralin (r ₁ , as shown below) and cis-to-trans decalin isomerization (r ₂ , as shown below) at 3540 kPa and 548 K, H ₂ /HC=25, TOS = 6 h	39
CHAPTER V		
5.1	Compositions, metal dispersion of Ir/SiO ₂ and Ir-K/SiO ₂ catalysts	55
5.2	Electron binding energies of the core levels for Ir 4f, K 2p and Si 2p in the K ion-promoted Ir/SiO ₂ catalysts	57

TABLE	PAGE
5.3 Structural parameters of iridium obtained from fitting of EXAFS data using theoretical references developed with FEFF	60
CHAPTER VI	
6.1 Composition and metal dispersions of the 0.9 wt.% Ir-containing catalysts	75
6.2a Liquid product distribution from 1,3-DMCH at 603 K, 3540 kPa, H ₂ /HC ratio of 30, and time on stream of 2 hours over the different catalysts investigated (low conversion)	77
6.2b Liquid product distribution from 1,3-DMCH at 603 K, 3540 kPa, H ₂ /HC ratio of 30, and time on stream of 2 hours over the different catalysts investigated (high conversion)	78

LIST OF FIGURES

FIGURE	PAGE
CHAPTER II	
2.1	Two-stage process for diesel aromatics removal. 5
2.2	Ring opening mechanisms on metal catalyst (Do <i>et al.</i> , 2006). 13
2.3	Ratio of substituted C-C cleavage to unsubstituted C-C cleavage of 1,3-DMCH over Ir on different supports. Without considering secondary hydrogenolysis, the ratio of (2-MC7 + 4-MC7)/2,4-DMC6 would represent the ratio of (a+b)/c cleavage (the statistical value of (a+b)/c is 2). ▲ = Ir/Al ₂ O ₃ ; ◇ = Ir/SiO ₂ ; □ = Ir/TiO ₂ (Do <i>et al.</i> , 2006). 14
2.4	Predicted cetane numbers of intermediates and products of the reaction pathway of acid-catalyzed ring opening of decalin (Santana <i>et al.</i> , 2006). 15
2.5	Predicted cetane numbers of intermediates and products of the reaction pathway of metal-catalyzed ring opening of decalin via dicarbene mechanism (Santana <i>et al.</i> , 2006). 19
2.6	Predicted cetane numbers of intermediates and products of the reaction pathway of metal-catalyzed ring opening of decalin via substituted C-C bond cleavage mechanism (Santana <i>et al.</i> , 2006). 19
2.7	Predicted cetane numbers of intermediates and products of the reaction pathway of the opening of one ring of perhydrophenanthrene. 20
2.8	Predicted cetane numbers and specific volume of typical products of selective ring opening (Santana <i>et al.</i> , 2006). 21

FIGURE	PAGE
CHAPTER III	
3.1 Schematic of the experimental set up for hydrogenation and ring opening reaction.	27
3.2 A photograph of the experimental apparatus.	28
CHAPTER IV	
4.1 Tetralin conversion to decalin as a function of space time during hydrogenation in a flow reactor at 3540 kPa and 548 K $H_2/HC=25$, TOS = 6 h. ■, Pt/ Al_2O_3 ; ○, Ni/ Al_2O_3 ; △, Pd/ Al_2O_3 . Solid lines are the results of the kinetic model.	37
4.2 Cis-to-Trans decalin isomerization in pure decalin feed (trans:cis feed ratio is 60:40). Reaction conditions: 3540 kPa and 548 K, $H_2/HC=25$, TOS = 3 h. ■, Pt/ Al_2O_3 ; ○, Ni/ Al_2O_3 ; △, Pd/ Al_2O_3 . Solid lines are the results of the kinetic model.	38
4.3 Trans/cis-decalin ratio of tetralin hydrogenation as a function of tetralin conversion. Reaction conditions: 3540 kPa and 548 K, $H_2/HC=25$, TOS = 3 h. ■, Pt/ Al_2O_3 ; ○, Ni/ Al_2O_3 ; △, Pd/ Al_2O_3 .	40
4.4a Rate of cis-to-trans isomerization in a combined feed (■) (tetralin:cis-decalin:transdecalin, 20:32:48) compared to the isomerization rate obtained in a pure decalin feed (□) (cis:trans, 40:60) on Pt/ Al_2O_3 as a function of W/F. Solid lines are the results of the kinetic model.	43
4.4b Rate of cis-trans isomerization in mixed feed (●) (tetralin:cis-decalin: trans-decalin, 20:32:48) compared to rate of cis-trans isomerization in pure feed (○) (cis:trans, 40:60) on Ni/ Al_2O_3 as a function of W/F. Solid lines are the results of the kinetic model.	44

FIGURE	PAGE
CHAPTER V	
5.1 Temperature-programmed reduction profiles of the catalytic precursors of potassium (K) promoted Ir/SiO ₂ catalysts.	56
5.2 Amplitudes of the Fourier transforms of EXAFS data of samples measured in H ₂ at room temperature after reduction at 723 K. Solid lines show the corresponding Fourier transforms of the fitted functions.	59
5.3 Surface representation of the potassium influence over silica-supported Ir particles.	60
5.4 Effect of the potassium loadings on 1,3-DMCH conversion and the (2-MC7+4-MC7/2,4-DMC6) ratios. Reactions were carried out at 593 K, 3540 kPa and H ₂ /HC ratio of 30.	62
5.5 Yield of 2,4-DMC6 product on Ir/SiO ₂ (□) and Ir-2K/SiO ₂ (■), and yield of (2-MC7+4-MC7) on Ir/SiO ₂ (○) and Ir-2K/SiO ₂ (●) from 1,3-DMCH conversion. Reactions were conducted at 593 K, total pressure of 3540 kPa and H ₂ /HC ratio of 30.	64
CHAPTER VI	
6.1 Temperature-programmed reduction of Ir, Ni and IrNi catalysts.	75
6.2 Octane number and vapor pressure of typical products of 1,3-DMCH ring opening.	79
6.3 Yield of high octane number products (2,4-DMC6, 2,4-DMC5, 2MC5, 3MC5) on Ir/Al ₂ O ₃ (■) and Ir/SiO ₂ (●) catalysts.	80

FIGURE	PAGE
6.4 Selectivities of hydrogenolysis of 2,4-DMC6 at different C-C bond position was conducted at 603 K and 3540 kPa. H ₂ /HC ratio of 30, whsv of 0.008 h on Ir/Al ₂ O ₃ and 0.025 h on Ir/SiO ₂ . Products 2,4-DMC5 (from C1-C2); 3-MC6 and 2MC6 (from C1-C3); 2-MC5, iso-C4 and iso-C5 (from C2-C3).	81
6.5 Selectivities of hydrogenolysis of 2-DMC7 at different C-C bond position was conducted at 603 K and 3540 kPa. H ₂ /HC ratio of 30, whsv of 0.008 h on Ir/Al ₂ O ₃ and 0.025 h on Ir/SiO ₂ . Products 2,4-DMC5 (from C1-C2); 3-MC6 and 2MC6 (from C1-C3); 2-MC5, iso-C4 and iso-C5 (from C2-C3).	82
6.6a Yield of high octane number products from ring opening of 1,3-DMCH over Ir/Al ₂ O ₃ catalyst. Reaction was conducted at 603 K and 3540 kPa, H ₂ /HC ratio of 30. □, 2,4-DMC6; ■, 2,4-DMC5; ▲, 2-MC5; ●, 3-MC5.	83
6.6b Yield of high octane number products from ring opening of 1,3-DMCH over Ir/SiO ₂ catalyst. Reaction was conducted at 603 K and 3540 kPa, H ₂ /HC ratio of 30. □, 2,4-DMC6; ■, 2,4-DMC5; ▲, 2-MC5; ●, 3-MC5.	84
6.6c Yield of high octane number products from ring opening of 1,3-DMCH over IrNi _{0.3} Al catalyst. Reaction was conducted at 603 K and 3540 kPa, H ₂ /HC ratio of 30. □, 2,4-DMC6; ■, 2,4-DMC5; ▲, 2-MC5; ●, 3-MC5.	85
6.6d Yield of high octane number products from ring opening of 1,3-DMCH over IrKAl catalyst. Reaction was conducted at 603 K and 3540 kPa, H ₂ /HC ratio of 30. □, 2,4-DMC6; ■, 2,4-DMC5; ▲, 2-MC5; ●, 3-MC5.	86

FIGURE	PAGE
6.7 Ratio of di-branched to mono-branched C8 products from 1,3-DMCH ring opening as a function of total conversion. Reaction conducted at 603 K and 3540 kPa, H ₂ /HC ratio of 30. Catalysts: ■, IrAl; ●, IrSi; △ IrNi0.3Al; □, IrK2.5Al.	87
6.8 Octane number of product mixture from ring opening of 1,3-DMCH, calculated by method of Ref. [38]. ■, IrAl; ●, IrSi; △ IrNi0.3Al; □, IrK2.5Al.	89
6.9 Reid vapor pressure (RVP) of product mixture from ring opening of 1,3-DMCH. ■, IrAl; ●, IrSi; △ IrNi0.3Al; □, IrK2.5Al.	90

LIST OF SCHEMES

SCHEME	PAGE
CHAPTER II	
2.1 Reaction pathway of tetralin hydrogenation (Weitkamp <i>et al.</i> , 1968).	9
2.2 Reaction pathway for isomerization of cis- to trans-decalin (Huang and Kang, 1995).	10
2.3 Aromatics saturation (ASAT) of multi-ring aromatic followed by selective ring opening (SRO) provides density and cetane number benefits (McVicker <i>et al.</i> , 2002).	11
CHAPTER V	
5.1 Cetane numbers and reaction pathways for the primary products from ring opening reaction of 1,3-DMCH.	61
CHAPTER V	
6.1 Some of the ring opening (primary) and hydrogenolysis (secondary) products obtained from 1,3-DMCH on Ir catalysts.	71