EFFECTIVENESS OF CoMo AND NiMo CATALYST ON CO-HYDROPROCESSING OF HEAVY ATMOSPHERIC GAS-OIL/WASTE COOKING OIL

S. Bezergianni

A. Dimitriadis

S.J. Kiartzis

M.C. Magiliotou

A.N. Skandilas

V.S. Dimitropoulos

Laboratory of Environmental Fuels & Hydrocarbons
Chemical Processes & Energy Resources Institute
Centre for Research & Technology Hellas

Hellenic Petroleum S.A.
Thessaloniki, Greece

Bio4SuD
Thessaloniki Greece
www.bio4sud.gr
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Waste Cooking Oil ➲ Diesel-2G

2nd Innovation Award
Η ΕΛΛΑΔΑ ΚΑΙΝΟΤΟΜΕΙ!
Eurobank EFG
ΣΕΒ

+ H_2

catalyst

✓

- Better combustion (increased cetane)
- More economic (high HHV)
- More stable (no TAN, high IP)
- Sustainable

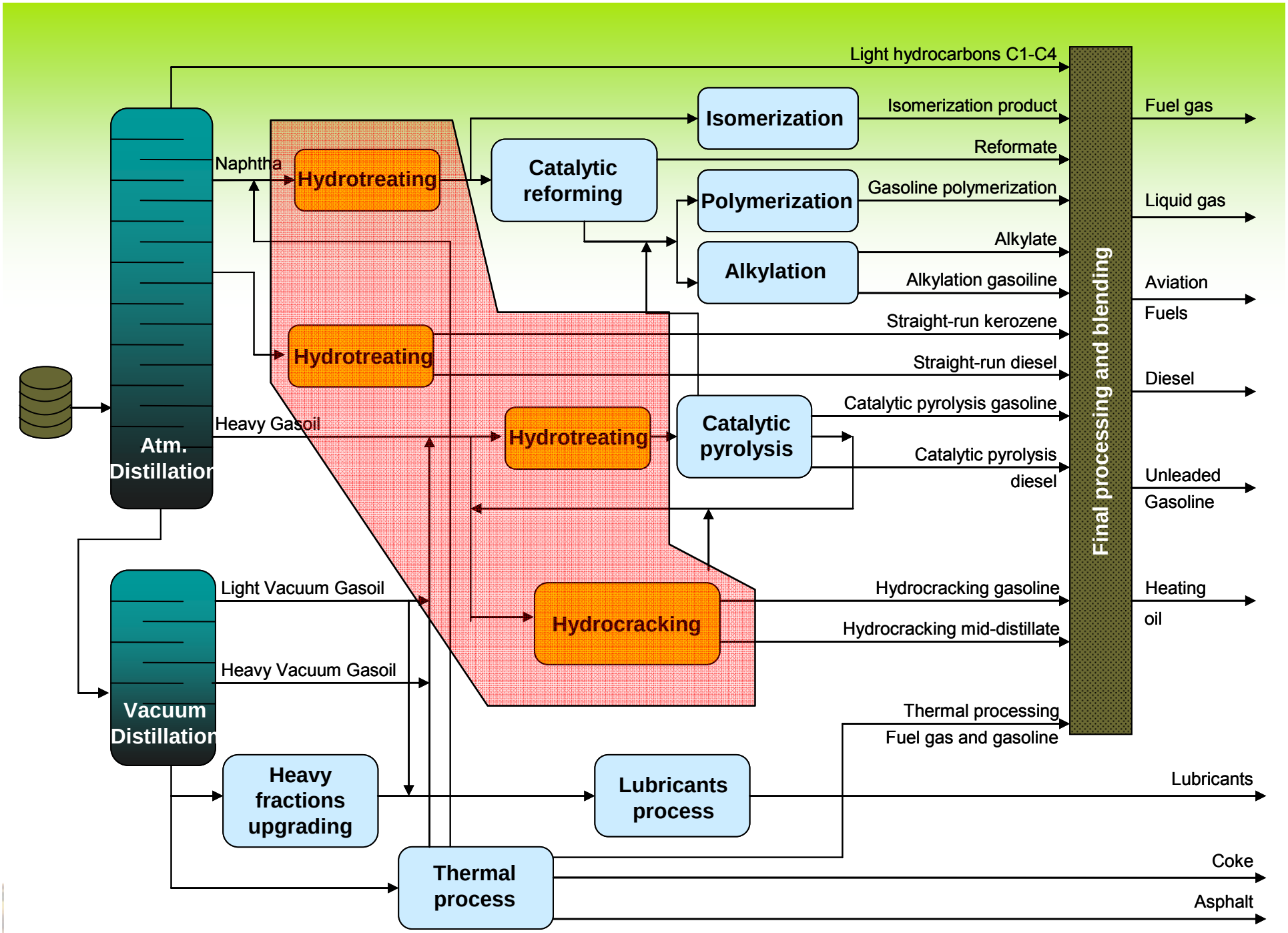
?

- Large-scale units require large investments

Potential to cover 9,5% of Greek diesel demand

Life

www.biofuels2g.gr


Light hydrocarbons C1-C4
Isomerization
Isomerization product
Fuel gas
Naphtha
Hydrotreating
Catalytic reforming
Reformate
Polymerization
Gasoline polymerization
Liquid gas
Alkylate
Alkylation
Alkylation gasoiline
Aviation Fuels
Straight-run kerozene
Hydrotreating
Straight-run diesel
Diesel
Atm. Distillation
Heavy Gasoil
Hydrotreating
Catalytic pyrolysis
Catalytic pyrolysis gasoline
Catalytic pyrolysis diesel
Unleaded Gasoline
Final processing and blending
Light Vacuum Gasoil
Hydrocracking
Hydrocracking gasoline
Heating oil
Hydrocracking mid-distillate
Heavy Vacuum Gasoil
Vacuum Distillation
Thermal processing Fuel gas and gasoline
Heavy fractions upgrading
Lubricants process
Lubricants
Thermal process
Coke
Asphalt

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SustainDiesel Project

- Aim: Improvement of diesel sustainability by incorporating WCO and RES in existing refinery
- Project duration: 23.3.2011 – 22.3.2014
- Partners:
  - Coordinator: Centre for Research & Technology Hellas (CERTH)
  - Academic partners: Aristotle University of Thessaloniki & National Technical University of Athens
  - Industrial partners: Hellenic Petroleum & Sunlight S.A.
- Financing: Program Competitiveness (ESPA) with funds from EU and Greek Government

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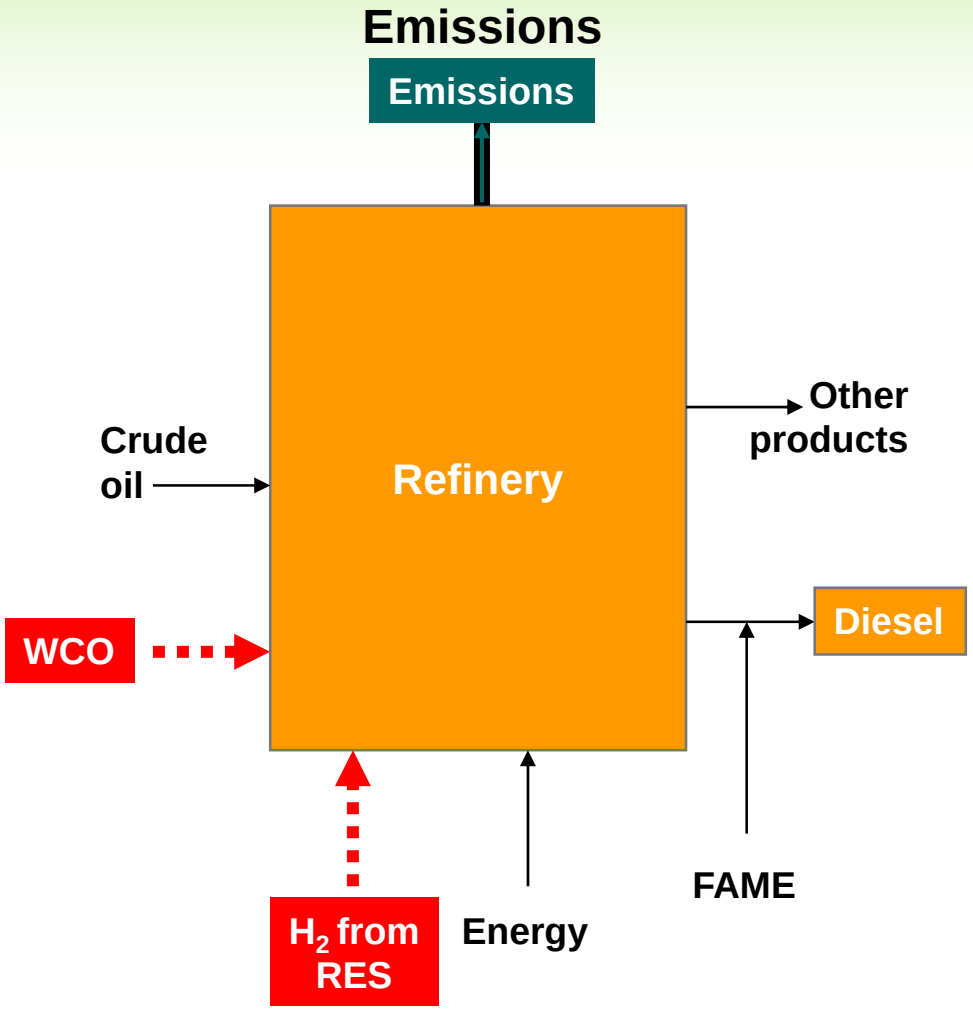
SustainDiesel Technology Overview



A. Evaluate technical feasibility of incorporating WCO as alternative feedstock for diesel production
   - Same infrastructure & operation

B. Assess carbon footprint and GHG emissions improvement versus current market diesel

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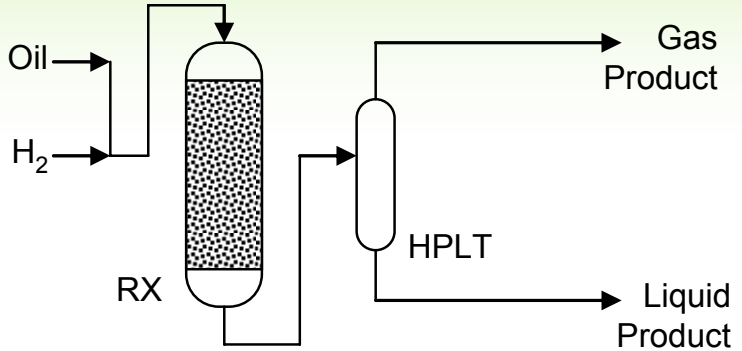
Technical Feasibility Study

1. Evaluation of hydrotreating catalyst √
2. Determine optimal operating conditions √
   - T, P, H_2/oil, LHSV
3. Determine max WCO mixing ratio
4. Evaluate emissions & engine performance



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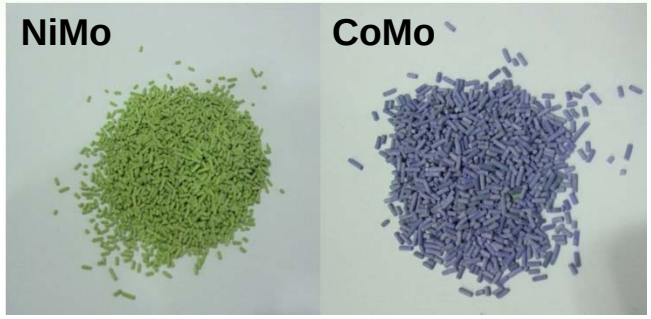
Experimental Methodology (1/3) Overview

- Two commercial catalyst
  - Commercial **NiMo**
  - Commercial **CoMo**



- Three feedstocks
  - Heavy Atmospheric Gas Oil 100% (HAGO)
  - HAGO with 10% waste cooking oil (WCO)
  - HAGO with 30% waste cooking oil (WCO)
- Small scale hydroprocessing pilot plant
- 8 experimental runs

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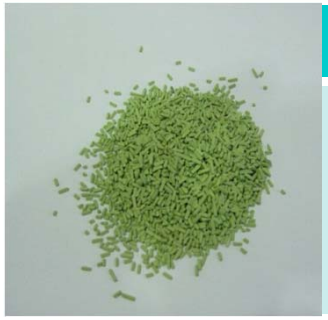
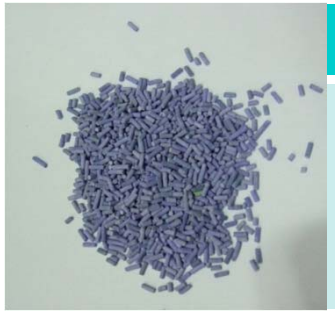
Experimental Methodology (2/3)
Catalysts & Operating Parameters



NiMo Catalyst

Temperatures	330°C	350°C	370°C
Feedstock (HAGO/WCO)	100/0	100/0	100/0
	90/10	90/10	90/10
	70/30	70/30	70/30



CoMo Catalyst

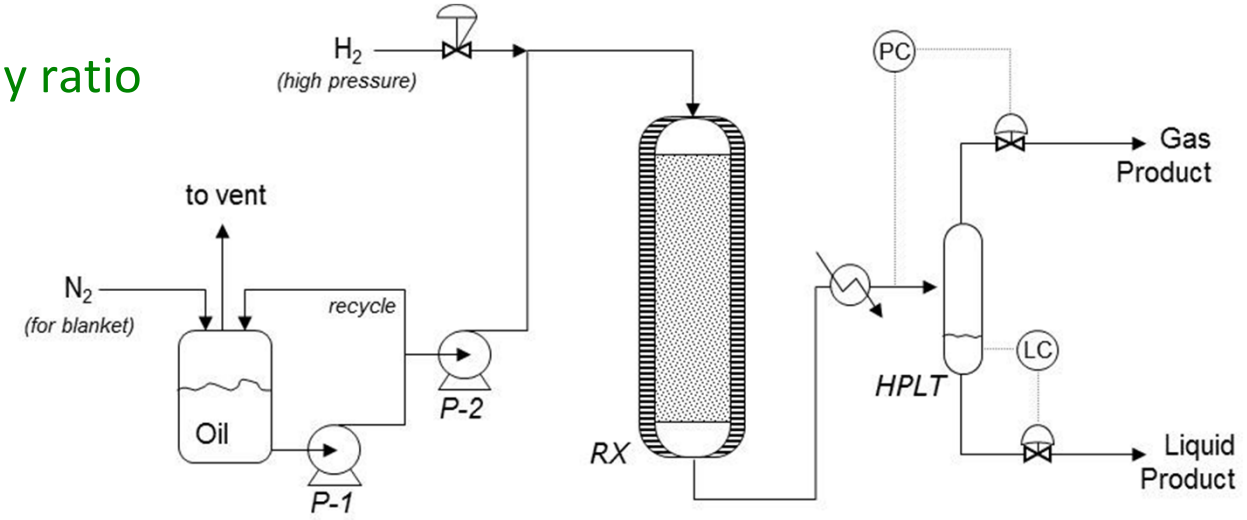
Temperatures	330°C	350°C	370°C
Feedstock (HAGO/WCO)	100/0	100/0	100/0
	90/10	90/10	90/10
	70/30	70/30	70/30

Pressure (psig)	812
LHSV (hr^{-1})	1
H_2/Oil (scfb)	3000

Comparison

Experimental Methodology (3/3) Infrastructure & Experiments

- Hydrotreating effectiveness parameters
  - Heteroatom removal (S, N)
  - Saturation of double bonds (Br, H/C)
  - Diesel yields (180°C - 360°C)
  - Conversion
  - Catalyst decay ratio



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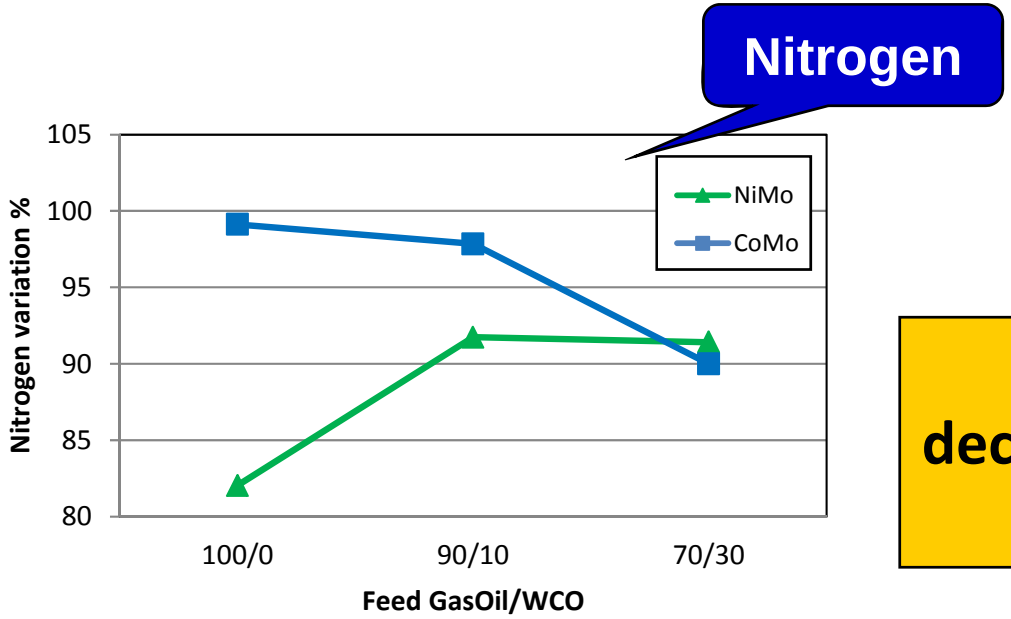
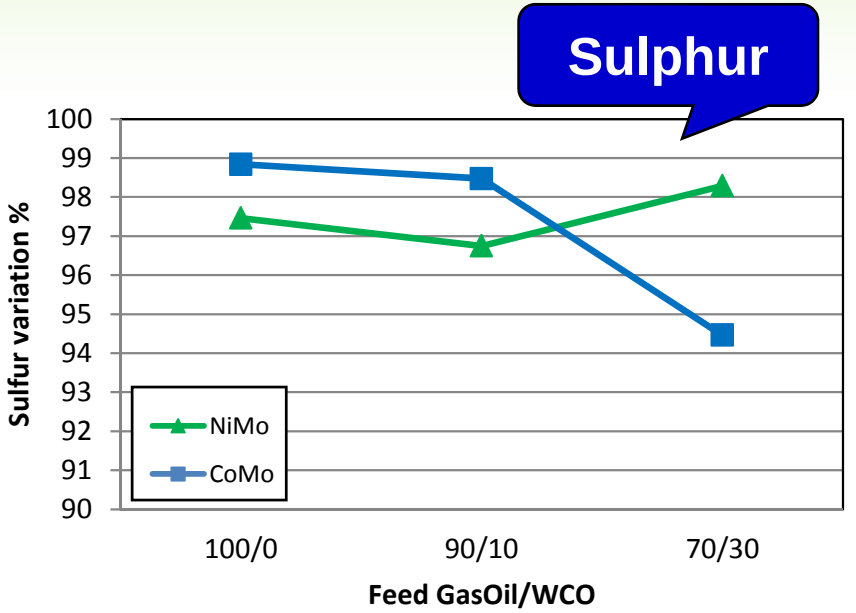
Heteroatom removal

- **NiMo** catalyst showed a performance increase for the feedstock with the largest WCO content
- **NiMo** catalyst exhibited increased HDN performance with increasing WCO content

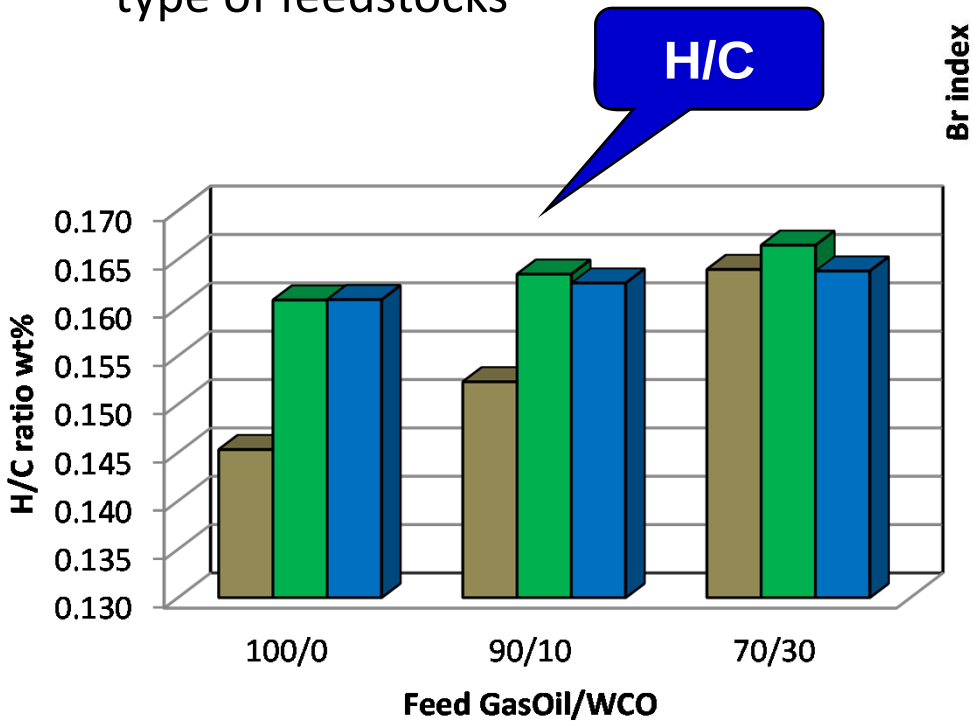


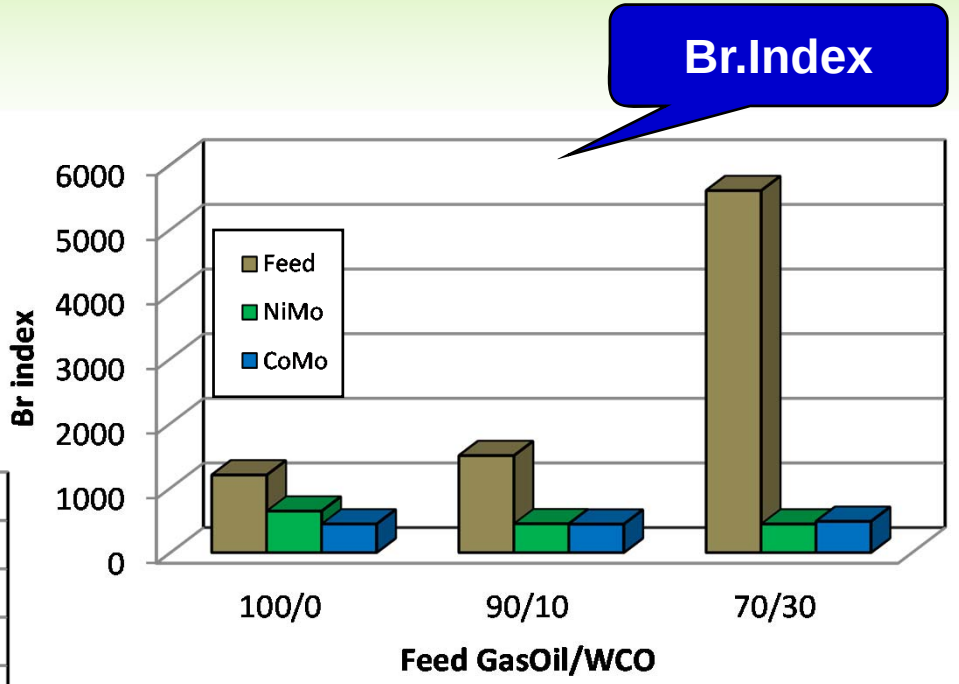


WCO addition does not decrease product quality when NiMo catalyst is used

Saturation

- Both catalysts provide good saturation of double bonds for all type of feedstocks





WCO addition does not limit saturation

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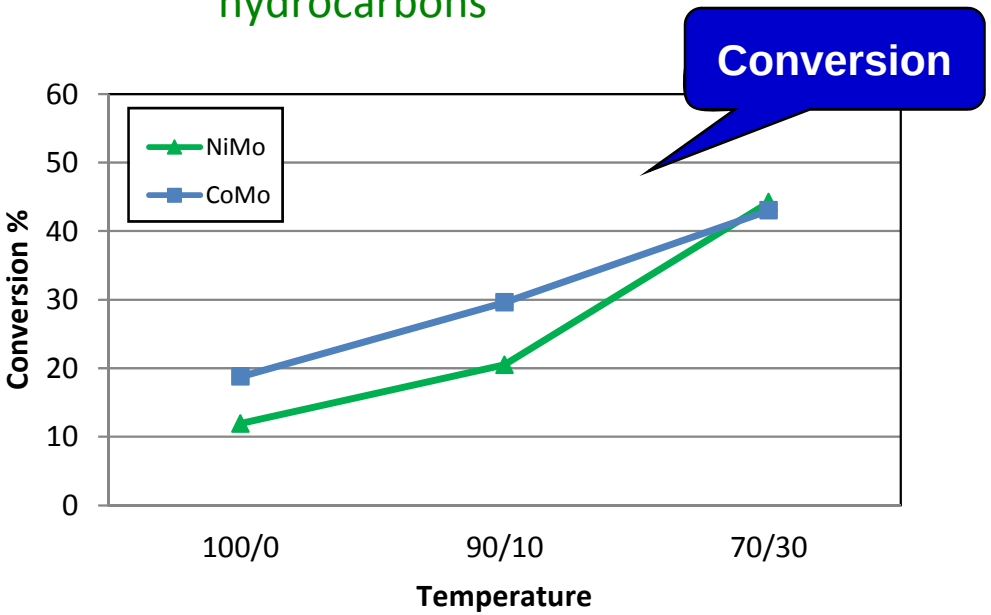
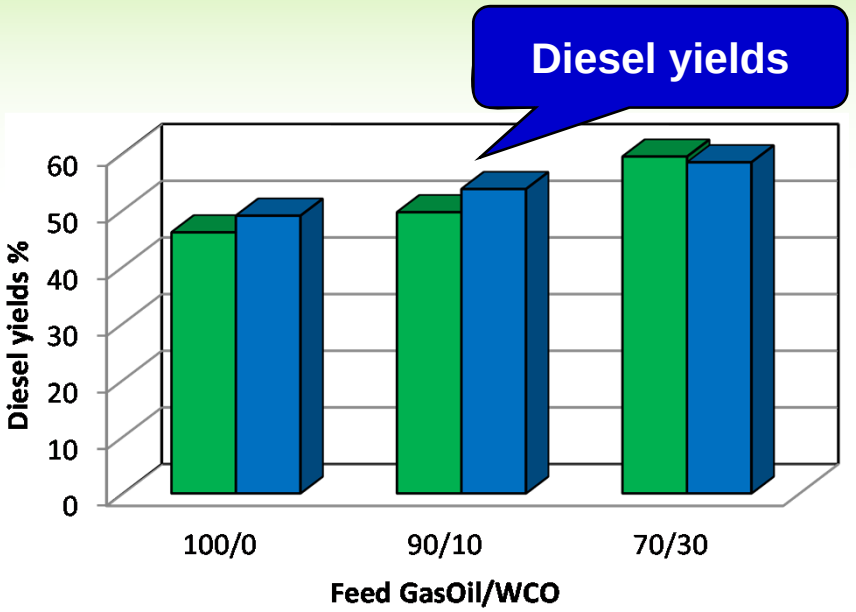
Diesel Yields-Conversion

- **CoMo** offers higher conversion and diesel yields for pure HAGO and low WCO content
  - Triglycerides contained in WCO can be more easily converted into diesel range hydrocarbons





WCO addition increases conversion and improves diesel yields

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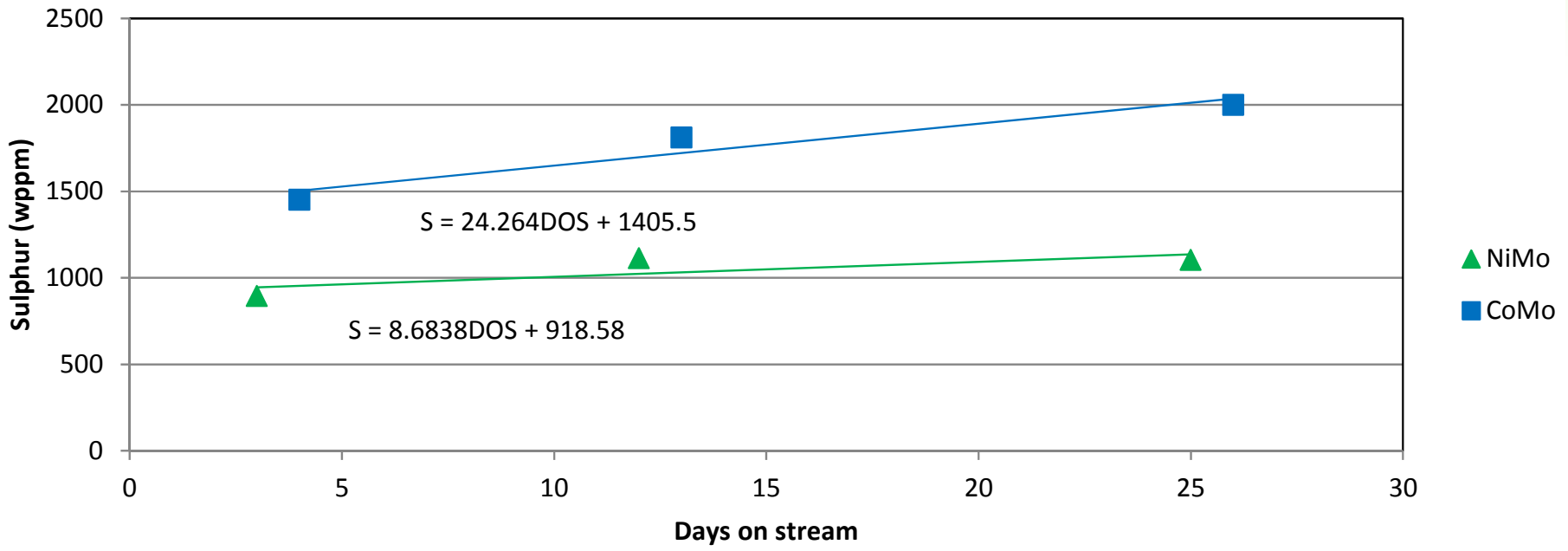
Catalyst Deactivation



NiMo deactivation rate is 3 times smaller than CoMo

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Conclusions & Future Steps

- WCO addition in HAGO hydrotreatment does not limit targeted reactions (heteroatom removal and saturation)
- WCO addition increases conversion and diesel yield
- NiMo catalyst more suitable for WCO containing feedstocks

- Future steps
  - Evaluation of maximum WCO ratio that can be incorporated in existing refinery
  - Assessment of maximum potential GHG emission benefits by incoporating WCO and H_2 from RES
  - Economic feasibility analysis

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Thank you

for your attention