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합성가스의 고부가화를 위한 KIER SponCat™ 촉매 기술

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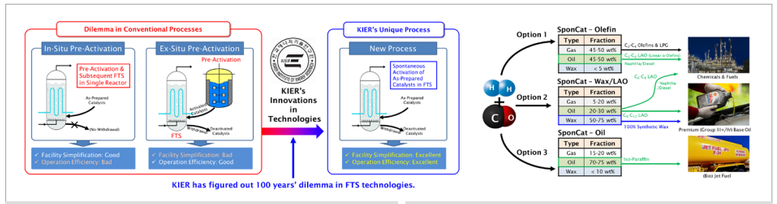
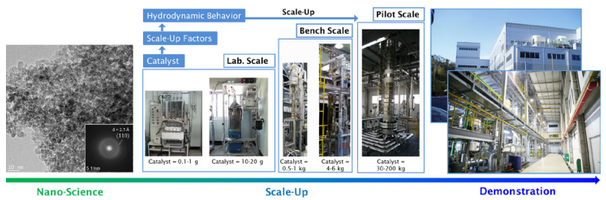
천연가스, 석탄, 폐목재, 이산화탄소/물 등에서 얻을 수 있는 합성가스로부터 저공해 액체연료, 고급 윤활기유, LAO(Linear Alpha Olefin) 등을 생산할 수 있는 피셔-트롭쉬 합성반응용 촉매 기술.

기술의 구성도/개념도



기술의 개념도 | 기술의 활용



기술의 구성: 나노과학부터 실증까지

기술의 주요 내용 및 특징

- 반응조건에서 자발적으로 활성화되는 나노 결정질 Fe계 촉매
  → 촉매 활성화처리에서 In-Situ 방식과 Ex-Situ 방식의 장점만을 취함
- 결정구조학을 바탕으로 나노 결정질 Fe계 촉매를 손쉽게 양산 성공
- 탄화수소의 탄소수 및 성상의 제어 가능

기술의 적용처

응용분야	적용제품	
석유화학/정유/CCU* (*CCU: Carbon Capture and Utilization)	저공해 액체연료, 고급 윤활기유, 화학원료물질(LAO: Linear Alpha Olefin)	

문의
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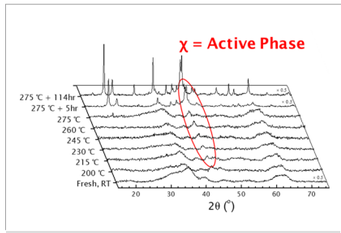
기술의 비교우위성/기존 기술 대비 차별성

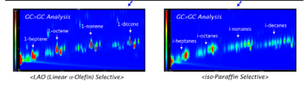
기존 기술	본 기술
◦ 합성가스 또는 일산화탄소를 이용한 활성화 전처리 필요 ◦ 목표 생성물에 따라 각기 다른 반응기 및 촉매의 조합이 필요	◦ 반응조건에서 자발적으로 활성화되는 신개념 스마트 촉매(세계최초) ◦ 하나의 반응기 및 촉매의 조합으로 다양한 성상의 탄화수소 생산 가능

실험 및 실증 데이터



자발활성화 기술

	Baseline (LT-FTS)	Case A	Case B	Case C
Major Products (Fraction in HCs)	Oil + Wax (78.2 wt%)	Oil + Wax (92.3 wt%)	C_{2-4} (O) + Oil (67.6 wt%)	Oil (72.2 wt%)
HCs Distribution Gas HCs (C_{1-4}) Oil (C_{5-18}) Wax (C_{19+})	21.8 wt% 30.9 wt% 47.3 wt%	7.66 wt% 20.1 wt% 72.2 wt%	44.5 wt% 47.2 wt% 8.34 wt%	16.9 wt% 72.2 wt% 10.9 wt%



촉매성능평가 결과

- 반응조건에서 자발적으로 활성종인 Fe계 탄화물로 변환
- 탄화수소의 성상을 LAO형, 왁스형, 이소파라핀형 등으로 각각 선택적 제어

기술의 성숙도

[TRL 6: 파일롯 규모 시작품 제작 및 성능 평가]

파일럿급 실증 단계

- 촉매 양산 성공: 500 kg 규모
- 일부 기술 파일럿급 촉매 성능실증 완료: 6-9 bbl/d 규모

지식재산권 현황

순번	발명의 명칭	출원번호	출원일자	등록번호	등록일자
1	철계 촉매의 제조방법 및 상기 제조방법으로 제조된 철계 촉매를 이용한 탄화수소의 제조방법	10-2017-0079499	2017.06.23	10-1847549	2018.04.04
2	Methods of Manufacturing Iron-Based Catalysts and Methods of Manufacturing Hydrocarbons Using Iron-Based Catalysts Made by the Method	US 15/568,538	2017.10.23	-	-
3		CA 2,938,738	2017.10.23	-	-
4		ZA 2017/07393	2017.10.31	-	-
5		CN 201680023535.8	2017.10.23	-	-
6		IN 201737038049	2017.10.26	-	-

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Principal researcher
Clean Fuel Laboratory of the Climate Change Research Division
Chun Dong-Hyun

KIER SponCat™ catalyst technology for production of value-added products from syngas

The present technology is a catalysis technology for Fischer-Tropsch synthesis process to produce clean liquid fuel, high-grade lube base oil, and linear alpha olefin (LAO) from the syngas obtained from natural gas, coal, waste wood, carbon dioxide, and water.

Structural Diagram/Conceptual Diagram

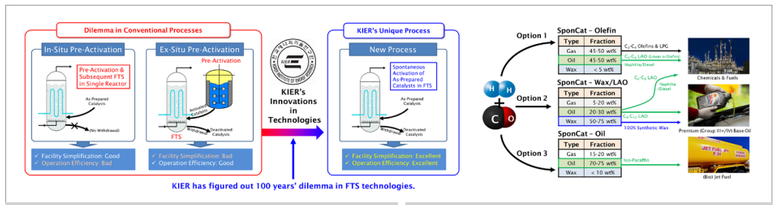
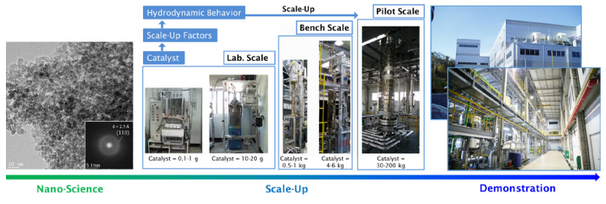


Diagram of technology | Utilization of technology



Features of technology: From nanotechnology to demonstration

Description and Characteristics of Technology

- Nanocrystal Fe-based catalyst is spontaneously activated under reaction conditions.
  → Only the advantages of in-situ and ex-situ methods are taken from the catalyst activation process.
- The nanocrystal Fe-based catalyst may be easily manufactured based on the crystal structure.
- The carbon number and the properties of hydrocarbons may be controlled

Scope of Application

Application Fields	Products
Petrochemical industry; oil refinery; CCU* (*CCU: Carbon Capture and Utilization)	Clean liquid fuel; high-grade lube base oil; basic chemical raw materials (LAO: Linear Alpha Olefin)

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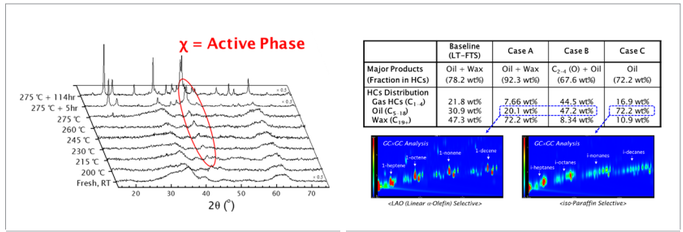
Comparative advantages of technology / Differentiation from existing technologies

Conventional Technology	Present Technology
◦ Activation pretreatment using syngas or carbon monoxide is necessary. ◦ Different reactor and catalyst combinations are required depending on the target products.	◦ The present technology provides a novel smart catalyst (first in the world) that is spontaneously activated under reaction conditions. ◦ Carbohydrates of various properties may be produced from one reactor and catalyst combination.

Experimental and empirical data



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Oil (C_{5-18})	30.9 wt%	20.1 wt%	47.2 wt%	72.2 wt%
Wax (C_{19+})	47.3 wt%	72.2 wt%	8.34 wt%	10.9 wt%

Results of catalyst performance evaluation | Spontaneous activation technology

››› Under the reaction conditions, conversion to a Fe-based carbide, an activated species, occurs spontaneously.

››› The properties of hydrocarbons may be selectively controlled as LAO, wax, and iso-paraffin types.

Maturity level of technology

1 2 3 4 5 **6** 7 8 9

Basic Research | Experiment | Prototype | Turning into practice | Commercialization

[TRL 6: pilot-scale prototype preparation and performance evaluation]

Pilot-scale demonstration stage

- Mass production of catalysts has been completed successfully on a scale of 500 kg.
- The performance of some catalysts has been demonstrated on a pilot scale (6-9 bbl/d).

Current status of intellectual property rights

No.	Title of Invention	Application Number	Application Date	Registration Number	Registration Date
1	Method for preparing iron-based catalyst and method of manufacturing carbohydrate using iron-based catalyst prepared thereby	10-2017-0079499	2017.06.23	10-1847549	2018.04.04
2	Methods of Manufacturing Iron-Based Catalysts and Methods of Manufacturing Hydrocarbons Using Iron-Based Catalysts Made by the Method	US 15/568,538	2017.10.23	-	-
3		CA 2,938,738	2017.10.23	-	-
4		ZA 2017/07393	2017.10.31	-	-
5		CN 201680023535.8	2017.10.23	-	-
6		IN 201737038049	2017.10.26	-	-