This product is a "New Technology Applied" product that has been verified by the Minister of Trade, Industry and Energy in accordance with Article 15-2 (3) of the "Industrial Technology Innovation Promotion Act" and Article 18-4 of the Enforcement Decree of the same Act.

CITY OIL FIELD



Urban Oil Field

Environmental Technology & Energy Specialist Company

Adding value to the environment.

+ Eco-friendly decomposition and treatment of plastic and plastic-film waste
+ Production of liquid fuel from plastic and plastic-film waste

Pyrolysis oil-conversion companies / Urban Oil Field technology comparison

List of Korea's leading traditional pyrolysis oil-conversion technology companies

*Urban Oil Field Co., Ltd. is a company using a non-traditional, non-combustion wavelength-decomposition oil-conversion technology.

- Eco Creation (Seo-gu, Incheon)
- Eco-in Energy (Yuseong-gu, Daejeon)
- Rebotech Co., Ltd. (Mungyeong-si, Gyeongbuk)
- Saehan Recycle Co., Ltd. (Jeongeup-si, Jeonbuk)
- Smart Green Energy Co., Ltd. (Gangjin-gun, Jeonnam)

Traditional Oil-conversion Technology: High-temperature Pyrolysis

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Venture Enterprise



Oil input (auxiliary fuel) _ combustion facility



Traditional oil-conversion technology: combustion method using a burner



Smoke emitted from the chimney (flue) during the traditional oil-conversion process



Operation of the melting reactor in traditional oil-conversion technology (combustion-burner ignition)

Technology Comparison

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Category		Pyrolysis Method	Urban Oil Field
Decomposition method		Melts and decomposes all waste using a burner	Uses ceramic waves to decompose only the waste plastics among the waste
Decomposition temperature		400~1,100℃	270℃~300℃
Decomposition heat source		Oil or Gas	Electric Power
Reactor		Cylindrical rotary type (Rotary Kiln)	Fixed type (Batch Type)
External outlet		Yes	No
Pollutants		Yes – generates dioxins, NOx, SOx, and odor	No – only trace amounts contained in waste plastics (within environmental standards)
Production yield		Target 60%	(EPR average) 40% / (agricultural waste) 80%
Daily processing capacity		Current 2 tons / Target 10 tons	(NET-certified) 24 tons/day
Feedstock		Pre-treated fluff (Fluff: plastic-film pieces)	Waste discharged by collection/sorting companies is fed in without pre-treatment
Residue		Sludge (wax, ash, heavy-metal impurities, etc. mixed in fine-powder form) ▶ Must be entirely consigned and disposed of as "industrial waste"	Solid carbide and foreign matter (glass, stones, metals, etc.) at the bottom of the basket ▶ Metals are separated and recycled ▶ Solid carbide can be recycled as an eco-friendly solid fuel
Refined fuel oil	Composition	Waxed liquefied mixture (requires development of a secondary refining unit)	Primary decomposition process: mostly pure liquid heavy oil (high hydrocarbon content) Secondary refining process: clean light fuel oil
	Use	No (auxiliary preheating fuel (diesel, gas) must be added for use ▶ incurs additional costs)	Yes (immediately usable as a light fuel oil with a pour point of -40℃)
	Quality	· Cannot remove the chlorine/sulfur/heavy-metal components contained in waste plastics at all · Cannot separate and remove wax components to prevent jellification. · Below the low-quality standard ▶ commercialization and sale impossible	· Meets national quality standards (recycled fuel oil, refined fuel oil) · Substances harmful to the human body measured below quality-standard values · Energy calorific value ▶ high calorific value of 10,000 kcal/kg or more

Process Comparison (Pyrolysis Method)

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The traditional pyrolysis technology — the "combustion type"

① **Fuel used: fossil fuels (auxiliary fuel + burner)**

② **Manual waste loading/unloading (direct worker involvement)**

③ **Manual equipment-door opening/closing (direct worker involvement)**

④ **Rotary kiln type (dust, noise, etc.)**

⑤ **Has a chimney (combustion type)**



전 처리된 플러프(Fluff:비닐 조각)

Pre-treated fluff (Fluff: plastic-film pieces)

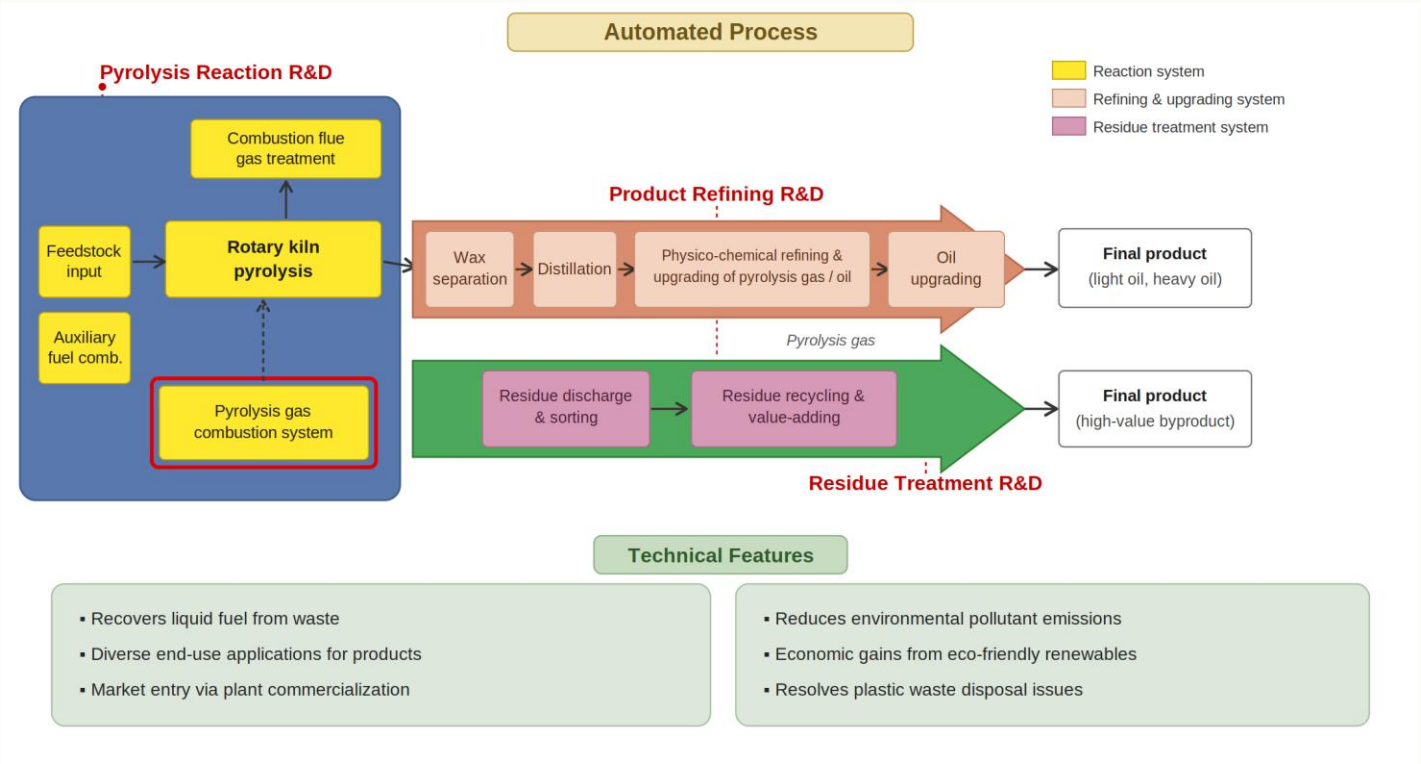
한국에너지

폐비닐 열분해 새 공정 개발

한국에너지 | 승인 2021.05.25 14:16 | 댓글 0

한국에너지기술연구원 이경환 박사 연구팀, 연속식 열분해 플랜트 개발
기존 공정과 비교해 원료 처리율 3배 이상 높아...고품질 및 60% 이상 생산 수율 유지 가능
2022년까지 일일 폐비닐 처리량 10t으로 끌어올릴 예정...사업화 가능 실증 규모

[이넷뉴스] 다 쓴 비닐에서 고품질 기름을 추출하는 공정을 국내 연구진이 개발했다. 현재 소수 기업이 상용 운전하고 있는 폐비닐 기름 추출 공정은 열분해 능력 제한으로 기름 품질과 생산 수율이 떨어지는 단점이 있다. 새 기술은 오랫동안 일정한 반응 온도를 유지할 수 있으며 고온에서 추출해 기름 품질이 좋고, 생산 수율도 60%를 웃돈다. 연구진은 2022년까지 일일 폐비닐 처리 규모를 10t까지 끌어올려 사업화에 나설 계획이다.



열분해 자동화 공정 개념도 (이미지=한국에너지기술연구원)

Process Comparison (Urban Oil Field)

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Non-traditional oil-conversion technology (the "non-combustion type")

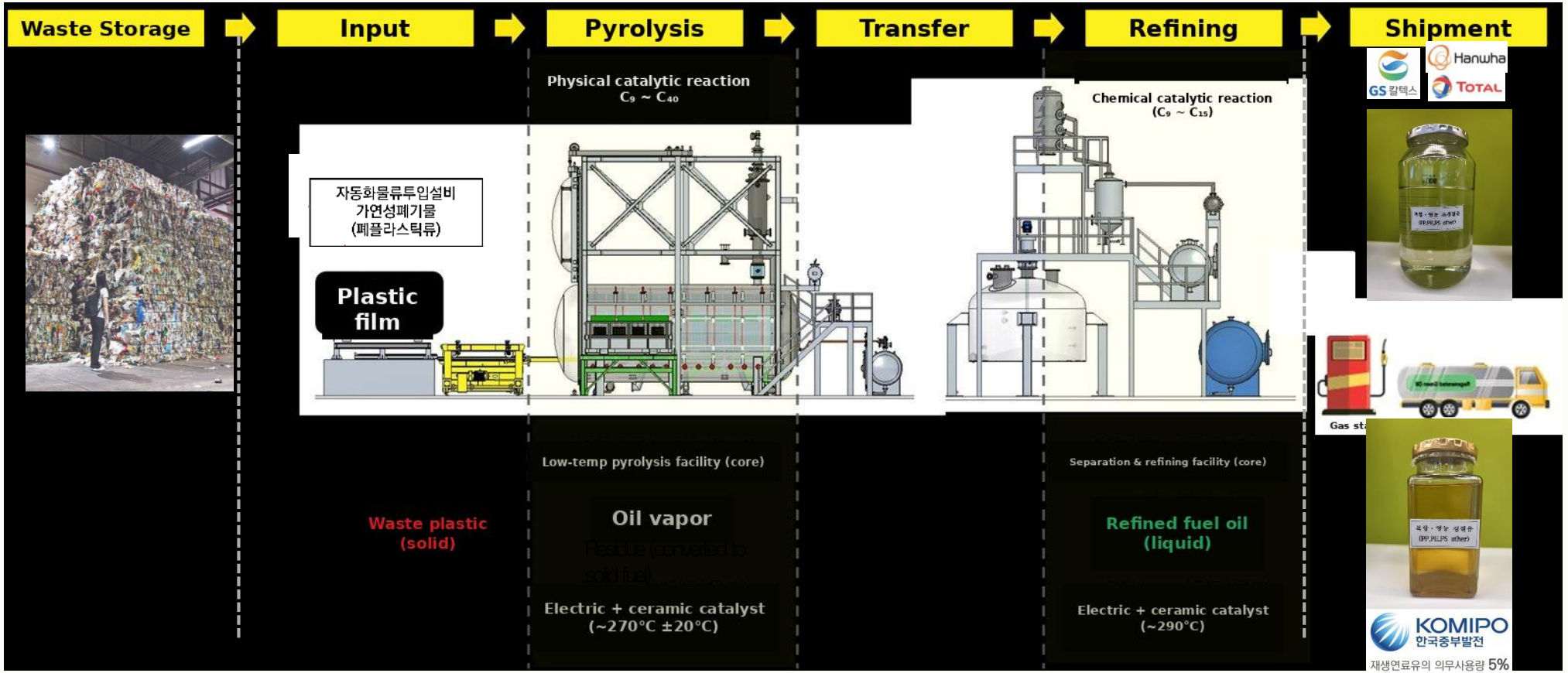
① **Fuel used: electric energy only**

② **Automated waste loading/unloading system: ensures waste quantification, worker safety, and equipment stability**

③ **Automated equipment-door opening/closing system: ensures worker safety and equipment stability**

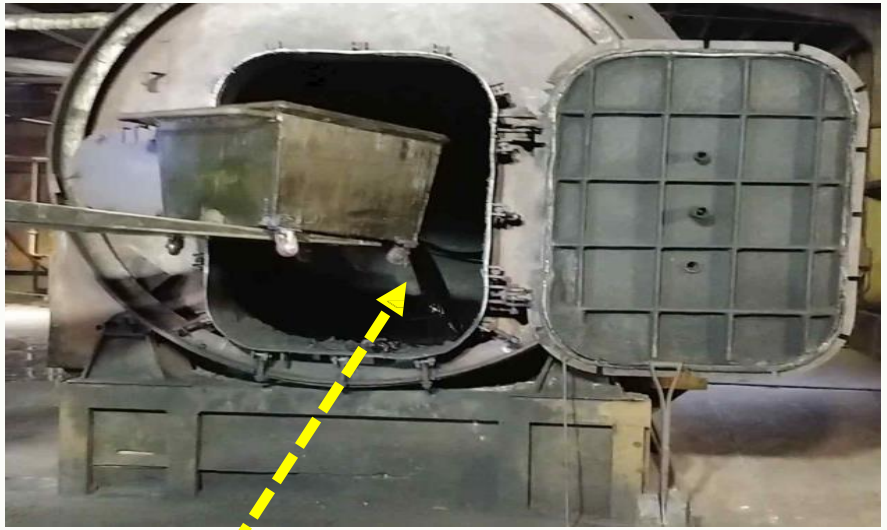
④ **Fixed type (no vibration, dust, or noise / easy maintenance)**

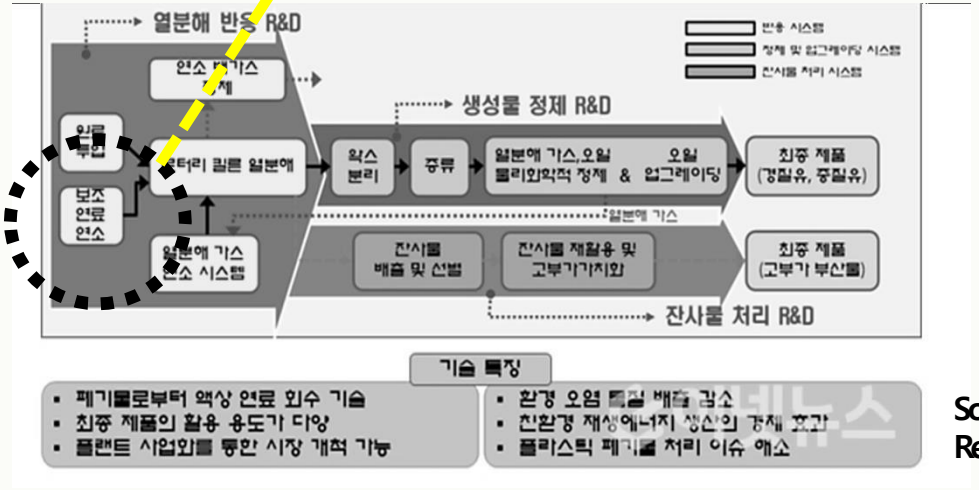
Yield: (EPR average) 40% / (agricultural waste) 80%



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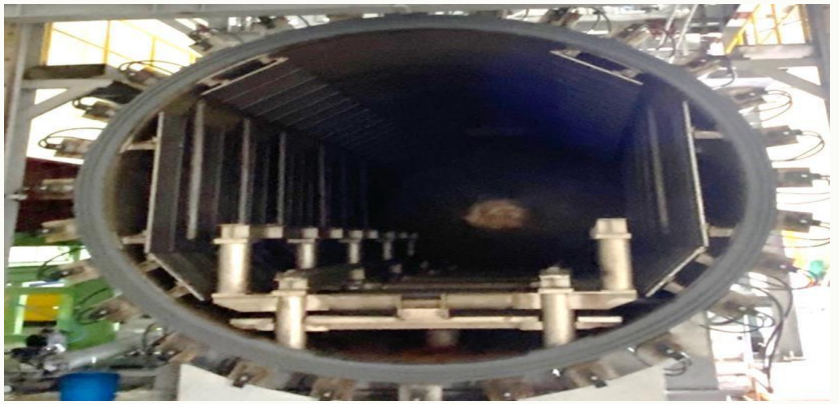
Traditional Oil-conversion Technology (Auxiliary fuel input, combustion type)





Source: Korea Institute of Energy Research (2021)

Non-traditional (Urban Oil Field) Oil-conversion Technology (Heater rods (electric) + ceramic balls, non-combustion type)



Urban Oil Field Co., Ltd.
No "auxiliary fuel" input

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Traditional Oil-conversion Technology (Equipment (forklift) · direct worker involvement)





Non-traditional (Urban Oil Field) Oil-conversion Technology (System automation, robot and PLC applied)



History of loading-method technoogy development (Urban Oil Field)

During the commercialization R&D period, attempts and experience with forklift (equipment)-based waste loading led to the conclusion that "quantitative waste input, accuracy, convenience, and worker safety" could not be secured. Therefore, an automated BOX-type + rail-type waste-loading method was developed and completed.











Traditional Oil-conversion Technology (Manual door opening/closing, direct worker involvement)



Non-traditional (Urban Oil Field) oil-conversion technology (door open/close system, PLC applied) — maximized worker safety, convenience, and management



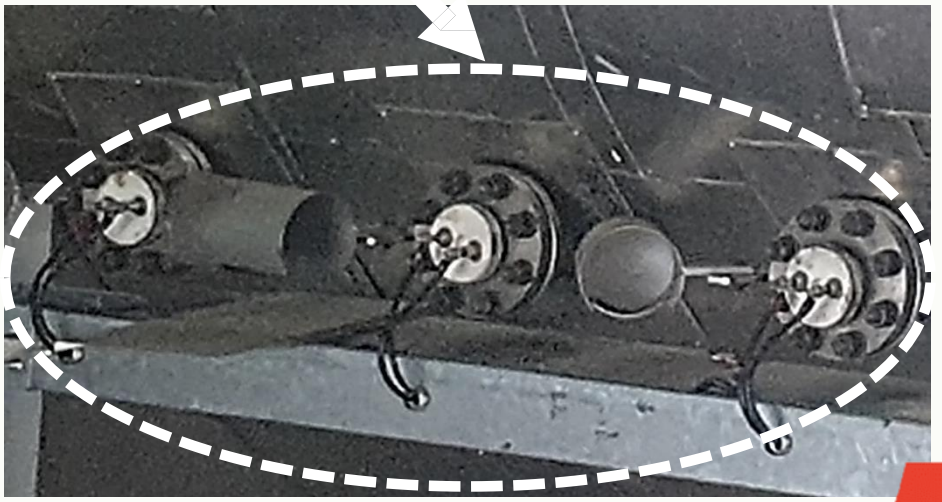
Traditional oil-conversion technology (combustion type, melting method, burner use)





Non-traditional (Urban Oil Field) oil-conversion technology (non-combustion type, electric energy only)





Resource Recovery Facility (Incineration Facility) Specification (Ministry of Environment)

1) Resource Recovery Facility

(A) Combustible Waste

A local government seeking to install a combustible-waste treatment facility must conduct a waste-characterization analysis of the waste generated within its treatment zone (analysis data by waste type, by source, and across the four seasons, etc.) in order to secure the appropriateness of the treatment method and the economic feasibility of the financial investment.

① Incineration facility (incl. pyrolysis-melting, gasification facilities, etc.)

- Areas installing a facility of 100 tons/day or more (300 days/year basis); even where unavoidable due to local conditions, areas installing a scale of preferably 50 tons/day or more.

※ Example of incineration capacity & budget (draft) estimation (mechanical treatment + incineration)

① Target waste generation: 46 tons/day

② Actual installed facilities & capacity: mechanical treatment facility (non-combustible removal, etc.) 62 tons/day + incineration facility 47 tons/day (incl. gasification facility)

③ Budget (draft) estimate (based on incineration capacity): 60 tons/day (46 t/d × 365 days ÷ 300 operating days ÷ 0.95 <operating rate, if needed>), 60 t/d × 310M won/ton = 18.6 billion won

→ Facility capacity is estimated as the pure furnace design capacity, excluding the capacity of mechanical-treatment facilities installed to raise incineration efficiency (e.g., if waste = 46 t/d, mechanical treatment = 62 t/d, incinerator = 47 t/d, then the incineration design capacity = 46 t/d).

- Priority support where the facility is installed in an area able to use, supply, and sell recovered steam, electricity, etc., via waste-heat recovery equipment.

※ Criteria for selecting the treatment method by local condition (draft)

① Areas where constant use of incineration waste-heat is easy → incinerate entire volume

② Areas that must produce heat & electricity seasonally

→ basic mechanical treatment (sorting non-combustibles such as cans), then incineration (waste heat converted to heat & electricity)

③ Areas where heat use is difficult

→ 1) mechanical treatment for homogeneity (separating non-combustibles & food waste), then incineration (power generation), or 2) RDF production

① Incineration facility (incl. pyrolysis-melting, gasification facilities, etc.)

- Areas installing a facility of 100 tons/day or more (300 days/year basis); even where unavoidable due to local conditions, areas installing a scale of preferably 50 tons/day or more.

■ **Clean Air Conservation Act Enforcement Rule [Table 3] <Amended Dec. 30, 2020>**

Air Pollutant-Emitting Facilities (re: Article 5)

1. Air pollutant-emitting facilities applicable until December 31, 2019

A. Criteria for applying emitting facilities

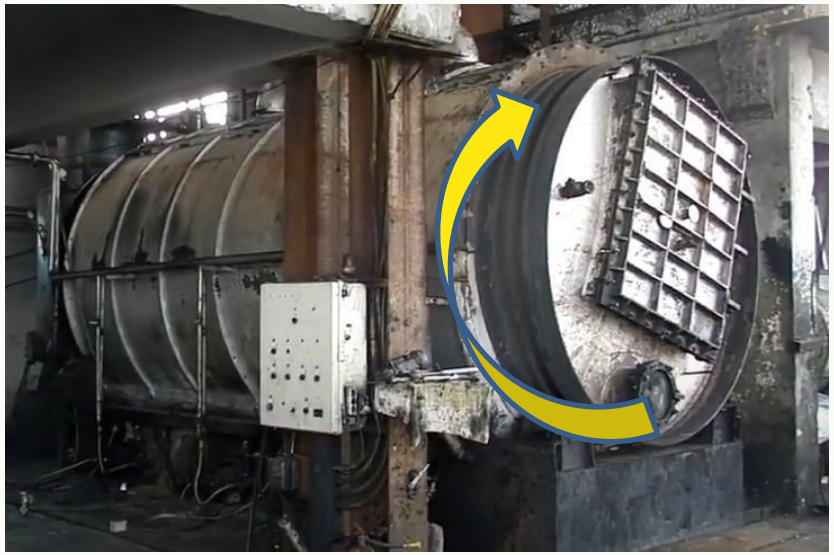
1) The scale of an emitting facility is based on the facility's weight, area, volume, heat output, power (kW), etc., taking the maximum facility scale. Where two or more facilities of the same kind below that scale (excluding storage facilities for solid particulate matter of 1 mm or more in diameter, and research facilities not run for business that the Mayor/Governor recognizes after considering surrounding environmental conditions) are installed at the same business site, and their total scale is at or above the scale specified in the target emitting-facility column of item B, those facilities are included as emitting facilities. However, where two or more emitting facilities are connected to a single power source and operate simultaneously, the scale of each is calculated in proportion to its power requirement.

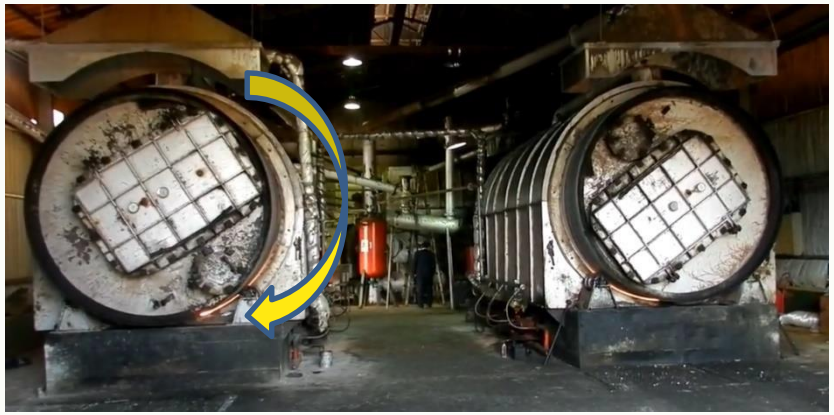
2) Notwithstanding item B, the following facilities are excluded from air pollutant-emitting facilities:

A) Indirect heating facilities that use electricity only

Guidelines on National Subsidy Budget Support and Integrated Administration for Waste Treatment Facilities (Feb 2013) _ Ministry of Environment

Traditional Oil-conversion Technology (Rotary kiln, rotary type)





Non-traditional (Urban Oil Field) Oil-conversion Technology (Fixed type, no vibration/noise/dust, easy maintenance, safe)



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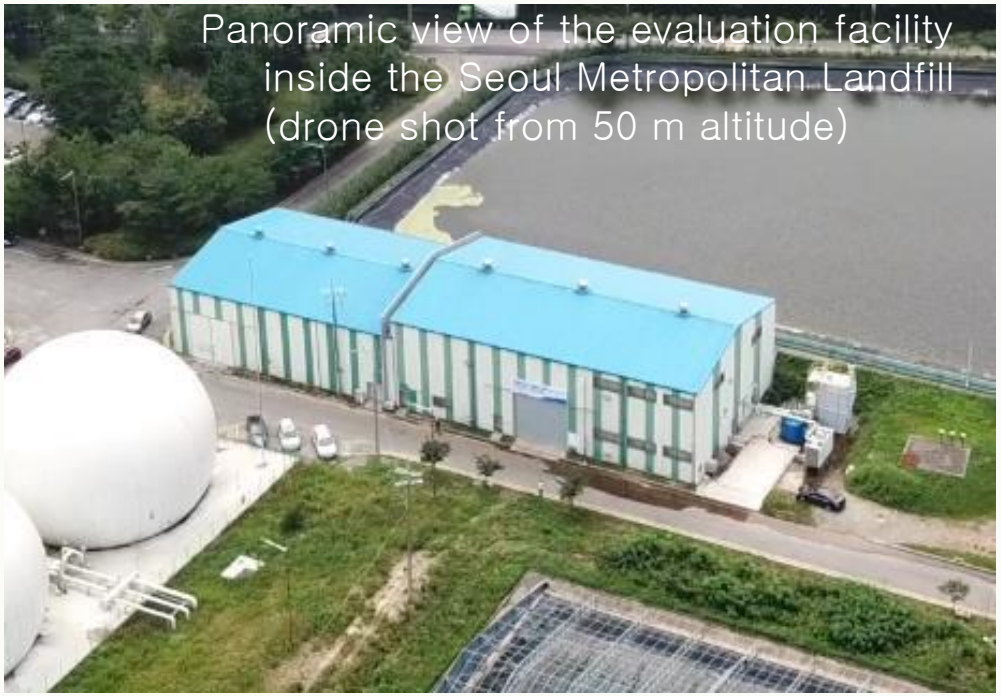
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Traditional Oil-conversion Technology (Combustion-type process, chimney (flue) required)



Non-traditional (Urban Oil Field) oil-conversion technology (indirect heating facility, electric energy only) — no chimney (flue)



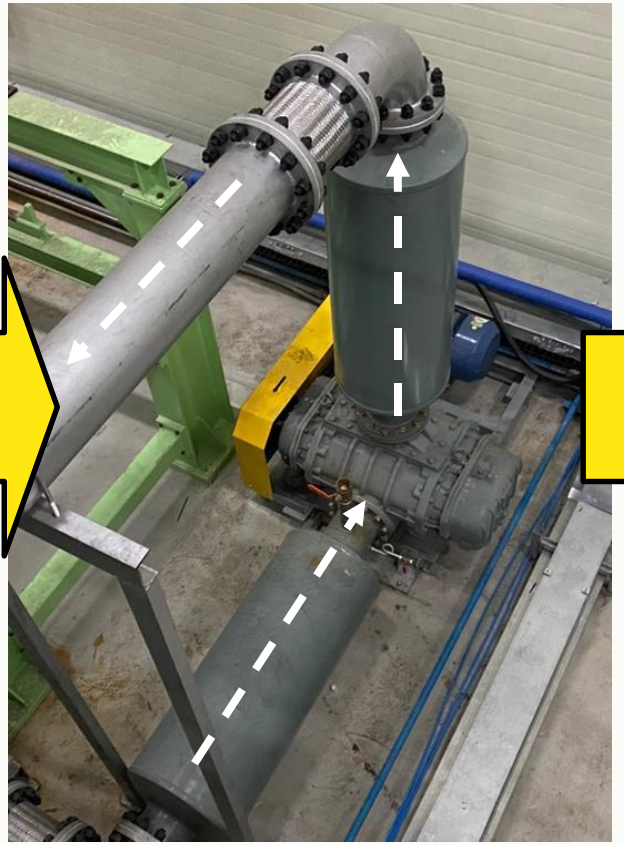
Panoramic view of the evaluation facility inside the Seoul Metropolitan Landfill (drone shot from 50 m altitude)

Traditional vs. Non-traditional (Urban Oil Field): Process Comparison

(After process completion, temperature is controlled using a blower (ensuring safety and stability) ▶ securing continuous-operation reliability)



Internal temperature OUT of the low-temperature decomposition facility
→ Water-cooled heat exchanger



Blower (Main-unit air-circulation device)



Controlled air temperature IN to the inside of the low-temperature decomposition facility

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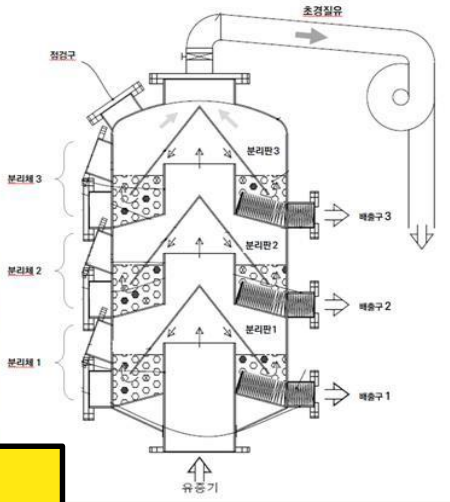
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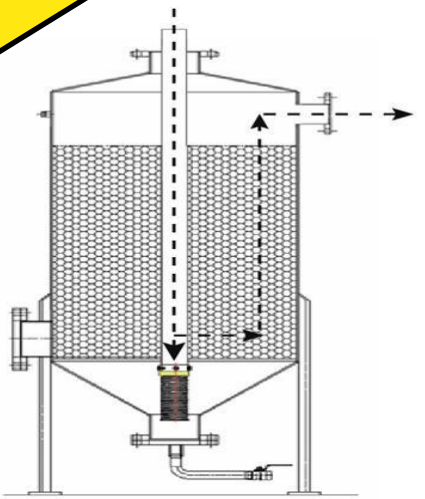
Separation/refining facility (distiller)

Separation/refining facility (1st refining facility): chemical catalytic reaction









Separation/refining facility (2nd refining facility): chemical catalytic reaction

Category	Oil-conversion Company	Urban Oil Field
Primary decomp. unit		
Secondary refining unit	None	

Refined Oil Comparison

Category	Oil-conversion Company	Urban Oil Field
Refined oil		

▶ Urban Oil Field can separately produce light oil and heavy oil: because the flash point can be adjusted,
it can supply the fuel oil that customers need.

Residue form
Why is it important?

▶ **Realizing a solution for "with what technology... and how" the residue will be treated in the future.**

Category	Oil-conversion Company	Urban Oil Field
Form		
Properties	Loss of shape due to high-temperature heat	Carbonized carbon (similar to charcoal) + non-ferrous metals + glass, etc.
Fuel recycling potential	No	Yes – higher quality than bituminous coal (calorific value of 5,000 kcal/kg or more)

Refined Fuel Oil Test Report

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Final refined, clean liquid light oil

Korea Petroleum Quality & Distribution Authority
Petroleum Technology Research Institute
www.kpetro.or.kr

(28115) 33, Yangcheong 3-gil, Ochang-eup, Cheongwon-gu, Cheongju-si, Chungcheongbuk-do
TEL: 043-240-7980
FAX: 043-240-7997

TEST RESULTS (COPY)

Report No.: TSC2018-0317W

Sample: [Dosiyujeon / Univ. of Ulsan] Analysis of recovered energy from the waste plastic of the R.G.O System

Test Item		Unit	Result	Test Method
Carbon residue (micro method)		(m/m) %	0.01	KS M ISO 10370:2015
Net calorific value		J/g	41,170	KS M 2057:2006
Gross calorific value		J/g	43,900	KS M 2057:2006
Sulfur content (ED-XRF)		(m/m) %	< 0.030	KS M ISO 8754:2016
Water content		(m/m) %	0.5	KS M 0010:2011
Water and sediment		(v/v) %	< 0.05	KS M ISO 3734:2011
Flash point (Pensky-Martens closed cup) (Method B)		°C	< 40.0	KS M ISO 2719:2003
Ash content		(m/m) %	0.001	KS M ISO 6245:2008
Metals	Cd	mg/kg	< 1	Inductively Coupled Plasma (ICP) atomic emission spectroscopy
	Cr	mg/kg	< 1	
	Pb	mg/kg	< 1	
	As	mg/kg	< 1	
Metals	Hg	mg/kg	< 1	Atomic absorption spectrometer (AAS)
Density (15°C)		kg/m³	809.9	ASTM D4052-16
Chlorine content		mg/kg	545	KS M 2457:2003

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- next page -

Refined Fuel Oil Quality Comparison

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RGO Refined fuel oil

Substances harmful to the human body ▶ below quality-standard values.
Energy calorific value ▶ high calorific value of 10,000 kcal or more

Category				Urban Oil Field Test Report (Issued by: Korea Petroleum Quality & Distribution Authority)	Quality standards under the Enforcement Rule of the Wastes Control Act (Source: Korea Petroleum Quality & Distribution Authority)		
Report No.				TSC2018-0317W	Recycled fuel oil	Refined fuel oil	Solid fuel (SRF)
Flash point			℃	Below 40.0		30.0 or more	
Pour point (Air/P)			℃	Below -48			
Density (15°C)			kg/m2	809.9			
Residual carbon			(m/m)%	0.01		0.15 or less	
Water and sediment			(v/v)%	Below 0.05		0.50 or less	
Ash (wt%)			(m/m)%	0.004		0.05 or less	20 or less
Sulfur (wt%)			(m/m)%	0.04	2.5 or less	0.20 or less	0.6 or less
Metals	Cd	Cadmium	mg/kg	Below 1	1 or less	1 or less	5.0 or less
	Cr	Chromium	mg/kg	Below 1	50 or less	1 or less	
	Pb	Lead	mg/kg	Below 1	100 or less	1 or less	150 or less
	As	Arsenic	mg/kg	Below 1	2 or less	1 or less	13.0 or less
	Hg	Mercury	mg/kg	Below 1	1.5 or less		1.0 or less
Elemental analysis	C	Carbon	(m/m)%	84.88			
	H	Hydrogen	(m/m)%	12..01			
	N	Nitrogen	(m/m)%	Below 0.75			
Calorific value		Net calorific value (kcal)		9,802			
		Gross calorific value (kcal)		10,452	3,500 or more		3,500 or more

Petroleum Product Analysis Comparison Table – Recycled Fuel Oil

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Category				Urban Oil Field Test Report (Issued by: Korea Petroleum Quality & Distribution Authority)				Quality standards for petroleum and alternative petroleum fuels (Source: Korea Petroleum Quality & Distribution Authority, 2016.05.21)				
Report No.				TSC2016-1061R	TSC2017-2991E	TSC2017-3036W	TSC2018-0317W	Diesel	Kerosene	Byproduct fuel oil	Refined fuel oil	High-temp. pyrolysis oil
Test completion date				2016.04.20	2017.08.16	2017.08.21	2018.02.09					
Flash point			℃	Below 40.0	Below 0.0 (Tag closed-cup)	Below 40.0	Below 40.0	40 or more	38 or more	40 or more	30 or more	30 or more
Pour point (Air/P)			℃	Below -57	Below -57	Below -57	-48	0.00 or less (Winter -17.5 or less)		-20 or less		
Density (15°C)			kg/m2	812	801.7	801.1	809.9	815 or more ~ 588 or less		850 or less		
Residual carbon in 10% residue			(m/m)%	0.07	0.06	0.03	0.01	0.15 or less		0.15 or less	0.15 or less	0.15 or less
Water and sediment			(v/v)%	Below 0.05	Below 0.005	Below 0.005	Below 0.05	0.02 or less	0.02 or less	0.01 or less	0.5 or less	0.5 or less
Ash (wt%)			(m/m)%	0.004	0.002	0.001	0.001	0.02 or less		0.02 or less	0.5 or less	0.5 or less
Sulfur (wt%)			(m/m)%	0.04	0.036	Below 0.030	Below 0.030	10 or less	0.01 or less	0.1 or less	0.2 or less	0.2 or less
Metals	Cd	Cadmium	mg/kg	Below 1	Below 1	Below 1	Below 1				1 or less	1 or less
	Cr	Chromium	mg/kg	Below 1	1	1	Below 1				1 or less	1 or less
	Pb	Lead	mg/kg	Below 1	Below 1	Below 1	Below 1				1 or less	1 or less
	As	Arsenic	mg/kg	Below 1	Below 1	Below 1	Below 1				1 or less	1 or less
	Hg	Mercury	mg/kg	Below 0.1	Below 1	Below 1	Below 1					
Elemental analysis	C	Carbon	(m/m)%	85.47	84.65	84.77	84.88					
	H	Hydrogen	(m/m)%	12.17	12.82	12.68	12..01					
	N	Nitrogen	(m/m)%	Below 0.75	Below 0.75	Below 0.75	Below 0.75					
Calorific value	Net calorific value (kcal/kg)			9,664	10,033	9,910	9.802	9,050	8,950			
	Gross calorific value (kcal/kg)			10,319	10,724	10,593	10,452	8,450	8,350			

Urban Oil Field / Competitor Economic Feasibility Analysis

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	Other pyrolysis oil-conversion companies (as posted on their website)	Urban Oil Field
Daily throughput (process)	10 tons/day	24 tons/day
Equipment type	Primary decomposition facility	Primary decomposition facility Secondary refining facility
Equipment and workspace	Approx. 160 pyeong (~530 m²)	Approx. 300 pyeong (~990 m²)
Process time	14–16 hours + (natural cooling) Blower cannot be installed because it is a rotary kiln (rotary type)	19 hours + (5 hours of cooling via blower) — blower can be installed because it is a fixed-bed sealed type
Reaction temperature	350~480℃	270±20℃
Final fuel oil	Kerosene/diesel grade	Naphtha, diesel grade
Yield	50%–80% (not specified)	40% (EPR) – 80% (PE, PP, PS)
Monthly operation count	18 times/month	25 times/month
Refined-oil sales revenue (per ton)	KRW 550,000	KRW 700,000
Monthly revenue	KRW 66.83 million	KRW 190 million

A company that adds energy to the environment

Urban Oil Field Co, Ltd. will lead the way.

Thank you