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Contact us:

Iranian The World of Petroleum and BitUMEN jOURNAL

Phone: +98 2633524014 – +98 2166988059 – +971 562634384

Managing Editor
Alireza farjam
Master's degree in structural engineering
Email: farjam@bitumenmag.com

Commercial Manager
Hoda Khoeiniha
Email:hkhoeiniha@bitumenmag.com

www.bitumenmag.com

+989192354148

To receive the journal monthly, please contact us through the following:
Email

info@bitumenmag.com

GREENVALE ENERGY'S ALPHA TORBANITE PROJECT SHOWS PROMISE FOR PREMIUM C170 BITUMEN PRODUCTION

- Greenvale Energy has demonstrated that with additional adjustments, its Alpha Torbanite resource can yield premium C170-grade bitumen.
- Testing led by the University of Jordan successfully identified the ideal conditions to enhance viscosity, bringing the product closer to C170 specifications.
- Bulk sampling may be considered to allow a more thorough analysis of bitumen characteristics.

In a recent study, Greenvale Energy has shown the potential to achieve high-quality C170 bitumen through optimized recovery methods from ore material within its Alpha Torbanite project, located in central Queensland.

Test Program 5, a controlled laboratory trial at the University of Jordan, revealed that refining the experimental conditions produced bitumen with a viscosity in line with C170-grade asphalt standards, addressing issues from the prior Test Program 4. The university suggested producing bulk samples under various reaction scenarios, following catalyst refinement, to better examine viscosity and other properties of the bitumen.

"These promising results from small-scale testing highlight the ability to recover bitumen with enhanced viscosity," said Mark Turner, CEO of Greenvale Energy. "We're now collaborating with the University of Jordan to decide on further steps, possibly leading to a larger bulk sampling program."

The Alpha Torbanite deposit, a high-quality resource holding up to 698 liters of hydrocarbons per tonne, has the potential to produce bitumen, a thick petroleum variant highly sought for infrastructure use. This could meet a ready demand in Australia, which imports over 1 million tonnes of the product

Greenvale Energy's Alpha Torbanite testing produces premium-grade bitumen

annually.

Test Program 5 Insights

Test Program 5 was initiated to address the challenges identified in Test Program 4, where the bitumen extracted from Alpha shales fell short of premium C170 specifications.

A blend of three formations—Cannelite L1, Torbanite LT, and Cannelite L2—from the Alpha site was used, with adjustments in temperature and pressure to maximize asphaltene yield. The application of various catalysts also helped improve the viscosity and penetration of asphaltene content.

The study examined the impact of catalysts, including the addition of iron and tin, on the liquefaction process, which boosted pre-asphaltene content under optimal conditions of 400°C and maximum pressure. While pressure increased viscosity, asphaltene content remained stable, with little change in bitumen density.

The University of Jordan pointed out that small sample sizes prevented penetration testing, which will proceed once larger bulk samples are gathered. The Greenvale Energy board will now review the findings of Test Program 5 to establish the next steps for the Alpha project.

SHANGHAI PORTS TO BREAK 50 MILLION CONTAINER BARRIER

MAYOR GONG ZHENG TOLD THE NORTH BUND FORUM, A SHIPPING INDUSTRY CONFERENCE, ON TUESDAY THAT SHANGHAI WOULD HANDLE MORE THAN 50 MILLION 20-FOOT EQUIVALENT UNIT (TEU) CONTAINERS THIS YEAR, ENOUGH TO HELP THE CITY RETAIN ITS CROWN AS THE WORLD'S NO. 1 CONTAINER PORT.

Shanghai's ports are on track to surpass 50 million containers in 2024, setting a new record in global shipping. To support this growth, the city is boosting investments in infrastructure and technology and is easing restrictions on its finance sector to appeal to international shipping companies.

This expansion is happening despite a decline in China's exports, which have dropped for four consecutive months, and amid a shipping industry landscape filled with uncertainties due to rising geopolitical tensions and recession concerns in some parts of the world economy.

At the North Bund Forum, a conference for the shipping industry, Mayor Gong Zheng announced that Shanghai would process more than 50 million 20-foot equivalent units (TEU) this year, ensuring it remains the world's leading container port.

"Shanghai will be the first city globally to surpass the 50-million TEU mark," Gong stated, noting that the government will continue to allocate resources toward making Shanghai an international shipping hub.

Last year, Shanghai managed 49.16 million TEUs, a 3.9 percent increase over 2022, maintaining its status as the largest container port globally since it overtook Singapore in 2010. From January to September 2024, the city handled 39.1 million TEUs, marking an 8 percent rise from the same period last year.

SOUTHEAST ASIA POISED TO BECOME AN ENERGY GIANT OVER THE NEXT DECADE

The International Energy Agency (IEA) reports that Southeast Asia is set to play an increasingly significant role in the world's energy landscape over the next ten years. As the region experiences rapid population growth and widespread industrialization, it will substantially impact both energy production and global demand. Emerging economies like Vietnam, Thailand, and Malaysia are expected to become key players in the global energy market in the coming years, though they will require increased financial support to meet their climate targets.

The IEA's sixth Southeast Asia Energy Outlook analyzes energy developments across Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam.

The report projects that Southeast Asia will emerge as one of the highest-demand regions for energy worldwide, driven by swift economic growth, population increase, and manufacturing expansion. This rising demand is likely to challenge the region's energy security and motivate governments to develop and diversify energy sources. From 2024 to 2035, Southeast Asia is expected to account for 25% of the world's increase in energy demand, with electricity consumption forecasted to grow at around 4% annually.

Renewable energy sources such as wind, solar, bioenergy, and geothermal are expected to meet over a third of the region's electricity needs by 2035. However, despite this renewable expansion, the region will likely continue depending on fossil fuels to meet its high energy demands. The IEA anticipates a 35% rise in Southeast Asia's CO2 emissions between 2024 and 2050.

IEA Executive Director Fatih Birol noted, "Countries in the region have a broad mix of energy sources, including highly competitive renewables. Yet, the pace of clean energy deployment is not fast enough, and heavy reliance on fossil fuel imports increases future risks. While Southeast Asia has made strides in areas such as energy access, clean cooking, and clean energy production, it must now accelerate domestic clean energy deployment. Securing finance and investment for the region's fast-growing economies will be critical to strengthening energy security and fulfilling emissions reduction commitments."

Among the 10 ASEAN nations, eight have pledged net-zero emissions targets, reflecting a commitment to green transition. To achieve these goals, the IEA advises an

The IEA's sixth Southeast Asia Energy Outlook analyzes energy developments across Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam.

increase in foreign investment, as the region currently attracts only 2% of global clean energy investment. This figure would need to grow fivefold to $190 billion by 2035 to support the region's climate objectives. This effort should be complemented by national emissions reduction strategies, especially with a focus on reducing emissions from the coal sector. Upgrading and expanding the regional grid system will also require substantial investment.

China remains a leading force in global energy production and demand, but several often-overlooked Southeast Asian economies are also becoming influential in global energy forecasts. Many countries in the region remain heavily dependent on fossil fuels, particularly coal. The Indonesian Coal Miners Association reported in September that Southeast Asian countries, including Vietnam and the Philippines, are likely to increase annual coal imports by nearly 3% annually from 140.9 million tonnes in 2023 to 170.9 million tonnes by 2030.

While coal use and imports are set to rise, renewable energy capacity across the region is also expected to grow. Vietnam is projected to continue leading as Southeast Asia's largest renewable energy market, with Indonesia and the Philippines following. However, the anticipated doubling of renewable capacity by 2030 falls short compared to global trends and does not fully meet the demand growth, according to the IEA report.

The growth of Indonesia's renewable energy sector will be closely tied to expected high levels of foreign investment. In November 2023, Indonesia launched its Comprehensive Investment and Policy Plan (CIPP) as part of the Just Energy Transition Partnership (JETP), reflecting its commitment to expanding renewable energy by 2050.

The International Partners Group and the Glasgow Financial Alliance for Net Zero have committed $21.6 billion to support the CIPP, aimed at significantly reducing Indonesia's grid emissions and increasing green energy capacity. This initiative highlights how increased foreign investment can drive Southeast Asia's green transition, potentially achieving goals that might otherwise be unreachable in the coming decades.

JAPANESE MARITIME COMPANIES UNVEIL PLANS FOR ENVIRONMENTALLY FRIENDLY VLCC TANKER

In 2024, four key companies in Japan's maritime industry collaborated on designing a sustainable VLCC (Very Large Crude Carrier) with enhanced environmental standards. Their objective was to create a vessel that surpasses current regulatory benchmarks, with a goal to cut emissions by over 40 percent.

The consortium, consisting of Idemitsu Tanker Co., IINO Kaiun Kaisha (IINO Lines), Nippon Yusen Kabushiki Kaisha (NYK), and Nihon Shipyard Co., introduced a concept for a 309,000 deadweight ton tanker, 1,114 feet (339.5 meters) in length. They anticipate this design will achieve a 40-percent-plus reduction in emissions compared to today's larger tankers.

The proposed vessel incorporates the latest dual-fuel engine technology, capable of operating on both methanol and heavy oil, enhancing fuel versatility and environmental performance. To further improve efficiency and lower emissions, shaft generators were included in the design. Additionally, provisions were made for wind-assisted propulsion as an optional feature, along with onboard carbon capture and storage technology.

The project was initiated by Idemitsu Tanker Co., which gathered industry partners and a leading shipbuilder to jointly explore the vessel's design, machinery, and environmental technologies, all aimed at achieving what they term the "Malacca Max VLCC."

Given that Japan sources about 89 percent of its oil from the Middle East, a priority was to develop a tanker large enough to navigate the Strait of Malacca, a vital trade route for transporting oil to Japan.

While conventional Phase III VLCC designs typically achieve around a 30 percent reduction in emissions, this project aims for a 40 percent or more reduction. Methanol alone is expected to reduce emissions by 15 percent relative to traditional fuels. Furthermore, the use of green methanol, including bio-methanol from biomass and e-methanol made from renewable hydrogen and CO2 capture, could potentially bring CO2 emissions down to net zero.

The companies plan to continue refining the design concept through additional research, with phased construction of these eco-friendly tankers planned to meet future demand for crude oil transport to Japanese refineries.

ISRAEL MIGHT TARGET IRAN'S OIL FACILITIES, AND WHILE THE ENERGY MARKETS ARE AWARE OF THIS POSSIBILITY, THEY ARE NOT REACTING WITH ALARM.

A potential Israeli strike on Iran's oil infrastructure has caught the attention of energy markets, though there's no sense of immediate alarm. President Biden's recent comments hinted at this possibility, which briefly impacted the oil sector. Still, the global oil supply is now more flexible and diversified, reducing the threat of severe disruptions.

Iran's new $2 billion refinery in Bandar-Abbas aims to make the country a significant refined petroleum exporter while addressing domestic needs. However, growing tensions between Israel and Iran are testing the resilience of energy markets against potential upheaval in the Middle East. Historically, conflicts in this resource-rich area have often shaken oil prices and affected economies. Yet recent skirmishes in the region are prompting a more subdued response, which is helpful for the Biden administration, facing criticism over fuel prices and trying to manage the fallout from Iran's recent missile launch into Israel.

Expanded oil production from the U.S., Brazil, and other countries over the past two decades has diversified the global energy supply, lessening dependence on Middle Eastern oil that Iran could potentially disrupt. Despite a brief price increase following Biden's comments, analysts note that oil prices have been more stable lately, demonstrating that the market can compensate for supply gaps.

As the conflict progresses, the durability of the oil market might be put to the test if Israel retaliates further. This could involve attacks on Iran's oil or nuclear sites, which might provoke Iran to target other facilities, such as those in Saudi Arabia, or even close key shipping routes in the Persian Gulf.

Asked if he would back an Israeli strike on Iran's oil

assets, Biden noted that discussions are ongoing without an immediate resolution. Oil traders have responded with caution. Prices initially spiked when rumors of an impending Iranian missile strike circulated, but they soon stabilized. They rose again briefly after Biden's comments but remained below summer peaks.

Experts suggest that even if hostilities spread to nearby oil-producing nations, oil would likely rise only modestly, perhaps reaching around $100 a barrel—impacting U.S. gasoline prices somewhat, but not to unprecedented levels. Increased American and South American production has helped offset Middle Eastern supply risks, and China's recent softer fuel demand has further moderated global prices. Additionally, countries like Saudi Arabia and the UAE maintain spare capacity, ready to fill any shortfalls if needed.

Following Russia's invasion of Ukraine, the Biden administration has taken steps to shield American consumers from oil market turmoil by crafting sanctions to exempt Russian oil at certain prices and deploying military resources to secure oil transit routes in the Middle East. Saudi Arabia appears more concerned about price declines rather than jumps, focusing on ensuring OPEC+ members adhere to production limits.

If Iran were to attack Saudi Arabia in retaliation, prices could rise significantly. Otherwise, experts believe the conflict's impact on oil prices would remain contained. Analysts emphasize that even a substantial reduction in Iran's output would barely dent a global market consuming 100 million barrels daily, which could be balanced by reserves from the U.S. or China.

The U.S. government has also been replenishing its Strategic Petroleum Reserve, which was heavily drawn upon in 2022 to stabilize prices amid the Ukraine crisis. Current reserve levels are about half of full capacity, which has drawn political criticism but still offers a buffer against supply disruptions. Experts estimate that an isolated impact on Iranian oil could push prices modestly, while any closure of the Strait of Hormuz might see prices reach higher but manageable levels.

Energy markets have adapted since the oil shocks of the 1970s. For example, after Iran's attack on Saudi oil infrastructure in 2019 briefly affected prices, the market quickly recovered. Today's supply chain is more resilient, suggesting that even a significant escalation in Middle Eastern hostilities might be absorbed without drastic global economic impacts.

Types of Asphalt Packaging and Their Applications in the Chinese Market

AHMAD REZA YOUSEFI- RAZIEH GILANI
INFINITY GALAXY

Ahmad Reza Yousefi, the managing director of Infinity Galaxy and a PhD candidate in international entrepreneurship, possesses over a decade of experience in the export of asphalt and petrochemicals. He leads a dynamic and committed team with a vision to enhance his country's economy through exports.
He places a strong emphasis on building trust with clients and delivering exceptional service. For the past three years, he has actively kept his clients updated on industry developments, trends, and market insights to help them make informed business decisions.
Infinity Galaxy also has a specialized team dedicated to East Asian markets, offering customized support to importers, enabling them to make timely and informed choices.

Razieh Gilani, the export manager at Infinity Galaxy, has over eight years of experience in analyzing and consulting on the asphalt market. With a specialization in the export, trade, and shipping of asphalt and petrochemicals, she concentrates on markets in Africa, China, India, and East Asia.
For the past 200 weeks, she has been delivering valuable market analyses to help industry stakeholders make informed decisions based on the latest trends. Working alongside a dedicated team of professionals with extensive commercial expertise, she effectively addresses market challenges by providing deep insights and strategic guidance.

Review on the Different Types of Asphalt Packing

Given the high demand for asphalt in China, the superior quality of Iranian asphalt, and its reasonable and acceptable price in global markets, particularly China, the Iranian asphalt market has always been attractive to Chinese buyers. In previous articles published by Infinity Galaxy in various magazines, the pricing of Iranian asphalt in Southeast Asian markets was extensively discussed. This article aims to explore the types of available packaging for asphalt and the most popular ones used in China.

Asphalt is a liquid product with high viscosity; therefore, its packaging is very important considering factors such as cost, environmental conditions, storage, and transportation. Asphalt packaging is mainly divided into four different types: bulk, jumbo bags, flexitanks, and new steel drums. The best type of packaging is chosen based on buyers' needs and factors such as target market, transportation conditions, and the volume and weight of the asphalt.

1. Bulk Asphalt:

Bulk asphalt refers to asphalt that is supplied in large quantities without specific packaging like drums or jumbo bags and is mainly used in large construction and civil engineering projects. Purchasing asphalt in bulk typically incurs lower costs compared to buying

it in drums because packaging and transportation costs are reduced. Using bulk asphalt decreases the need for additional packaging, which helps reduce waste and environmental impact. This type of asphalt can be easily transferred to the consumption site through pumps, increasing work efficiency.

Transporting bulk asphalt requires trucks that pick up the asphalt from the refinery and transfer it to a bulk carrier at the port. Upon arrival at its destination, another truck collects the asphalt and delivers it to the project site or asphalt storage facility.

The highest demand from Chinese companies is for bulk asphalt; however, due to the long geographical distance between Iran and China, loading must be done onto mother vessels. Given the sanctions, these vessels do not enter the Persian Gulf, making bulk loading practically impossible. Even if a mother vessel is arranged, there are significant potential costs and risks involved.

2. Jumbo Bags:

The 1MT jumbo bag packaging, which encloses the asphalt with a wooden pallet and metal cage, is among the most popular types of asphalt packaging in China. This packaging is considered one of the effective and economical methods for transporting and storing asphalt. Its reasonable price and ease of use have made it very popular in various markets, including China. Unlike drums, using jumbo bags reduces asphalt waste by about 3 to 4 percent.

To unload asphalt from a drum, it must be heated before unloading. However, with a jumbo bag, it is sufficient to tear the outer layer from the bottom and pour the asphalt into the furnace. The plastic layer inside the jumbo bag is double-layered and resistant to hot asphalt; thus, when the asphalt enters it, the jumbo bag does not melt. Once the asphalt inside the jumbo bag has cooled sufficiently, it is ready for loading into a container. Many jumbo bags are made from recyclable materials, contributing to environmental preservation.

In each 20-foot container, 20 1MT jumbo bags are loaded in two tiers. The metal frame of the jumbo bags on the lower tier is more robust than those on the upper tier to withstand pressure without tearing or leaking.

Another type of jumbo bag is the 300KG jumbo bag; however, demand for this packaging in the

Chinese market is nearly zero as Chinese buyers prefer larger and more efficient packaging options.

The specification of different sizes of jumbo bags can be seen in the below table:

Jumbo Bag Specification

Type of Jumbo Bag	Dimensions	Height	Description
Bag 300 kg	100*55*55 cm	55 cm	–
Bag 1 MT	100*105*105 cm	100 cm	Placed in a steel cage on a wooden pallet, with dimensions of 100*105*105 cm.
Bag 1.3 MT	140*101*101 cm	140 cm	Placed on a wooden pallet and contains an interior metal frame.

3. New Steel Drums:

Another packaging option is new steel drums, which are among the most common due to their safety and consistent quality. These drums vary depending on the volume of asphalt, height, thickness, and lid size. The thickness of the drum body is 6 mm. Although new steel drums offer high transport safety, they are more expensive compared to other packaging options.

The most common type is 180KG long drum, which typically accommodates 110 new steel drums per 20-foot container, with a total loading capacity of about 20 tons for this number of drums. This type of packaging is not popular in the Chinese market due to environmental concerns and significant waste issues that deter Chinese buyers.

The specifications of various types of new steel drums are shown in the table below:

New Steel Drums Specification

Specification	Long New Steel Drum 180 kg	Short New Steel Drum 150 kg	Short New Steel Drum- big lid 156 kg
Material	New Cold Rolled Steel	New Cold Rolled Steel	New Cold Rolled Steel
Height (mm)	980	860	890
Diameter (mm)	500	500	500
Body thickness (mm)	6	6	6
Top/Base thickness (mm)	6	6	6
Net weight (kg) ± 2.5	182	150	156
Gross weight (kg) ±2.5	192	158	164
Empty drum weight(kg) ±1	9.5	8.5	8.5
Lid (a removable cover on the top of a drum)	11	11	17

4. Flexitank

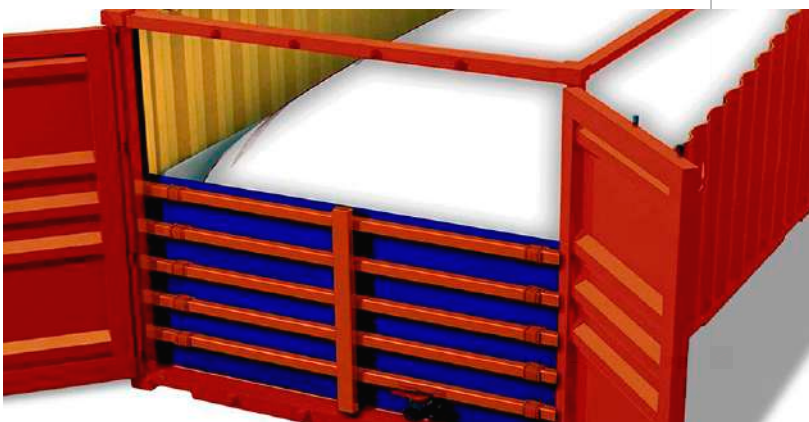
A flexitank is a type of flexible container used for transporting non-corrosive liquids, such as asphalt. This type of packaging has gained significant popularity among Chinese buyers due to its lightweight, ease of transport, and cost savings.

Flexitanks are typically made from multi-layer plastic materials that offer good resistance to the heat of asphalt and can withstand high temperatures. To unload this packaging at its destination, special facilities are required to ensure complete unloading without any asphalt wastage. Due to their flexible design, flexitanks occupy very little space after the contents are emptied and are easy to move.

Most of the requests currently coming from the Chinese market to Iran are related to asphalt 200/300, with buyers preferring this asphalt in jumbo bag or flexitank packaging. However, since this type of asphalt is very liquid, the risk of transporting it and the danger of bursting the jumbo bag or flexitank is quite high. Therefore, the best packaging for this type of asphalt is new steel drums.

As a result, choosing the appropriate type of packaging for asphalt not only affects the quality of transportation but also impacts costs and customer satisfaction. Thus, accurately understanding market needs and selecting suitable packaging is of particular importance.

For more information on various packaging types and pricing, you can visit the Infinity Galaxy website at www.infinitygalaxy.org.



German airport tests out cashew-based asphalt in green push

BY WPB

A German airport is experimenting with asphalt made from cashew shells as part of its environmental sustainability efforts.

Workers are paving a runway at Germany's Frankfurt Airport using an innovative material sourced from cashew shells. This eco-friendly asphalt concrete, tested as part of Frankfurt Airport's sustainability efforts, aligns with its aim to reach zero carbon emissions within the next two decades.

Traditional asphalt concrete combines bitumen—a residue from refining crude oil—with aggregate materials. However, German start-up B2SQUARE has developed a more environmentally-friendly version, named "BioBitumen." According to the airport, this organic bitumen is created by blending a natural hydrocarbon resin with a cashew shell extract.

Axel Konrad, project manager at Frankfurt Airport Services, highlights two major advantages: quality and carbon impact. "First, we expect a much higher quality from this organic bitumen, as it avoids the quality inconsistencies often found with oil-based bitumen. Secondly, we anticipate that this material will lead to at least a carbon-neutral road surface," Konrad explained.

B2SQUARE claims that BioBitumen can sequester approximately 3,400 pounds of CO2 for every 2,200 pounds of bitumen produced due to the carbon captured in the cashew shells. Additionally, they report that this bio-based bitumen lasts up to ten times longer than its conventional counterpart.

To assess the performance of both materials, Frankfurt Airport has paved one side of a 650-foot road with bioasphalt and the other with regular asphalt. A successful trial could see bioasphalt playing a significant role in the airport's environmental transformation.

The 16th Iranian Bitumen, Asphalt and Machinery

Chinese company signs agreement to develop Iraqi oil field

CNOOC has announced that it has signed an exploration, development, and production agreement with the state-owned Midland Oil Company to explore petroleum and gas in Iraq's "Block 7" field.

According to ISNA, CNOOC Africa Holding, a fully-owned subsidiary of CNOOC, will hold a 100% stake and act as the operator for the 6,300-square-kilometer Block 7, located in Iraq's Diwaniyah province. This contract formalizes CNOOC's win in the tender for the exploration of this block
. To attract international companies, the Iraqi government has shifted from its previous technical service contracts and is now offering profit-sharing agreements instead.
CNOOC announced that the initial exploration phase is expected to take three years. The company, a major international petroleum producer in Iraq, has primarily focused its operations in the Maysan field in southeastern Iraq.

According to Reuters, a senior CNOOC official stated in August that Block 7 has the potential for a major discovery, and the company follows high standards in selecting new international investment opportunities outside China.

Kazakhstan could import 500,000 tonnes of bitumen from Russia in 2024 - ministry

According to ministry sources, Kazakhstan has the capacity to produce 1.2 million tonnes of bitumen annually, though real output falls short due to limited raw material availability. This year, demand stands at approximately 1 million tonnes, which is also projected for 2025. Local production should be able to meet this future demand.

The ministry added that it intends to engage in fresh discussions with Russian officials to agree on a supply plan for 2025. While the ministry acknowledged current production challenges, it emphasized that Kazakhstan is not necessarily facing a bitumen shortage.

What happened at the 16th Iranian Bitumen, Asphalt and Machinery Conference and Exhibition?

16th Bitumen & Asphalt ...

Conference and Exhibition was inaugurated by Iran's Minister of Roads on October 29, 2024 in Tehran. This bitumen and asphalt conference, considered one of Iran's largest national events in this field, annually hosts the country's leading producers, contractors, and stakeholders in bitumen and asphalt. Key topics in the conference included reviewing specialized and scientific papers by university professors, and offering scientific solutions and examining technical and operational aspects with a focus on the need for adopting modern technologies and artificial intelligence.

The showcase of capabilities by private-sector manufacturers and distributors in this industry is also a notable aspect of this annual conference.

Experts believe that adherence to guidelines, regulations, and standards in the production and implementation of products is essential. This process must be standardized from start to finish, covering every step from design to the final stages of execution and operation. Additionally, the impact of overloading in transportation, which affects pavement integrity and load-bearing capacity, must be carefully considered and managed.

The need for comprehensive oversight in many asphalt projects helps prevent reliance solely on factories and ensures that materials remain consistent throughout the execution phase. For PG (Performance Grade) bitumen, there was a discussion on whether the exact specified bitumen is being supplied to projects or if it varies. In recent years, experience has shown that shifting towards modified bitumen is beneficial, as it significantly extends the useful lifespan of projects. In Iran, about one-third of the country's bitumen production is allocated to government agencies, with approximately two million tons consumed domestically and another four million tons exported annually.

Mohammad Mahdi Heidari, head of the Road, Housing, and Urban Development Research Center and organizer of the conference, commented on the poor condition of the roads. He noted that, given limited resources and the significant gap between Iran's maintenance costs and the global average, substantial efforts are being made in research centers to bridge this financial gap by employing advanced technologies to help offset some of this imbalance.

He stated that the most important initiative of the Research Center in recent years regarding bitumen and asphalt production has been the issuance of technical certifications, an area that also requires dedicated focus for asphalt factories. Last year, approximately 10 bitumen factories lacked laboratory facilities, but thanks to follow-ups, all of these factories are now equipped with suitable laboratory standards.

Regarding bitumen transportation, he highlighted the addition of smart transport systems to ensure the delivery of high-quality bitumen to asphalt plants. With recent grading standards introduced, he announced that an A+ grade has been added

to the rankings for bitumen production factories. Heidari further noted a successful application of the PCI (Pavement Condition Index) model in Iran's Yazd province on the Ardakan to Naein route. This project, which has yielded positive results over the past 12 years, underscores the importance of relying on advanced knowledge and modern technologies.

Additionally, Davoud Mohammadi, head of the Iran Bitumen Association and honored at the conference as Iran's Distinguished Bitumen Figure of 2024, spoke in a panel on implementing a smart bitumen transport system. He recounted the history of the association, explaining that since 2016, there was a felt need to establish an organization to address the industry's professional demands. After continued efforts, the Ministry of Interior granted permission to establish the Iran Bitumen Association in 2019, and today it includes 75 domestic and export-oriented bitumen producers as members.

He highlighted the advantages of bitumen exports, noting that despite the numerous challenges and issues facing the country, bitumen production units contribute approximately $2 billion in annual foreign currency revenue for Iran.

The head of the Iran Bitumen Association noted the various applications of bitumen, stating that its primary use is in road construction projects, with a smaller portion also used in the production of waterproofing membranes (known as isogam in Iran).
Mohammadi then addressed the challenges faced by the Iran Bitumen Association, stating that the country's bitumen production units had claims against the government. One significant issue was a claim of 1,000 billion tomans, which was pursued and eventually settled with the establishment of the association.

He added that one of the current issues facing the association is the currency imbalance, which has been addressed through interactions with the Central Bank of Iran, with an agreement in place to resolve this problem.

The head of the Iran Bitumen Association remarked on the state of bitumen production in the country, stating that before 2011, bitumen was produced and transported traditionally, which led to numerous problems, including issues with heating and a decline in bitumen quality. However, following 2011, and with the implementation of mandatory regulations from the Research Center requiring companies to use double-walled tankers, these issues have been resolved. Currently, there are over 4,000 double-walled tankers in the country.

Mohammadi also discussed the smart bitumen monitoring system, noting that with the support of the management at the Research Center, starting from 2024, every producer is required to equip their bitumen transport tankers with laboratory sheets and subsequently send the bitumen to asphalt plants.

In conclusion, he highlighted the outlook for the 16th Bitumen, Asphalt and Machinery Conference and Exhibition, stating that the presence of bitumen production units at the exhibition has tripled compared to 16 years ago.

This is very encouraging, as, despite the numerous challenges and problems, there has been consistent collaboration with the Ministry of Roads, Housing, and Urban Development whenever there has been a need for bitumen.

Seyed Hossein Mirshafi', advisor and representative of the Minister of Roads and Urban Development for infrastructure affairs, stated at the closing ceremony of the 16th Bitumen, Asphalt and Machinery Conference and Exhibition: "Each year, we witness improved initiatives at the exhibition, and it is a point of pride that the combination of youth and experience has been achieved in this field, which effectively contributes to its dynamism."

He continued: "In the Road Maintenance and Transportation Organization, which consumes the most bitumen and asphalt, there is also a noticeable youthful spirit that embraces new methods. The

use of thin asphalt and new technologies promises high-quality asphalt and a reduction in project costs. The advisor and representative of the Minister of Roads and Urban Development for infrastructure affairs emphasized that, despite successes in this field, there are still challenges that need to be addressed. One significant issue is the shortage of resources and the lack of order in project funding, which adversely affects execution quality and reduces fixed investments.

Mirshafi' noted that in recent years, bitumen has been supplied in a centralized manner outside of the government's allocation, leading to improvements in this area. He expressed hope that contractors' claims will be settled and that both employer and supervisory entities will ensure the quality of operations. He also pointed out weaknesses in quality assurance, emphasizing that while there are not many regulatory issues in the execution phase, the guidelines are not updated timely.

The main concern lies in the implementation of these regulations, as there is a lack of skilled technicians in the field. There are deficiencies from workers to asphalt plant operators, and resistance exists in the machinery sector, where, despite significant investments in infrastructure, the necessary tools are not being provided.

the 16th Iranian Bitumen, Asphalt and Machinery Conference and Exhibition

THE FUTURE OF GREEN ROADS: EXPLORING BIO-BITUMEN FOR SUSTAINABLE INFRASTRUCTURE

The non-renewable nature of bitumen and its increasing consumption pose a significant challenge in infrastructure development, particularly in constructing and maintaining asphalt roads. To address this issue, sustainable approaches are essential.

Substantial efforts have been made to enhance the resilience, sustainability, and circular nature of asphalt pavements. One promising solution is the use of bio-based materials. This article provides a comprehensive review of the current advancements in bio-bitumen development, focusing on wood-based oils, waste cooking oils, and bio-bitumen from manure. It is evident that bio-oils currently used are more effective as additives, such as softeners, rejuvenators, or modifiers, rather than as full replacements for binders. One of the most promising roles for bio-oils is as rejuvenators, with potential antioxidant properties.

Incorporating polymers into bio-oils is another viable method to improve bio-bitumen's performance. However, caution is needed when producing bio-bitumen due to potential compatibility issues that could affect performance, and this should be carefully managed.

1. Introduction

Bitumen, a by-product of refining petroleum, has been widely used since its discovery. Over time, its applications have grown alongside technological advancements. Today, asphalt plays a key role in industries like road construction, building, and waterproofing roofs. A significant portion of the world's bitumen production is dedicated to road construction and maintenance, solidifying its leading role in the construction sector.

However, the finite nature of bitumen, alongside declining global petroleum reserves and external market pressures, has led to a continuous increase in bitumen prices. This situation has profoundly impacted the road construction industry, where the demand for asphalt pavements is rising in parallel with bitumen usage. The growing mismatch between supply and demand has made it crucial to find greener, renewable, and cost-effective alternatives to petroleum-based bitumen.

In recent years, bio-oils have gained significant interest from researchers due to their plentiful supply, renewability, and low cost. Bio-oil is derived from biomass, including wood, agricultural residues, animal manure, and used cooking oil, through processes such as pyrolysis, hydrothermal liquefaction, and plasma electrolytic liquefaction. The main elements found in bio-oil—carbon, hydrogen, oxygen, and nitrogen—are similar to those in petroleum-based bitumen, along with certain bonding and viscoelastic properties. Bio-oils are viewed as potential binders for road applications, with the potential to partially or fully replace petroleum bitumen.

2. Wood-Based Bio-Bitumen

Among various biomass sources, wood biomass is

plentiful and accessible, with timber, discarded wood products, and sawdust providing reliable materials for producing pyrolysis oil. These resources can often be sourced locally. Researchers have investigated the physical and chemical properties of different wood-based bio-oils, focusing on their use as additives to enhance bitumen performance, rejuvenate aged bitumen, and improve resistance to aging. Some progress has been made in these areas.

However, challenges remain. High levels of light and volatile components, weak resistance to deformation at high temperatures, and high sensitivity to aging limit the current effectiveness of bio-oil applications. The replacement rate of bio-oils for petroleum bitumen remains low, and numerous technical hurdles must be overcome before bio-bitumen can fully replace its petroleum counterpart.

2.1. Wood-Based Bio-Oil Production for Bitumen Modification

Wood-based bio-oil is created by chemically processing wood materials like logs and sawdust to break down organic polymers such as cellulose, hemicellulose, and lignin. These intermediate products undergo various physical and chemical changes to produce a dark, viscous liquid. Pyrolysis is currently the most widely used method for producing bio-oil, given its similarity to petroleum refining systems. This process can be further categorized into thermal cracking methods based on the residence time of gases generated during pyrolysis.

Fast pyrolysis, which yields high quantities of bio-oil and meets the demand for binding materials in road construction, is the most common method used in this field. Fast pyrolysis involves heating dried biomass in an oxygen-free environment at very high temperatures (400-550°C), causing rapid cracking and producing bio-oil in a matter of seconds.

2.2. Characteristics and Enhancements of Wood-Based Bio-Oil

Like petroleum asphalt, wood-based bio-oil is primarily composed of carbon, hydrogen, oxygen, and nitrogen, with slight variations based on the biomass source. Studies indicate that bio-oil generally contains higher oxygen levels, lower carbon content, and a lower hydrogen-to-carbon ratio compared to petroleum bitumen. These differences are due to the presence of oxygenated compounds formed during the breakdown of wood polymers like cellulose and lignin. These compounds, along with the presence of water, contribute to bio-oil's susceptibility to aging.

Wood-based bio-oil is a complex mix of water, soluble and insoluble organic compounds, including acids, alcohols, aldehydes, esters, and phenols. It contains over 400 identified compounds, though this number is not exhaustive due to technological limitations in identi-

fying all constituents. Water, which makes up 20-40% of bio-oil, significantly affects the performance of bio-asphalt, necessitating extensive water separation processes before bio-oil can be used as a binder.

By employing distillation and other techniques to reduce water content, researchers have successfully concentrated bio-oil's usable components, resulting in a product known as "bio binder." However, even after water removal, bio binder still differs significantly from petroleum bitumen in terms of chemical composition, with notable differences in resin, aromatic, and asphaltene content. These variations play a crucial role in the differences between bio-oil and petroleum bitumen's rheological properties.

2.3 Potential for Substituting Bitumen with Wood-Derived Bio-Oil

The chemical makeup and rheological traits of bio-binders closely resemble those of petroleum bitumen, making it a promising candidate for complete replacement. If a suitable bio-binder derived from wood could be developed to serve as the primary binding material for flexible pavements, it could significantly advance sustainable road construction. Consequently, many studies have been carried out to assess whether bio-binders can fully take the place of petroleum bitumen. Binder properties play a pivotal role in determining the performance of road mixtures and structures. To maintain the durability of asphalt pavements and prevent early binder failure, road engineers have proposed various performance indicators from different angles. These indicators help mitigate potential issues with petroleum bitumen, including high-temperature, low-temperature, fatigue, and aging-related failures. Since research on bio-binders for road construction is relatively new, studies on bio-binder performance in roads have mostly relied on established methods and tools originally developed for petroleum bitumen.

Although using wood-based bio-binders directly in road engineering is still rare, laboratory research has revealed several limitations when employing these materials for flexible pavements. Therefore, it is reasonable to conclude that, particularly in their pure form, bio-binders are not yet capable of fully replacing petroleum bitumen.

One notable drawback is that wood-based bio-binders generally have lower viscosity and exhibit a narrower viscous temperature range—about 30°C to 40°C less than petroleum bitumen. Additionally, bio-binders display higher sensitivity to temperature and shear rates, which can lead to shear thinning. Even with improvements made to bio-binders from oak wood, their dynamic shear modulus, rutting resistance, and elastic recovery remain relatively low, and their high-temperature performance grade is below 40°C.

To tackle this poor performance at elevated temperatures, researchers have applied modification techniques from the bitumen industry, blending common additives like SBS, rubber particles, and terpolymers with bio-binders to improve their heat stability. Research suggests that the presence of more light components in bio-binders aids in better swelling and distribution of these additives. The inclusion of appropriate modifiers may thus represent a crucial strategy in achieving the complete replacement of petroleum asphalt by bio-binders in the future.

A notable field study compared the structural and roughness performance of conventional petroleum-based asphalt (HMA) and bio-binder pavement (BM) over three years. The results indicated that bio-binder pavement performed comparably to its petroleum counterpart, showcasing the potential of using suitable modifiers to enhance bio-binders and possibly replace petroleum bitumen.

During pavement construction and use, binders naturally age. Therefore, in addition to evaluating fresh bio-binders, it's essential to examine their performance after aging, particularly in terms of low-temperature durability and fatigue resistance. One study compared the dynamic shear modulus of pine resin bio-binder and petroleum bitumen before and after short-term

aging. The findings revealed that, at both higher and lower frequencies, aged bio-binder showed a greater increase in dynamic shear modulus compared to aged petroleum bitumen. Moreover, aged bio-binders were more rigid and brittle than their petroleum counterparts. Despite this rigidity improving high-temperature performance, it adversely affected bio-binder's fatigue resistance.

The tendency of bio-binders to age quickly is linked to the higher concentration of light components in their composition. Bio-binders contain a significant portion of volatile light components, with up to 40% evaporating at temperatures around 290°C. Testing has shown that these components have low molecular weights, contributing to the brittle nature of the residual material. Additionally, the lower molecular weights (Mn, Mw, Mz) in bio-binders compared to petroleum bitumen further contribute to aging issues. The higher oxygen content in bio-binders also exacerbates their susceptibility to aging, though a comprehensive understanding of how bio-binders age on multiple levels remains lacking.

2.4 Utilization of Wood-based Bio-binder as a Modifier

While bio-binders can sometimes match or even surpass certain properties of petroleum bitumen, only a few bio-binders currently satisfy the evaluation criteria required for petroleum bitumen substitutes. Consequently, the most prevalent use of wood-derived bio-binder in road construction is as an additive, replacing a portion of petroleum bitumen. This blend of bio-oil and petroleum bitumen is often termed bio-bitumen.

For bio-bitumen to provide satisfactory road performance, similar to polymer-modified bitumen, a key factor is the compatibility between bio-oil and petroleum bitumen, which should form a stable, homogeneous mixture. One study evaluated the molecular compatibility between wood-based bio-binder from Michigan and petroleum bitumen using the Automatic Flocculation Titration (AFT) technique to examine their miscibility. It found that with 2% bio-oil content, the two materials were stable and compatible. However, it is hypothesized that higher bio-oil content would reduce compatibility, though no studies have been conducted on mixtures with a higher concentration of bio-oil.

Another method, the ASTM D7131 standard, was used to assess the separation of bio-binder and petroleum bitumen in bio-bitumen by observing the difference in rutting factors between the top and bottom sections of a sample. When the bio-binder content reached 50%, the rutting factors showed significant discrepancies between the sections, indicating a drop in compatibility. Studies also analyzed the thermal stability of bio-bitumen with varying bio-binder content, ranging from 10% to 30%. The results showed lower thermal stability for bio-bitumen compared to base bitumen, with significant differences in softening points, viscosity, and rutting factors between the upper and lower portions after storage, particularly as bio-binder content and storage time increased.

To conclude, current research on the compatibility between bio-binder and petroleum bitumen is limited. Claims of "good compatibility" based on elemental or rheological similarities have not been sufficiently validated in practice. Studies indicate that at higher bio-binder contents, compatibility weakens. Therefore, it is critical to develop multi-scale characterization techniques for their compatibility and propose technical solutions to improve their performance.

A key question remains whether chemical reactions occur when bio-oil and petroleum bitumen are blended, and how this impacts the colloidal structure of the resulting bio-bitumen compared to petroleum bitumen. Some researchers have explored this by analyzing changes in functional groups using Fourier-transform infrared spectroscopy. They found alterations in the absorption peaks of certain compounds, though it's uncertain whether these changes result solely from chemical reactions or other factors like the volatility of compounds during blending. Similarly, another study indicated that while there were noticeable shifts in certain spectral peaks, no significant chemical re-

actions seemed to occur when bio-oil and petroleum bitumen were mixed.

As a result, researchers typically attribute performance changes in bio-bitumen to alterations in colloidal structure rather than chemical reactions. Bio-binder has lower levels of saturated fractions and asphaltene compared to petroleum bitumen. One study found that bio-bitumen containing 15% bio-oil had a significantly higher resin and aromatic fraction than petroleum bitumen, with corresponding reductions in the saturated fraction and asphaltene content. This suggests no chemical reactions occur during blending, further supporting the idea that changes are primarily physical.

The material characteristics of the chosen petroleum bitumen are crucial to these results. Therefore, using the performance grading system for petroleum bitumen as a reference for bio-binder may offer a more standardized approach. However, this also presents challenges.

For example, the high-temperature grading system used for petroleum bitumen, which involves subjecting the material to an RTFOT test at 163°C for 80 minutes, may not be suitable for bio-binder, as it would cause significant aging due to bio-binder's lower heat tolerance. Consequently, the current grading standards for petroleum bitumen are not directly applicable to bio-binder.

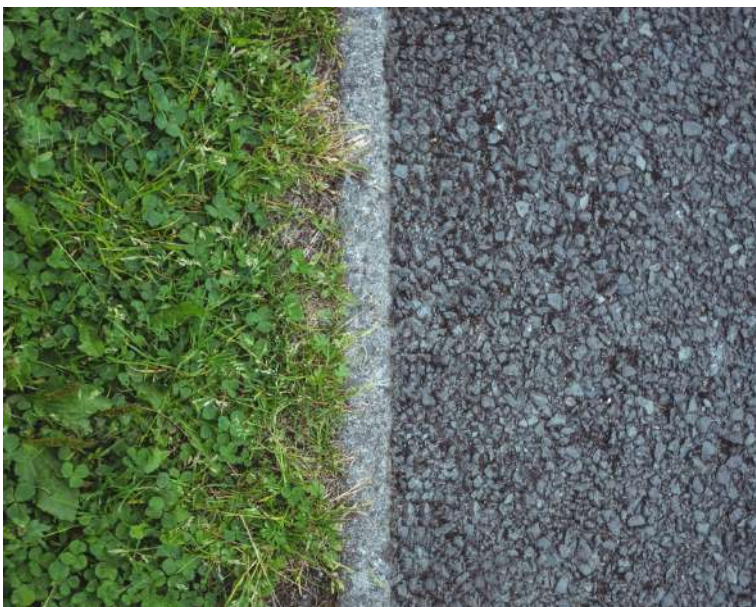
2.5 Wood-based Bio-oil as an Antioxidant in Bitumen

Despite bio-binder's vulnerability to aging due to its high volatile content and elevated oxygen levels, research shows that bio-bitumen undergoes significantly less oxidative aging than petroleum bitumen. Specifically, after aging, bio-bitumen has lower aging indices, such as the carbonyl index and activation energy, compared to petroleum bitumen, suggesting it is more resistant to oxidative degradation. This reduced oxidative aging effect is linked to a lower ratio of polar to non-polar components in bio-bitumen.

The key role of specific phenolic compounds in mitigating the oxidative aging process is one reason why bio-binder might serve as an effective antioxidant in bitumen. These compounds can neutralize free radicals formed during the oxidation of petroleum bitumen, halting oxidation-related chain reactions. Phenolic compounds also help counteract aggregation during aging by reducing the increase in intermolecular forces caused by oxidation. Given that wood-based bio-binder contains many phenolic compounds, understanding the types of phenolic compounds in bio-oil and their antioxidant properties under different conditions is a promising research direction.

In addition to phenolic compounds, bio-oil contains carbon particles that can absorb UV light and scavenge free radicals, slowing down the photo-oxidative aging of bio-bitumen. Some researchers have also proposed that bio-binder contains highly reactive components, such as α-tocopherol, which act as sacrificial agents, protecting the more sensitive elements of petroleum bitumen from oxidation. Additionally, bio-binder's molecular components are less polarizable than those in petroleum bitumen, further reducing their likelihood of developing new polar functions in the presence of oxidizing agents.

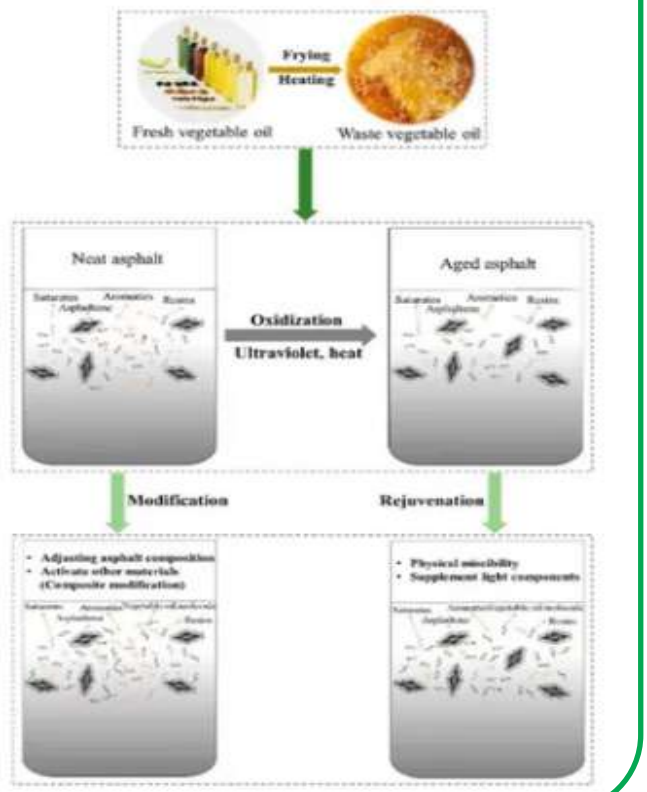
It is important to note that bitumen aging involves more than just oxidation. Other processes, such as chain scission, aromatization, aggregation, and the evaporation of volatile components, also play a role. As a result, when assessing bio-binder's anti-aging effects using various indicators, its performance may vary. Furthermore, bio-bitumen still experiences the loss of light components through volatilization, especially when present in higher concentrations or in thin layers.



3 Vegetable Oil-Based Bio-Bitumen

Vegetable oils, extracted through either physical or chemical processes from various plants, come in two main categories: fresh vegetable oil and waste vegetable oil. Both types have the potential to modify petroleum-based asphalt or rejuvenate aged petroleum asphalt, as illustrated in Figure 1.

Figure 1



Vegetable oils are primarily composed of fatty acids (FAs) and triglycerides derived from glycerol. Common fatty acids include palmitic, stearic, oleic, linoleic, and linolenic acids. The unique properties of each vegetable oil are defined by its fatty acid profile, which greatly impacts the oil's physical and chemical behavior, and thus its potential effects when combined with bitumen.

Soybean oil and its derivatives have been the subject of significant research in terms of their application in asphalt and bitumen mixtures. These oils have been tested in experimental road sections, where their long-term performance under various environmental and traffic conditions has been evaluated. Sunflower seed oil is another alternative that can be used in road engineering alongside soybean oil. Oils that contain higher amounts of oleic acid, known as high-oleic vegetable oils, exhibit better oxidative stability. The level of oleic acid purity in such oils influences the chemical, thermal, and rheological properties of polymers based on vegetable oils, impacting factors like viscosity, thermal resistance, and glass transition temperature.

However, using fresh vegetable oil as a binder in pavements is often considered wasteful, especially given the ongoing food scarcity in many parts of the world. Waste vegetable oil (WVO), a by-product created when fresh oil is subjected to high temperatures in cooking, is non-edible and has a darker color and higher viscosity than fresh oil. The characteristics of WVOs vary depending on the source, processing methods, and the type of food cooked in them. During the frying process, vegetable oils undergo changes like hydrogenation and oxidation, which alter the fatty acid profile from polyunsaturated to more saturated forms, alongside the creation of compounds like aldehydes and trans-fatty acids.

3.1 Waste Vegetable Oil as Rejuvenators

Traditional rejuvenators for bitumen, derived from heavy oil, replace the light components lost in aged asphalt. However, they tend to evaporate at high temperatures, reducing their effectiveness. In contrast, fresh and waste vegetable oils, primarily composed of triglycerides and unsaturated fatty acids, resemble the light fractions of bitumen and offer better temperature resistance. Classified as bio-rejuvenators, these oils are environmentally friendly, biodegradable, and cost-effective, making them an attractive alternative to traditional rejuvenators.

Many studies have explored the potential of vegetable oils as bio-rejuvenators to restore the properties of aged asphalt binders, focusing on aspects like rheological performance and low-temperature behavior. For instance, one study used waste vegetable oil from restaurants as a substitute for heavy oil and a commercial rejuvenator to treat aged asphalt from reclaimed

asphalt pavement (RAP). Rheological properties were measured with a dynamic shear rheometer (DSR) and rotational viscosity tests, while the low-temperature performance was assessed with bending beam rheometer (BBR) tests. The results showed that vegetable oil rejuvenators effectively reduce the viscosity and stiffness of aged asphalt, improving fatigue resistance and crack performance at lower temperatures.

Other research examined the microstructure of aged asphalt treated with varying amounts of waste vegetable oil and different rejuvenation times, finding that adding WVO replenished saturates and aromatics, preventing their transformation into asphaltenes and resins. Optimal results were achieved with a rejuvenation time of 60 minutes and a 7% content of waste vegetable oil.

Additionally, studies have evaluated the impact of WVO viscosity on the recovery of aged bitumen's performance. One investigation found that both extremely high and low viscosity levels in WVO negatively affected the rejuvenated bitumen's properties. Meanwhile, another experiment using sunflower seed oil revealed that a 5% addition could recover 30% of the modulus loss in aged bitumen, showing its potential for restoring rheological performance.

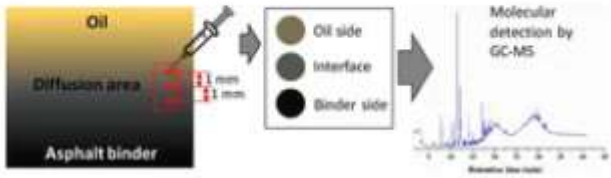
On a microscopic level, aging leads to the oxidation of benzyl and sulfuric compounds in bitumen, transforming them into carbonyl and sulfoxide groups. Visibly, the honeycomb structure of the asphalt binder breaks down over time. However, adding plant-based oils can slow the oxidation process, helping restore this structure. Plant oils do not chemically interact with asphalt, but they replenish light components like saturates and aromatics, preventing further aging of the binder.

Compared to traditional rejuvenators, bio-rejuvenators offer greater stability and are less prone to high-temperature evaporation, which significantly improves the efficiency of the rejuvenation process.

The Penetration Effect of WCO on Aged Asphalt

It is important to highlight that the penetration ability of WCO (waste cooking oil) rejuvenators on aged asphalt plays a crucial role in the effectiveness of asphalt regeneration. Research has demonstrated that when WCO is used to rejuvenate aged asphalt, it forms a diffusion area without a clear boundary, as depicted in Figure 2. Understanding the physicochemical characteristics of the binder at different points within this diffusion zone provides valuable insight into how WCO rejuvenators work. Xiao, through advanced techniques like interface image thresholding and tracer analysis, explored how bio-rejuvenators and aged bitumen interact at a microscopic scale. This research helped establish links between the microscopic and macroscopic properties of plant oil-rejuvenated asphalt, offering a deeper understanding of the modification process.

Figure 2



3.2 The Role of WVO in Bitumen Modification

Conventional bitumen often falls short of meeting the demands posed by heavy traffic and extreme weather. As a result, polymers and other additives are used to improve the performance of base bitumen, enhancing its rheological characteristics and extending the lifespan of pavements. Plant oils, recognized as eco-friendly alternatives, have been increasingly studied for their role in modifying bitumen.

The modification of bitumen with plant oil can be divided into three approaches: directly incorporating plant oil into base bitumen, combining it with other materials like plastics or rock bitumen, or using plant oil to activate other additives, thereby enhancing their effectiveness. Due to their similar chemical makeup, plant oils blend well with bitumen. The linear alkane struc-

ture of fatty acids in plant oil can lower the viscosity of base bitumen, improving its resistance to cracking at low temperatures. However, the introduction of light molecules may cause the bitumen to melt unevenly, which could negatively affect its ability to withstand high temperatures and resist rutting. Additionally, the inclusion of plant oils in petroleum-based asphalt can reduce the polymer content by adding light components. WVO, in particular, significantly alters the composition of the asphalt's colloidal system, resulting in notable changes to its high-temperature performance compared to conventional asphalt.

To address the trade-off between high- and low-temperature performance in plant oil-modified bitumen, some studies have looked at combining plant oil with other polymers or additives. For instance, research on composite bitumen modified with bio-oil and rock bitumen found that adding bio-oil improves low-temperature performance but decreases high-temperature resistance. The modification process is primarily physical, and except for waste and plant oils, there is no clear relationship between the rheological properties of other bio-oils and their infrared spectra.

In another study, PET particles treated with WVO were mixed into bitumen and aged in the lab using RTFO and PAV methods. The changes in the bitumen's properties were tracked using dynamic shear rheometer (DSR) and FTIR spectroscopy. The findings showed that oil-treated PET-modified bitumen retained 15.6% of its healing ability after long-term aging, while the untreated binder lost nearly 66% of its healing capacity. This suggests that the addition of WVO-treated PET can effectively reduce aging in asphalt binders.

Plant oils in composite bitumen modification not only supplement light components but can also activate other additives, enhancing their overall performance and compatibility with bitumen. For instance, waste polymers like PVC, LDPE, PS, and PE can absorb the light components in bitumen, forming a network structure that improves viscoelasticity and enhances high-temperature performance, though it may also make the bitumen more prone to cracking at low temperatures. The compatibility between plant oil-modified bitumen and other additives varies depending on the materials used. Although these initial studies show promise for using plant oil in bitumen modification, more research is needed to optimize the techniques

and fully understand how plant oil interacts with other materials in bitumen.

3.3 WVO as an Antioxidant

In addition to its role as a rejuvenator and modifier, sunflower seed oil (SO) has shown potential as an antioxidant modifier in asphalt binders. It has been observed that the inclusion of SO can improve fatigue resistance and delay aging in asphalt binders. The α-tocopherol present in sunflower seed oil is believed to react with carboxylic acids and anhydrides in the binder, forming esters that slow down aging and inhibit the evaporation of light components in the binder. Similarly, ricinoleic acid, the main component of castor oil, contains hydroxyl groups that may also react with the same compounds in asphalt, though further research is needed to clarify its anti-aging effects.
Similarly, ricinoleic acid, the main component of castor oil, contains hydroxyl groups that may also react with the same compounds in asphalt, though further research is needed to clarify its anti-aging effects.

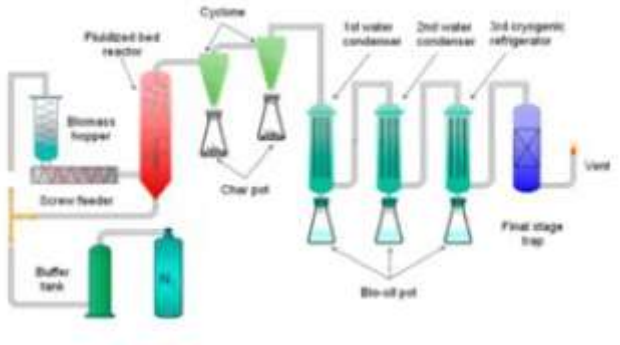
4 Manure-Based Bio-Bitumen

Bio-bitumen, derived from organic materials like manure, offers several economic, social, and environmental advantages. Its use helps reduce the reliance on non-renewable resources and contributes to environmental sustainability. Modifying bitumen with materials such as swine manure aligns with these goals.

4.1 Production of Swine Manure Bio-Oil

Researchers have developed methods to produce bio-oil from swine manure. One such method involves dehydrating and crushing manure particles before passing them through a fluidized bed reactor under nitrogen flow. Inside the reactor, the manure particles quickly exchange heat with preheated quartz stones in an oxygen-free environment, undergoing rapid pyrolysis as the temperature rises quickly.

Figure 3



4.2 Impact of Manure-Based Bio-Oil as a Bitumen Modifier

Following the development of this modifier, assessing its effectiveness is crucial, particularly through basic performance tests for bitumen and asphalt mixtures.
A study evaluated the behavior of modified bitumen produced by various methods under high and low temperatures using MSCR and BBR testing. The findings revealed that adding bio-oil from swine manure to petroleum bitumen improves workability but negatively affects its performance at high temperatures and its resistance to fatigue.

Despite the negative impact on bitumen's high-temperature characteristics, the manure-derived bio-oil enhances bitumen's flexibility. In another evaluation, the performance and workability of bitumen with and without a bio-binder made from swine manure and Recycled Asphalt Shingles (RAS) were compared. The results demonstrated a significant improvement in ductility and fracture energy in the RAS-modified bitumen when the bio-binder was added.
Moreover, research involving the addition of a swine-manure-based biological modifier to Reclaimed Asphalt Pavement (RAP) material showed that this bio-modified binder improved fatigue resistance and crack durability without compromising moisture sensitivity or rutting resistance.
Another study utilized various methods, including DSR and X-ray diffraction, to analyze the chemical makeup

and structure of biochar and bio-oil derived from waste wood and swine manure. This research indicated that biochar can significantly change the fundamental properties of petroleum bitumen, such as softening point, viscosity, and complex modulus. Importantly, the performance of upgraded manure-based bio-oil surpasses that of untreated bio-oil, increasing its potential for replacing petroleum asphalt partially or entirely.

4.3 Influence of Manure-Based Bio-Oil on Bitumen's Antioxidation and Rejuvenation

It has been observed that bio-oil from swine manure shows effective resistance to bitumen aging and contributes to its rejuvenation, which could be key to its application as a swine manure modifier. One study explored the effects of introducing bio-binders made from swine manure, mango grass, corn straw, and sawdust on the chemical and rheological properties of bitumen before and after aging. Results indicated that swine manure-based bio-binders are less prone to aging compared to plant-derived bio-oils.

Another research introduced a bio-binder made from swine manure through hydrothermal liquefaction, which was used to modify silica nanoparticles. These bio-binder functionalized nanoparticles were characterized through various techniques and demonstrated superior capability in slowing the aging of bitumen, while being cost-effective.

Further analysis examined aged bitumen before and after rejuvenation, showing that the bio-oil derived from swine manure significantly restored its performance. Additionally, research on co-liquefying high-protein algae with swine manure resulted in bio-oils that could restore the molecular balance of aged bitumen, enabling its rejuvenation.

In conclusion, swine manure-modified bitumen is often combined with other modifiers in the rejuvenation of aged bitumen. Its addition enhances bitumen's flexibility and low-temperature performance, though an incorrect dosage can negatively impact high-temperature performance and fatigue resistance.

5-Conclusion

This article provides a comprehensive overview of the latest advancements in the use of bio-binders for asphalt pavements. The potential and challenges associated with bio-based additives have been discussed. Specifically, wood-based bio-oils, waste cooking oils, and manure-based bio-oils were identified as some of the most promising alternatives for modifying or replacing petroleum bitumen.
Several conclusions can be drawn from this review:

1.Currently, bio-based oils are primarily suitable as additives, such as softeners, rejuvenators, or modifiers, rather than being complete replacements for binders. Studies have shown that bio-oils can work effectively as additives; however, existing technologies do not yet support replacing petroleum-based bitumen with bio-oils.

2.Among the most promising uses for bio-oils is their role as rejuvenators. Research indicates that bio-oils can soften aged bitumen, reducing its stiffness and enhancing flexibility. This improvement boosts bitumen's low-temperature performance and resistance to fatigue while maintaining adequate high-temperature performance.

3.Bio-oils also hold potential as antioxidants. Research clearly demonstrates that bitumen modified with bio-oils shows greater resistance to aging, suggesting that bio-oils could serve a dual function in bitumen modification.

4.Bio-oil and polymer blends offer another approach to enhancing bitumen performance across a wide temperature range, particularly for rejuvenating aged binders. The inclusion of polymers can help address high-temperature performance concerns. However, compatibility among the different components remains a primary challenge.

THE RENUCORE TECHNOLOGY ALLOWS THE REUSE OF ASPHALT SHINGLES IN HOT MIX ASPHALT PAVING BY RECYCLING THEM EFFECTIVELY.

Saint-Gobain, a prominent global company in sustainable and lightweight construction, has introduced RenuCore by CertainTeed. This advanced manufacturing technology empowers recyclers in the construction and demolition sectors, along with hot mix asphalt producers, to process asphalt shingle waste from old roofs, turning it into pellets for reuse in asphalt paving.

RenuCore technology was initially developed by Asphaltica and acquired by CertainTeed in 2023. It enables CertainTeed to divert shingle waste from landfills and boosts the recycled content in asphalt paving mixes, while ensuring the recycled asphalt's performance matches conventional materials. This launch aligns with Saint-Gobain's ongoing Grow and Impact strategy, a global initiative with strong sustainability targets, including achieving zero waste-to-landfill at all Saint-Gobain facilities worldwide.

This recycling innovation enhances the quality of recycled asphalt, aiming to deliver comparable road durability to asphalt made with new materials. By pelletizing and pre-treating the shingles, RenuCore tackles early recycling obstacles, ultimately producing asphalt that resists rutting, shoving, and cracking.

"The launch of RenuCore highlights Saint-Gobain's dedication to cross-industry partnerships necessary to 'Make the World a Better Home,'" stated Carmen Bodden, President of CertainTeed Roofing Products Group. "From roofing to asphalt paving, we remain committed to CertainTeed's longstanding motto, 'Quality Made Certain, Satisfaction Guaranteed,' which has been our standard for 120 years."

RenuCore's official debut will take place at the 10th Shingle Recycling Forum organized by the Construction and Demolition Recycling Association. This flagship event, held on October 29-30, 2024, in Louisville, Kentucky, will feature discussions led by members of the CertainTeed Roofing team.

MALVERN, PA / ACCESSWIRE / October 28, 2024 / Saint-Gobain, a global leader in light and sustainable construction has launched RenuCore by CertainTeed, an innovative manufacturing technology that allows construction and demolition recyclers and hot mix asphalt producers to pelletize asphalt shingle waste at the end of their original life to be reused in asphalt paving applications.

CHINA'S FIRST "SMART FACTORY" FOR PRODUCING OFFSHORE OIL AND GAS EQUIPMENT BECAME FULLY OPERATIONAL IN TIANJIN, LOCATED IN THE NORTHERN REGION OF THE COUNTRY.

Spanning roughly 575,000 square meters along the Bohai Sea coast, this advanced facility—built by China Offshore Oil Engineering Company (COOEC), a subsidiary of China National Offshore Oil Corporation—focuses on manufacturing high-tech offshore oil and gas platforms and specialized products, including liquefied natural gas (LNG) modules.

The facility comprises four automated production workshops, eight support centers, 16 assembly stations, and key infrastructure like docks for transporting large equipment. Over 600 smart production machines operate within the base. A specialized manufacturing management platform enables streamlined operations, such as material handling, pipe shaping, cutting, and hydraulic bending, all executed with a single command at the Tianjin site.

Wang Lei, a senior official at COOEC's Tianjin branch, explained that manufacturing offshore oil and gas equipment traditionally required complex processes and customized specifications. To streamline this, COOEC developed an intelligent management system capable of automating production in intricate conditions. "Thanks to this system, most manufacturing tasks are handled by machines, with only a few workers needed for fine adjustments," said Wang.

The construction of the facility took place in two stages. The initial phase, completed in June 2022, produced 35 offshore platforms for markets like China and Canada, totaling over 87,000 tonnes. The second phase introduced additional assembly stations, an advanced pipe production line, and increased dock capacity. According to Wang, the intelligent pipe line has boosted efficiency by 20 percent compared to the first phase, and overall production capacity at the factory has doubled due to digital precision management.

In 2023, China's offshore crude oil production surpassed 62 million tonnes, an increase of 3.4 million tonnes from the previous year, accounting for approximately 70 percent of the country's total growth in crude output.

Iran expands share in joint oil fields through drilling industry development

The chairman of the board of directors of Iran's Oil Exploration Operations Company (OEOC) emphasized that boosting production from joint oil fields should be regarded as a top priority. He stated that with the development of the drilling industry, there is full readiness to expand and increase extraction from these fields.

Hedayatollah Khademi highlighted drilling as the foundation of the petroleum industry and, by extension, the national economy. He added that improving collaboration with contractors to overcome existing obstacles remains a priority.
Khademi described Iran's Oil Exploration Operations Company as a growing enterprise, noting that, with strong trust from clients and all eight owned drilling rigs in operation, the company is expanding and upgrading its fleet to meet the needs of new clients. He said that the second half of 2024 would mark a new chapter for exploration operations in Iran's drilling sector. He emphasized that increasing production from joint fields is Iran's foremost priority, adding that there is complete readiness to expand operations in these fields.

Khademi further stated that with available potential in human resources and satisfactory quality, if long-term contracts with the National Iranian Oil Company (NIOC) are secured, Iran's Oil Exploration Operations Company is prepared to take responsibility for developing certain joint fields. This would involve collaboration with other Iranian petroleum firms and, if necessary, foreign experts to boost Iran's share of extraction from joint fields, thereby safeguarding national interests and addressing shortages.

He pointed out that continuous, professional training of young employees domestically and abroad has been instrumental in the company's achievements. Additionally, the experience of seasoned professionals has enhanced confidence in the organization's major decision-making processes.

Reflecting on the company's performance in 2023 and the first half of 2024, Khademi noted a 100% project execution rate, which, alongside generating approximately 3 trillion tomans in revenue, has yielded about 3 trillion rials in net profit for the company.

Reduced drilling time in joint oil fields

Mohammad Moein Pourhosseini, Deputy of Operations at Iran's Oil Exploration Operations Company, highlighted the company's strengths in synergy, alignment, experience, and the youthfulness of its drilling fleet and management team. He explained that recent projects, including the drilling of three wells in the Azadegan oil field, were completed 31 days ahead of schedule, while the drilling of two wells in the Bibi Hakimeh oil field finished 70 days early, and a well in Mansourabad was completed about 45 days ahead of plan.
Pourhosseini stated that these efficiencies resulted in over 1.4 trillion rials in cost savings

for both public and private clients. This accomplishment has not only saved costs but also provided Iran's Oil Exploration Operations Company with a competitive advantage, setting a record within the drilling sector.
He attributed the company's success to teamwork, effective planning, optimized resource management, timely and quality maintenance, decisive decision-making at both strategic and operational levels, and a combination of a young technical and operations team with experienced professionals.

Pourhosseini added that the company currently operates four active drilling rigs in the southern oil-rich regions, two rigs in the 28-reservoir projects, and two rigs in the EPD (Early Production Development) project at the South Azadegan joint oil field, all operating continuously according to schedule.

He also identified the provision of ancillary drilling and production services as another key competitive advantage, which has positioned Iran's Oil Exploration Operations Company as the second-largest onshore drilling company and service provider in Iran after the National Iranian Drilling Company.
Pourhosseini emphasized that these capabilities, alongside high service quality, have increased clients' interest in integrated cooperation with the company.

The company's ancillary services include mobile tubing, acidizing, nitrogen lifting, well logging and wellhead services, surface and downhole testing, formation testing, casing and tubing running, cementing, directional drilling for casing, coring, and well testing with MPFM equipment. He assured that each of these services is delivered with the highest operational and support quality.

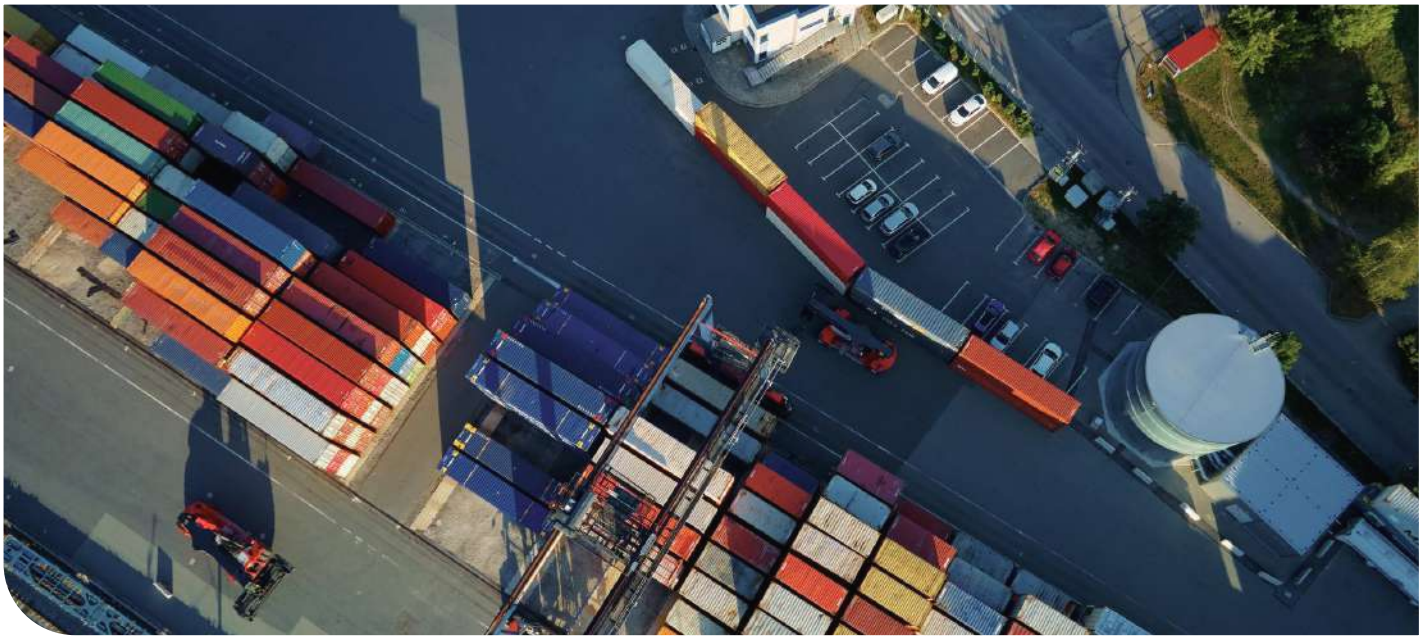
Drilling of 6 new wells in the South Azadegan joint oil field

Rashid Ansari, Head of Drilling Engineering at Iran's Oil Exploration Operations Company, identified the company's drilling contract model as a key factor in its success. He explained that a carefully planned approach has been adopted, making rig relocation a key operational indicator, with all activities before, during, and after rig moves meticulously scheduled.
Ansari noted that Iran's Oil Exploration Operations Company was the first to replace traditional contract structures with a new, mutually beneficial, "win-win" exploration operations model, which has been approved. This change has positively impacted the company's profitability and performance, with drilling efficiency reaching between 98% and 100% in 2023 and the first half of this year.

He described the South Azadegan field development project as a successful venture. In the first phase, which began on February 20, 2023 under the new contract model, the company completed the drilling of six wells, as well as the repair, completion, and artificial lifting of ten wells with full material and equipment support. Now, in the second phase, they have commenced drilling one additional well and are set to repair and complete four more wells.

In conclusion, Ansari emphasized the importance of identifying and addressing the root causes of drilling issues as a crucial approach in overcoming operational challenges. Alongside comprehensive planning and design, root-cause analysis is essential for decision-making and developing effective drilling guidelines in large-scale projects.

Latin American petroleum finds new buyers



With the recent shift in Canadian pipeline flows, refineries along the U.S. Gulf Coast are increasingly turning to heavy crude oil from Latin America.
Mexico's state-owned petroleum company Pemex recently purchased Colombian crude for its Texas refinery, while US-based Valero Energy has received Colombian petroleum grades typically exported to India and China.

Fuel producers in North America are facing a supply squeeze, as the expanded Trans Mountain pipeline redirects Canadian crude mostly to the Pacific Coast. Market insiders, who preferred to remain anonymous, noted that Pemex is also retaining more of its Mexican crude for the startup of its new Dos Bocas refinery.

According to Argus market data, in recent weeks, some Latin American crude grades usually shipped to California have been redirected to the Gulf Coast. The Trans Mountain pipeline expansion has boosted Canadian crude prices, making similar-quality Latin American petroleum more appealing. For instance, Canada's heavy Cold Lake crude—frequently used by Gulf Coast fuel producers—was priced $4.80 per barrel below the benchmark West Texas Intermediate (WTI) this past Tuesday, down from a $7.40 discount the previous year.

U.S. Energy Information Administration (EIA) data indicates that since the Trans Mountain pipeline expansion, Gulf Coast refineries imported an average of 485,000 barrels of Canadian crude per day between May and July, the lowest level for this period since 2018.

Bloomberg reports that since April, Pemex has purchased three shipments of Colombian petroleum for its Deer Park refinery in Texas. Meanwhile, Valero has acquired Colombia's Mars and Apiay crude grades, which are typically exported to Asia.

US electricity generation becomes more dependent on fossil fuels than China

Since June, the share of fossil fuels in US electricity generation has surpassed that of China, casting doubt on America's claim to lead the transition to clean energy.

According to data from the energy think tank Ember, US power companies relied on fossil fuels for 62.4% of total electricity generation over the past four months.

During the same period, fossil fuels accounted for over 60.5% of electricity generation in China, the world's largest electricity producer and biggest polluter.

The high reliance on fossil fuels in the US occurred over the summer when domestic electricity demand reached its peak due to extensive use of air conditioning. Meanwhile, China's dependence on fossil fuels decreased somewhat amid a prolonged economic downturn.

Nevertheless, the higher reliance on fossil fuels in the US indicates that China has made efforts to increase clean power production and has come closer to reaching peak fossil fuel consumption in electricity generation compared to the US.

Without a rapid reduction in fossil-fuel-based electricity generation, the US risks falling behind other major economies in decarbonizing its power sector and losing its credibility as a leader in combating climate change.

Power producers have taken a dual approach in advancing the shift to clean energy by both reducing fossil fuel consumption and increasing clean energy supplies.

According to the report by Ember, clean electricity generation in the US has become a priority over the past five years, with electricity production from clean energy sources increasing by approximately 16% since 2019.

However, the continuous growth in electricity demand has limited the ability of power companies to reduce fossil fuel-based generation.

In fact, fossil fuel power generation in the first nine months of 2024 decreased by only 0.8% compared to the same period in 2019, reaching 1,967 terawatt-hours. Coal's share of US electricity production fell from around 25% in 2019 to 15% this year.

But as electricity demand has continued to rise annually, power companies have had to increase gas-fired power generation to compensate for the reduction in coal use. From January to September this year, gas-fired power production reached 1,450 terawatt-hours, marking a 20% increase from the same period in 2019. The share of natural gas in the power mix rose from 38% in 2019 to 43% this year.

According to Reuters, overall electricity production in the US grew by about 5.5% from 2019 to 2024, driven by increased usage of electric vehicles, data centers, and AI applications, which have all contributed to higher overall energy consumption.

US petroleum imports from Saudi Arabia decline

U.S. petroleum imports from Saudi Arabia have dropped to their lowest level in nearly four years, coinciding with an increase in Canadian petroleum exports to the Gulf Coast region.

With the expansion of Canada's "Trans Mountain" pipeline, the capacity for sending petroleum from Canada's Pacific Coast has nearly tripled, reaching 890,000 barrels per day, and significantly altering global trade flows.

According to the US Energy Information Administration, U.S. petroleum imports from Saudi Arabia fell to 13,000 barrels per day in the week ending October 25.

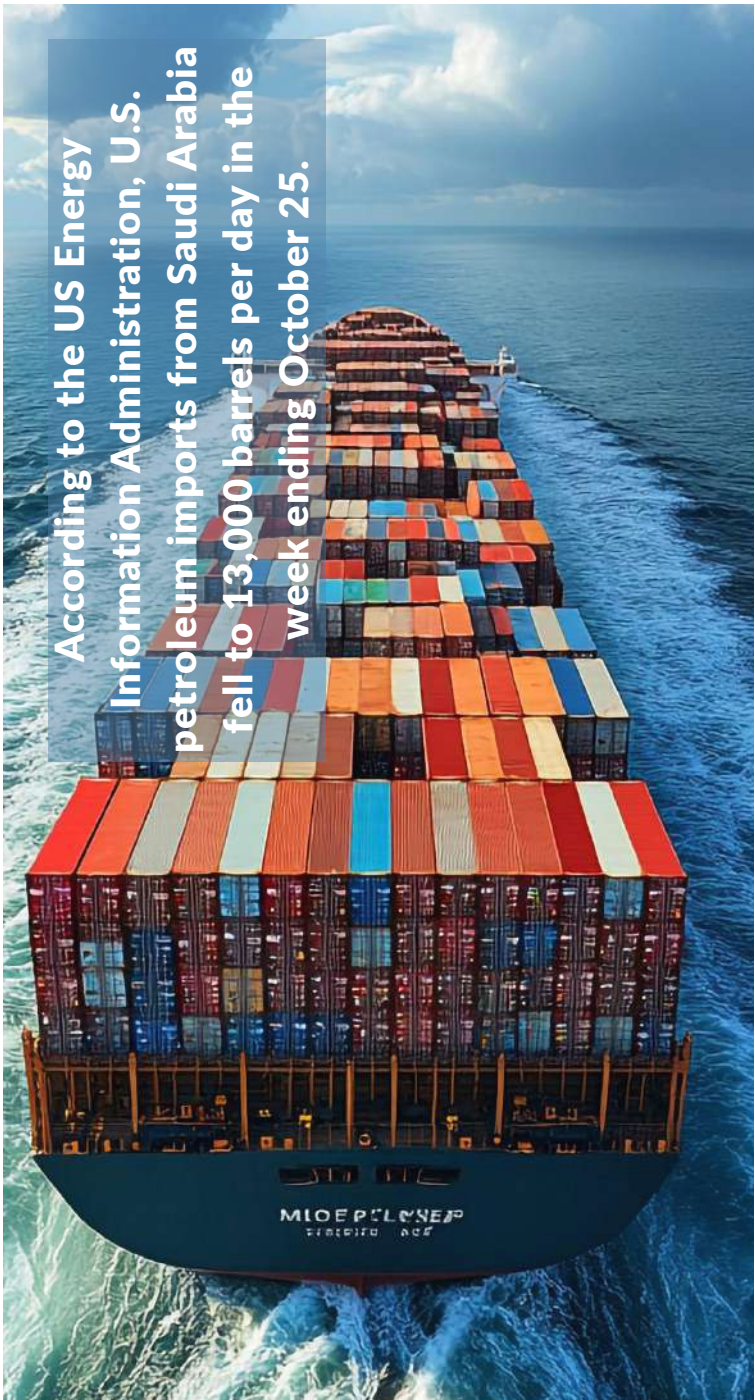
Data from Kepler indicates that Gulf Coast refineries reduced petroleum imports from Saudi Arabia to 23,000 barrels per day in October, marking a record low. Overall, these refineries are projected to average imports of around 50,000 barrels per day from Saudi Arabia in 2024, approximately 63% lower than last year.

Meanwhile, American refinery imports of Canadian petroleum surged to a record high in July, facilitated by the expanded Trans Mountain pipeline. Marathon Petroleum refineries in Los Angeles and Anacortes, Washington, and Phillips 66 in Ferndale, Washington—all of which were buyers of Saudi petroleum last year—have become major purchasers of Canadian petroleum in 2024.

Rohit Rathod, an analyst at Vortexa, a shipping analytics firm, noted that the increased flow from the Trans Mountain pipeline to the Gulf Coast has effectively pushed Saudi petroleum out of these markets.

However, Saudi petroleum exports to the Gulf Coast are expected to continue, as Saudi Aramco supplies petroleum to the Motiva refinery in Texas.

According to a Reuters report, Saudi Aramco, the world's largest petroleum exporter, cut the price of its Arab Light crude for Asia to its lowest level in three years in October, but the price reduction for the U.S. market was considerably smaller.



Venezuela's petroleum exports reach four-year high

Venezuela's petroleum exports in October surged to their highest level in four years, driven by increased production and greater sales to India and the United States.

The rise in Venezuela's petroleum exports to 950,000 barrels per day in October occurred despite significant challenges, including a fire at a major storage terminal, intensified U.S. sanctions since June, and the arrest of Pedro Tellechea, the former petroleum minister and former director of the state petroleum company PDVSA, on corruption charges.

Documents from the state-owned PDVSA revealed that the improvement in petroleum production was largely due to the stabilization of refining activities in the Orinoco Belt, Venezuela's largest petroleum-producing region.

According to data based on tanker movements, PDVSA and its subsidiaries collectively exported 947,387 barrels per day of crude oil and fuel, marking a 21% increase from the previous month and reaching the highest monthly figure since early 2020.

This South American country, which has been under U.S. sanctions since 2019, also exported 315,500 tons of byproducts and petrochemical products in October, slightly up from 267,000 tons in September. Venezuela's petroleum exports to the U.S., conducted by Chevron, reached 280,000 barrels per day — the highest since this American company resumed shipments of Venezuela's heavy crude early last year. In October, Spain's Repsol also shipped Venezuelan petroleum to the U.S. and Spain.

PDVSA increased exports to India, a major market before U.S. sanctions, sending three shipments totaling approximately 141,000 barrels per day. Venezuelan petroleum exports to the U.S., Europe, and India are permitted under U.S. licenses granted to select customers and joint venture partners of PDVSA, including Chevron, Repsol, Eni, Maurel & Prom, and Reliance Industries.

Nevertheless, China remained the primary destination for Venezuelan petroleum exports in October, receiving 385,300 barrels per day directly and indirectly. In September, exports to China were higher, at approximately 451,500 barrels per day. Venezuela's exports to Cuba, a political ally facing its own energy crisis, also saw a modest increase from 22,000 barrels per day in September to 28,000 barrels per day in October.

According to Reuters, Venezuela's fuel imports also rose from 67,000 barrels per day in September to 81,000 barrels per day in October.

World's largest tunnel boring machine in China unveiled

China has unveiled its 5,000-ton heavy-duty tunnel boring machine, known as "Jianghai," which has the largest diameter of its kind.

The production of this massive tunnel boring machine, with a diameter of 16.64 meters, has been completed. This new machine will be used to construct a tunnel beneath the Yangtze River in Jiangsu Province, China, connecting two regions.

"Jianghai" means "river and ocean" in Chinese. The machine weighs nearly 5,000 tons and is 145 meters long, making it the largest tunnel boring machine in the world.

The Jianghai was manufactured by CRCHI (China Railway Construction Heavy Industry Corporation).

A few months ago, China also announced that it had developed the world's first BBM (boring and blasting machine), which offers 30% greater tunneling efficiency.

Advanced tunnel boring machine

This new tunnel boring machine is designed to build a tunnel across the Yangtze River in Jiangsu Province, connecting the cities of Nantong and Suzhou.

The tunnel will form part of a 39-kilometer highway expected to be completed by 2028.

The tunnel, spanning 11.2 kilometers, will be bored at a depth of 75 meters below the Yangtze River.

According to You Shaoqiang, the chief engineer of the project, this tunnel faces unique challenges due to underground water sources, soft soil, and mud, which make conventional tunneling methods impossible.
Jianghai will bore through the ground at a speed of 12 to 16 meters per day, with the entire tunnel excavation anticipated to take about two and a half years.

Since the tunnel is located near the Yangtze River's estuary, tunneling precision must remain within one centimeter to ensure the safety of the dams constructed along this waterway.

Jianghai, with its 16-meter diameter and 5,000-ton weight, is comparable in scale to a six-story building.

Strengthening innovation in infrastructure

Zhao Hui, president of CRCHI, stated that this development marks a significant milestone in the industrialization of large-diameter tunnel boring technology, specifically within the 16-meter class, in China.

In 2022, CRCHI produced a 16.07-meter diameter tunnel boring machine for a renovation project in Beijing.

According to Chinese chief engineer Fan Ruiqiang, the team spent over two years developing Jianghai, which is newer and larger than previous models.
Reports indicate that this advanced machine is now more intelligent, equipped with a database that records past tunneling issues.

This feature enables the machine to offer suggestions to operators if similar challenges arise.
Wang Jun, deputy director of the construction office for this project, noted that this tunnel boring machine represents a crucial step forward for the Jiangsu Highway project and a major transportation initiative for China. He added that this machine is a remarkable achievement for China's manufacturing industry, reflecting both the hard work of engineers and China's progress in large-scale machinery production.

Jianghai employs completely different drilling and blasting methods and is claimed to be a valuable asset for water conservation, mining, railway, and highway projects.

Designed to operate in fault zones and withstand sudden inflows of mud or water, Jianghai's ring-shaped cutting head enables tunneling in challenging conditions, while its dual-mode function allows simultaneous drilling and blasting, enhancing both speed and efficiency.

Additionally, Jianghai's hollow cutting head facilitates routing and progress in complex geological conditions.

Shell Shifts Rheinland Refinery in Germany to Sustainable Focus

Shell is preparing a major overhaul of its largest German oil refinery, Rheinland, with plans to transition the Wesseling facility from crude oil processing to a hub for base-oil production. The transformation, scheduled to start next quarter, marks a pivotal step as Shell shifts from traditional refining practices toward producing high-quality lubricants. By 2025, crude processing at Wesseling will be phased out, with the site instead dedicated to manufacturing Group III base oils, essential for top-grade engine and transmission lubricants.

The motivation behind this shift is clear: adapting to changing markets. With Europe's growing emphasis on cleaner technologies and a decrease in demand for some petroleum products, Shell is making a strategic move. This decision is pragmatic, capitalizing on the growth in niche products as traditional fuel markets in Europe contract.

Meanwhile, Shell's Rheinland site in Godorf will continue crude oil operations, though with a few adjustments. A temporary shutdown is planned for the fall to fine-tune the crude unit, ensuring that Germany's energy supply remains stable despite reduced capacity. This staggered approach is designed to prevent any significant disruption.

At the same time, BP is scaling back at its Gelsenkirchen refinery, leaving Miro in southwestern Germany as the largest oil processor in the country. As Rheinland shifts focus, Germany's refining landscape is consolidating, with Shell positioning itself to navigate these changes rather than resist them.

Shell's investment in high-grade lubricants could lead the way for European refineries: specialize, diversify, or step aside. It's a bold shift in an industry traditionally focused on sheer capacity, with the Rheinland complex aiming to produce 300,000 tons of base oil annually to meet EU demand.

In recent years, Shell has divested from several refineries worldwide, including selling the Martinez Refinery in California to PBF Holding Company and its 50% stake in Texas's Deer Park Refinery to joint venture partner Pemex.

A truck breakdown near Rotorua(in new Zealand) led to the leak of thousands of liters of bitumen and a small fire, which has since been extinguished.

Due to the incident, State Highway 5 between Ngongotahā Rd and Barnard Rd has been closed, and drivers are advised to take alternative routes to avoid "significant delays." According to police, emergency services responded to the breakdown between Henderson Rd and Fairy Springs Rd early in the morning.

A Fire and Emergency NZ (Fenz) spokesperson reported that the leak has now been controlled, with approximately 12,000 liters of bitumen leaking from the truck toward a nearby drain at a rate of 4 liters per minute. The bitumen has since been contained within a "bunded area," a designated, walled zone used for managing spills. The process of transferring the remaining bitumen from the truck has also begun.

During this decanting process, a minor fire ignited in the truck but was promptly put out. On-site were three fire engines, two support vehicles, a Hazmat unit, a water tanker, a digger, and a bobcat. Fenz personnel, equipped with protective gear and breathing apparatus, are collaborating with contractors at the scene.

The Bay of Plenty Regional Council has been informed and is en route from Tauranga to assess the situation further.

HD Hyundai Begins Autonomous Operation Tests with Large Containership

South Korean shipbuilder HD Hyundai Heavy Industries initiated trials to demonstrate autonomous functions on a large containership specifically built with advanced autonomous technology. This effort is part of a government-backed initiative led by Korea's Ministry of Trade, Industry, and Energy, along with the Ministry of Oceans and Fisheries, aimed at promoting autonomous shipping and its eventual commercial deployment.

Constructed at the Ulsan shipyard, this 8,000 TEU containership is equipped with HD Hyundai's proprietary autonomous navigation systems. The project is among 44 initiatives granted regulatory exemptions by the ministries, enabling HD Hyundai to proceed with these trials and further the development of international guidelines for autonomous maritime operations.

The demonstration, which began on November 4, involves autonomous collision-avoidance maneuvers in Ulsan's coastal waters. Additionally, the ship's speed and course will be remotely managed from HD Hyundai's Global Research Center (GRC) in Seongnam, Gyeonggi Province.

Currently, testing autonomous systems on ships poses challenges due to the lack of a legal framework that allows shore-based operators to control vessels remotely. The South Korean "regulatory sandbox" program provides an exemption from these rules, permitting companies to conduct demonstrations, collect crucial data, and drive advancements in autonomous technologies.

This trial is the latest in a sequence of tests in partnership with POS Ocean, PAN Shipping, and HD Hyundai's Avikus division, which is dedicated to commercializing autonomous solutions. Previously, the group has conducted successful tests on smaller vessels and has introduced autonomous technology for recreational boats. Their focus is now broadening to include larger commercial vessels.

Earlier this year, in April 2024, the containership POS Singapore (22,800 dwt), built at Hyundai Mipo Dockyard and delivered with built-in autonomous systems, became the first such newbuild with this technology. This 576-foot (172-meter) vessel, registered in Liberia with a capacity of 1,800 TEU, finished its system installations in September, marking the beginning of its autonomous testing.

In October, further trials were launched with the Sea Shanghai, a 324,272 dwt ore carrier built in 2020 and managed by POS Ocean. Together, Pan Ocean and POS Ocean successfully carried out tests to ensure stable autonomous operations, including route planning, route and speed tracking, collision avoidance, and testing of safety functions.

The autonomous navigation system, developed with Artificial Intelligence (AI) and Augmented Reality (AR), calculates optimal routes and avoids collisions by analyzing data from numerous sensors and navigation tools. It aims to ease deck officers' navigation workload, improve fuel efficiency, and reduce emissions, contributing to greener operations.

Based on insights gathered from these offshore tests, HD Hyundai Heavy Industries intends to drive international standards in the field of autonomous maritime technology.

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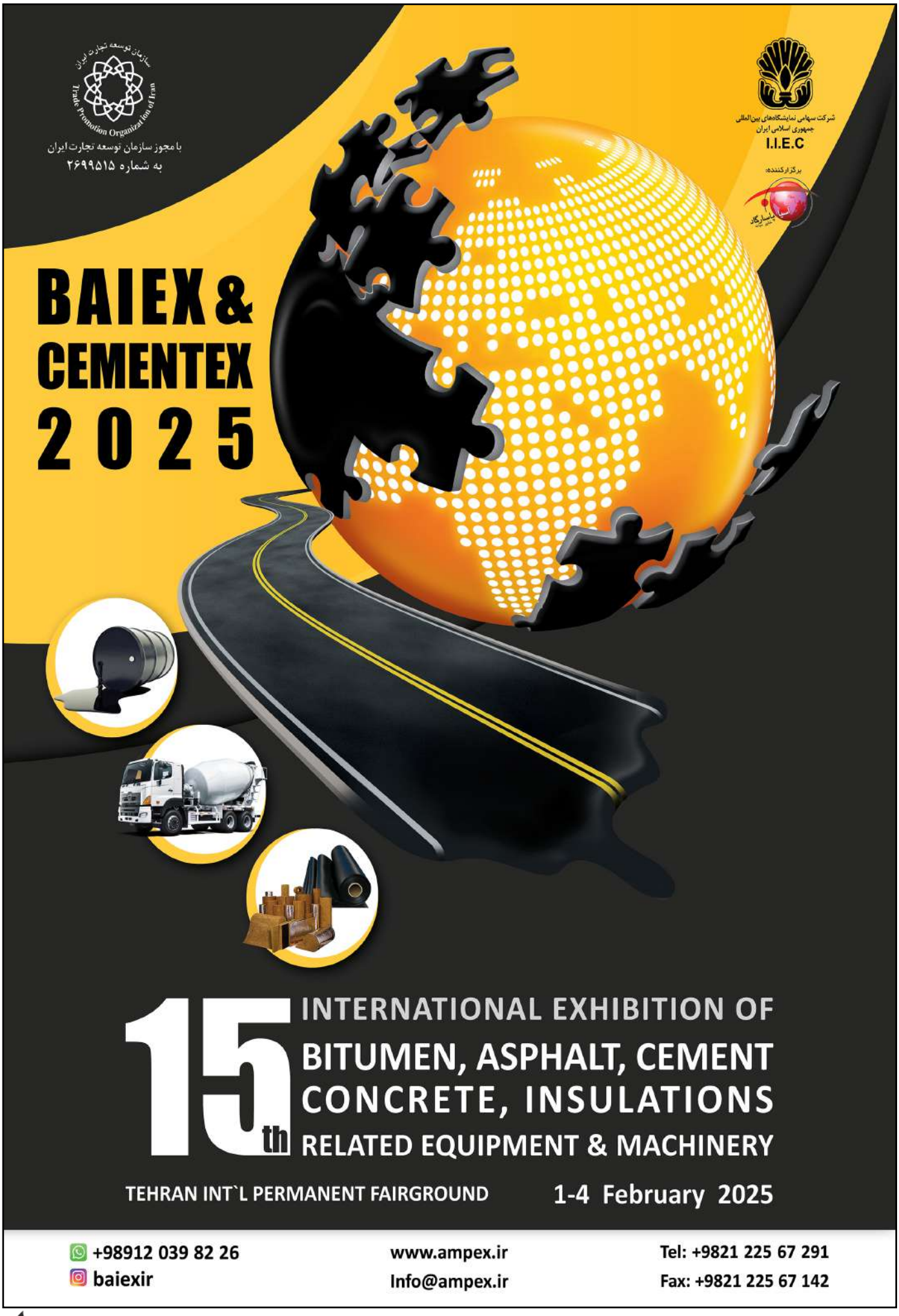
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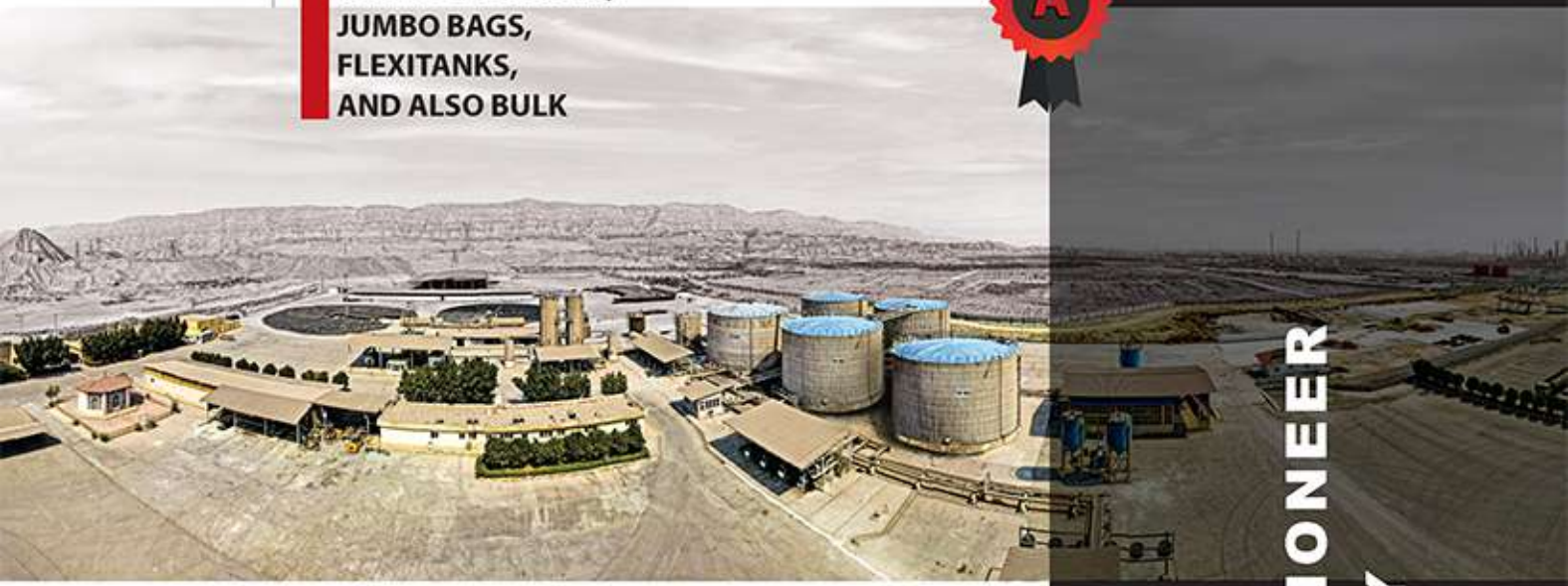

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