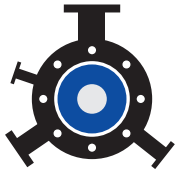


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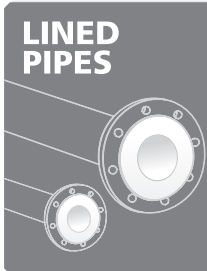
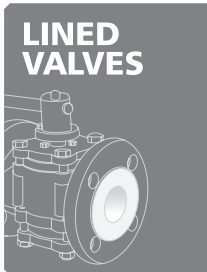
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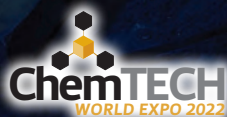
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RNI REGISTRATION NO. 11403/66

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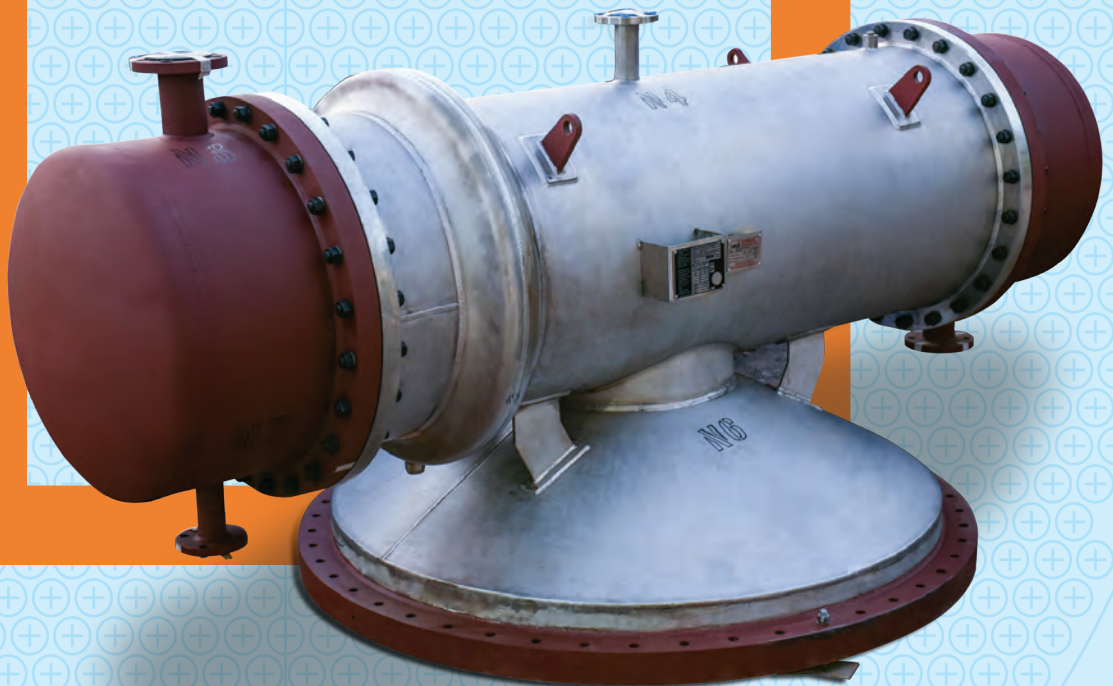
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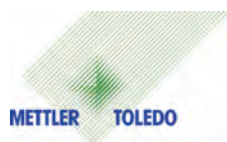
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Due to Fine Mist Creation, huge surface area is available for heat transfer & hence direct saving of 30 to 50% on Fan power is achieved.



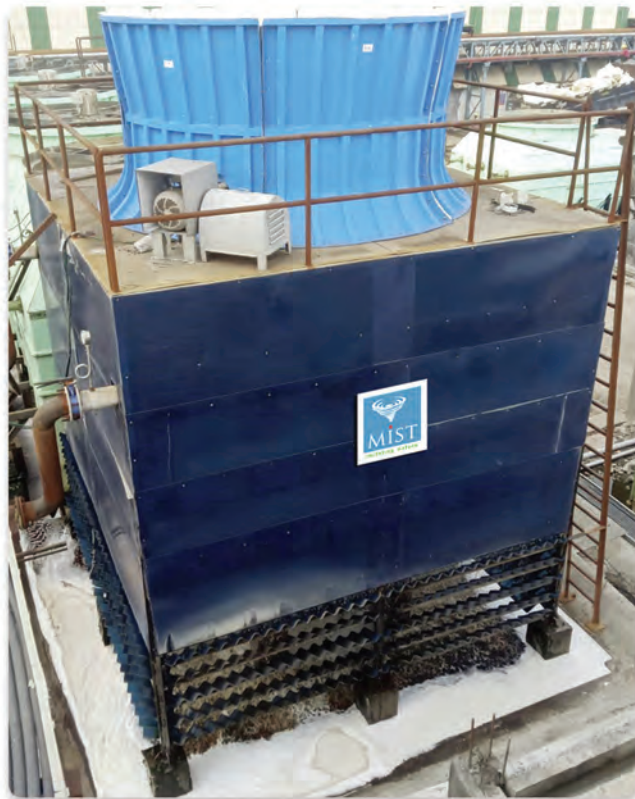
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Minister of Petroleum and Natural Gas of India and Minister of Mines and Energy of Brazil have a Bilateral Cooperation in the Energy Sector

partnership between the two countries. The two sides recognized the importance of the robust investment in the Brazilian oil and gas sector made by Indian companies and reaffirmed their commitment to safeguard



New Delhi, India: The Minister of Mines and Energy of the Federative Republic of Brazil, H.E. Bento Albuquerque paid an official visit to the Republic of India on April on the invitation of the Minister of Petroleum & Natural Gas of the Republic of India, H.E. Hardeep Singh Puri. H.E. Minister Albuquerque was accompanied by a delegation of private sector leaders of the biofuels and automotive sectors.

The leaders reviewed the existing bilateral cooperation across the entire spectrum of the energy sector and committed to enhance the beneficial partnership between the countries, and in this context expressed satisfaction at the important role bilateral energy cooperation plays in deepening the strategic

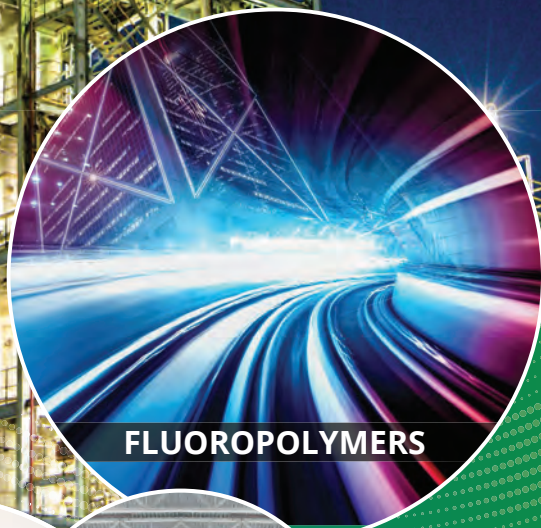
existing investments, while encouraging further bilateral investments. The two sides highlighted the importance of the bilateral trade in oil and its by-products, and expressed their willingness to expand this mutually beneficial trade. The Indian side expressed interest for sourcing crude oil under long term special contracts.

The two sides acknowledged the immense potential for collaboration between the two countries to scale up international production and use of sustainable bioenergy and biofuels, as an important vertical of the global transition to a low carbon future. In this context, they agreed on the importance of strengthening the bilateral cooperation in

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Operations

bioenergy. To this end, the two sides agreed to work towards developing an Indian-Brazil Alliance for Bioenergy and Biofuels.

The two Ministers reviewed the long list of bilateral and international activities and initiatives undertaken in the biofuels sectors in recent years, including the exchange of technical visits, the two editions of the Brazil-India Ethanol Talks, Symposium on Aviation Biofuels, launching of the Joint Working Group on Bioenergy Cooperation, Roundtable on India-Brazil Collaboration in Biofuels in the automobile Sector etc. They also noted bilateral coordination within G-20 on Climate and Energy, BRICS Energy Ministerial, Biofuture Platform, Clean Energy Ministerial, Mission Innovation initiative and IBSA joint Working Group on energy, and the work carried out in the context of the United Nations High-Level Dialogue on Energy.

Technology and future fuels: Sustainable aviation fuels – policies, feedstocks and implementation steps, Second generation ethanol – policy and technologies, and Synthetic biology cooperation.

IREDA Finances Blusmart Mobility Rs. 268 Crores to Purchase 3000 Electric Cars

New Delhi, India: In a bid to promote electric vehicles in the Delhi-NCR region, Indian Renewable Energy Development Agency Ltd. sanctioned a loan of Rs. 267.67 crores to BluSmart Mobility for the purchase of 3,000 all-electric cars.



Pradip Kumar Das, CMD, IREDA

BluSmart Mobility will use the fresh capital to purchase 3,000 all-electric cars, leading to an expansion of its EV fleet. From the sanctioned loan of Rs. 267.67 crores, the first tranche of Rs. 35.70 has been disbursed by IREDA to the company.

Speaking on the collaboration, Pradip Kumar Das, CMD, IREDA said, "We at IREDA believe that electric mobility has huge growth potential in India. BluSmart has been providing its services in the national capital region of India, and we support their team behind this good work. This is our first major investment in this space and towards making India a cleaner and greener country. IREDA is looking forward to financing more EV projects to speed-up the progress of moving transportation to clean sources in the country. This is part of the company's endeavour to help reduce emissions in the National Capital Region."

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Dr. Manas Kumar Sharma takes over as Director (E&D), OIL



discoveries as well as formulation of revitalization plan for existing brownfields within Operational Areas in Assam and Arunachal Pradesh. He is also instrumental in establishing Industry-Academia collaboration with Universities in the Northeast, which has helped in better understanding of the Assam & Assam-Arakan Basin for carrying out extensive exploration activities by OIL in the Northeast.

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Chandrakant Nayak - CEO & Country President, Dow India

New Delhi, India: Dr. Manas Kumar Sharma took charge as Director (Exploration & Development) of Oil India Limited (OIL). Dr. Sharma was serving OIL as Executive Director (Basin Manager-Shelf) prior to his appointment as Director (E&D), where he was involved in various E&P activities within the operational areas in Assam and Arunachal Pradesh of OIL. A skilled geoscientist and operational manager, Dr. Sharma carries with him more than 30 years of experience in the oil and gas industry, he has first-hand knowledge & experience in the subsurface & surface domain, both in the working as well as in the senior management level.

Dr. Sharma has conceptualized action plan for various exploration activities leading to identification of prospects for continued hydrocarbon exploration, appraisal of

Mumbai, India: Dow Chemical International Private Limited (DCIPL) is a Great Place to Work® Certified in India from March 2022 to March 2023 for building a High-Trust and High-Performance Culture. This certification marks the excellent work that Dow India has done to nurture a culture that places employee wellbeing, care, and safety at its core. Dow India believes people are its greatest assets and has amply displayed this

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through the support extended during the COVID-19 pandemic as well as by successfully embedding LGBT+ and inclusion across the organization's policies and practices.

Commenting on this recognition, Chandrakant Nayak, CEO & Country President, Dow India, said, "We are elated on being recognized as a Great Place to Work®. At Dow India. Our people make conscious efforts to foster a trustful and facilitative environment and are fully committed to creating an all-inclusive culture in the workspace. We are incredibly proud to have received this honor. This certification is testament to our firm resolve to build an atmosphere of innovation, inclusivity, and trust."

Underpinned by the ideals of diversity, inclusion and customer-centricity, Dow India empowers its exceptionally talented employees to create and deliver products and solutions to shape a better future for all its stakeholders and mankind. The company is invested in each of its employees' potential and growth, which is reciprocated through the favorable employee score received through this year's survey.

Freudenberg technology group's financial figures

Bangalore, India: The Freudenberg technology group can look back on a successful year. Sales and profit increased significantly in the past 2021 calendar year. "It was a strong and very successful year for Freudenberg. For the first time, sales exceeded the €10 billion mark," said Georg Graf, Freudenberg Regional Representative India and CEO of the Freudenberg Regional

Corporate Centre, India, commenting on the results. At €10,038.7 million, sales were significantly above the previous year's figure of €8,840.8 million. Furthermore, Freudenberg reported a profit from operations of €877.3 million, also considerably higher than the figure of €669.9 million for 2020. At €322 million, sales were significantly higher for Freudenberg in India as well.

"We continue to invest in machinery, equipment and future-oriented technologies at a high level. The battery and fuel cell business are being grouped together in a separate Freudenberg Battery & Fuel Cell Business Group. These changes took effect April 1," Georg Graf added.

ABB India expands Gujarat factory for Digital Substation Products and Digital Systems

Mumbai, India: ABB India announced the inauguration of its expanded Digital Substation Products and Digital Systems factory in Vadodara, Gujarat. Located within ABB India's largest manufacturing campus, this new factory will meet the growing demand for a wide range of digital substation products and digital solutions in India and in more than 50 countries. The manufacturing portfolio includes products like relays, while the solutions range from centralized protection and control systems, distribution automation, to bus transfer systems and arc protection for the electrical distribution network. These products are deployed across multiple industries from cement, steel, oil and gas to utilities (power distribution companies) and renewable energy projects through OEMs.

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This facility manufactures four variants or series of relays, constituting a significant portion of ABB's portfolio of this product. The manufacturing of relays follows a complex testing sequence comprising of high voltage test, functional test and heat run test. ABB is one of the first in the industry to have automated the entire testing sequence.

18 A special packaging software has been deployed which allows the products to be placed in the packaging bay only after checking the correct sequence of testing. Distribution Automation systems also enable remote monitoring and control of relays.

"India is projected to be among the top 3 energy consumers of the world by 2030 and currently is the fifth largest consumer*. This exponential increase in demand followed by the mix of diversified and distributed energy sources has increased the requirement for quality power equipment manufacturing in India. ABB's wide portfolio and future-proof technology has a significant role to play in supporting this growing demand," said Sanjeev Sharma, Country Head and Managing Director, ABB India. "We have been consistently investing in Gujarat, making it one of our largest manufacturing campuses.

The inauguration of this facility demonstrates our commitment to partner India's grid expansion and clean energy targets."

By supervising the safe continuity of electrical networks and reliable power distribution, relays,

centralized protection and control systems will play a critical role in India's renewable energy and carbon reduction targets. The Indian government has a vision to increase the local manufacturing of electrical and electronic equipment, making India a global hub by setting up dedicated manufacturing zones in the country.

Anupam Rasayan completes Tanfac Industries acquisition of 24.96%



Anand Desai, Managing Director of ARIL

Mumbai, India: Anupam Rasayan India Ltd one of India's leading custom synthesis and specialty chemical player, announced

the consummation of recently announced acquisition. The Company has completed the acquisition of 24.96% of the total equity shareholding of and joint control of Tanfac Industries Limited from Birla Group Holdings Private Limited, a promoter company which is part of Aditya Birla Group) and few other promoter group of TIL ("Sellers"). The Company has acquired joint management control and has become promoter of the company along with Tamilnadu Industrial Development Corporation Limited ("TIDCO") with effect from March 11, 2022, pursuant to acquisition of shares as aforesaid and under the terms of the Amendment to the Joint Venture Agreement Dated February 1, 2022 executed between the Company, TIDCO, Tanfac Industries Limited and Birla Group Holdings Private Limited.

Incorporated in 1972, TIL is a specialty fluorides chemical manufacturer. The company is also a leading producer of Hydrofluoric Acid and is engaged in manufacturing other organic and inorganic fluorine-based products such as Aluminium Fluoride, Sodium Silico Fluoride, Potassium Fluoride. In addition to that, Sulphuric Acid and Oleum are key products of the company. The company has one manufacturing unit at Cuddalore, Tamil Nadu, spread across 60 acres and strategically located adjacent to the Cuddalore Port. TIL posted revenue of ₹253 crores, EBITDA of ₹65 crores and PAT of ₹46 crores till Q3 of FY2022.

Speaking on the appointment, Anand Desai, Managing Director of ARIL, said, "We are very pleased to announce that our acquisition of Tanfac industries from Birla Group Holdings has successfully completed. We are excited to

create significant value through synergies and expand our fluorination chemistry business. Tanfac has an excellent management team and with this talent, we will together take its business to the next level. We look forward to work with them for a smooth integration"

India's Cosmo Speciality Chemicals launches eco-friendly Wetofast range for all kinds of textile



Anil Gaikwad, Business Head, Cosmo Speciality Chemicals

New Delhi, India: Cosmo Speciality Chemicals, a 100% subsidiary of Cosmo Films Ltd. announces the launch of Wetofast range – a completely eco-friendly solution to maintain high quality of fabrics. The range introduces three new products - Wetofast GN, a pretreatment of all fibers, Wetofast LOR which helps to remove oils, waxes and greasy impurities effectively, and Wetofast LD which confirms high absorbency to textile goods after bleaching process. These products are APEO and NPEO free, and will be available across Indian/global market.

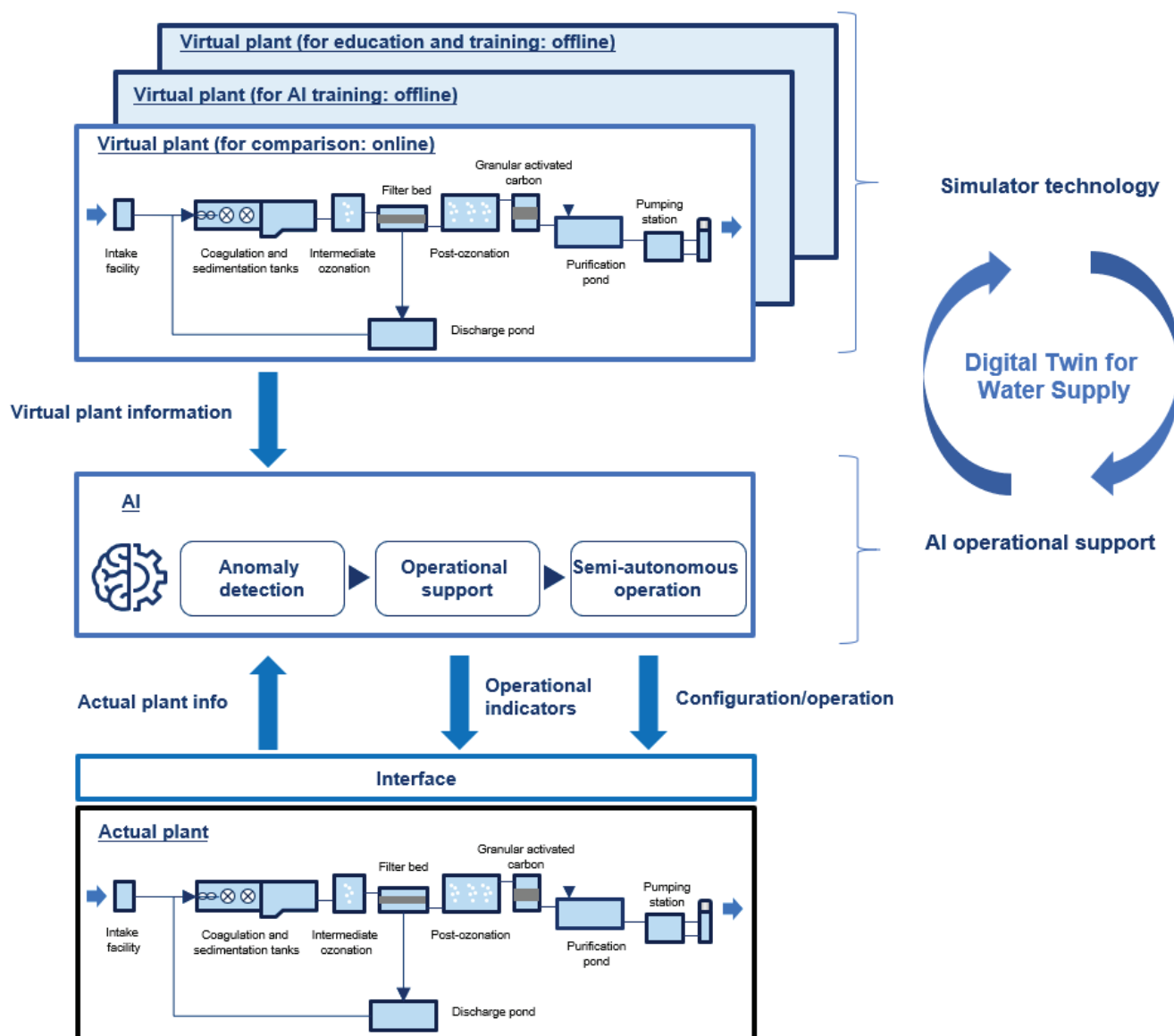
Wetofast GN is a non- ionic agent which can be used for pre-treatment of all fibers but particularly for natural and regenerated cellulosic, wool, and synthetic fibers and their blends. With very good wetting and emulsion properties, it poses a very good stability to alkali, acids and enzymes. Being good resistant to oxidative and reductive agents, it can be diluted in cold as well as warm water. 1.0-1.5% dose for exhaust application is recommended for Wetofast GN. The product is APEO and NPEO free. Wetofast LOR is an agent with excellent emulsification power which helps to remove oils, waxes and greasy impurities effectively. Especially suitable for Lycra blended fabric to emulsify the oil and ease of extraction, it confirms high rewetting property to textile goods after bleaching process. Free from enzyme poison, it's an APEO and NPEO free product and is exclusively recommended for continuous process where quick wetting is required to get sufficient pick-up for heavy gsm fabrics like twills. 0.5-1.0% dose for exhaust and 2-5g/l for continuous application are the recommended dosages for Wetofast LOR. Wetofast LD is a wetting agent which confirms high absorbency to textile goods after bleaching process and is suitable for all types of fabrics. It helps in removing oils and waxes effectively. With good soil suspending properties the agent is an APEO and NPEO free product. Being good resistant to oxidative and reductive agents, it is free from enzyme poison and possesses a good stability to alkali and acids. 0.7-1.0% dose for exhaust application is recommended for Wetofast LD.

Yokogawa Solution Service Commences Joint Research with Osaka City Waterworks Bureau



Tokyo, Japan: Yokogawa Solution Service Corporation, a subsidiary of Yokogawa Electric Corporation that is responsible for the company's control business in Japan, announces the commencement in February 2022 of a joint research project with the Osaka City Waterworks Bureau that will verify and evaluate the effectiveness of anomaly detection, operational support, and semi-autonomous operations by utilizing Yokogawa simulation and AI technology at water treatment and distribution facilities. This research will also aim to establish effective methods for the use of simulators in human resources training.

With the aim of improving its responsiveness to accidents and other incidents, the Osaka City Waterworks Bureau has been working to establish the centralized management and monitoring of operations at its water treatment and distribution facilities. As this requires advanced skills and capabilities, there is a need for the development of an effective operator support system that will enable swift anomaly detection, and methods to accelerate the training of plant personnel.



Overview of actual operation using simulation and AI technology

This project will entail the use of Yokogawa simulation technology to construct a virtual plant called a digital twin* that will utilize actual process data, analytical data, and facility information. Data from this digital twin and the actual plant will be compared to increase the accuracy of the simulation, and to verify whether it is possible to detect any anomalies with AI and notify operators before such a malfunction actually occurs. It will also be verified whether it is possible to predict important indicators and give appropriate

operation instructions after an anomaly is detected, and whether semi-autonomous operations are feasible. In addition, the research will focus on the establishment of effective methods for human resources training using the simulator's instructor function. This joint research will continue until the end of March 2024.

The research will explore how to provide operational support through workload reduction, work optimization, and risk avoidance, and look for ways to build an

emergency-response training environment that will utilize a simulator for self-training and automatic evaluation. Together with the Osaka City Waterworks Bureau, the company will build an optimized operating model for water treatment and distribution facilities. And by verifying the effectiveness of semi-autonomous operations of treatment and distribution facilities, Yokogawa will facilitate the transition from industrial automation to industrial autonomy (IA2IA).

Utilizing the results obtained through this research and the company's extensive experience and know-how in water supply and water treatment, Yokogawa will help to find solutions to problems faced by the water industry, including aging facilities, deteriorating profitability, and a declining number of engineers

* A model in which a real-world situation is reproduced through the statistical and data analysis of a range of data gathered in the real world. ■

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IndianOil, L&T and ReNew to form JV for development of Green Hydrogen Business



Mumbai, India: In a bid to enable India's decarbonization push, Indian Oil Corporation Ltd, and Larsen & Toubro (L&T), India's premier engineering & construction conglomerate, and ReNew Power ("ReNew") India's leading renewable energy company, announced signing of binding term sheet for the formation of a Joint Venture (JV) company to develop the nascent green hydrogen sector in India.

The tripartite venture is a synergistic alliance that brings together the strong credentials of L&T in designing, executing, and delivering EPC projects, IndianOil's established expertise in petroleum refining along with its presence across the energy spectrum, and the expertise of ReNew in offering

and developing utility-scale renewable energy solutions. Additionally, IndianOil and L&T have signed a binding term sheet to form a JV with equity participation to manufacture and sell Electrolyzers used in the production of Green Hydrogen.

Speaking about the joint venture, SN Subrahmanyam, CEO & MD, L&T, said, "India

plans to rapidly march ahead in its decarbonization efforts and production of Green Hydrogen is key in this endeavour. The IndianOil-L&T-ReNew JV will focus on developing Green Hydrogen projects in a time-bound manner to supply Green Hydrogen at an industrial scale. While L&T will bring its strong EPC credentials to the table, IOC being India's premier oil refiner with extensive capabilities in chemical processes and refining has established deep R&D capabilities in many aspects of green hydrogen value chain, and ReNew Power has in a short time established itself as a leading renewable energy supplier and has built itself a very strong reputation. We consider this partnership as a significant step in India's quest for alternative energy. Addressing

another gap in the Green Hydrogen manufacturing chain, IndianOil-L&T JV will focus on production and sale of Electrolyzer.” “Both these JVs aim to enable the nation’s ‘Aatmanirbhar Bharat’ mission to rapidly build, expand and bring in economies of scale to make green hydrogen a cost-effective energy carrier and a chemical feedstock for many sectors.”

Commenting on the occasion, Shrikant Madhav Vaidya, Chairman, IndianOil, said, “Being the Energy of India, we are committed to powering India’s drive towards carbon neutrality by leveraging the power of green hydrogen. IndianOil is forging this alliance to realise India’s green hydrogen aspirations, which is in sync with the Hon’ble Prime Minister’s vision of making India a Green Hydrogen generation and export hub.”

OIL commissions India’s first 99.999% pure green hydrogen plant in Jorhat, Assam

Oil India Limited (OIL) has taken the first significant step towards Green Hydrogen Economy in India with the commissioning of India’s First 99.999% pure Green Hydrogen pilot plant with an installed capacity of 10 kg per day at its Jorhat Pump Station in Assam today. The plant was commissioned in a record time of 3 months.



Shri S.C. Mishra, CMD, OIL inaugurating OIL's Green Hydrogen plant



Green Hydrogen plant of Oil India Limited

Sushil Chandra Mishra, Chairman & Managing Director, inaugurated the plant in the presence of Shri Harish Madhav, Director (Finance) and Shri Prasanta Borkakoty, Resident Chief Executive of the company. The plant produces Green Hydrogen from the electricity generated by the existing 500kW Solar plant using a 100 kW Anion Exchange Membrane (AEM) Electrolyser array. The use of AEM technology is being used for the first time in India.

Speaking on the occasion, Mishra said that the company has taken an important step towards fulfilling the vision of our Hon'ble Prime Minister for an Energy-Independent India. This plant is expected to increase its production of green hydrogen from 10 kg per day to 30 kg per day in future. The company has initiated a detailed study in collaboration with IIT Guwahati on blending of Green Hydrogen with Natural Gas and its effect on the existing infrastructure of OIL. The company also plans to study use cases for commercial applications of the blended fuel.

Godavari Biorefineries Inaugurates Research Lab at Sakarwadi, Maharashtra



Godavari Biorefineries Ltd, a pioneer in manufacturing ethanol-based chemicals in India and one of the largest producers of ethanol in India (source:

Frost & Sullivan Report), held a Bhoomi Poojan ceremony for its Sakarwadi Manufacturing Facility at Sakarwadi in Maharashtra. GBL also inaugurated a research laboratory for bio-chemical research and new product development. The Hon'ble Shri Subhash Desai, Cabinet Minister of Industries, Maharashtra, presided at the Bhoomi Poojan while unveiling the research laboratory to augment its pioneering work in biochemical research.

The Sakarwadi Manufacturing Facility manufactures bio-based chemicals that find use in a number of applications, while the research facility is equipped to undertake advanced bio-chemical research fostering the government's vision of 'Atmanirbhar Bharat' and 'Make

in India.' Speaking on the occasion, Subash Desai, said: "I congratulate Godavari Biorefineries and Mr. Samir Somaiya on this momentous occasion. I'm confident that the journey of betterment of mankind initiated by his forefathers will get a boost with the new R&D center."

Samir Somaiya, chairman and managing director, Godavari Biorefineries, said: "We are delighted that the specialty

chemicals facility and our ramped up research laboratory will enable us to expand the biochemical industry. India has been increasing its exports of chemical products in recent years, and at Godavari Biorefineries our vision is to make green chemicals that reduce the impact on the environment, focus on bio-diversity and the prudent use of scarce resources."

Godavari Biorefineries Sakarwadi Manufacturing Facility utilizes ethanol and rectified spirits and can use ethanol and rectified spirits manufactured by them to manufacture specialty chemicals including bio-ethyl acetate, MPO, 1,3 butylene glycol, crotonaldehyde and paraldehyde and commodity chemical ethyl acetate. The Company is in the process of expanding its plant to expand their capacity for existing products and introduce additional ethanol-based chemicals. ■

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“Focus on the Given Objective of Work Rather than on your Gender”



Ashima Sushilchandra

Head- Engineering & Technical Expertise Hub India, GEA/OS,
BASF Chemicals India Private Ltd

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How would you describe your journey in the space of handling projects in the chemical industry which has not been a natural choice for most women so far?

I started my career as a Process Design Engineer in an Engineering Consultancy firm handling projects. I worked on several Chemical and Petrochemical plant engineering, assuming I would see the entire project cycle at work. Soon I realized that we were denied an opportunity at execution and pre-

commissioning due to the limitations in statutes. The Factories Act didn't permit women to work beyond 6 P.M. in the factory premises, in any Manufacturing industry. I moved on to an engineering workshop leading the Planning and Procurement division of the firm.

My journey with BASF started with joining the Projects team in 1998 to gain valuable on-field experience. As I was joining the manufacturing/ projects arena for BASF in India, initially there

were some apprehensions concerning this but all such anxieties and doubts faded away when I was in action & adapted to the environment.

One of the most interesting challenges for me, a woman at the helm of a project in the late 90s was to deal with contractors who had to adapt and accept me, a woman within the manufacturing site. I navigated through these challenges by remolding my own personality to suit the occasion. Sometimes I would be a tough taskmaster and sometimes I would be highly flexible as well as an empathetic team leader supporting colleagues to achieve our set targets.

I am happy to note that from the time I joined BASF, the work environment has evolved with changes in laws and the companies providing infrastructure for women. We now have women working in shifts at our manufacturing sites in BASF India and I know of other manufacturing firms that have entire plants run by women now. Globally, organizations have taken note of the significant value addition that women have brought into the workforce, with the focus on diversity and upping their emotional quotient. BASF too set up a target of securing at least 30% of leadership roles being filled by women by 2030. That's how the work

environment is evolving and helping us get diverse views and perspectives.

How do you see the changed mindset while dealing with a lot of contractors onsite where they start treating women at par at every level?

It wasn't easy at the start, and I have had my set of tough situations since I began my journey 25 years ago. Some of the contractors would try to circumvent tried and tested methods to gain a financial advantage thinking it would be easy to do this, with a lady at the helm. I managed to deal with all such situations in a brisk manner, confidently asserting that I meant business! I see that the situation has greatly evolved and we do not see this attitude displayed now.

Early on, I realized that if you leverage your experience and learnings pay heed to the concerns of their workforce, and act on them, you would garner the trust and respect of your colleagues. In my opinion, it is much easier to garner the support and respect of the blue-collar workers as compared to the management personnel, if you are inclusive in your approach. I also think it's the inherent empathy in women that helps us connect with the people and understand them better which gets conveyed over time.

Share with us your career highlights.

My transition thereafter from being a Project Manager, to my other roles (including process safety champion) as Head of Responsible Care for BASF South Asia was smooth. I then had a brief stint of approximately three years as the Head of the Thane manufacturing site before I moved to my current role as Head Engineering and Technical Expertise for the Mumbai hub.

My short stint of three and a half years at the Thane manufacturing site where I led the oldest manufacturing site for BASF India Ltd proved to be very valuable.

I had relocated to Mumbai and away from my family to take up this opportunity. My role as Site Head at Thane, was initially accompanied by disbelief as it was hard to believe that women could take on the important task as a Site Head at the oldest Manufacturing site, especially one with a legacy of close to 50 years and with two labour unions to manage!

As a newbie in every sense, with no prior experience in industrial relations or production background, managing the manufacturing site seemed a herculean task at that time. I had to manage the administration and profitability of the site and manage the Contractor Unions

too. Much credit for my successful stint goes to my organization for backing me up, reposing trust and empowering me. This backing really nudged me to perform at my best and made me gear up to venture into uncharted waters. All of this was also possible with the strong support from my family too.

I had to really tweak my personality, it was what you call situational leadership to create a shift in the culture and bring about improved reliability as well as profitability. I am happy to note that I pushed the entire team to discover their true potential and we thus, achieved our given objective of green audits, and profitability and mutually concluded the settlement with two employee unions at the manufacturing site. Our efforts brought about a positive change as I was also able to congregate the employee unions and contractors successfully.

As a leader, I realized that each employee brings some strength to the table and every one counts, this truly promotes and propagates inclusivity. In all the different stints where I was deployed, I only focused on the given objective of the work at hand rather than on my gender. It was done with a clear motive of attaining success and this helped me in making my team excel at the task.

“Having women in manufacturing creates a gender-intelligent environment and increases the emotional quotient. As women, we have an edge towards perfecting tasks, multi-tasking and setting the right priorities.”

Have you come across girls who are hesitant to pursue the field due to a lack of family support? What is your advice to them?

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Quite a few manufacturing/project sites are situated in remote locations and this can pose a challenge in terms of safety and security of getting women involved in various shifts. It takes time to make a transition from deep-rooted cultures. It will take time to adapt and change.

The evolving work environment has given rise to confident and stronger ladies more than ever. I do not see any gender discrimination or differentiation at the BASF workplaces. The infrastructure is well developed with allocated restrooms and facilities, making it a safe place to work in.

Hence, the first would be to focus on the given objective or work rather than on your gender.

A realization that for biases to be demolished there must be an additional effort by women to be accommodative as well and ensure we perform all the jobs without pre-conditions

Having women in Manufacturing creates a gender-intelligent environment and increases the emotional quotient. As women, we have an edge towards perfecting tasks, multi-tasking and setting the right priorities. The women will be under the lens always (as is the case with outliers!). I truly believe, it is our attitude that determines who or what we are. So, get comfortable with uncomfortable. The woman who has the tenacity to withstand pressure could also be in an enviable position later.

A person with a positive mindset can make anything happen and mold their work environment into a better place. You make the difference. ■

Compression Options for Carbon Dioxide Transport and Sequestration

For a carbon constraint economy the main energy carriers will be electricity and hydrogen.

Hydrogen has the advantage that it can be easily stored, while electricity does not have to be re-converted to be useful for most electricity applications. For the near future most hydrogen will be derived from natural gas since electricity conversion to hydrogen from alternative energy sources is too expensive in terms of capital cost and roundtrip efficiency. Several prominent studies have shown that, even if the supply cost of electricity from alternative sources is zero, the total cost of producing hydrogen via electrolysis is still higher than producing it from natural gas because of the high initial and maintenance costs of electrolyzers.

Natural gas is still abundant and cheap in North America, and the methane steam reforming process to convert natural gas to hydrogen is a proven and relatively inexpensive process. Thus, most hydrogen in a de-carbonized energy economy will be blue hydrogen from widely available natural gas rather than green hydrogen

from curtailed alternative energy sources. But for every ton of hydrogen produced from natural gas, approximately 8-12 tons of carbon dioxide greenhouse gas will also be produced. Consequently, carbon dioxide will have to be managed: It will have to be transported and injected into an appropriate geological sequestration end-storage site

Although the natural gas to hydrogen conversion can be performed at either the natural gas well site or near the end-use location, because of the existing natural gas infrastructure and the cost of developing a completely new hydrogen transport infrastructure, it is likely that in most cases the conversion will be performed near the site where the hydrogen will be utilized; i.e., near a power plant that utilizes hydrogen fuel for combustion or near a fuel-for-transportation distribution hub. Specifically, in most cases the existing natural gas pipeline and storage infrastructure (worth billions of dollars) will dominate the economics and the natural gas to hydrogen conversion will be

placed as close as possible to the end use location of the hydrogen to minimize the cost and complexity of having to transport the hydrogen. This then creates the critical need to develop an infrastructure to transport the carbon dioxide to an appropriate sequestration site.

The pressure of the CO₂ gas from the separation process is dependent on the type of separation process utilized, and can vary from slightly above atmospheric to several hundred psi. There is also significant uncertainty about the geological formation injection pressure since it strongly depends on the type of formation and its depth of injection. However, a generally accepted rule is that for every kilometer of depth of injection, about 1150 psi of gas pressure is required. Since many of the geological formations that are being considered are relatively shallow, injection pressures between 1500 to 2500 psi are expected to dominate. Thus, a typical carbon separation and storage pressure application requires CO₂ to be compressed from below 50 psia to somewhere above 2000 psia.

Regardless of the sequestration injection pressure, the industry generally accepted convention is that CO₂ should be transported as a supercritical fluid above 2100 psi in pipelines. At 2100 psi CO₂ is well above its critical point in a supercritical (dense phase) state for

almost all ambient temperatures. Fluids in a dense phase share some physical properties of liquids, such that they have a very low compressibility, and also some of gases in that they will expand in space to fill voids. The advantage of transporting CO₂ at supercritical pressures is that its density does not change much with pressure, and from a thermodynamic perspective it is basically pumped rather than compressed. This significantly reduces the power demand for the pumping stations along a CO₂ pipeline.

Carbon Dioxide Compression

Since CO₂ is a very heavy gas it is relatively easy to compress. This means that for a given head the pressure ratio per compressor impeller stage is high. But because of the high pressure ratio per stage, CO₂ also has a significant specific volume decrease with pressure and a very high heat of compression. Consequently, CO₂ will heat up when compressed which requires stage intercooling to maintain the gas temperature at reasonable levels so as to not damage the seals and bearings of the compressor. Furthermore, because of its rapid density change with pressure, there is a significant flow volume reduction that requires a wide range of aerodynamic high-to-low flow compression stages.

The types of compressors that are usually considered for high-pressure ratio carbon

(CO₂) sequestration applications are reciprocating, screw, centrifugal barrel, centrifugal horizontally split, integrally geared, and hybrid centrifugal with dense phase pump. Since both reciprocating and screw compressors are severely flow limited, they cannot be practically used for large-scale carbon sequestration applications. The remaining technology options all rely on proven centrifugal compressor or pump impellers but use different layouts and stage arrangements. The focus here will be on hybrid centrifugal barrel with dense phase pump compression since it shows the highest potential for large industrial scale, reliable, and low-cost carbon dioxide compression.

A schematic of the configuration to compress CO₂ from about 50 psia to 2100 psi for from carbon separation into pipeline header for transport or geological storage injection using a hybrid barrel compressor and dense phase pump is shown in Figure 1. Specifically, Figure 1 shows an inter- and discharged-cooled barrel straight-through centrifugal compressor with a dense phase (supercritical) pump in a single-gear train. For this compressor arrangement, about 7-10 compression and pumping stages with intercoolers between some stages are required. For most carbon sequestration CO₂ compression applications, this solution is advantageous since it can be used for large scalable plants, allows for a range

wide operating conditions, can handle significant downturn, meets the most stringent industry norms and standards, is not limited to the plant type, has low maintenance requirements and overhaul cycles, and has a much higher reliability and availability than other commercially available compression options.

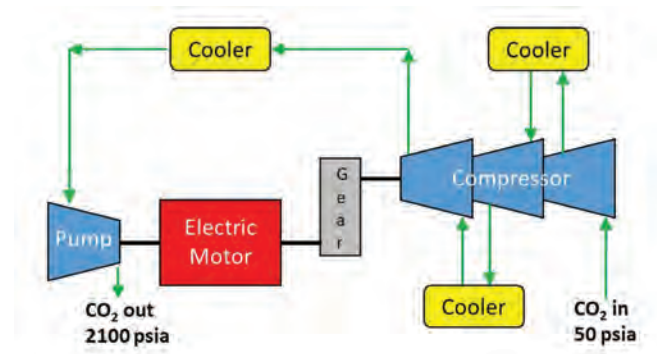


Figure 1: Intercooled Centrifugal Barrel Compressor Feeding a Dense Phase Pump

Barrel Compressor Designs

For the hybrid compression-pumping option, a dense phase pump and a barrel type compressor is required. Figure 2 shows an eight impeller stage barrel type centrifugal compressor design with multiple nozzles for intercooling or side-streams. Similarly, Figure 3 shows a multi-stage horizontally split compressor with nozzles for two intercoolers driven by an electric motor through a gear-box. These designs are similar to the multi-section low pressure compressor shown in the schematic in Figure 1 located upstream of the dense phase pump. Two casing

section intercoolers and one discharge cooler are needed to avoid overheating and efficient CO₂ compression. Typical CO₂ carbon separation operating conditions for these machines are suction pressures from <50 psia to discharge pressures of >1150 psia. At 1150 psia, the compressor discharge gas will be in the supercritical state, and after cooling, can be fed directly into the dense phase pump for higher pressure pipeline transport or storage injection.

Several machinery solutions for compression and pumping of CO₂ are commercially available and have been field demonstrated. However, for large-scale industrial CO₂ transport and sequestration the most favorable solution appears to be the usage of a conventional barrel compressor in combination with a dense phase pump. This solution provides the most cost-effective, safest, reliable and operationally flexible solution for most carbon dioxide transport and sequestration applications. ■

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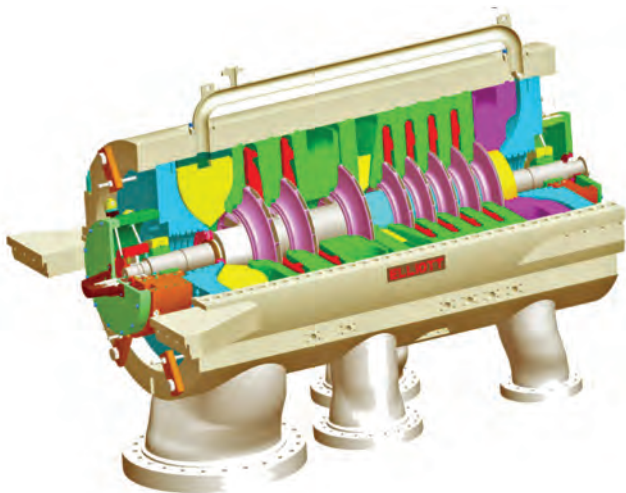


Figure 2: Multi-stage Barrel Centrifugal Compressor Design

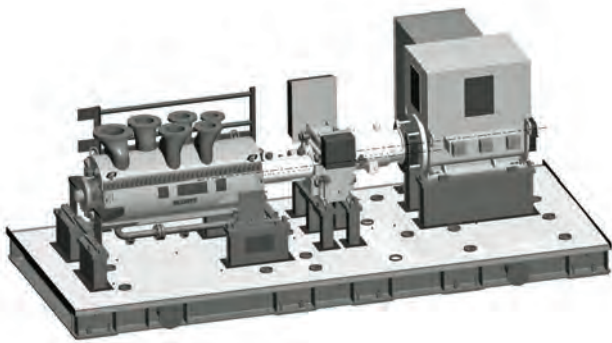


Figure 3: Horizontally Split Centrifugal Compressor with Multiple Intercooling Nozzles



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Recycling Lithium-Ion Batteries Paving Way to Efficient Energy Storage



The battery recycling industry is the new focal point in the global conversation about sustainable energy. Several countries have created initiatives and directives, all of which aim to recycle batteries, break them down into their constituent metals and re-introduce them into the value chain. From India's perspective, there are one or two hurdles when it comes to manufacturing batteries and it is this, in order for Indian companies to produce their own Lithium-ion batteries, the only choice they currently have is to import all of the raw materials needed for cell manufacturing. This is because none of the Rare Earth metals such as Lithium, Nickel, Cobalt and Manganese which are used in the manufacturing of Lithium-ion cells are mined in India in any significant quantity. In addition to this, they will either have to develop proprietary technology to manufacture cells, or they will have to import the required technology as well as pay huge licence fees. Therefore, it has always been much more cost-effective to directly import Lithium-ion cells from a country such as China and assemble them

into batteries in India; which is the industry norm currently.

India does, however, have an abundant domestic source of these metals, used Lithium-ion batteries from which the aforementioned four Rare Earth metals along with Graphite can be extracted through recycling. At an increasing rate, this would cut down the burden on imports while securing an alternative raw-material supply chain, reducing our dependence on exporting economies. At the moment, less than 5% of Lithium-ion batteries are recycled globally. This means that 95% of all the Rare Earth metals used in the manufacturing of such batteries are wasted after being used just once. One way to look at this is that the technology and processes required to extract these metals didn't exist until very recently. In fact, we are in the midst of a global race to find the exact formula to achieve just this. A handful of companies are throwing all their resources in the pursuit of the first mass-produced recycled Lithium-ion battery; which is the key to a circular economy.

To understand this, let's consider the mobile phone industry in India. Most studies that we've looked at agree that out of a population of circa 1.4 billion people, India has 1.2 billion mobile subscribers out of which 750 million use smartphones. When these devices reach the end of their cycle, they are scrapped. Their Lithium-ion batteries end up in a landfill. That's a conservative estimate of 250 million batteries per year. That equates to 12,500 tonnes worth of Lithium-ion batteries from mobile phones alone.

36 Within the context of transportation, the Electric Vehicle industry in almost all countries is being encouraged with grants, subsidies and other special privileges in order to drastically reduce greenhouse gas emissions and meet climate targets. One of the most promising possibilities is electric vehicles powered by Lithium-ion batteries. This market is expected to grow tremendously over the next decade, owing to measures taken by both industry and governments alongside genuine consumer demand for EVs. As a result, the need for raw materials is expected to skyrocket. There's an additional concern for the availability of essential metals like Lithium and Cobalt. Because cathode materials account for 30-40% of total battery cost, a cost-effective and environmentally-friendly direct recycling process that provides reusable battery-grade cathode materials will reduce energy usage and battery material costs.

Lithium-ion batteries lose approximately a quarter of their capacity when removed from electric vehicles. That still leaves a lot of useful energy within the battery which recyclers can and should use for other purposes as well. The few Lithium-ion battery recyclers that exist globally are now actively working with automakers to help them transition their Lithium-ion batteries into a more recyclable and reusable state. That is a significant shift in the industry's business practices; especially compared to Lead Acid batteries of the past and is a promising sign for a new approach to waste. In addition, Lithium-ion battery technologies have reduced in price to levels equivalent to solar energy technology such as Photovoltaic modules that are often regarded as the gold standard in sustainable energy.

Direct recycling will become a viable choice if the technology gets developed to allow for large-scale processing of end-of-life EV batteries in huge quantities. In addition, direct recycling is more cost-effective and environmentally-friendly than older processes that involved the melting of materials. As clearly stated in a recent report by Rystad Energy, electric passenger vehicles (EV) will become a consequential benefactor to the future of battery growth, accounting for approximately 55% of the industry's total demand by 2030. Additionally, the need for Lithium-ion batteries will reach 4.9 TWh by

2030, which is more than 13 times higher than 2021's comparatively low capacity of 373 GWh.

Extracting Lithium, Cobalt, Manganese, Nickel (and other valuable materials such as Copper, Aluminium, and Graphite) from spent Lithium-ion batteries has only recently become profitable. In addition, the electric vehicle boom resulted in a threefold increase in the price of Lithium and a fourfold increase in the price of Cobalt between 2016 and 2018. Thus, a handful of Lithium battery recycling businesses have opened in India and around the world; with those that already exist growing capacity. Aside from Lithium-ion batteries fast-becoming the default choice for energy storage, recycling remains the only long-term cost-effective and sustainable solution. ■



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New Research Exposes Dire Vulnerabilities in Operational Technology



he nation's ability to protect critical infrastructure from cyberattacks has come under the spotlight. Notable events such as the cyberattack on the U.S. Colonial Pipeline and recent Russian attacks on power stations in Ukraine have drawn the attention of the private and public sectors alike. In the U.S, the Biden Administration reacted to these attacks by adding a mandatory 72-hour maximum time frame for reporting cyberattacks to the Cybersecurity and Infrastructure Security Agency (CISA). Regulatory action may help to shore up the country's defense against cyber threats, however government oversight has a tendency to move slowly, and even when fully implemented it can be limited.

For example, the recent TSA cyber regulations for pipelines which created confusion and contained unwieldy requirements. These new regulations are generally focused more on personal

computers as opposed to pipeline controllers and suggest a lack of industry insight into the regulatory framework. Companies that build our critical infrastructure must lead the fight to secure operational technology (OT) environments from cyber threats, but are they equipped to do so? The numbers don't look great.

Where are Organizations Lagging Behind? Just About Everywhere

A recent survey from the SANS Institute titled "Threat-Informed Operational Technology Defense: Securing Data vs. Enabling Physics" has exposed glaring holes in the industries' capacity to prepare for inevitable cyberattacks on OT systems.

To start, an organization must know their points of vulnerability and have the ability to detect an attack. Sadly, many threats go undetected for an extended period of time such as the SolarWinds attack in 2020.

In that instance, threat actors infiltrated the company's software system "Orion" for 6 months before the attack was even detected. According to the SANS survey, 30-40% of respondents don't have a formal process to identify and inventory OT and industrial control system (ICS) assets and 65% indicate their visibility is limited for these control systems. Without having the ability to properly assess and detect vulnerabilities, these organizations remain exposed to potential cyber threats, a dangerous place to be in today's heightened geopolitical climate.

Additionally, even after an organization is able to detect a threat, they need to develop a way to effectively respond to it once detected. However, the SANS survey found that 47% of ICS organizations do not have dedicated 24/7 OT cybersecurity response resources to manage OT/ICS incidents. Furthermore, slightly more than 40% of organizations report not having completed training exercises to prepare for potential attacks. This startling lack of preparedness leaves critical infrastructure vulnerable to threat actors who increasingly seek to disrupt cyber operations that can lead to cyber and physical consequences. Unlike attacks on informational technology (IT), attacks on OT environments can result in physical harm to workers, equipment and the environment.

Why the Lack of Preparedness?

The results of the SANS survey also reveal the disconnect between workers on the frontlines and the decision-makers. 61% of survey participants indicate a gap exists in the perception of cybersecurity risk to their ICS facilities between OT/ICS cybersecurity frontline teams and other parts of the organization. Responsibility for OT cybersecurity typically sits with IT since the perception from the C-suite is often that the same solutions and practices that protect IT can be replicated in OT environments. However, this just isn't the case. The Department of Homeland Security points out, "Standard cyber incident remediation actions deployed in IT business systems may result in ineffective and even disastrous results when applied to ICS cyber incidents, if prior thought and planning specific to operational ICS is not done." Organizations need to have a clearly defined security structure that has knowledge of OT environments and does not rely on IT practices to protect OT systems from physical, real-world consequences.

The lack of cybersecurity programs in industrial environments has had massive impacts on the chemical industry, with a recent study out of the U.K. estimating that cyberattacks cost the industry £1.3 billion per year. The chemical sector is an appealing target because it deals

in large sums and organizations are especially invested in maintaining a positive brand reputation. If a cyberattack forces production to grind to a halt, the consequences are often severe, making companies highly motivated to pay large ransoms. In 2021, chemical distribution company Brenntag paid a \$4.4 million dollar ransom to prevent the cyber hacker group DarkSide from leaking stolen data.

What Does the Future Hold- The Race to Build OT Cybersecurity

The good news is organizations are becoming increasingly aware of the impact cybersecurity has on industrial settings and the surging threat to OT environments. Results from the SANS survey show a trend towards greater investment in OT security practices with increased visibility into control system assets (52%) and implementing ICS-specific network security monitoring (NSM) for control systems (51%) ranking as the top two budgeted initiatives for organizations within the next 18 months. On a broader scale, there is evidence of industrial and technology organizations from the private sector attempting to take the lead on cybersecurity initiatives and standards, rather than relying on federal mandates and compliance-based action to do the job. The Operational Technology Cybersecurity Coalition, formed in April

of 2022, aims to lobby Washington to give the private industry managing critical infrastructure a voice in how cybersecurity standards are created and implemented for OT environments.

The results of the SANS survey reveal how the industry is playing catch up to a threat that's already here. Companies managing critical infrastructure are severely lagging in OT cyber practices. No longer are cyber attackers here just to steal data; recent attacks have demonstrated the harm that can be caused to people, equipment, and the environment if organizations are unable or unwilling to be proactive in the war against cyber. It's not "if" you will come under attack, but "when". Is your organization OT cyber ready? ■



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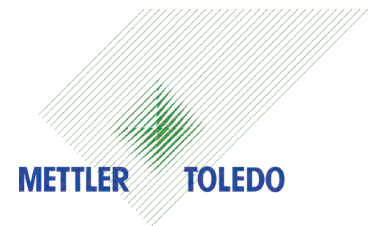


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Truck scales are convenient targets for fraud. Thieves constantly devise new ways to cheat businesses that buy or sell truckloads of material by weight. Protect yourself with the built-in security features of DataBridge™ MS software.

Many software programs rely on password protection alone. DataBridge™ MS software uses

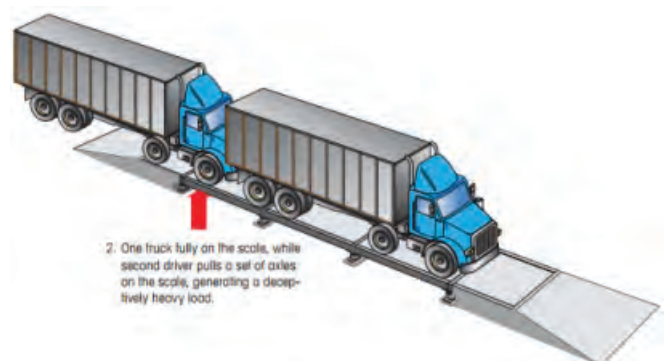
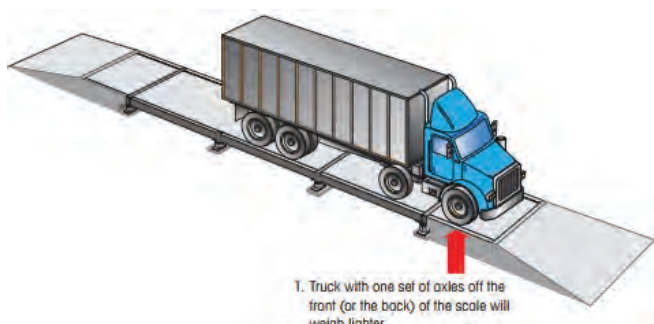
password protection with defined access levels, but that is just the first layer of fraud prevention. The software provides

an arsenal of anti-fraud features designed to stop the tactics that are being used to cheat truck scales. i.e. weight curves, stored tare weights, camera capabilities, pre-loading, audit logs etc.

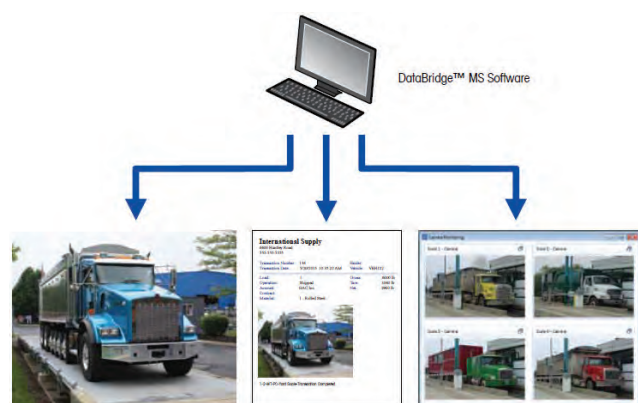
The most common way to cheat at the truck scale is also the simplest—improper positioning of the truck on the weighbridge. Several scenarios make this possible for a truck driver to accomplish.

Truck with one set of axles off the front (or the back) of the scale will weigh lighter.

One truck fully on the scale, while second driver pulls a set of axles on the scale, generating a deceptively heavy load.



Camera Capabilities



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This software is also having capability for complete unattended weighing system, which helps to avoid weighing attendant, improve data accuracy and faster weighing throughput. ■

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