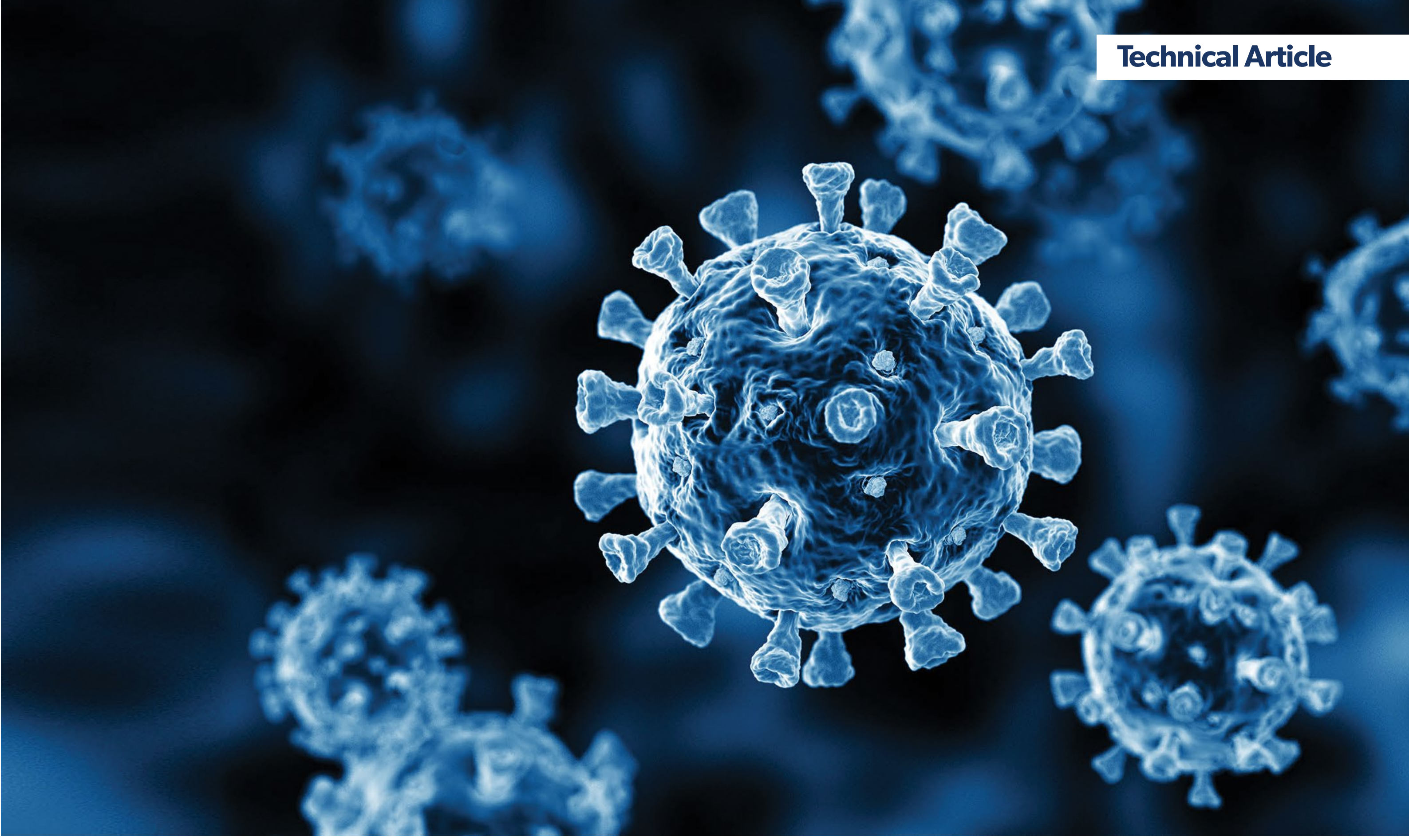

Impact of Covid-19 and needs of digital transformation to protect assets from corrosion

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Corrosion is a problem that can impact human health, destroy infrastructure, and cost trillions of dollars every year throughout the world. Before we design any equipment, the impact of corrosion on the plant asset and its surroundings must constantly be considered. Despite this, catastrophes such as fatalities, economic losses, and environmental negative effects caused by corrosion continue to occur often. The "International Measures of Prevention, Application, and Economics of Corrosion Technology (IMPACT)" report estimates the global cost of corrosion to be US$2.5 trillion, or nearly 3.4 percent of global GDP. According to the report, implementing corrosion prevention best practices could save the world between 15% and 35% (USD $375 to $875 billion) in damage costs [1].

On the other hand, coronavirus disease 2019 (COVID-19) has had a substantial economic impact in addition to its influence on equipment corrosion. The COVID-19 pandemic has wreaked havoc on people's lives in all countries and communities and has had a negative impact on global economic growth in 2020 and unlike anything seen in nearly a century. According to estimates, the virus slowed global economic growth in 2020 by roughly -3.2 percent on an annualised basis. Economic growth in most countries decreased drastically in the second quarter of 2020, swiftly rebounded in the third quarter, and has been largely positive since then.

The global economy was projected to grow by 5.6 percent in 2021, the fastest pace since the Great Depression. Globally, the recovery is patchy. Most emerging market and developing economies (EMDEs) are underperforming, with growth concentrated in a few large markets. Only around one-third of EMDEs are likely to reach their pre-pandemic per capita income levels by 2022, compared to about 90% of developed nations. As a result, numerous poorer regions' per capita income catch-up with advanced economies is anticipated to stagnate or even invert [3]. Global capital market economies, which account for 60% of global economic activity, are expected to function below their optimum output levels until at least 2024, implying worse national and individual economic welfare than before the Covid-19 [4]. To reduce the impact of Covid-19, many countries' governments decided to preserve lives before saving their economies in reaction to the pandemic, declaring immediate or phased lockdowns in their countries. Overnight, policies such as "social distancing" and "stay-at-home" were enacted, adversely affecting a variety of businesses across industries [5-7].

With such constraints, most of the companies postponed their planned shutdowns, inspection and testing work and preventive maintenance work due to unavailability of labour, logistics and other resources. These delays increased the risk of asset failure with the threat of a major failure occurrence and the consequences could be much higher. For instance, corrosion is one of the most serious problems in energy pipelines, and a significant investment has been made to protect these pipelines from corrosion [8]. To control corrosion, companies follow proper mitigation strategies to run the assets for the long term and reduce the rate of corrosion, wear and other failures. Due to pandemic, mitigation work is either on hold or reduced but the risk of a corrosion problem is increasing as corrosion is a continuous chemical reaction and changes in the environment are contributing to making it worse.

After the third coronavirus pandemic was managed, the restrictions imposed on global residents were eased, bringing relief to economies all around the world. Plant owners and operators started planning to continue with the inspection and maintenance of their critical assets for any corrosion or other damage to their equipment. Many businesses increased their existing workforce and devised strategies to make up for the lost revenue. Despite the fact that the vast majority of the global population has been vaccinated against COVID-19, the fourth wave of the Omicron variant of the coronavirus pandemic is already wrecking disaster in numerous countries. Worldwide, governments are once again under pressure to find innovative ways to keep the variant under control while avoiding putting people, jobs, and businesses in risk. Everyone is under financial hardship these days, as no one budgeted for a pandemic in 2020. COVID-19, as challenging as it has been, has forced everyone to be inventive and execute tasks that are economically viable. To carry out some of the inspection or maintenance tasks using the latest technologies, that were not previously considered, and now need to be used in a way that benefits both the industry and the end user, have undoubtedly been impacted by, not only COVID-19, but also the fact that the demand has decreased while supply has increased, and prices have risen. The current situation has caused significant impacts on the energy and other industry sectors globally.

To cover the present paradigm, companies especially oil and gas operators, will have to dig deep and draw on their proud history of significant technological changes, innovation, and safe and profitable operations in the most difficult of circumstances to control corrosion. Technologies are continuously advancing, for instance, enhanced monitoring system, more sensor data collection, enlarged storage volumes, fast data processing, and enhanced decision-making process are applied to understanding the current condition of the assets for determining strategies to increase the equipment life and protect it from corrosion. Following a year of enormous upheaval, 2022 appears to be on track to provide even more rapid change and digital transformation. Businesses are speeding up their adoption of artificial intelligence, machine learning and data analytics, as well as constructing online platforms to predict their assets current condition while creating more adaptable and resilient asset management systems.

Digital leaders will be better equipped than their competitors to ride the pandemic's tremors and then seize new possibilities when the global economy recovers, particularly through enhanced data analytics and artificial intelligence (AI). The disruptive potential arising from the joint deployment of the Internet-of-Things (IoT), robotics, artificial intelligence, machine learning, and other advanced technologies is projected to be more than US $300 trillion over the next decade [9]. The application of Big Data has become prominent as the amount of data generated and recorded in the oil and gas industry has significantly increased. The improvements in seismic acquisition devices, channel counting, fluid front monitoring geophones, carbon capture and sequestration sites, logging while drilling (LWD) and measurement while drilling (MWD) tools have provided vast amount of data to be processed and analysed [10]. Digital sensors are now being used to help reduce the expense of monitoring metal corrosion as well as the likelihood of devastating and significant breakdowns. This kind of digital sensor-driven digital transformation seems to have become extremely prevalent in manufacturing and engineering, as well as nearly every other industry, during COVID-19. This type of digital transformation allows a company to streamline procedures for better decision-making while simultaneously significantly transforming the work environment, giving it a look into the future before it happens. Meanwhile, artificial intelligent techniques will continue to gain wide applications in energy pipeline integrity management with more focuses on asset condition assessment and prediction [11].

Digital transformation in the oil and gas industry, could boost productivity by as much as 5%–8% through the use of technology like digital sensors. One example is the General Electric Predictive Corrosion Management programme. This programme uses Right-Trax PM digital sensors and runs on their Predix platform for the Industrial Internet. The software measures and monitors wall thicknesses in real time, allowing engineers to transition from point-in-time to continuous thickness monitoring, while powerful data analytics can aid in the detection of system flaws [12]. Another good example is the drone. Flying drones equipped with cameras speeds up the asset inspection process. Drones collect thousands of photos, but it is still a time-consuming task and prone to human error. To expedite the data processing and reduce errors, Artificial Intelligence (AI) is a technique that can integrate Deep Learning-powered automated corrosion detection into Smart-Data. The corroded regions can then be visualised at the touch of a button, substantially speeding up the process of assessing afflicted assets [13].

Hayden, CEO of EDI said that his company is trying to use machine learning to help manage risk, creating failure probabilities, corrosion growth rate probabilities, or what the real growth corrosion rate is. Some companies are using statistics to estimate corrosion growth rates and EDI is working to take it a step further by including computing technology, deep learning, and neural networks [14, 15]. Anand [10, 16] gives an excellent explanation of why and how big data can now disclose too much secret information in the oil and gas business from the huge amount of data available. Anand demonstrated the relationship between data, science, technology, engineering, and mathematics (STEM) techniques, and pattern recognition using a three-dimensional plane. When a small amount of data is combined with basic STEM methods, the output reveals limited patterns that may lack depth and contain a lot of uncertainty. If a huge data collection is provided and combined with advanced STEM methods, more promising patterns can be identified, which may be considerably closer to the real values [10, 16]. Detecting anomalies and accurately predicting future behaviour during operations will enable more effective decision making that can best help focus operational spend on risk reduction.

Frequent checks are mandatory to keep the plant assets in a reliable and safe condition. In the last decade, numerous inspection techniques, like Ultrasound and Magnetic Flux leakage (MFL), have been developed. These methods provide precise and efficient information for energy pipeline operators to identify pipeline defects that could lead to a catastrophic failure. In line inspection (ILI) is another very useful and proficient tool, used for pipeline inspection, that clearly detects and/or predicts pipeline anomalies like pitting and metal loss [17]. According to reports, maintaining these databases is a major problem for related firms. Brule [18] says, pipeline engineers and geoscientists spend more than half of their time searching for and assembling information. For handling and analysing large datasets, this big data analytics approach relies on emerging technology. These datasets are reported in a variety of formats and produced in large quantities in various operations of the upstream and downstream energy industries [19-27]. Decision making is usually based on the data produced on the basis of these criteria from condition evaluation, modelling outcomes, preservation and maintenance strategy and the future condition expected [28-30]. In-life prediction, multiple evaluation and analysis methods are used, such as failure mode impact analysis [28, 31], reliability assessment process [28, 32], finite element analysis or probabilistic failure assessment or simulation modelling and efficiency analysis of capabilities [28, 29, 33].

Big data and the Internet of Things (IoT) complement each other. Data from IoT devices is used to build a chart of device interaction and integration. The media industry, businesses, and governments have all used such mappings to better target their audiences and improve media efficiency. The Internet of Things is also being widely used to collect sensory data, and has been used in medical, manufacturing, and transportation applications [34-36]. The bulk of data from such technologies will be generated and shared by machines in the future, as machines communicate with one another across data networks, in keeping with the datafication concept and ever-increasing technical advancements [37, 38].

The financial model for taking advantage of the Industrial Internet's possibilities and enduring a digital transformation seems to be compelling. From seamlessly connecting machines and gathering data at the edge to offering real-time, remote-access analytics and insights to constructing "digital twins" to get insight into past performances and possible consequence, the possibilities are endless [39]. This will provide new business models, boost efficiency, and change the company's business paradigms.

To conclude, it is time for the oil and gas sector to work on digital transformation system, use maintenance and inspection data from their computerised maintenance management system (CMMS) to identify the critical assets, recognise bad actors, and disclose reasons for corrosion failures. This information can be extracted and utilised to minimise the risk level and define strategies to protect assets from corrosion via advanced analysis techniques associated with big data.

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