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Blockchain in the Chemical Industry

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Abstract: Blockchain is a distributed, digital database (ledger) which can hold any information (such as records, events, transactions) and can set rules on how this information is updated. The blockchain is now being widely regarded as one of the most disruptive technologies across a wide range of industries including chemical industry. The purpose of this paper is to provide an introduction into blockchain technology in the chemical industry.

Keywords: *chemical industry, blockchain*

I. INTRODUCTION

Blockchain is a member of the larger family of distributed-ledger technologies, which encompass all techniques for decentralized record keeping of transactions as well as data sharing across multiple servers, institutions, or nations. It uses distributed ledger and advanced encryption to guarantee the provenance of every transaction. It is commonly associated with peer-to-peer electronic cash transfers systems such as Bitcoin and Ethereum. For example, it is used in the financial industry with over 90% of banks exploring blockchain technology for payment tracking. The capabilities of Blockchain can extend far beyond money tracking, reaching into other industries. It is making a significant impact on how chemical companies source rare materials and generate capital through investments [1].

Blockchain, headquartered in Luxembourg, is a company that provides a software platform for digital assets. Its product offerings are largely responsible for advancing blockchain technology, which is basically a distributed ledger. Blockchains are primarily used in the finance industry but this same transfer of custody technology characteristics can be applied to the chemical industry. Blockchain has the disruptive potential across all industrial sectors with the general goal of reducing costs, increasing efficiency, and reducing the complexity of getting things done [2].

II. BLOCKCHAINS

Fundamentally, blockchains are distributed digital database that record and maintain a list of transactions taking place in real time. They may also be regarded as decentralized ledgers that sequentially record transactions or interactions among users within a distributed network. They have the following properties [3]:

- Firstly, they are autonomous. They run on their own, without any person or company in charge.
- Secondly, they are permanent. They're like global computers with 100 percent uptime. Because the contents of the database are copied across thousands of computers, if 99 per cent of the computers running it were taken offline, the records would remain accessible and the network could rebuild itself.
- Thirdly, they are secure and tamper-proof. Each record in blockchain is time stamped and stored cryptographically. The encryption used on blockchains like Bitcoin and Ethereum is industry standard, open source, and has never been broken.
- Fourthly, they are open, allowing anyone to develop products and services on them.
- Fifthly, as blockchain is a shared system, costs are also shared between all of its users.

A blockchain is literally a giant spread sheet for registering all assets, and an accounting system for transacting them on a global scale. The information contained within each 'block' of the blockchain is first agreed to through consensus of the nodes that constitute the system and then added to the history of all other blocks. Hence, the term is "blockchain" [4]. Blockchains can be public and open to all (as is the case with Bitcoin and Ethereum), or private, as is the case with Hyperledger for example.

III. APPLICATIONS

Blockchain technology is being explored across different industries such as healthcare, real estate, smart contracts, smart power grid, media, travel, hospitality, agriculture, government, voting, cybersecurity, insurance, and Internet of things. In chemical industries, blockchain is applied in manufacturing, automation, supply chain management, food, and pharmacy.

- *Food industry*: Food is one of the most basic requirements of human survival and contaminating it can cause sickness and disease. Companies explore food supply chain traceability and authenticity using blockchain technology. They are incorporating blockchain technology into the global food supply chain.
- *Supply chain*: This is one of the most obvious blockchain applications. Different partners can access the distributed ledger with the necessary permissions. The blockchain enables tracking of where products were produced, which quality standards were applied, and where they are on their way to the end customer. Additionally, it enables supply chain to handle the payment process [5]. Blockchain technology also has the potential for adding trust and security to the transfer of assets in the supply chain.
- *Quality control:* Oil companies, for example, frequently contract with third-party blenders to manufacture specialty products. The risk of counterfeits is a major concern for manufacturers. A blockchain transaction ledger could track the sourcing and provenance of raw materials and products from suppliers through wholesale and retail channels. If the unique code on the label is not traceable to the blockchain data, the product can be assumed to be counterfeit. Blockchain has the capability to help track all related components and assets, and tracking performance and reliability [6].

Other applications of blockchain in chemical industries include commercial trades/deals and service execution contracts, marketing and loyalty programs, trading in carbon emissions,

cryptocurrency integration to existing gas stations, production sharing, and shareholder voting [7].

IV. BENEFTIS AND CHALLENGES

Blockchain is a distributed ledger technology, commonly used in the cryptocurrency Bitcoin. Besides cryptocurrencies, blockchains are used for securely managing assets. Blockchain offers a secure way to exchange any kind of good, service, or transaction. It provides an effective means not only of cutting out intermediaries (such as banking, law and government), but also of radically lowering transaction costs, turning firms into networks, distributing economic wealth.

Another advantage of blockchain over a central database is that a central database has an administrator who can edit, modify, delete, or alter records as he chooses. But with the blockchain the records are permanent and cannot ever be changed. It is secure and tamper-proof by design.

Blockchain allows individuals to sign contracts electronically, without having to rely on a trusted third party to verify the contract's validity. By eliminating the need for a middleman, it reduces the exposure of data to hackers.

Despite the benefits, there are still many challenges that need to be overcome prior to any large scale industrial adoption of the blockchain technology [7]:

- *Privacy:* Existing blockchain deployments rely on the availability of transactions and their order of execution to all nodes in the system. Clearly, this comes at odds with current industry practices which only restrict data sharing and distribution to the intended stakeholders.
- *Scalability*: Existing permissionless blockchains (e.g., Bitcoin) are able to scale to a considerable number of nodes at the expense of attained throughput, while permission-based blockchains can achieve higher throughput, but can only scale to few hundred nodes.
- *Lack of Governance*: Blockchain is decentralized in nature, while organizations are typically not democratic entities who like to retain control of their systems in order to enforce policies.

The blockchain technology has limitations regarding scalability and operational requirements such as skills, computing power, and energy resources.

CONCLUSION

A blockchain is basically a spreadsheet that sequentially records transactions among users operating within a decentralized peer-to-peer network. It is gaining a foothold in the diverse economic sectors with the promise of efficiency improvement. Blockchain has the potential to generate significant benefit for chemical industries. Chemical industry executives should continue to develop strategy for extracting value from blockchain technologies.

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