

Turbines and manufacturing transform with technology

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Steam turbines offer reliability, produce minimal vibrations, and require fewer resources, making them ideal for various industrial applications. This technology aligns with India's goal of achieving a more sustainable and eco-friendly manufacturing landscape. The article emphasizes the importance of technological advancements and the role of steam turbines in meeting energy needs in the manufacturing sector.

In the past few years, India has undertaken a significant and dynamic effort to position itself as a prominent global manufacturing hub. The "Make in India" campaign has emerged as a driving force in strengthening the nation's manufacturing sector. This catapulted the expansion of the manufacturing sector into new geographies and segments. A noteworthy catalyst for this expansion has been the implementation of the Production Linked Incentive (PLI) program, which has drawn in investments, totalling INR 62,500 Cr as of March 2023, fostering inventive strides within the manufacturing sector.

As a result of these policy measures, India has experienced an unparalleled revolution within the manufacturing sector over recent years. In 2022, this sector contributes approximately 17% to the nation's GDP and offers employment opportunities to a workforce exceeding 27.3 million individuals. The government's anticipation is to achieve a quarter of the economic output from this sector by 2025. Furthermore, it is expected that the sector will generate export commodities valued at \$1 trillion by the year 2030.

Nevertheless, the sector has encountered several obstacles that have impeded its expansion and output. These challenges stem predominantly from a significant dependence on labour-intensive operations and a preference for moderately automated practices. The power supply emerges as a paramount concern in this context. Manufacturers not only require a consistent and adequate power supply, but also the reduction of energy costs, which inevitably impacts the pricing of goods in the market. Concurrently, the sector is anticipated to align with India's global commitment of achieving a net-zero economy by 2070, necessitating a swift shift toward eco-friendly manufacturing practices.

In pursuit of this objective, alongside other measures, it becomes imperative to curtail energy consumption. This can be realised by enhancing machinery efficiency and fulfilling energy needs through alternative sources. Clean technologies, including renewable energy systems such as Bagasse, Biomass and Process Waste Heat can play a pivotal role in facilitating the manufacturing sector's transition towards sustainable environment. This underscores the environmentally conscious solutions in steering the trajectory towards a sustainable future.

Why tech advancement in power sourcing for the manufacturing sector

With the growing population and increasing business activities, the country is witnessing a continuous surge in the demand for energy. The reliance on traditional sources of energy is not a viable option today. The manufacturing industry must scout for ways to mitigate energy requirements and meet the same sustainably.

The advancement of technology in the manufacturing sector holds immense significance for several critical reasons in the on-going IR-4.0. Firstly, it allows manufacturers to meet their power requirements in a sustainable manner. Traditional manufacturing processes often rely heavily on fossil fuels, which not only deplete finite resources but also contribute significantly to greenhouse gas emissions. With technological innovations such as renewable energy sources, energy-efficient machinery and smart grid systems, manufacturers can transition towards greener, more sustainable power solutions. This not only reduces their environmental impact but also ensures a stable and reliable energy supply, reducing the vulnerability of production processes to energy shortages or price fluctuations.

Secondly, technological advancements in manufacturing is vital for reducing the sector's carbon footprint. Cutting-edge technologies enable manufacturers to optimise processes, minimise waste and use resources more efficiently. This translates into lower emissions, decreased energy consumption and reduced environmental harm.

Most importantly, energy-efficient technologies can lead to cost savings in the long run, making manufacturing more competitive on a global scale. By reducing operational expenses, manufacturers can allocate resources to further innovate and action on the sustainability efforts. Steam turbines have the potential to help the sector fulfil its energy demand efficiently.

The need to embrace energy-efficient technologies has spurred organisations to increase their investments for in-house research and development (R&D) efforts, as well as to enhance collaborations with universities for technological advancements. For entities within the manufacturing sector that are backed by in-house R&D and design teams, this enables quicker development cycles from concept to market-ready products. The Indian market, characterised by its demand for rapid technology adoption and prompt returns on investment, underscores the urgency for this approach.

Leaders in the manufacturing industry, equipped with in-house R&D capabilities, have effectively showcased that product development can be both expedited and capable of delivering enduring value. By adopting this innovative R&D strategy of tailoring product development to align with market demands such as efficiency, cost-effectiveness and serviceability, prominent Indian capital goods manufacturers like Triveni Turbines have expanded their product footprint globally. The incorporation of efficient technologies and tools has genuinely unlocked new business prospects.

How steam turbines can help meet energy needs

Steam turbines offer several advantages in various industrial applications, primarily due to their high reliability. These machines excel in cases requiring sustained high-power output. Unlike some other forms of power generation, steam turbines can operate continuously without significant wear and tear, making them ideal for applications like power plants. Reliable supply of power is crucial for industries where power disruptions can lead to substantial financial losses.

In addition to their reliability, steam turbines also have the advantage of generating less vibration compared to reciprocating engines. This characteristic is essential in many industrial processes where excessive vibration can lead to equipment damage, reduced efficiency or compromised product quality. The smoother operation of steam turbines minimises these issues, contributing to their suitability for a wide range of applications.

Steam turbines require less mass flow rates compared to gas turbines, which means they can produce the same power with fewer input resources. This efficiency is advantageous for both cost savings and environmental considerations, as it reduces fuel consumption and emissions. Furthermore, steam turbines boast a very high power-to-weight ratio when compared to reciprocating engines, making them more compact and space-efficient while delivering substantial power outputs.

Another key advantage of steam turbines is their high thermal efficiency, especially when compared to reciprocating engines. This means they can convert a larger portion of the heat energy from the fuel into useful mechanical work. This efficiency not only reduces operational costs but also contributes to lower greenhouse gas emissions. Finally, steam turbines' rotary design makes them particularly well-suited for driving electricity generators. Their continuous, rotational motion aligns perfectly with the requirements of electricity generation, ensuring stable and efficient power production in various applications, from power plants to marine propulsion systems.

Utilising CO2 as working fluid

As outlined in the IEA report on energy utilisation, the world faces a "cold crunch". Cooling needs are set to increase energy demand by three-fold, from 12TW in 2016, to 36TW in 2050. This surge in energy demand has the potential to doubling CO2 emissions by 2050, leading to a substantial increase in global warming. To address the heating necessities and to achieve Net Zero by 2050, 50% of heating demand has to be met by Heat Pumps.

As the world progresses in its efforts to address the energy trilemma, there is an immediate requirement to have alternative technologies to address the heating and cooling needs. The existing cooling requirements predominantly depend on refrigerants with a considerably higher Global Warming Potential than that of CO₂. CO₂ presents itself as both an ecologically friendly and cost-effective substitute for synthetic refrigerants. In light of these benefits, prominent Indian research and development entities have undertaken the development of Transcritical CO₂ (tCO₂) Cooling Skid and Heat Pump technology.

The supercritical CO₂ (sCO₂) technology presents itself as a more efficient and a compact replacement to steam-Rankine cycle. Additional benefits include operational flexibility in terms of quick start/stop and improved overall lifecycle cost. A significant reduction in size, up to a factor of four (4), is anticipated with the implementation of sCO₂ power blocks compared to steam power blocks. With these essential factors in mind, Indian research and development centres are actively engaged in advancing sCO₂ technology, and the manufacturing sector is embracing this challenge. The industry is eagerly anticipating governmental support, such as subsidies, to accelerate the swift adoption of these advanced technologies.

Conclusion

Amidst India's on-going drive towards sustainability and clean energy, it is evident that manufacturing companies must adopt technological advancements to guarantee energy-efficient and eco-friendly production processes. This transition will not only contribute to curtailing the carbon footprint but also holds a pivotal position in propelling India's industrial landscape towards a cleaner and more sustainable trajectory. In this era of transformation, the fusion of technology and sustainability stands as the cornerstone for manufacturing's continued relevance and prosperity.

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