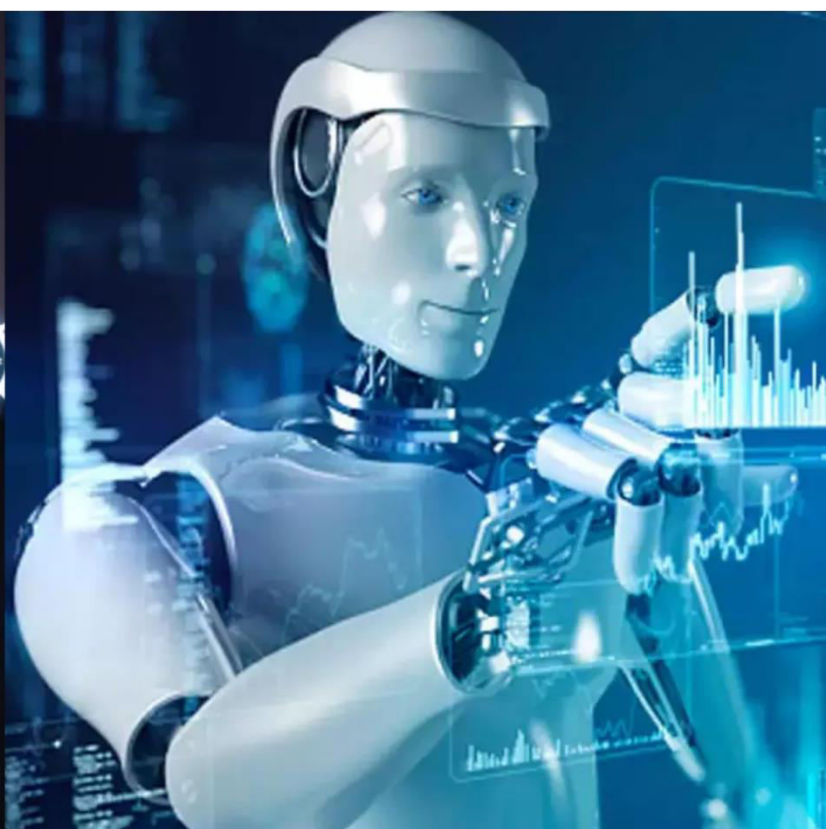




International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 9.935

Volume 15, Issue 7, July 2026

Recent Developments in Foundry Technology: A Comprehensive Review

Nagaraj Hugar¹, Rajashekar B², K Ramesh Goud³, Niyaz Ahmed⁴, Pulkit Raj⁵

Senior Grade Lecturer, Department of Mechanical Engineering, Sanjay Gandhi Polytechnic, Bellary,
Karnataka, India ^{[1][2][3]}

Students, Department of Mechanical Engineering, Sanjay Gandhi Polytechnic Bellary, Karnataka, India ^{[4][5]}

ABSTRACT: Foundry technology continues to evolve rapidly with the adoption of advanced casting processes, computational modelling, Industry 4.0 technologies, artificial intelligence, additive manufacturing and sustainable production practices. This review summarizes recent technological developments, their industrial applications, advantages, limitations and future research opportunities. Emphasis is placed on process optimization, defect reduction, automation, energy efficiency and environmentally responsible manufacturing. The review highlights how digital technologies are transforming conventional foundries into smart manufacturing facilities capable of producing high-quality castings with improved productivity and reduced environmental impact.

KEYWORDS: Foundry Technology, Casting, Industry 4.0, Artificial Intelligence, Additive Manufacturing, Sustainable Manufacturing, Process Simulation

I. INTRODUCTION

Foundry technology forms the backbone of manufacturing industries such as automotive, aerospace, railway, defence, heavy engineering and energy. Conventional casting methods have been continuously improved through innovations in moulding materials, melting techniques, alloy development and quality control. During the last decade, digitalization has accelerated the transformation of foundries into intelligent production systems. Computer-aided design, casting simulation, robotics, sensors and real-time monitoring have significantly improved casting quality while reducing production cost and waste.

II. LITERATURE REVIEW

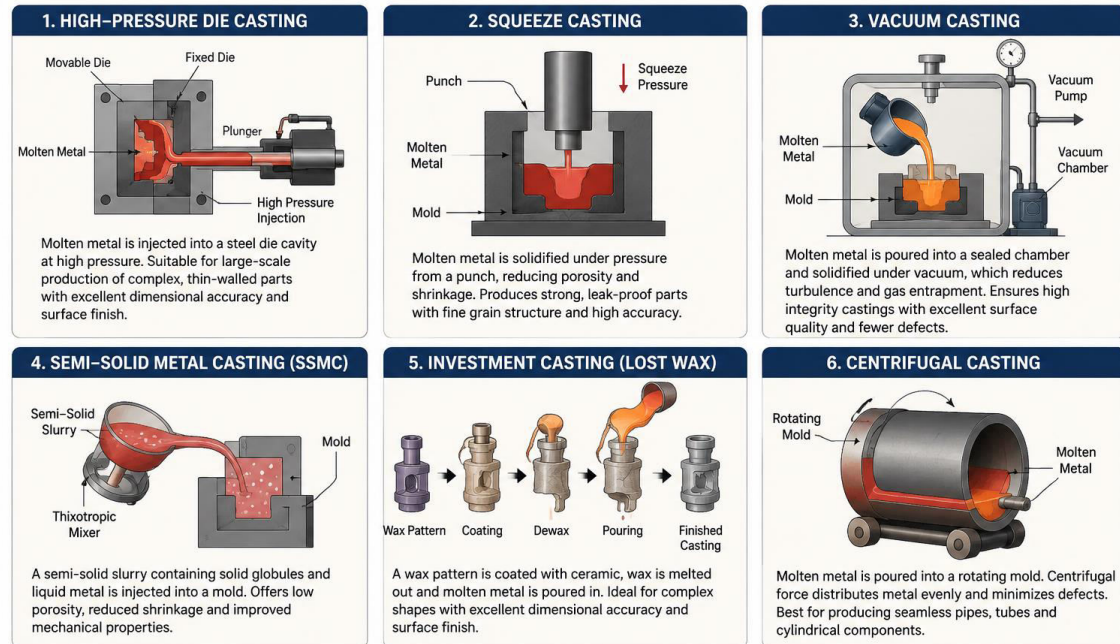
Recent publications indicate substantial improvements in mould design, gating optimization, numerical simulation and defect prediction. Researchers have increasingly focused on integrating machine learning algorithms with process monitoring systems to predict shrinkage, porosity and inclusions before production. Sustainable foundry practices including reclaimed sand, bio-based binders and energy-efficient furnaces are also receiving considerable attention.

III. ADVANCED CASTING PROCESSES

Modern foundries employ high-pressure die casting, squeeze casting, vacuum casting, semi-solid metal casting, investment casting and centrifugal casting according to product requirements. These processes offer superior dimensional accuracy, improved mechanical properties, better surface finish and higher production rates than conventional methods. Selection depends on alloy type, component geometry, production volume and economic considerations.

ADVANCED CASTING PROCESSES

Modern foundries use advanced casting processes to achieve superior dimensional accuracy, improved mechanical properties and better surface finish.



IV. DIGITAL MANUFACTURING AND INDUSTRY 4.0

Industry 4.0 technologies enable continuous monitoring of melting temperature, mould conditions, pouring parameters and cooling rates. Internet of Things sensors collect production data which are analysed using cloud computing and artificial intelligence. Digital twins provide virtual representations of foundry processes, enabling engineers to optimize production without interrupting actual operations.

V. ADDITIVE MANUFACTURING IN FOUNDRIES

Three-dimensional printing has revolutionized pattern, mould and core manufacturing. Complex internal passages can be produced without conventional tooling, reducing lead time and enabling rapid product development. Hybrid manufacturing combining additive and conventional casting offers significant opportunities for aerospace and biomedical components.

VI. ARTIFICIAL INTELLIGENCE AND PROCESS OPTIMIZATION

Machine learning models assist in defect classification, predictive maintenance, quality inspection and process optimization. Computer vision systems automatically inspect castings for surface defects, while optimization algorithms determine the best gating and riser configurations to maximize casting yield



VII. SUSTAINABLE FOUNDRY PRACTICES

Environmental sustainability has become a major research focus. Modern foundries reduce emissions through induction furnaces, efficient burners, heat recovery systems and improved ventilation. Waste sand reclamation, recycling of scrap metal, eco-friendly binders and optimized energy consumption reduce environmental impact while lowering production costs.

VIII. CHALLENGES AND RESEARCH GAPS

Despite significant progress, several challenges remain, including high investment costs, shortage of skilled manpower, cybersecurity concerns, standardization of digital platforms and integration of legacy equipment with modern technologies. More research is required on low-carbon foundry operations and AI-driven autonomous process control.

IX. FUTURE SCOPE

Future developments are expected in autonomous smart foundries, real-time quality assurance, digital twins integrated with artificial intelligence, advanced lightweight alloys, hydrogen-based melting technologies and circular manufacturing systems. Collaboration between academia and industry will accelerate commercialization of these technologies.

X. CONCLUSION

Foundry technology is undergoing rapid transformation through digital manufacturing, automation and sustainable engineering practices. Adoption of Industry 4.0, additive manufacturing and artificial intelligence has significantly improved casting quality, productivity and resource utilization. Continued research and industrial implementation will further strengthen the competitiveness and sustainability of modern foundries.

REFERENCES

- [1] S. K. Singh, *Modern Foundry Technology*, New Delhi: McGraw-Hill, 2019.
- [2] J. Patel, "Advancements in investment casting processes," *J. Mater. Process. Technol.*, vol. 270, pp. 220–230, 2020.
- [3] L. Zhao, "High-pressure and semi-solid die casting techniques," *Appl. Therm. Eng.*, vol. 160, pp. 320–330, 2019.
- [4] R. Gupta, *Centrifugal and Precision Casting Methods*, Springer, 2020.
- [5] M. Kumar, "Additive manufacturing applications in foundries," *Int. J. Adv. Manuf. Technol.*, vol. 110, pp. 112–123, 2021.
- [6] T. Li, "AI-based optimization in foundry processes," *J. Mater. Eng.*, vol. 220, pp. 50–60, 2020.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details