An intelligent control method reduces carbon emissions in energy-intensive equipment

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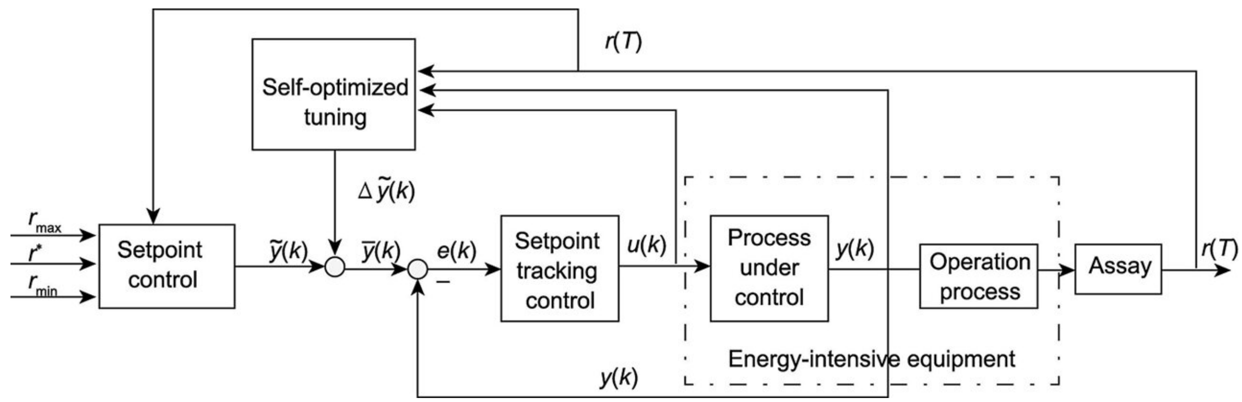

Structure of the intelligent control method for low-carbon operation. Credit: Tianyou Chai et al.

A research team led by Professor Tianyou Chai from Northeastern University, China, has developed an innovative intelligent control method for the low-carbon operation of energy-intensive equipment. This research, published in the journal *Engineering*, presents a significant step towards reducing carbon emissions in the process industry.

The research team's method combines mechanism analysis with deep learning, linking control and optimization with prediction, and integrating decision-making with control. By employing setpoint control, self-optimized tuning, and tracking control, the method ensures that the energy consumption per ton is minimized while remaining within the target range.

The intelligent control system developed by adopting the end–edge–cloud collaboration technology of the Industrial Internet has been successfully applied to a fused magnesium furnace, yielding remarkable results in reducing carbon emissions. The CO_2 emissions were reduced by an impressive 8.82%, while simultaneously increasing the yield of high-quality products by 3.65% and reducing electrode consumption by 3.73%.

The setpoint control component of the method includes a tracking control presetting model, a prediction model of energy consumption per ton, a feedforward compensator, and a feedback compensator. The self-optimized tuning component involves operating condition recognition, an intelligent prediction model of energy consumption per ton, and a self-tuning compensator. Lastly, the tracking control adopts an adaptive proportional–integral–derivative (PID) controller based on signal compensation.

While the research team celebrates these achievements, they acknowledge that further challenges lie ahead. The development of a modeling method based on digital twin technology, optimal decision-making of the setpoint for process control with conflicting objectives, and controller parameter optimization of a high-performance control system are among the challenges that require attention.

To realize the low-carbon operational control of complex industrial systems, the research team emphasizes the need for further study in several areas.

These include developing a modeling method based on digital twins for complex production processes by combining mechanism analysis with deep learning, creating a method for high-performance control systems by combining digital twins with machine learning, establishing a low-carbon operational control method for complex industrial systems based on the industrial metaverse, and implementing end–edge–cloud collaboration technology to realize low-carbon operational control.

Professor Chai and his team's research opens up a new path towards achieving low-carbon operational control in the process industry. By combining cutting-edge technologies and innovative approaches, they have demonstrated the potential for significant reductions in carbon emissions while maintaining optimal operational efficiency.

Nan Zhang, editor of the subject of chemical, metallurgical, and materials engineering of *Engineering*, commented, "This research has far-reaching implications for the future of sustainable industrial practices. As the world continues to grapple with the challenges of climate change, the intelligent control method developed by Professor Chai's team presents a promising solution for reducing carbon emissions in energy-intensive equipment."

More information: Tianyou Chai et al, An Intelligent Control Method for the Low-Carbon Operation of Energy-Intensive Equipment, *Engineering* (2023). DOI: 10.1016/j.eng.2023.05.018

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