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Evaluation Method of Energy Efficiency on Discrete Manufacturing

离散制造能效评估方法

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1 Scope

This document specifies the evaluation indicators, evaluation model and evaluation method of energy efficiency on the discrete manufacturing production process.

This document is applicable to the evaluation of energy efficiency on the discrete manufacturing production process.

2 Normative References

This document does not have normative references.

3 Terms and Definitions

The following terms and definitions are applicable to this document.

3.1 Energy Conversion

Energy conversion refers to the conversion of the physical or chemical form of energy.

[source: CEN/CLC/TR 16103-2010, 4.1.7]

3.2 Primary Energy

Primary energy refers to energy that has not undergone any conversion process.

NOTE: primary energy includes non-renewable energy and renewable energy. The sum of primary energy from all energy sources may be referred to as total primary energy.

[source: CEN/CLC/TR 16103-2010, 4.1.6]

3.3 Secondary Energy

Secondary energy refers to energy obtained through the energy conversion of primary energy.

NOTE: electricity, gasoline, process steam and compressed air.

[source: CEN/CLC/TR 16103-2010, 4.1.8]

3.4 Energy Consumption

Energy consumption refers to the amount of consumed energy.

3.5 Energy Efficiency

Energy efficiency refers to the ratio or other quantitative relations of output energy, products, services or performance to input energy.

Example: conversion efficiency, energy demand / actual consumption of energy, output / input, theoretically operated energy / actually operated energy.

3.6 Energy Efficiency Indicator

Energy efficiency indicator refers to the indicated value of energy efficiency.

NOTE: it is primarily used as a metric in policy assessment and macroeconomic study.

[source: CEN/CLC/TR 16103-2010, 4.3.8]

3.7 Energy Consuming Working Medium

Energy consuming working medium refers to a working medium that is not consumed as a raw material in the production process, does not enter the product, but needs to consume energy.

NOTE: such as: oxygen and compressed air, etc.

3.8 Discrete Manufacturing Production Process

Discrete manufacturing production process refers to the process of producing products or parts composed of discrete components.

3.9 Energy Management

Energy management refers to a coordinated activity that guides and controls an entity’s energy use.

[source: CEN/CLC/TR 16103-2010, 4.5.1]

3.10 Manufacturing Resource

Manufacturing resource refers to a physical or logical entity in the manufacturing process.

[source: ISO 22400-1:2014, 3.1.6]

energy supply and demand balance, distribution of materials and intermediate production materials, etc.

Example: the management of workshop production operation in the production process of auto parts, including: production planning and scheduling, logistics management, process and equipment parameter optimization, and production execution, etc.

4.5 Yield Factor

The yield factor includes: quantity and quality of products, amount and quality of output and converted energy, etc.

Example: the quantity and quality of forging parts, as well as the recycling of waste heat in the forging production process, etc.

5 Energy Efficiency Indicators on Discrete Manufacturing

5.1 Overview of Energy Efficiency Indicators on Discrete Manufacturing

The discrete manufacturing production process refers to the entire process from raw materials to finished products exiting the factory, which generally includes: processing and treatment of raw materials, equipment maintenance, inspection and calibration, manufacturing of special instruments and auxiliary instruments, product packaging, storage and power supply, etc. The energy efficiency indicators on discrete manufacturing can be defined from three dimensions: production equipment, production process management and economic output.

The energy efficiency indicators of production equipment reflect the energy efficiency level of manufacturing equipment in the discrete manufacturing production process, which include: energy consumption per unit capacity of production equipment, equipment energy conversion efficiency and processing time ratio, etc.

The energy efficiency indicators of production process management reflect the impact of the organization and management of manufacturing resources on energy efficiency in the discrete manufacturing production process, which include: logistics arrival rate, process operation time ratio, equipment / unit operation rate, material utilization rate, rework rate and scrap rate, etc.

The energy efficiency indicators of economic output reflect the comprehensive consideration of the impact of various factors, such as: equipment, production process management, operation management and production cost on energy efficiency. They include: energy consumption per unit product, energy cost per unit product and energy consumption per ten-thousand-yuan output, etc.

5.2 Energy Efficiency Indicators of Production Equipment

Production equipment mainly has the following energy efficiency indicators:

In accordance with user demands, select the manufacturing plant, production workshop, production line, manufacturing unit or equipment as the energy efficiency evaluation object. Multiple evaluation objects can be selected. If the manufacturing plant is used as the energy efficiency evaluation object, the workshop, production line or equipment also need to be selected as the evaluation objects of the evaluation process.

b) Establish an energy efficiency evaluation object model

In accordance with the evaluation object, define the evaluation boundary; divide the evaluation object into various constituent parts and equipment, etc. Based on the production process, production process and field data, establish the energy flow and material flow of the energy efficiency evaluation object; form the energy efficiency evaluation object model.

c) Energy efficiency indicator calculation

In accordance with the production flow and process characteristics, analyze key factors affecting energy efficiency; determine energy efficiency indicators that need to be evaluated. In accordance with the start-stop range of a unified time, calculate the energy efficiency indicator values.

d) Energy efficiency evaluation report

Based on the calculated energy efficiency indicator values, analyze the energy-saving potential at the equipment level and the production process management level. In combination with the current situation of the enterprise and the follow-up development planning, provide suggestions for the current implementation of energy efficiency improvement and the overall implementation path of subsequent energy efficiency improvement.

An example of the evaluation method of energy efficiency on discrete manufacturing is shown in Appendix A.

Appendix A

(informative)

An Example of Evaluation Method of Energy Efficiency on Discrete Manufacturing

A.1 Determine the Object of Energy Efficiency Evaluation

Take the solid-state die forging production workshop of a certain wheel hub manufacturing enterprise as the object of energy efficiency evaluation. The production process of the workshop is: input raw materials and auxiliary materials; through processes like blanking, heating, forging, thermal treatment, machining, cleaning and assistance, consume energy in the various processes; produce qualified forging products, for example: auto parts like wheel hubs. The processing process generates heat, vibration, noise, waste gas and waste liquid, etc. Except noise, the other wastes can be recycled.

A.2 Establish an Energy Efficiency Evaluation Model

A.2.1 Consumption of energy and materials of forging workshop

An energy and material supply and demand network is formed among the main energy supply system, processing equipment and production process of the forging workshop. The main types of energy and materials used by the workshop are:

a) Raw materials

Mainly carbon steel and alloy steel of various compositions, aluminum, magnesium, copper and titanium, as well as their alloys.

b) Auxiliary materials

Lubricating media (such as: lubricating oil and heavy oil, etc.) used by various equipment.

c) Fuels

Forging workshops generally adopt gasoline, diesel, natural gas and liquefied petroleum gas as alternative energy sources for raw coal.

d) Electricity

Electric energy consumption runs through the production process of the various processes of the forging workshop. The workshop has many high-power electrical equipment, such as: counter-blow hammers, gas furnaces and intermediate frequency furnaces, etc.

e) Water

processes with relatively high energy consumption. In addition, energy supply, for example, compressed air, generates relatively high energy consumption. The effective application of equipment and unplanned downtime in production management, as well as the efficiency of production organization management affect the overall energy efficiency.

A.3.2 Determination and calculation of energy efficiency indicators

Select heating furnaces, forging machines, thermal treatment furnaces, air compressors and machining equipment as the equipment-level energy efficiency evaluation. Among them, heating furnaces, thermal treatment furnaces and forging machines adopt the indicators of equipment operation rate and energy consumption per unit capacity; air compressors adopt the indicator of energy conversion efficiency; machining equipment adopts the indicators of equipment operation rate, energy consumption per unit capacity and processing time ratio. For the blanking, heating, forging, thermal treatment and machining processes, adopt the indicators of process operation time ratio, rework rate and scrap rate. For the entire forging workshop, adopt the indicators of energy consumption per unit product and energy consumption per ten-thousand-yuan output. Select different evaluation cycles; on the basis of energy efficiency-related data, calculate the energy efficiency indicators.

A.4 Energy Efficiency Evaluation Report

A.4.1 Content framework of energy efficiency evaluation report

The energy efficiency evaluation report shall include, but not be limited to: description of evaluation object, detailed production process and energy flow and material flow, analysis of energy efficiency influencing factors, selection / definition and calculation of energy efficiency indicators, comprehensive energy efficiency evaluation and suggestions for energy efficiency optimization.

A.4.2 Suggestions for energy efficiency optimization (example)

For the solid-state die forging workshop of a certain wheel hub manufacturing enterprise, carry out energy efficiency diagnosis from three perspectives: energy supply, energy consumption of typical equipment and production process management. The following suggestions for energy efficiency optimization are provided:

a) Energy supply optimization

   1) Fuel gas optimization: optimize the optimal ratio of gas volume and air volume, reduce oxygen content and achieve the optimal air-fuel ratio; supply fuel on demand and minimize fuel gas consumption; maximize production capacity: automatically switch between large and small fire states and provide continuous production conditions.

   2) Compressed air optimization: reach a balance between demand and supply, and reduce leakage.

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