供热供电煤耗计算方法

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[摘要] 通过实例计算,对目前供热供电煤耗计算中不一致的部分提出简便实用的计算方法及计算供电煤耗考核定额值的注意事项。

关键词 热电煤耗 计算
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1 对供热比(热电分摊比)计算的探讨

电力部规定的供热比计算式为:

$$供热比 = \frac{供热量}{发电供热总耗热量} \times 100\%$$

式中:发电、供热总耗热量 = 各汽轮机进汽的含热量 − 锅炉给水总含热量 + 从锅炉至减温减压器及直接对用户的供热量。

而地方热电厂的供热比有几种计算方法,因方法不同使管理水平和锅炉效率都相近的热电厂计算得出的供电供热煤耗却相差较大。有的相差近 60 g/(kW·h)及 3kg/GJ,所以对供热比计算方法进行探讨,力求基本一致是必要的。

1.1 南通热电厂供热比计算方法

$$供热比 = \frac{供热量}{发电·供热总耗热量} 100\%$$

其中,供热量 = $\sum D_r(i_r - 14.1868 t_n)$,$D_r$:供热汽(水)流量,$i_r$:供热汽(水)热焓;式中,$t_n$:补充水平均自然温度(南通市全年平均气温取 15℃)。

由于流量表不全,各汽轮机进汽总含热量 = $\Sigma 0.99 D_o i_o - 1.02 D_o i_g$ 式中,D_o:各锅炉蒸发量;i_o:过热蒸汽焓;0.99:管道效率;锅炉给水总含热量也近似用 $1.02 D_o$;i_g:给水焓,所以

$$供热比\ T_r = \frac{D_r(i_r - 15 \times 4.1868)}{D_o i_o \times 0.99 - 1.02 D_o \times i_g} \times 100\%$$

用以上方法计算的南通热电厂背压供热比 T_r 为 0.84左右。

1.2 供热比 T_r 简化计算式

经过推导验算供热比(T_r)也可简化为:

$$T_r = \frac{供热量(百万千焦) \times 100^{①}}{总耗标煤量 \times 29.3076(百万千焦) \times Z_{炉} \times Z_{管道}}$$

2 供热煤耗计算

2.1 按制造厂提供的数据和图表对 C_b − 35/5型抽凝供热机组不同抽汽供汽量下的供电供热标煤耗 b_g.b_r 进行计算。计算汇总表(锅炉效率 Z_k = 75%,厂用电率 e_d = 7%)如下:

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① 通常 $Z_{炉}$ 为百分数,在此计算式中分子还应乘上 100

供汽量 D_r t/h	汽机进汽量 D t/h	供热比 T_r –	供电标煤耗 b_g g/(kW·h)	供热标煤耗 b_r kg/GJ
10	35.4	0.304 97	549.69	46.41
15	38.8	0.417 36	505.05	46.41
20	42.2	0.511 65	460.41	46.41
30	47.6	0.680 4	339.86	46.41
40	54	0.799 69	241.65	46.41
45	57.5	0.844 89	199.25	46.41
50	62	0.870 6	179.2	46.41
56.25	68	0.893	162.5	46.41

计算结果发现供热量与供热耗煤量都是按供热比同一比例成线性关系变化的，所以在某一锅炉效率下尽管供热量、供热压力、温度及供热比有所不同而计算得出的供热标煤耗 b_r 是不变的。

2.2 供热标煤耗的简化计算式

1990年 10月把《电力工业生产统计指标解释》的计算式中:

供热耗用标煤量 = 发电·供热耗用标煤总量(吨)

$$\times \frac{\text{供热量(百万千焦)}}{\text{发电·供热总耗热量(百万千焦)}}\ \text{kg/GJ}$$ 作简单推导就得出:

$$\text{供热标煤耗}\ b_r = \frac{\text{发电·供热耗用标煤总量}}{\text{发电·供热总耗热量}}\ \text{kg/GJ}$$

再作简单推导得:

$$\text{供热标煤耗}\ b_r = \frac{10^6}{29307.6\times Z_k\times Z_g}\ \text{kg/GJ}$$

一般取管道效率 $Z_g = 0.98$ 则:

$$b_r = \frac{34.81}{Z_k}\ \text{kg/GJ}$$

这说明在管道效率一定时，供热标煤耗 b_r 只与锅炉效率 Z_k 成比例关系，在某一锅炉效率下供热标煤耗 b_r 是一个定值。

这样只要算出锅炉效率就能很快算出供热标煤耗 b_r。

举例说明简化计算式 $b_r = \frac{34.81}{Z_k}$ 的可靠性:

原始数据:

1. 锅炉产汽量 $D = 487\ 505$ t/h

2. 主汽焓 $i_0 = 3314$ kJ/kg, 给水焓 $i_g = 589.7$ kJ/kg, 饱和水焓 $i_m = 1057.6$ kJ/kg($p = 3.6$ MPa)

3. 总耗标煤量 $B_b = 61\ 414$ t/h

4. 供热量 = 785 331 GJ

计算:

1. 锅炉效率 Z_k

$$Z_k = \frac{D(i_0 - i_g) + 0.02D(i_m - i_g)}{B_b\times 29.3076}$$ 代入原始数据后 $= \frac{1\ 332\ 671.944}{1\ 799\ 896.949} = 74.04\%$

2. 供热比 T_r

$$T_r = \frac{\text{供热量}}{\text{发电·供热总耗热量}}$$

$$= \frac{785331}{487\ 505\times 3.314\times 0.99 - 1.02\times 487\ 505\times 0.589\ 7}$$

$$= \frac{785\ 331}{1\ 306\ 204.332} = 0.60123$$

3. 供热标煤耗 b_r:

$$b_r = \frac{\text{供热耗标煤量}}{\text{供热量}}$$

$$= \frac{61\ 414\times 10^3\times 0.601\ 23}{785331}$$

$$= \frac{36\ 923.939\times 10^3}{785\ 331}$$

$$= 47.017\ \text{kg/GJ}$$

表明简化计算式是可靠的。

如果供汽流量压力温度都升高使供热量增加到 1 177 996.5 GJ,

即 $T_r = \frac{1\ 177\ 996.5}{1\ 306\ 204.332} = 0.901\ 847$

$$b_r = \frac{61\ 414\times 10^3\times 0.901\ 847}{1\ 177\ 996.5}$$

$$= \frac{55\ 386.03\times 10^3}{1\ 177\ 996.5}$$

$$= 47.017\ \text{kg/GJ}$$

表明: 在某一锅炉效率下尽管供汽流量、压力、温度及供热比有所不同而计算得出的

供热标煤耗 b_r 是不变的,是一个定值。

3 简化计算式 $b_r = \frac{34.81}{\eta_k}$ 的实用性

3.1 可简化计算方法缩短计算时间

(1) 按 $b_r = \frac{34.81}{\eta_k}$ 很快计算出 b_r (kg/GJ)

(2) 接着计算供热耗标煤量 $B_r = b_r \times$ 供热量 (吨)

(3) 发电耗标煤量 B_d = 总耗标煤量 B − 供热耗标煤量 B_r

(4) 然后计算供热比

$$\alpha_r = \frac{\text{供热耗标煤量}}{\text{总耗标煤量}} = \frac{B_r}{B}$$

(5) 用供热比计算供热厂用电量 E_r = 总厂用电量 $\times \alpha_r$ (kW·h)

发电厂用电量 E_d = 总厂用电量 $\times (1-\alpha_r)$ (kW·h)

(6) 最后算出供电标煤耗率

$$b_g = \frac{\text{发电耗标煤量} \times 10^6}{\text{发电量} - \text{发电厂用电量}} \ \text{g/(kW·h)}$$

用以上计算顺序可省去较复杂的供热比计算,简化了计算方法,缩短了计算时间。从 1993年起南通热电厂就采用这种方法顺序计算供电供热标煤耗。

3.2 可校验供电供热标煤耗的计算正确性

在目前电力部及省电力对热电厂只注重考核供电标煤耗情况,某些单位就想法在计算中增加供热比来降低供电标煤耗

计算实践说明供电供热标煤耗与总耗标煤量,锅炉效率有热平衡关系,用 $b_r = \frac{34.81}{\eta_k}$ 这个计算式可很快校验供电供热标煤耗计算是否正确,也可用 $b_r = \frac{34.81}{\eta_k}$ 来推算锅炉效率 η_k。

3.3 可用于新建扩建热电厂技术经济分析

用 $b_r = \frac{34.81}{\eta_k}$ 计算式能很快计算出供热机组的供热供电标煤耗对新建扩建热电厂技术经济分析有一定的作用。

4 计算供电煤耗考核定额值需注意的事项

供电煤耗考核定额值是上级电力管理部门对热电厂经济指标的主要考核定额。

供电煤耗考核定额值 = $(Q_0 - C_{pi} \cdot \bar{S} \cdot R_{pi}) S_2$ g/(kW·h)。式中,R_{pi}: 供热时热电比。

$$R_{pi} = \frac{\text{全部供热机组年供热量}}{\text{全部供热机组年发电量}} \ 10^6 \text{kJ}/(10^4 \text{kw·h})$$

在计算热电比 R_{pi} 时要特别注意不能把不供热的抽凝机组纯凝发电量算在全部供热机组年发电量内,否则计算结果是错误的。例如,某热电厂把不供热的抽凝机纯凝发电量也算在全部供热机组年发电量内,使计算结果错误地把原本没有完成供电煤耗考核定额值而变成了较好地完成了考核定额值。

因此热电厂有的抽凝机组不供热纯凝运行应按凝气混合式电厂计算供电煤耗考核定额值。

参考文献 (略)

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the structural features specific to the raw material return feed valve used during the present test. An analysis is conducted of the transport characteristics curves and gas-solid ratio curves obtained from the test, thus creating a fine basis for realizing the industrial application of the steam-gas-electricity triple production. Key words: steam-gas-electricity triple production, return feed valve, maximum gas-solid ratio, start-up air flow

供热供电煤耗计算方法= **A Method for Calculating Coal Consumption of Heat and Electricity Supply** [刊,中]/Chen Yingmao (Nantong Thermal Power Plant)// Journal of Engineering for Thermal Energy & Power. -1998, 13(2). - 112~ 114

Based on the computation of specific examples this paper proposes a simple and practical method for coping with the existing discrepancies encountered during the calculation of coal consumption for heat and electricity supply. Also given are some points requiring special attention in the evaluation of norms of coal consumption for electricity supply. Key words: coal consumption of heat and electricity supply, computation

遗传算法在透平性能在线诊断神经网络中的应用= **The Application of Genetic Algorithms to Neural Networks for the Diagnosis of Turbine Online Performance** [刊,中]/Gao Hongtao, Huang Zhongyue (Dalian University of Science & Thechnology)// Journal of Engineering for Thermal Energy & Power. -1998, 13(2). - 115~ 117

In applying neural networks for the diagnosis of turbine online performance it is of vital importance to select proper input variables for the neural networks from a variety of related processing variables and environmental ones in order to ensure success. Genetic algorithms have been employed in this paper to guide the search for an optimal combination of inputs for the neural networks used to diagnose the turbine online performance with a view to achieving the criteria of fewer inputs, faster training and more accurate recall. The results of the present study have shown that the neural networks with fewer inputs selected by the genetic algorithms are capable of making an accurate diagnosis of the turbine online performance. Key words: neural network, genetic algorithm, turbine performance, failure diagnosis

等雷诺数法在板式换热器传热试验中的应用 = **The Application of Equal Reynolds Number Method in the Heat Transfer Test of Plate Heat Exchangers** [刊,中]/Ouyang Xinping, Tao Leren (Shanghai University of Science & Technology)// Journal of Engineering for Thermal Energy & Power. -1998, 13(2). - 118~ 120

The determination of convection heat exchange factors constitutes a major element in the heat transfer performance test of heat exchangers. A multitude of methods can be used to determine the convection heat transfer factors with their respective application scope and conditions. So far as plate heat exchangers are concerned, equal Reynolds number method can be considered as a fairly appropriate one. The present paper describes the working principle of the equal Reynolds number method and its use for the plate heat exchangers. Specific examples are given to illustrate their test and computation methods. Key words: equal Reynolds number method, plate heat exchanger, heat transfer test

工业锅炉计算机辅助设计系统的尝试= **A Preliminary Attempt in the Application of a Computer Aided Design System for Industrial Boilers** [刊,中]/Li Jiuru, Dong Shen, Wang Wenyu (Harbin Architectural Engineering University)// Journal of Engineering for Thermal Energy & Power. -1998, 13(2). - 121~ 123

This paper deals with a computer aided design system for industrial boilers, which integrate