

東方電氣評論

- 中国发电设备专业技术期刊、首届《CAJ-CD规范》执行优秀期刊
- 《中国学术期刊综

储能电池技术发展研究浅析

TM912

A

1001-9006 2022 03-0001-04

Latest Technological Developments of Energy Storage Batteries

L E , F L E

DEC Academy of Science and Technology Co., Ltd., 611731, Chengdu, China

Abstract: With the rapid development of renewable energy, the electrical power system typically suffers from the energy consumption and power supply and demand, which drives the development of electrochemical energy storage. The battery performance directly determines the electrochemical energy storage efficiency. In terms of reserves, safety and life performance, lithium-ion battery cannot require the demand of the new electrical power system. In the future, various batteries with designed and tunable properties together serve the needs for energy storage. Here, we provide an overview of lithium-ion battery, sodium-ion battery, sodium sulfur battery, and all vanadium redox flow battery, supporting the new development of batteries in the electrical power system.

Key words: energy storage battery; lithium-ion battery; sodium-ion battery; sodium sulfur battery; all-vanadium flow battery

“ ”

“ ”

2022-06-02

1994

2021

Wh/kg

1

80~90%

12 000

2020

14.2 GW

0.006 5%

/

1.2

MW

[2]

“ ”

0.102 nm

0.076 nm

1.1

92%

2.75 %

0.006 5 %

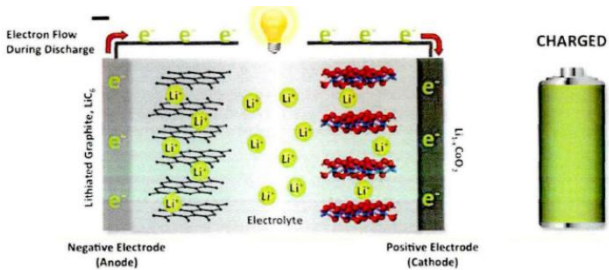
“ ”

2

0.55 /Wh

[3-4]

0.2~0.3 /Wh



2

[5]

210

Wh/kg,

300

η

1.3

3.6 % NGK

β Al₂O₃

3

300~350

Al₂O₃

Na⁺ β
S²⁻

3 [1]

300~350

[1,9]

1.4

VRB

[12]

4 000 /kWh

1/3~1/2

2

0~45

1

1

%	0.0065	2.75	2.75	0.02
Wh/kg	160~300	120~160	150~240	15~40
	-20~60	-40~80	300~350	0~45
	5~10	5~10	10~15	10~20
/Wh	0.6~1.0	0.5	2.2~3	3~3.2

, 2021, 10(3):781-798

[2] , , . .

, 2019, 34(4), 443-449

[3] Etacheri V, Marom R, Elazari R, et al. Challenges in the development of advanced Li-ion batteries: a review[J]. Energy Environ. Sci., 2011,4:3243-3262

[4] , , .

[J]. , 2011, 35(12):1596-1598

[5] M.M. Thackeray, C. Wolverton, E.D. Isaacs. Electrical energy storage for transportation-approaching the limits of, and going beyond, lithium-ion batteries [J]. Energy Environ. Sci., 2012,5(7):7854-7863

[6] , . [J].

, 2021, 48(2):7-10

[7] . [J]. , 2020, 9(3), 757-761

[8] , , . :

[J]. , 2020, 9(2), 517-522

[9] , . [J].

, 2021, 14(1), 58-62

[10] Yuanhang Cheng, Xun Wang, Songpeng Huang, et al. Redox targeting-based vanadium redox-flow[J]. ACS Energy Lett., 2019, 4: 3028-3035

[11] , , , .

[J]. , 2015, 4(5), 458-464

[12] , , , , .

[J]. , 2019, 8(1), 65-74

[1] , , .

—

[J].

危险废物等离子体处理技术的应用研究

X327

A

1001-9006 2022 03-0005-06

Discussion on the Application of Plasma Treatment Technology for Hazardous Waste

F A 1 H G L E 2

1. DEC Academy of Science and Technology Co.,Ltd., 611731, Chengdu, China;
2. Chengdu Huanfu Technology Co., Ltd., 610213, Chengdu, China

Abstract: The application status of hazardous waste disposal and utilization technology is introduced, and the basic principle and system composition of plasma treatment technology are discussed. This paper focuses on the analysis of the domestic demonstration application of plasma treatment technology.

Tetronics

SNCR



2.1



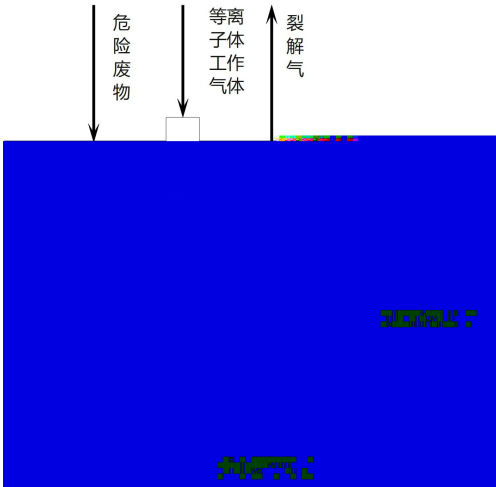
“ ”

“ ” “ ”

[1]

[2]

1

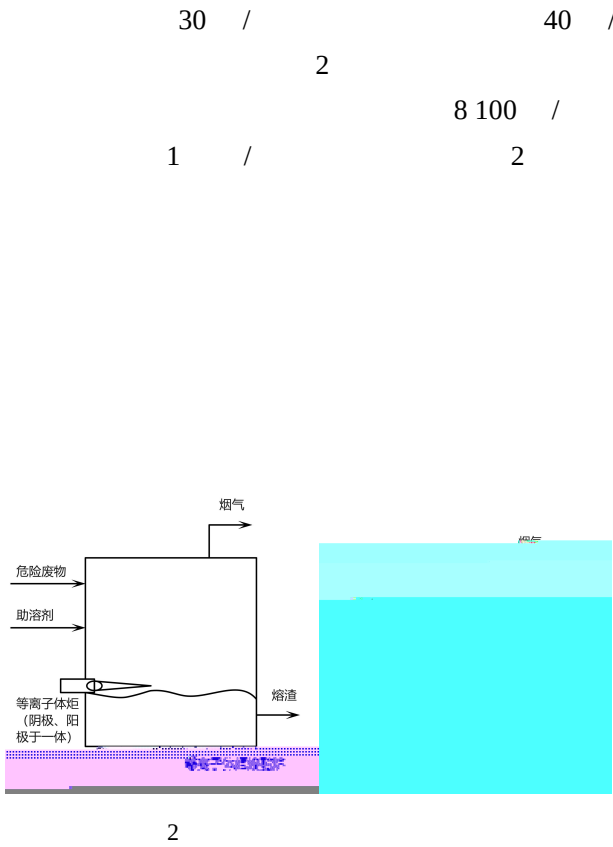


1

2020

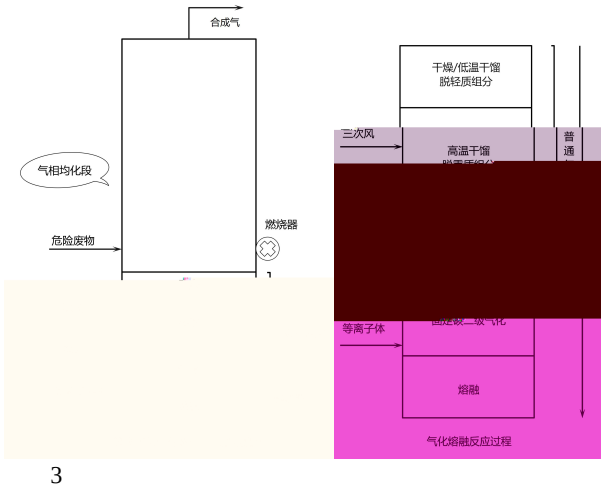
2.2

75 /



2.3

2.3.1



2.3.2

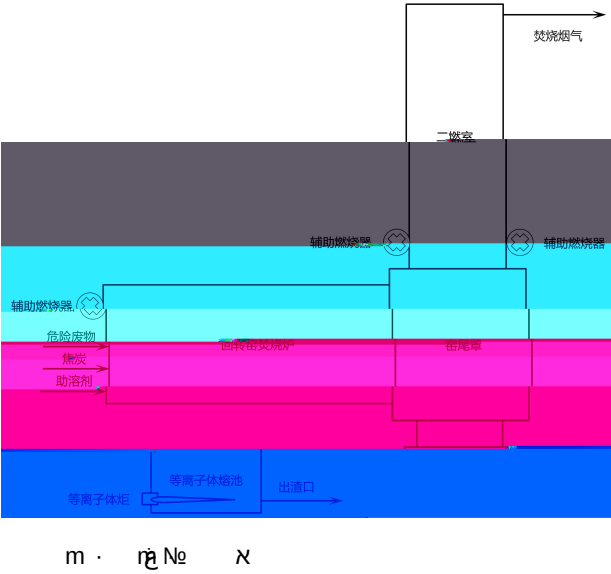
18

3

0.99 /

4

-



m · r₀ Ne λ

柔性作业车间分批调度问题优化研究进展

TH165

A

1001-9006 2022 03-0011-04

Research Progress on Batch Scheduling Optimization of Flexible Job Shop Problem

1,2, L D 2, F L E H 2, J G H 1, L E J 1

1. DEC Academy of Science and Technology Co., Ltd., 611731, Chengdu, China;

2. Southwest Jiaotong University, 610031, Chengdu, China

Abstract: In order to adapt to the demand transformation of batch production mode for job shop scheduling, the batch scheduling problem of flexible job shop is summarized and prospected. firstly, introduces the flexible job shop batch scheduling problem from the two aspects of problem description and solution strategy secondly summarizes the current research status of flexible job shop batch scheduling problem at home and abroad from the perspective of equal batch and flexible batch; and finally puts forward the problems that need to be further studied and improved, Suggestions for future research work are put forward.

Key words: flexible job-shop scheduling problem; batch scheduling; batch splitting; sorting optimization

Flow-shop Scheduling

Problem FSSP

Job-shop

[1]

Scheduling Problem JSP

JSP

2022-03-21

2021YFG0039

1989

2016

			1
JSP		Non-deterministic Polynomial,	
NP	[2]		2
		Flexible Job-Shop Scheduling	
Problem	FJSP	JSP	
			3
	[3-5]		
	FJSP		4
		[6] FJSP	
			5
			6
	FJSP		
	Flexible Job-Shop Batch Scheduling Problem		7
FJBSP	FJBSP		
			8
	[7]		
	FJBSP		

1.2

①

②

③

1



1.1

N

M

R

2

3

Lei [16]

Buscher

[17]

Zhao [18]

Low^[8]

Alyne [19]
MIP

2.2

[20]

2.1

[9]

[21]

[10]

Pareto

[11]

[22]

[23]

[12]

[24]

[13]

Chan FTS [25]

[14]

Andrzej Frank [26]

Wong [15]

Soroush [27]

II

Chen JC Chen TL [28]



1

2

3

[1] , . [J]. , 2020(23):123-124

[2] . [D]. , 2020

[3] Zhan J, Deng T M, Jiang H F, et al. Bi-level dynamic scheduling architecture based on service unit digital twin agents[J], Journal of Manufacturing Systems.2021(60):59-79

[4] , , , . [J]. , 2021, 27(10):2880-2888

[5] Zhang J, Ding G F, Zou Y S, et al. Review of job shop scheduling research and its new perspectives under Industry 4.0[J]. Journal of Intelligent Manufacturing, 2019, 30(4):1809-1830

[6] , , . [J]. , 2010, 21(04):424-429

[7] , , , . [J]. , 2012, 27(04):513-518

[8] Low C Y, Hsu C M, Huang K I. Benefits of lot splitting in Job-Shop scheduling [J]. International Journal of Advanced Manufacturing Technology, 2004, 24(9/10):773-780.

[9] , . [J]. ,2004,40(4):36-39.

[10] , , . [J]. , 2008, 19(2):183-187

[11] , , . [J]. , 2014, 26(01):121-130

[12] , , , . [J]. , 2012, 48(16):237-243

[13] , , . [J]. , 2016, 27(23):3221-3229

[14] , , . [J/OL]. , 2020-09-08:1-22

[15] Wong T C, Ngan S C, A comparison of hybrid genetic algorithm and hybrid particle swarm optimization to minimize makespan for assembly job shop[J].Applied Soft SComputing, 2013, 13(3): 1391-1399

(下转第 36 页)

基于整数线性优化的蛇形管备料中心智能排料

0.1

NP



[1-3]

[4]

[5]

[6-8]

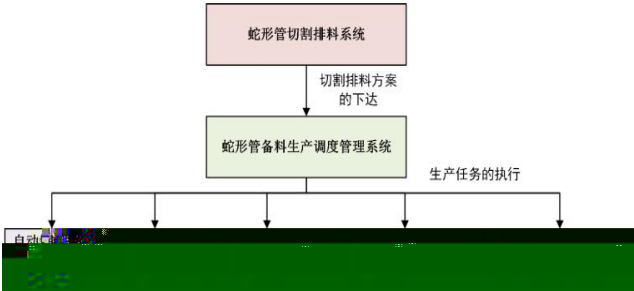
1

[9-11]

[12]

[13]

[14]



1



[15]

2.1

[16]

[17]

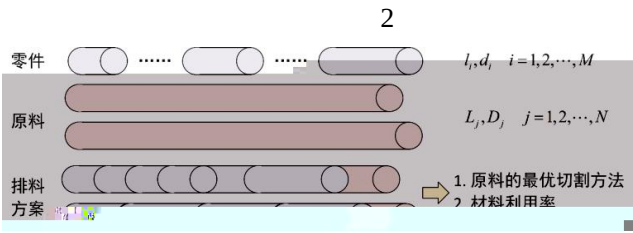
$$= \begin{matrix} 0 & \cdots & K \end{matrix}, K$$

J

$= \theta \cdots, L$

L

$=_J - \sum_{=1}^k \times \alpha$



2

2.2

$P=\left\{ \right. _N \left. \right\}$

α

N

$\sum_{=1}^j \alpha$

$_N = \left[\alpha_1, \alpha_2, \cdots, \alpha_k \right]$

$_J \geq \sum_{=1}^k \times \alpha$

(1)

ERP

or-tools

4	10221	3*2824 1*1729	2
5	10763	1*1823 1*1547 2*2824 1*1729	3
6	10763	1*2482 1*1547 1*2824 1*1961 1*1927	3
7	10763	1*1823 1*1391 2*2792 1*1927	1
8	10763	1*1391 2*2792 1*1837 1*1927	2
9	9414	1*1823 1*2824 1*1961 1*2792	3
10	9414	3*1547 1*2824 1*1927	1

99.758 % 7.704 08 s



10

5

1

100

[1200,3000]

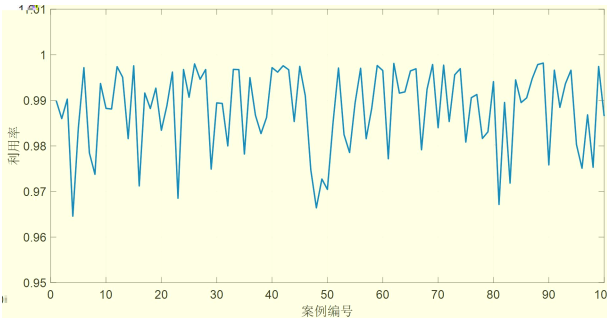
[1,30]

[9000,11000]

[1,20]

1.1

1					
1	2482	7	1	9651	1
2	1823	8	2	9642	15
3	1547	13	3	10221	3
4	2824	19	4	10763	9
5	1391	3	5	9414	4
6	1961	24			
7	2792	20			
8	1837	11			
9	1729	5			
10	1927	25			



3

2					
2					

1	9642	1*2482 1*1547 2*2792	4
2	9642	2*1961 1*1837 2*1927	9
3	10221	1*1823 3*2792	1

60s

100

21

NP-

100

98.8 %

99.8 %,

96.5 %

100

60 s



[1] DELL'AMICO M, FURINI F, IORI M. A branch-and-price algorithm for the temporal bin packing problem. *Computers & Operations Research*, 2020, 114: 104825

[2] WEI L, LUO Z, BALDACCIO R. A New Branch-and-Price-and-Cut Algorithm for One-Dimensional Bin-Packing Problems. *INFORMS Journal on Computing*, 2020, 32(2): 428-443

[3] ALVES C, VALÉRIO DE CARVALHO J M. A stabilized branch-and-price-and-cut algorithm for the multiple length cutting stock problem. *Computers & Operations Research*, 2008, 35(4): 1315-1328

[4] BELOV G, SCHEITHAUER G. A cutting plane algorithm for the one-dimensional cutting stock problem with multiple stock lengths. *European Journal of Operational Research*, 2002, 141(2): 274-294

[5] FURINI F, MALAGUTI E, MEDINA DURÁN R. A column generation heuristic for the two-dimensional two-staged guillotine

cutting stock problem with multiple stock size. *European Journal of Operational Research*, 2012, 218(1): 251-260

[6] SULIMAN S M A. Pattern generating procedure for the cutting stock problem. *International Journal of Production Economics*, 2001, 74(1-3): 293-301

[7] KOKTEN E S, SEL ?. A cutting stock problem in the wood products industry: a two - stage solution approach. *International Transactions in Operational Research*, 2022, 29(2): 879-907

[8] CAMPELLO B S C, GHIDINI C T L S, AYRES A O C, . A residual recombination heuristic for one-dimensional cutting stock problems. *TOP*, 2021[2022-02-24]

[9] JANS R, DEGRAEVE Z. Meta-heuristics for dynamic lot sizing: A review and comparison of solution approaches. *European Journal of Operational Research*, 2007, 177(3): 1855-1875

[10] KALLRATH J, REBENNACK S, KALLRATH J, . Solving real-world cutting stock-problems in the paper industry: Mathematical approaches, experience and challenges. *European Journal of Operational Research*, 2014, 238(1): 374-389

[11] SANTOS J L, SANTOS J, FERREIRA M J, . Application of the Two-Stage One-Dimensional Cutting Stock Problem in the Steel Industry//2018 IEEE 27th International Symposium on Industrial Electronics (ISIE). Cairns, QLD: IEEE, 2018: 683-690 [2022-02-24]

[12] A genetic algorithm approach for the cutting stock problem. 10.

[13] JAHROMI M H, TAVAKKOLI-MOGHADDAM R, MAKUI A, . Solving an one-dimensional cutting stock problem by simulated annealing and tabu search. *Journal of Industrial Engineering International*, 2012, 8(1): 24

[14] JIANG J Q, XING X L, YANG X W, . A hybrid algorithm based on PSO and genetic operation and its applications for cutting stock problem//Proceedings of 2004 International Conference on Machine Learning and Cybernetics (IEEE Cat. No.04EX826): 4. 2004: 2198-2201 4

[15] PRESTWICH S D, FAJEMISIN A O, CLIMENT L, . Solving a Hard Cutting Stock Problem by Machine Learning and Optimisation//APPICE A, RODRIGUES P P, SANTOS COSTA V, . Machine Learning and Knowledge Discovery in Databases: 9284. Cham: Springer International Publishing, 2015: 335-347 [2022-05-09]

[16] GU S, HAO T. A pointer network based deep learning algorithm for 0-1 Knapsack Problem//2018 Tenth International Conference on Advanced Computational Intelligence (ICACI). 2018: 473-477

[17] PITOMBEIRA-NETO A R, MURTA A H F. A reinforcement learning approach to the stochastic cutting stock problem. *EURO Journal on Computational Optimization*, 2022, 10: 100027

锅炉燃尽风对氮氧化物排放影响研究

NOx	0 %	CO	NOx	137 mg/Nm ³	70 mg/ Nm ³	CFB
					CFB	
TM621	A			1001-9006	2022	03-0020-04

Research on the Influence of the Burn Out Air on Nitrogen Oxide Emission in CFB Boiler

[illegible]

1. Clean Combustion and Flue Gas Purification Key Laboratory of Sichuan Province, 611731, Chengdu, China
2. Dongfang Boiler Co., Ltd., 643001, Zigong, Sichuan, China)

Abstract: Due to the need of circulating fluidized bed CFB boiler to further reduce NO_x emission, According to the formation and transformation mechanism of NO_x in CFB boiler. The effects of bed temperature, oxygen content and burn out air rate on NO_x emissions were studied, The effects of burnout air on CO emission and carbon content of fly ash were studied. The results show that burning out air has a significant effect on reducing NO_x emission of CFB boiler. When the ratio of exhausted air increased from 0 % to 16 %, and NO_x emission value decreased from 137 mg/Nm³ to 70 mg/Nm³. Burn out air plays a positive role in maintaining the stability of NO_x emission when the oxygen content of CFB boiler fluctuates, It is demonstrated that the burnout air technology has certain advantages in low emission performance of CFB boiler.

Key words: NO_x; burn out air; CFB boiler

Technology	[1-2]	[3-4]	CFB
CFB	100 mg/kWh	100 mg/kWh	100 mg/kWh
(CFB)	150 mg/kWh	150 mg/kWh	150 mg/kWh
3 MW CFB	200 mg/kWh	200 mg/kWh	200 mg/kWh
NOx	250 mg/kWh	250 mg/kWh	250 mg/kWh

2022-06-23

1986 2010

NO_x

[11-14]

NO

CFB

NO

[15]



3MW CFB

1

24.5 m

0.9m × 1.1m

M

6.0%

1

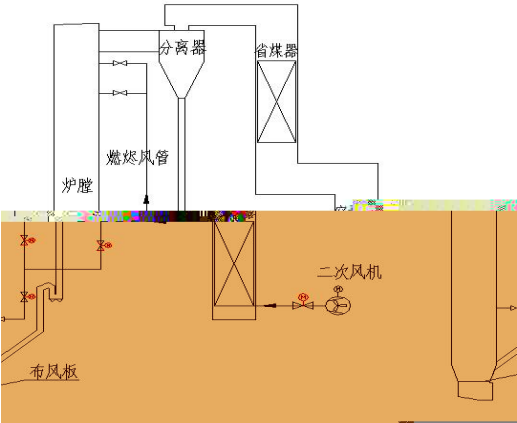
DCS

ABB

4.9 m

19.4 m 22.4 m

23.4 m



1



1

1			
κ _t	%	9.2	
κ _{ad}	%	5.63	
ar	%	33.20	
ar	%	27.44	
daf	%	47.66	
D _A ar	%	30.14	
o _{gr,v,ar}	MJ/kg	17.84	
o _{net,v,ar}	MJ/kg	16.99	
A ar	%	42.95	
F ar	%	3.10	
L ar	%	0.86	
M ar	%	9.27	
t _{a,ar}	%	1.40	

3.1

2

NO_x

CO

55 %

N

N

880

3.2 %

N^[5-8]

N

HCN

NH₃

0 %~16 %

HCN

NCO

NCO

NO_x

CO

NO

N₂O

NH₃

10 %

NO^[9-10]

10 %

16 %

CO

84 mg/Nm³

NO

0

NO_x

NO

145 mg/Nm³

10.0 %

NO_x

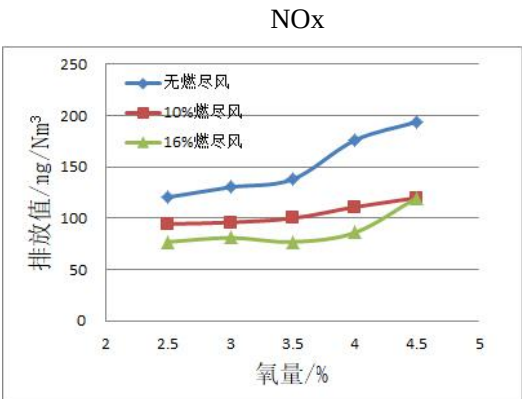
NO

102 mg/Nm³

CFB

NO_x

2.5 % 4.5 %
NO_x 121 mg/Nm³ 194 mg/Nm³
10 % NO_x 94 mg/Nm³
120 mg/Nm³ 16 % NO_x
77 mg/Nm³ 120 mg/Nm³ CFB
NO_x



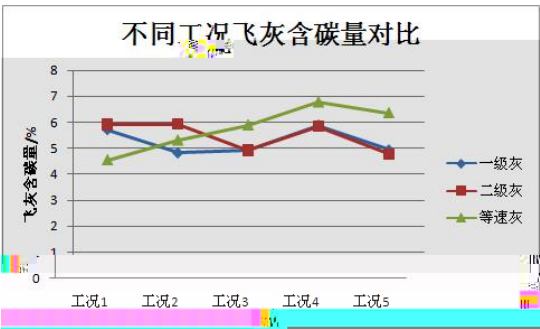
6

NO_x

3.4

7

1 10 % 2 16 % 3~5



7

25.5 % 16 % NO_x

49.1 %

NO_x

2 3.5 % NO_x 3.5 % NO_x

3 10 % 16 % NO_x

NO_x

CFB

NO_x

NO_x

4 15 %

[1] , , .
[J] , 2016, 49(1):1-13

[2] LYNGFELT A, MANDL E, LECKNE B Reversed air staging method for reduction of N₂O emissions from fluidized bed combustion of coal[J] Fuel, 1998, 77(9):953-959

[3] , . NO_x
[J]. , 2015, 46(2):55-59

[4] , , . NO_x [J].
, 2015, 31(1):71-72

[5] , , . N₂O
[J]. , 1994, 14(4):1-7

[6] , . N₂O [J].
, 1997, 5(5):2-15

[7] , , . Fe
CO N₂O/NO N₂ [J]. ,
2001, 21(1):44-47

[8] , , . Co-Mg/Al
N₂O [J]. , 2007, 3(2):162-168

[9] , , . N₂O
[J]. , 2007, 36(3):303-307

[10] , , . N₂O NO_x
[J]. , 2002, 18(2):51-52

[11] , , .
N₂O [J]. , 2001, 1(3):44-47

[12] , , .

1

NO_x

10 % NO_x

大型

钢弯头成型工艺研究

G115

G115

G115

TM621

A

1001-9006 2022 03-0024-04

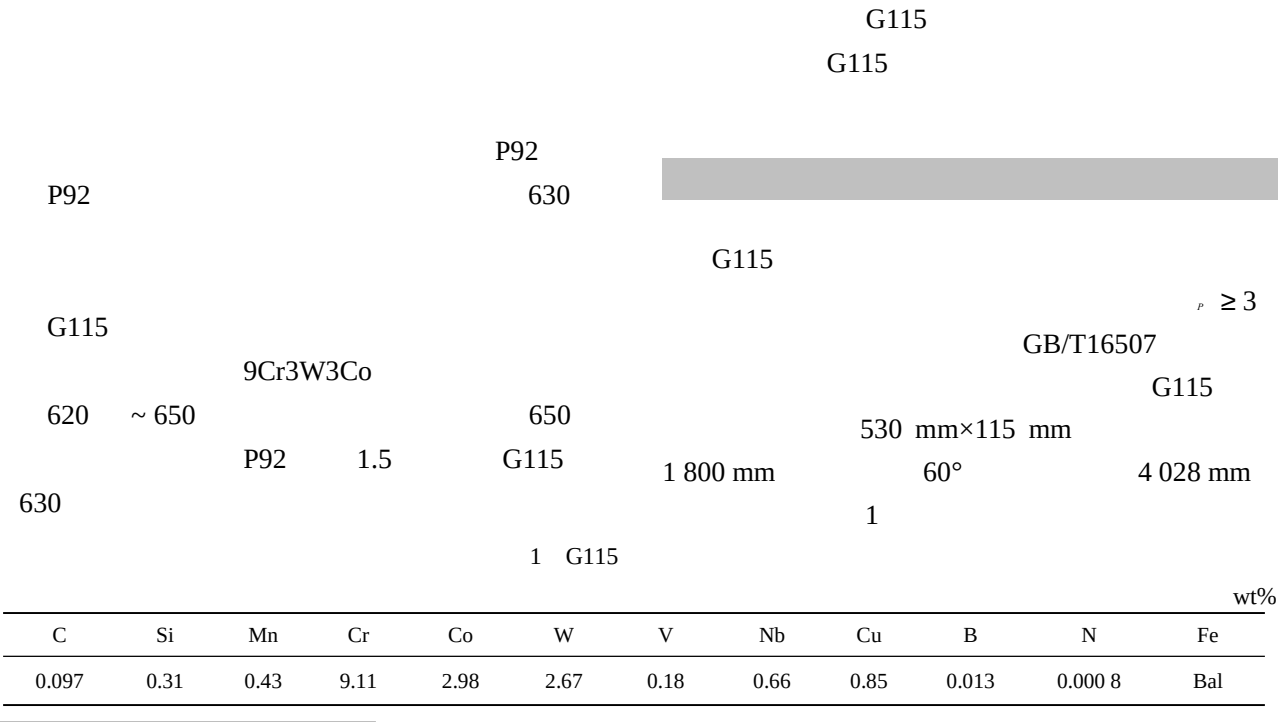
Research on the Forming Process of Large G115 Steel Elbows

J F F L E H E M L E

Dongfang Boiler Co., Ltd., 643001, Zigong, Sichuan, China

Abstract: This paper mainly expounds the formation of the large G115 steel elbows by, respectively, medium frequency induction heating process and hot extrusion forming process. The control temperatures and the heat treatment process adequate for G115 steel elbow formation are identified through tests of the two process methods, ensuring the technology preparation for the manufacturing of boilers with high-grade parameters.

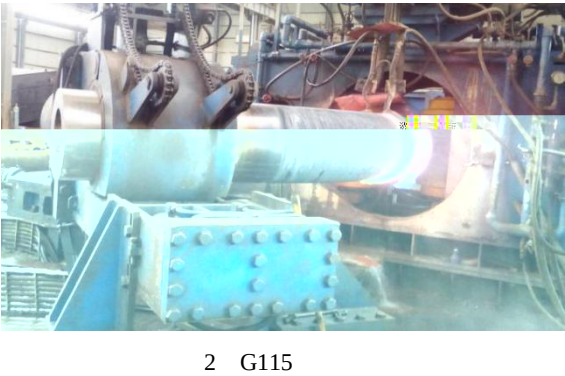
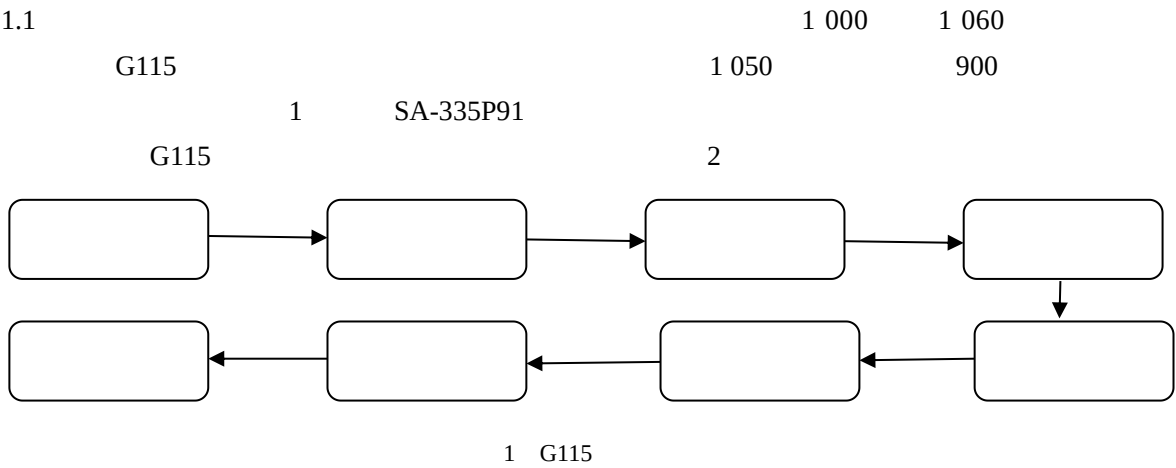
Key words: G115 steel; hot working forming; process



2022-04-12

1980

1.1



2

G115

30

1 060

780 ± 15

300

300+15 min

≤ 150 /h

1.2

G115

G115

1070 ± 15

150+15 min

550

≤ 150 /h

1.3

G115

2

2		G115				530 mm×115 mm; 1800	
	0	0°	22.5°	45°	67.5°	90°	
		108	107.2	108.5	107	107	
		114.7	114.5	114.5	114.8	114.5	
min		533	533	533	534	533	

max

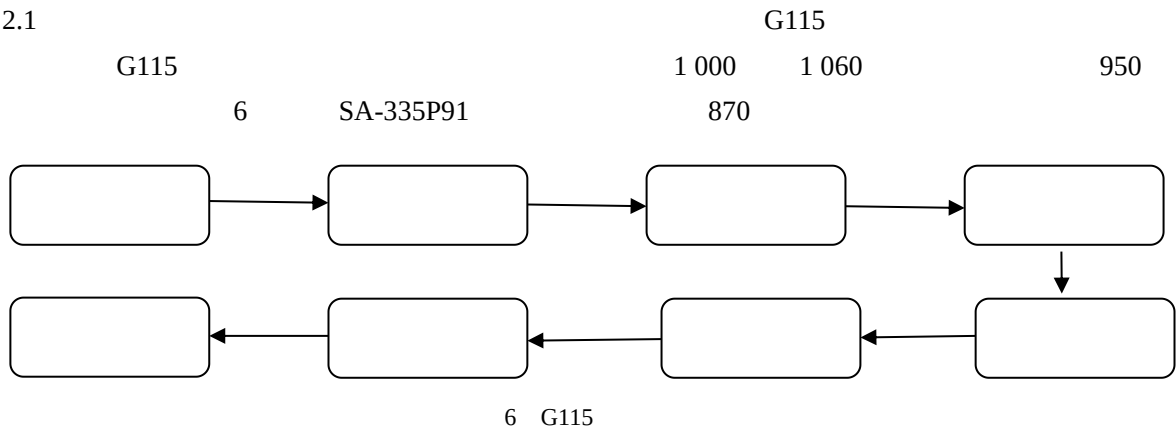
535

535

535

535

535



2.2

G115 5

7

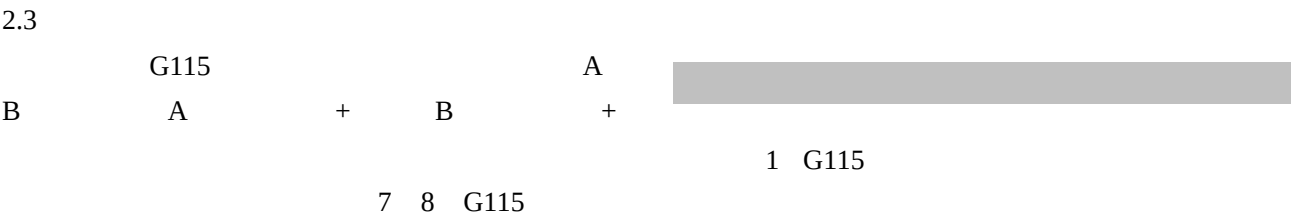
			8		
			mm	10×10	KV2
A1	20	T/4	130/73/116	/	/
A2	20	T/2	93/81/118	/	/
B1	20	T/4	118/111/86	/	/
B2	20	T/2	96/106/118	/	/



2.4

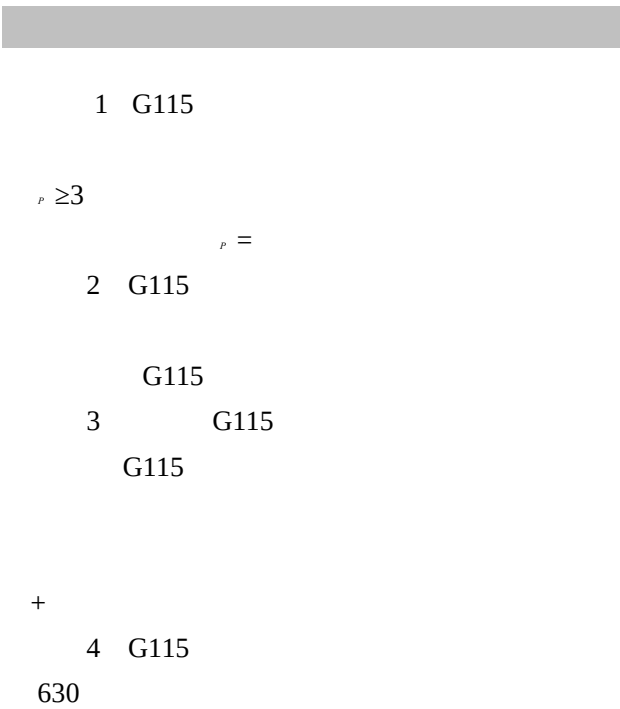
A B

+ +



7

			MPa	MPa	A	
A1	20	T/4	519	678	25.0	/
A2	20	T/2	529	682	25.0	/
B1	20	T/4	521	676	23.0	/
B2	20	T/2	497	668	21.5	/
A1	650	T/4	267	278	34.0	/
A2	650	T/2	260	280	38.0	/
B1	650	T/4	265	271	33.0	/
B2	650	T/2	262	281	37.0	/



(下转第 55 页)

供热抽汽改造方式及管道布置分析

300 MW

TM621

A

1001-9006 2022 03-0028-05

Analysis of Extraction Steam Heating Supply Retrofit Methods and Pipeline Layout

G J , J G H , F L E r , L E H

Dongfang Electric(Chengdu) Engineering & Consulting Co.,Ltd., 611731, Chengdu, China

Abstract: In recent years, with the demand of heating and deep-peak regulation of thermal power units, qualified thermal power units have begun to carry out heating retrofit according to plant conditions, in order to improve the comprehensive utilization efficiency of energy and achieve the goal of energy conservation and emission reduction. At present, the heating retrofit of 300 MW and above capacity units in China mostly adopts the technology of drilling steam extraction heating retrofit and low-pressure cylinder cutting cylinder retrofit. This paper analyzes and discusses the similarities and differences between the above two kinds retrofit technologies and the layout of steam extraction pipeline, in order to provide reference for the subsequent projects.

Key words: heating retrofit; lower pressure cylinder zero output; extraction piping; expansion

2022-02-14

1983

2008

200 MW

300 MW

1	[7]			
	200 MW	200 MW	300 MW	600 MW
MPa	0.3	0.245	0.85/0.5*	1.1
	270	245	335	360

*

[1-3]

[4]

600 MW

1.2

[5]

[6]

(20 t/h)

300 MW



1.1

2 300 MW/600 MW			
	300 MW	300 MW	660 MW
MPa	0.6	0.98	0.5
	296	350	350

2

D-GD2000

X

Y

2.3

1~2

2

cii^[9]

3

4

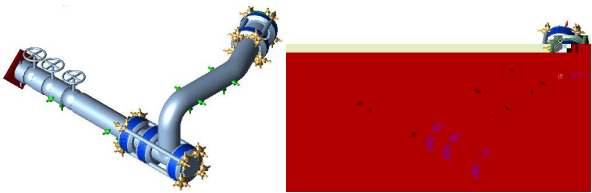
350

0.6 MPa(g),

0.1

2

SUS



2 600 MW

OPE

3

3							
/		1 GUIDE	2 GUIDE	3 GUIDE	4 GUIDE	5 ANC	
+	FX N	58	-180	15	5	-41 015	4
	FY N	0	-4	20	5	43 338	-8
	FZ N	-23 335	-73 505	-30 520	-73 715	-86 500	-15 732
	MX N.M	0	0	0	0	-36 635	-32 940
	MY N.M	0	0	0	0	81 640	-17 735
	MZ N.M	0	0	0	0	161 780	1
SUS	FX N	-2 210	7 440	-502	-176	-45 512	-152
	FY N	0	-191	16	6	43 338	181
	FZ N	-54 385	-57 380	-28 880	-72 340	-85 960	-13 735
	MX N.M	0	0	0	0	-35 080	-36 565
	MY N.M	0	0	0	0	81 385	60 035
	MZ N.M	0	0	0	0	161 780	-1

OPE		FX N	-4	27	3 125	5	-6	835
		FY N	0	-	456	26	3	185
		FZ N	-10 295	86 360	75	72	5 525	755
	+	MX N.M	0	0	0	0	-36 280	-67 000
		MY N.M	0	0	0	0	81 650	-75 810
		MZ N.M	0	0	0	0	161 765	-1 265
		FX N	-951	23 380	2 920	7 220	-70 150	-3 558
		FY N	0	-4 618	-302	155	43 305	4 400
		FZ N	-65 240	-46 185	-29 185	-72 210	-85 990	-13 870
	+	MX N.M	0	0	0	0	-34 806	-45
		MY N.M	0	0	0	0	81 395	16 345
		MZ N.M	0	0	0	0	161 770	105

2

2



1 300~600 MW

2

3

关于对压缩空气储能与电站锅炉耦合运行系统的研究

TK02

A

1001-9006 2022 03-0033-04

A Study of Air Pressing Energy Storage and Boiler Couple System

Dongfang Electric International Corporation, 611731, Chengdu China

Abstract: This article creatively proposes a coupling system of compressed air energy storage with power station boilers, which effectively solves the problem of low efficiency, it could help the grid to absorb the electricity fully generated by new energy sources and it can be used for peak shaving and valleys filling, and the grid runs more reliably.

Key words: compressed air; energy storage; compressed air energy storage (CAES); coupling

2019 486 000.00
280 422.00 ,
91 854.00 ,
39 366.00 ,
74 358.00 [1]
76.6 % 2019 169
57.7 % , 2017 46 4 % 2019
2 %^[3]
46 % 45 % SO_x 59 %
26 % NO_x +
21 % 57 % PM₁₀ 3
28 % 52 % PM_{2.5} [2]

3

2022-03-03

1984 2007

2 ~ 3

[4]

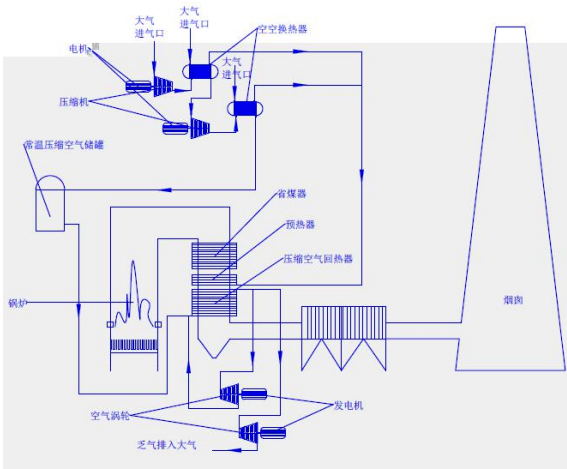
(AA CAES)

54 %

70 %^[5]

[5]

[5]



1

2.1
2.2.1

1

P_0

N

1 N 1

0

N 1

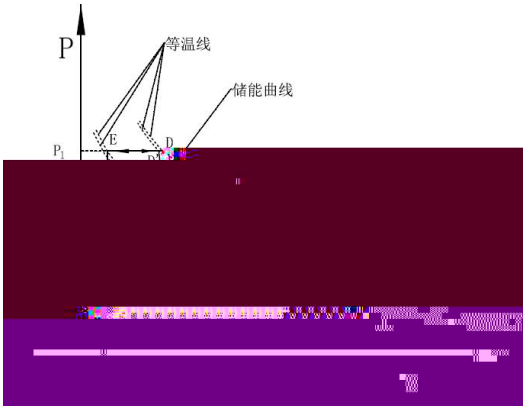
2

o 2,

0 N 1

2 N 1,

N 1



o 1= o 2

1= 2

N 1= N 0

A N 0 0

ABCDEF A'B'C'D'EF

DD'C'C BB'A'A

A-B-C-D-E,

E-D'-C'-B'-A'

2.2.2

o 1 $>$ o 2

1' $<$ 1

1

1' $>$ 1

1

1' $=$ 1

o 2=0

2.2.3

o 1 $<$ o 2

2.2

2

70 %

5
6

$$\begin{array}{ccccc} & & 1' < 1 & & \\ 1 & & 1' = 1 & & 1 \\ 1' > 1 & & & & 1 \end{array}$$

- 1
- 2
- 3
- 4

- [1] [DB/OL]. <http://data.stats.gov.cn/easyquery.htm?cn=C01&zbs=A070B&sj=2019>
- [2] , .
[J]. , 2011, 31(9): 1858-1871
- [3] [DB/OL]. http://www.nea.gov.cn/2020-03/06/c_138850234.htm,
- [4] , . [J].
2014, 33 6 : 1-6
- [5] , , , [J].
, 2012, 1(1): 26-40

(上接第 14 页)

[16] Lei D, Guo X. scheduling job shop with lot streaming and transportation through a modified artificial bee colony[J]. International Journal of Production Research, 2013, 51(16): 4930-4941.

[17] BUSCHER U. SHEN I An integer programming formulation for the lot streaming problem in a job shop environment with setups[C]//Proceedings of the International Multi Conference of Engineers and Computer Scientists. long Kong International Association of Engineers, 2011:1343-1348

[18] Zhao Y W. Wang H Y. Xu X L. et al. A new hybrid parallel algorithm for consistent-sized batch splitting job shop scheduling on alternative machines with forbidden intervals[J]. The International Journal of Advanced Manufacturing Technology. 2010. 48(9/10/11/12):1091-1105

[19] Alyne T, Deisemara F, Reinaldo M. Formulation and MIP-heuristics for the lot sizing and scheduling problem with temporal cleanings[J]. Computers and Chemical Engineering, 2020, 142

[20] , , , . [J]. , 2010, 16(2):396-403

[21] , , . [J]. , 2013, 19(10):2481-2492

[22] , , , . [J]. , 2013, 19(10):2481-2492

[23] , , . [J/OL]. : 1-18[2022-03-12]

[24] , , . [J/OL]. (): 1-11[2022-03-12]

[25] Chan F T S, Wang T C, Chan L Y. Lot splitting under different Job Shop conditions[C]//Proceedings of 2007 IEEE Congress on Evolutionary Computation. Washington, D. C. USA: IEEE, 2007: 4722-4728. [26]

[27] Andrzej B and Frank W. Flexible job shop scheduling with lot streaming and subplot size optimization [J]. International Journal of Production Research, 2018,56(19):6391-6411

[28] Chen J C, Chen T L, Hung H C. Capacity allocation with lot splitting in photolithography area using hybrid genetic algorithm based on self-tuning strategy[J]. Computers & Industrial Engineering, 2020, 148:106656

绍兴某燃机电厂二期扩建项目的可行性分析

H -

TM621

A

1001-9006 2022 03-0037-04

Feasibility Analysis of Phase II Expansion Project of A Gas Turbine Plant in Shaoxing

L E , L F

Dongfang Electric Co., Ltd., 611731, Chengdu, China

Abstract: This paper analyzes the important supporting role of large-scale gas steam combined cycle generator units on the social power demand in the region, and introduces in detail the advantages of H-class gas steam combined cycle power generation in the expansion unit project and the risks that need to be paid attention to from the aspects of technology, economy and environment, so as to provide reference for subsequent gas turbine projects.

Key words: H-class gas steam combined cycle power generation; social power demand in the region; risk point

—		2019	
		2	
		82.8	
		90.4	6 000
		()	87.705
		2.075	81.85
		3.78	6 000 ()
			109.249 13.081
2030		3.155	
2060	“ ”	93.013	
		2019	828
[1-2]		7.45 %	“ ”
		2025	
		742	

“ ”

“ ”

2×40

2×30+4×5

4.35 %

2

1	/ /	2022.2 (
2		19 1# 22 2#
3		20
4	%	30
5	%	4.9
6		15
7		15
8		4 500
9		51
10	/	8
11	%	0.25
12	/MWh	8
13	/MWh	12
14		0
15		0
16	%	3.5
17	/t	1.15
18	/	640
19	10% ()	Nm³/MWh 167.66×1.1
20		% 1.933
21		% 25
22		% 10
23		% 7

3.2.2

1 0.425 3 /kWh
9 %

4 500

3

	/Nm³	1.707
	%	5.76
	%	10.48
		10.70
	%	9.00
		402 610
	%	7.31
		11.82
		6 336
	%	13.21
		8.37
		43 102
	%	7.58
		17.29
		6 480

3.2.3

1

± 20 % 4 500

1.707 /Nm³

4

4

()

(%)				
0.00	9.00	0.00	0.00	
-20.00	12.56	39.48	-1.97	
-15.00	11.56	28.40	-1.89	
-10.00	10.64	18.20	-1.82	
-5.00	9.79	8.77	-1.75	
5.00	8.26	-8.19	-1.64	
10.00	7.57	-15.87	-1.59	
15.00	6.92	-23.10	-1.54	
20.00	6.31	-29.93	-1.50	
-20.00	5.62	-37.60	1.88	
-15.00	6.52	-27.62	1.84	
-10.00	7.38	-18.07	1.81	
-5.00	8.20	-8.88	1.78	
5.00	9.77	8.59	1.72	
10.00	10.53	16.94	1.69	
15.00	11.26	25.05	1.67	
20.00	11.97	32.95	1.65	
-20.00	23.19	157.63	-7.88	
-15.00	19.90	121.06	-8.07	
-10.00	16.48	83.12	-8.31	
-5.00	12.89	43.15	-8.63	
5.00	4.63	-48.59	-9.72	
10.00	-0.70	-107.77	-10.78	
15.00	-8.41	-193.41	-12.89	
20.00	-24.22	-369.02	-18.45	
-20.00	-54.94	-710.34	35.52	
-15.00	-22.07	-345.18	23.01	
-10.00	-4.50	-150.01	15.00	
-5.00	3.32	-63.12	12.62	
5.00	13.83	53.65	10.73	
10.00	18.22	102.38	10.24	
15.00	22.34	148.14	9.88	
20.00	26.28	191.93	9.60	

()

3.2.4

H

9 %

1.707 /Nm³

2.31 /Nm³
LNG

4.1

4.4

4.2

“ ”

700 MW -

4.3

[1] , , .
[J]. . 2020, 39(9):109-117
(下转第 44 页)

GDP

卧式电袋复合除尘器技术在半干法脱硫系统中的应用

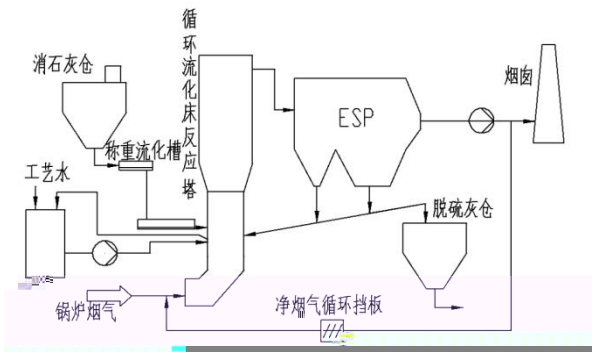
X773

A

1001-9006 2022 03-0041-04

Hori

1



1 CFB-FGD

1

~1 000 g/m³

2

3

5 % 7 % 10 %

12 %

4

[1]

10~25

70~90

Ca/S

1.2

10~25

SO₂

Ca(OH)₂

SO₂

SO₃

CaSO₃·1/2H₂O

CaSO₄·1/2H₂O

~1 000

g/m³

1



2

2

70~90

80 % 90 %

A

65° B

3

4

5



CFB-FGD

1

/

PPS+ PTFE
~14 500
(m/min)0.9

3.3

3.3.1

1

2

”

3.3.4

PTFE

PTFE

160

190



5 mg/Nm³

3.3.2

66°

110

3.3.3

10 kPa

“ ” “ ” “ ”

[1] , . [J]. , 2017, 44(22):116-117

[2] , . [J]. 2016,38(9):8-9+22+77

[3] . [J]. , 2019, 29(3):47-49

(上接第 40 页)

[2] . “ ” [J]. 2021, (8):54-55+58

[3] , , . [J]. , 2021, 41(6):152-161

[4] . [J]. 2020, 18(10):91-94

[5] , . [J]. 2020, 40(7):138-145

[6] . “ ” [J]. . 2020, (31):39-41

[7] . 200 MW [D]. , 2012

[8] . [D]. , 2012

TM315

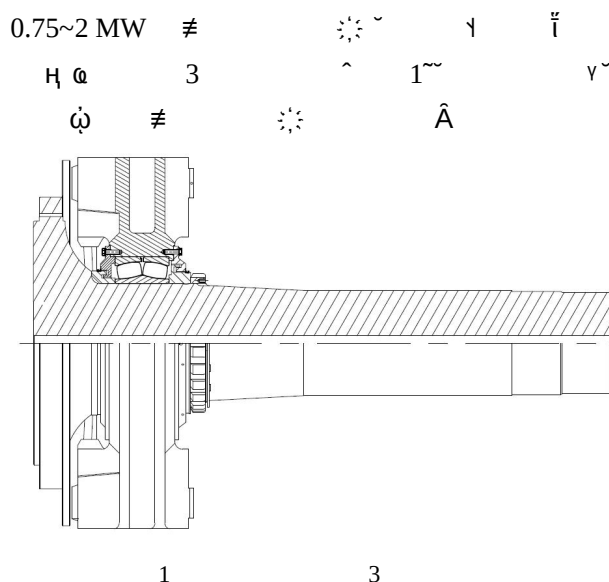
A

1001-9006 2022 03-0045-02

$$F, L, E, F, 1, M, L, E, 2, F, 1, F, M, 2, E, M, 1$$

1. China Three Gorges Construction Engineering (Group) Co., Ltd., 610000, Chengdu, China;
2. Dongfang Electric Wind Power Co., Ltd., 618000, Deyang, Sichuan, China~

Key words: transmission chain; bearing arrangement


$$1.1 \quad \begin{array}{ccccccc} & & 3 & & & & \gamma \omega \\ a & & \gamma & & \bar{w} & & \\ & & & & \tilde{T} & n & \psi \dot{t} \\ & & & & h & & z^{\sim} \tilde{\sim} \end{array}$$

1. 1990 年 10 月 1 日以前， $\hat{A}$ 的装机容量为 10MW， $\hat{A}$ 的装机容量为 10MW。

基于人工智能的风电叶片破损识别及破损面积计算的算法设计

YOLO

TM315

A

1001-9006 2022 03-0047-04

Algorithm Design of Wind Power Blade Damage Identification and Damage Area Calculation Based on Artificial Intelligence

J G N 1 F L E 1 F L E N 2 A F L H 1 K M I 2 L E H 1 F 1

1. Dongfang Electric Wind Power Co.,Ltd.,618000, Deyang, Sichuan, China;

2. DEC Academy of Science and Technology Co.,Ltd., 611731, Chengdu, China

Abstract: For monitoring and identification of the wind turbine blade damaged areas in equipment maintenance measures of the wind power projects, one kind of recognition algorithm based on YOLO neural network is proposed to automatically identifies the wind turbine blade damaged areas by the aerial photos of the wind field. Another kind of algorithm which is based on traditional computer vision algorithms has been designed to match the before one to extract and calculate the damaged areas of the wind turbine blade. The algorithms proposed in this paper can intelligently and automatically identify, track and manage the damaged areas and their changes of the wind turbine blade. The proposed algorithms also have been tested, the experimental results showed that the designed algorithms are effective and accurate.

Key words: artificial intelligence; wind turbine blades; damage identification; damage area; algorithm

2022-01-13

1974

1979



1

TB

1

[1]



YOLO You Only Look Once ʌ s E

() ()
[2]



2 3

YOLO v4
YOLO v4

Gaussian

2 3

10
11 12
13
[3]

YOLO v4

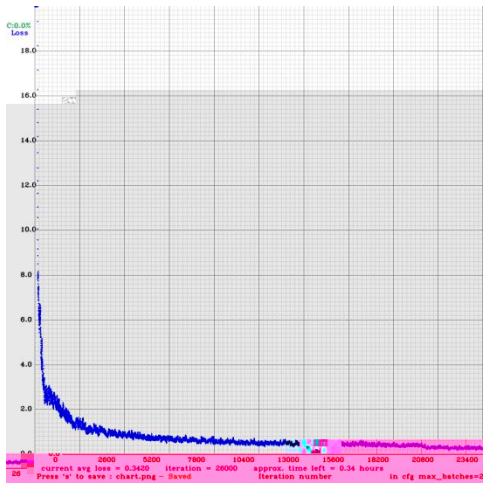


1 8
1 1
26 000 1 Loss
10 000

RGB

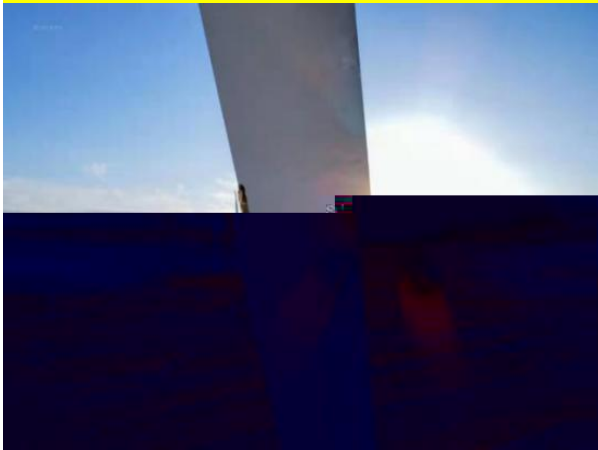
Gaussian

[4]

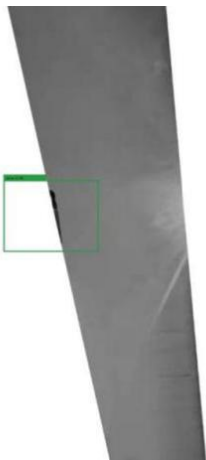


1 loss

2
1
3 3
99 %
1 000
85 %



2



3
4 3

95%



4



YOLO v4

85 %

YOLO

v4

-
- [1] , , .
[J]. , 2014, 16(2): 307-313
- [2] Gautam R, Panigrahi S. Image processing techniques and neural network models for predicting plant nitrate using aerial images[C]. Proceedings of the International Joint Conference on Neural Networks, 2003(2):1031-1036
- [3] Walter V. Object-based classification of remote sensing data for change detection [J] . ISPRS Journal of Photogrammetry and Remote Sensing, 2004, 58(3-4): 225-238
- [4] Redmon, J., Divvala, S., Girshick, R. and Farhadi, A. (2016) You Only Look Once: Unified, Real-Time Object Detection[C]. 2016 IEEE Conference on Computer Vision and Pattern Recognition, 2016:779-788

大型整体式核能发电机定子机座焊接制造工艺
技术

49

5 103

TM623

A

1001-9006 2022 03-0051-05

Welding Manufacture Technology of

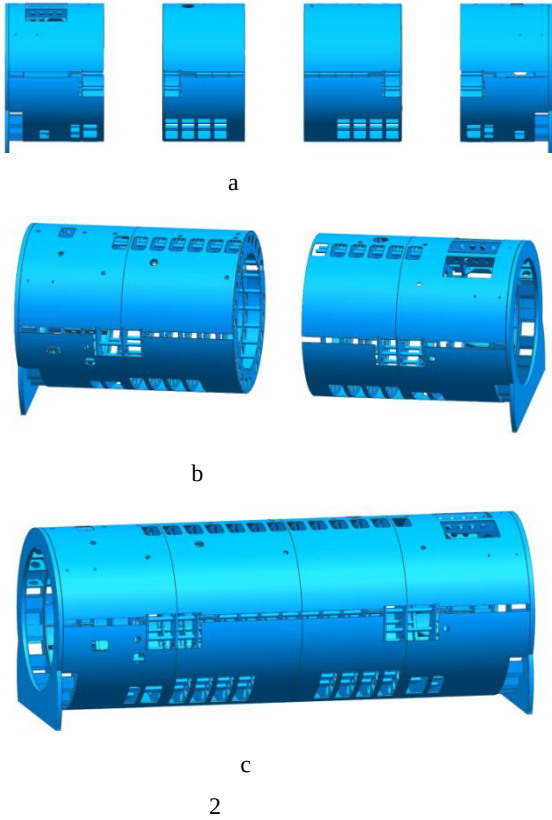
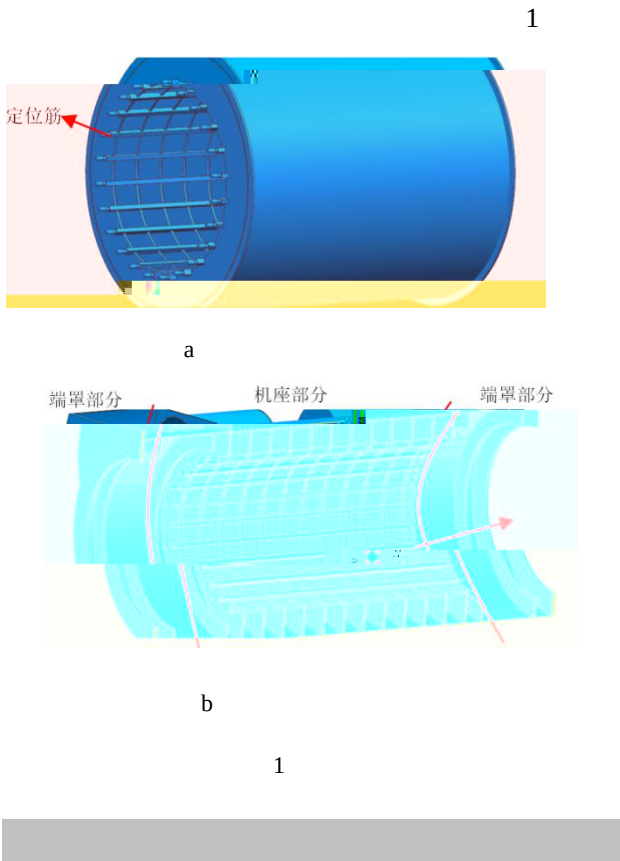
ACP1000

12.3 m

4.6 m

20

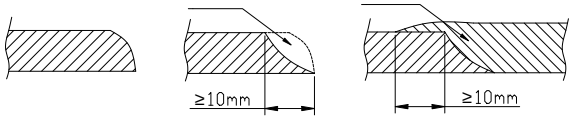
2



2.2

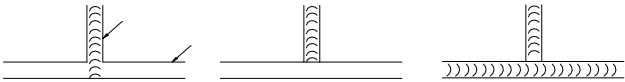
2.1

3



3

4



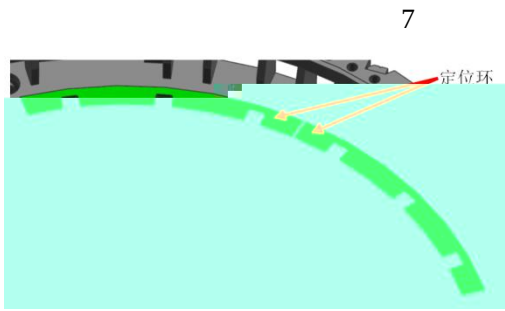
4

ACP1000

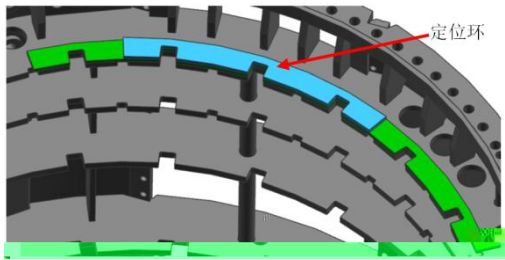
2.3

5

Ø



a

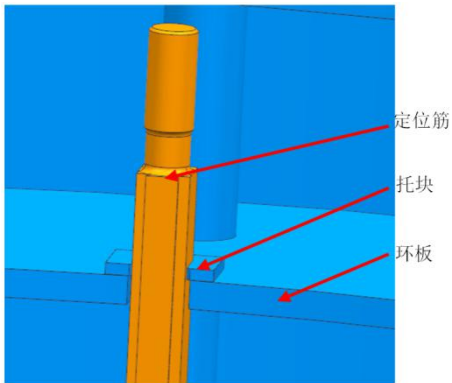


b

7

2.3.2

8



8

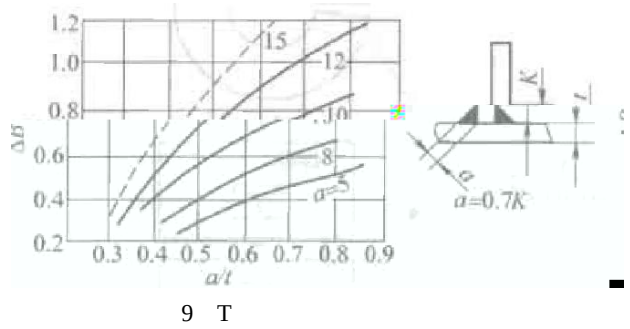
T

9

[1]

16 mm

0.8 mm



R 1 mm

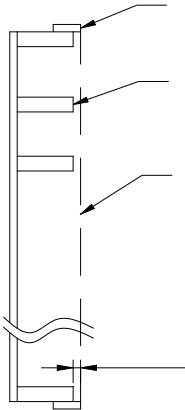
2.3.3

ASME GB
ISO

2.3.4

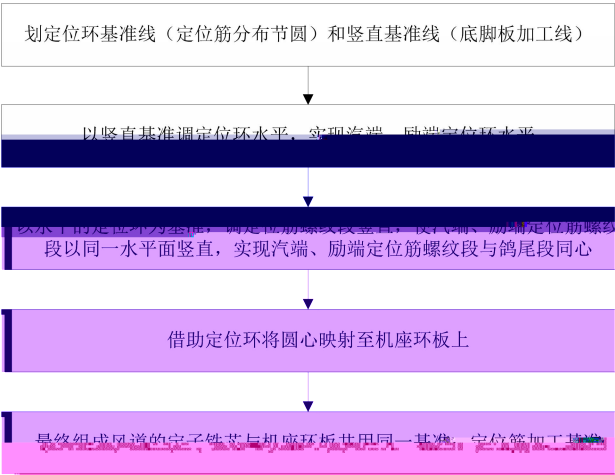
24

300 mm



10

11



10

11

ACP1000

24 8m
mm

≤ 1.5

ACP1000

[1] , , . [M]. , 2012

（上接第 27 页）

[1] , , . 630

[J]. , 2017, 49(S1):109-113

[2] , , . G115 650 [J]. , 2021(5):45-48+60

3 . G115 J . 2021 3 :34-39

核电厂氢冷发电机气密试验的影响因素分析

TM623

A

1001-9006 2022 03-0056-04

Analysis of Influencing Factors of Hydrogen Cooled Generator Airtight Testing Nuclear Power Plant

A F L L , L E , O , J G , L E F I , G L J

CNNO, 314300, Haiyan, Zhejiang, China

Abstract: Air tightness test is an important means to verify the internal tightness of hydrogen cooled generator. After the generator is disassembled and repaired, it must pass serious air tightness before it can be put into use. Based on the analysis of various factors affecting air test, putting forward the corresponding countermeasure and approach, and raising the optimization measures actively, generator sealing inspection is carried out smoothly and leakage eliminating provides effective reference value, thereby reduces the delay which due to overhaul key the path is not qualified by air tight test, and provides a guarantee for the safe and stable operation of unit.

Key words: hydrogen cooled; airtight; leakage eliminating

M310

6227-2005

JB/T

2022-04-26

1987

2009

2.3

40

4

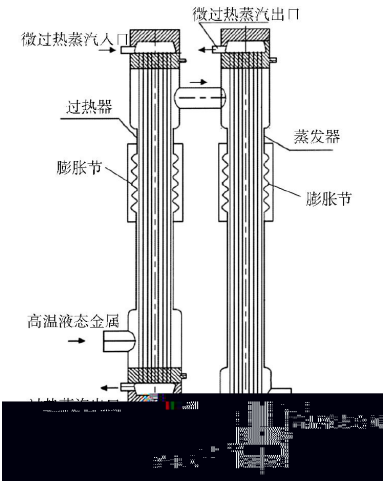


1

2

- 3 dz

钠冷快堆蒸汽发生



1

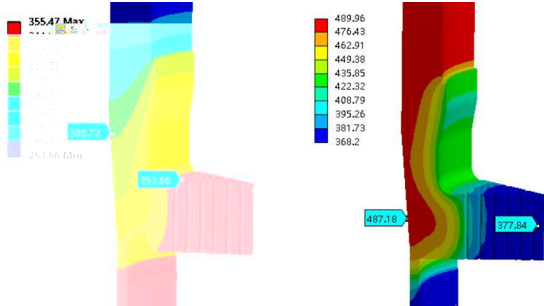
2



2

[2] 1/8

3



(a)

(b)

3



1.1

1.1.1

200~250

(0~11790

s/3.275 h)

250

330

1.1.2

1

SA-336M Gr.F22 Cl.1

1

1

	1		
	kg/m ³	K W/(m·°C)	Cp J/(kg·
40	7750	36.4	456
100	7750	36.9	483
150	7750	37.1	501
175	7750	37.2	510
200	7750	37.2	519
225	7750	37.2	529
250	7750	37.1	538
275	7750	36.9	547
300	7750	36.7	558
325	7750	36.5	569
350	7750	36.2	580

2

=0.0928 m³

r =0.64

m²

Δt =80

11 790 s

1.1.3

[3]

o

$$\rho = \rho_0 \cdot \Delta \tag{1}$$

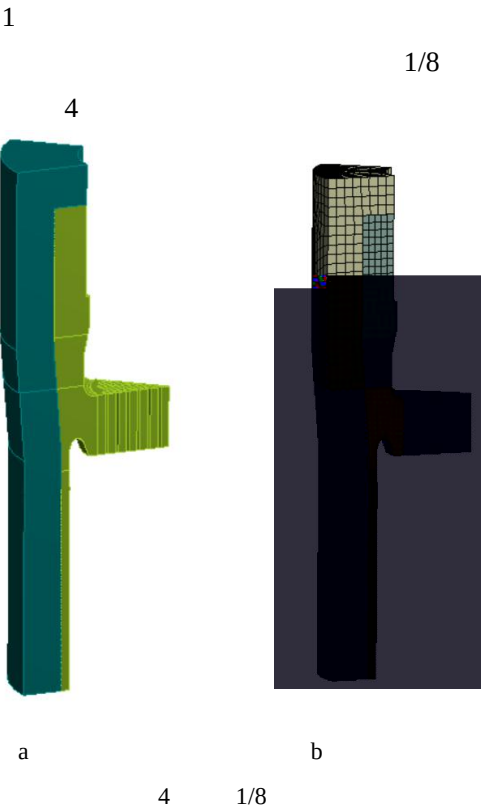
$$\rho = \frac{m}{V} \tag{2}$$

$$F_D = \rho \cdot v^2 \cdot A \tag{3}$$

1.2
1.2.1

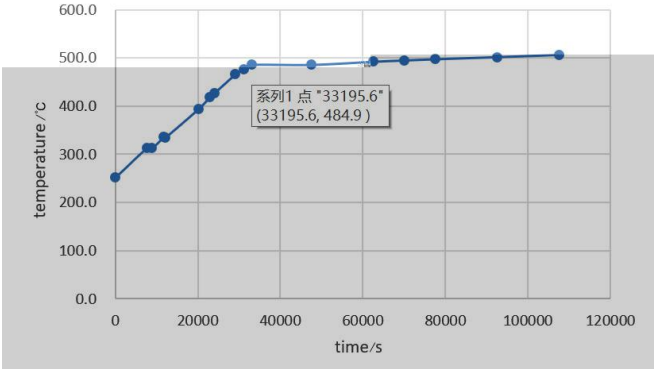
ANSYS Workbench

1.2.2

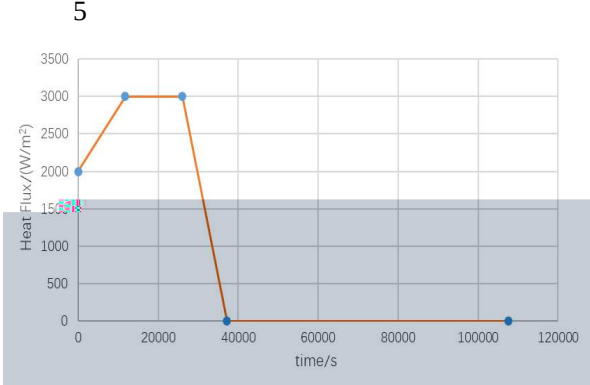


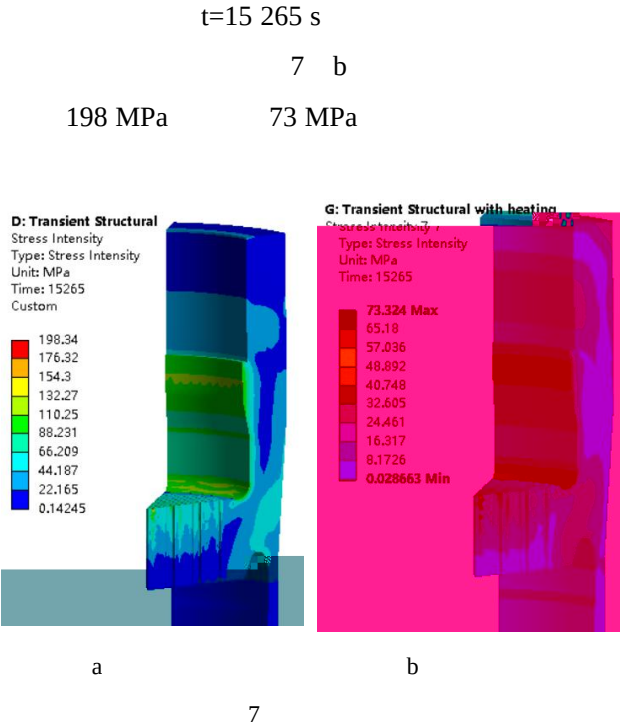
4
W/m²
2
W/(m²·K)
1
2
30
F_D = 4 222
200 mm
8.141

		K	C _p
	kg/m ³	W/(m·°C)	J/(kg·
100	200	0.021	501.6
200	200	0.026	501.6
300	200	0.035	501.6
400	200	0.045	501.6
500	200	0.068	501.6



1.2.3





60 %

[1] , . [J]. , 2016, 45(9): 561-568

[2] ASME B&PVC SECTION III Rules for Construction of Nuclear Facility Components Division 1 - Subsection NH Class 1 Components in Elevated Temperature Service [S]. 2015

[3] , . [M]. 4 . : , 2006



（上接第 46 页）



- 1.1 1.5 MW
- 1.2
- 1.3 2 MW~3 MW
- 1.4
- 1.5 8 MW

[1] . [M], , 2017

[2] Guideline for the Certification of Wind Turbines Edition 2010[Z], Germanischer Lloyd Hamburg, 2010

[3] , . [M], , 2018

大型抽水蓄能完全向心塔形磁极装配质量提升

TV743 TV734 A 1001-9006 2022 03-0064-03

The Assembly Quality Improvement of Large-scale Pumped Storage Centripetal Tower Magnetic Poles

L E A , L E , F L E

(Dongfang Electric Machinery Co., Ltd., 618000, Deyang, Sichuan, China)

Abstract Large-scale pumped storage units have the characteristics of fast speed, high manufacturing accuracy, and complex operating conditions. The magnetic pole adopts a centripetal tower structure to eliminate side tension. The high standards of manufacturing and assembly bring unprecedented challenges to the traditional process. For the problem handling and process control of a large magnetic pole, an effective process plan is proposed to reduce the magnetic pole assembly gap, and the quality is continuously improved and significantly changed.

Key words: large pumped storage unit; centripetal tower pole; assembly clearance; quality improvement

[1]



300 r/min

1~3 T

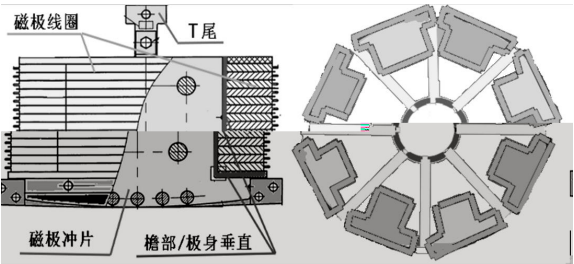
[2]

2021-11-23

1987

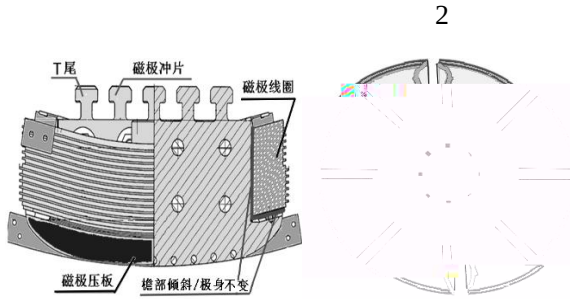
2013

1



1

T

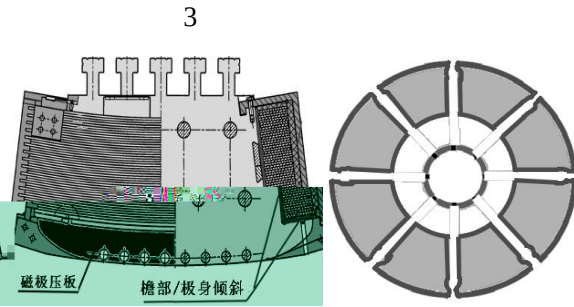


2

2

500 r/min

425 r/min



3

3

2.1

$\leq 1\text{ mm}/300\text{ mm}$

2 mm

4

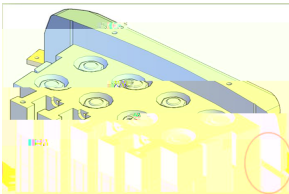


4

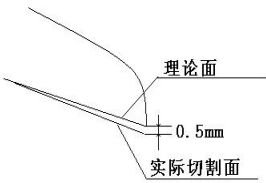
2.2

0.5 mm

5



5

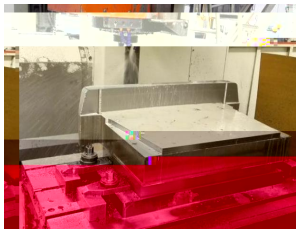


2.3

2.4

1

T



6



7

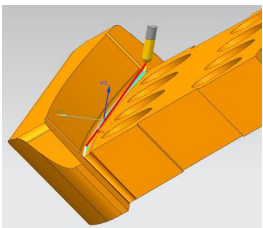
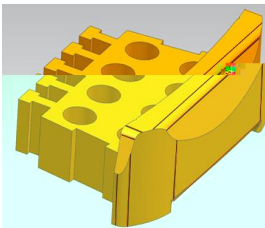


6

80

100

7



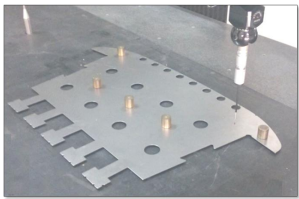
8

2

9

1 mm

300 mm



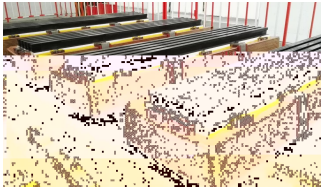
9



3

12
1# 1 mm 40 mm 5#
0.8 mm 70 mm 10
0.5 mm 100 mm
80 %
0.5 mm/100 mm

10



10



(下转第 75 页)

调质钢晶粒度检测方法的研发

Ac₁

4%

Ac₁

Ac₁

TG142

A

1001-9006 2022 03-0067-03

Research and Development of Grain Size Detection Method for Quenched and Tempered Steel

L E F , L E F , F L E H , J G

Dongfang(Guangzhou) Heavy Machinery Co., Ltd., 511455, Guangzhou, China

Abstract: This paper is a detection method developed for quenched and tempered steel, which is difficult to corrode the grain boundaries and difficult to accurately measure the grain size. According to the principle of metallurgy, the actual grain size will not change when the metal material is heated at a temperature lower than the critical point Ac₁; at the same time, heat treatment in a non-protective atmosphere furnace is often accompanied by surface oxidation and decarburization. The actual grain boundaries of quenched and tempered steel can be obtained clearly by the decarburization method, which facilitates the accurate measurement of grain size. The test results show that the real, clear and complete grain boundaries can be obtained by the decarburization method on the surface of the sample, and 4% nitric acid alcohol can corrode. The operation process is simpler, and there is no environmental pollution. This method has been used in the detection, and the effect is good. Experiments show that the grain size of the 20 steel sample after heat treatment at a temperature lower than Ac₁ does not change.

Key words: quenched and tempered steel; grain size; Ac₁; decarbonization

+

()

2022-06-22

1975

1996

[1]



20Cr1Mo1VTiB

Ac₁

14 %

1

2

800 810 [4] 780

70 min 4 %

2Fe₃C+O₂ 6Fe+2CO↑

Fe₃C+2H₂ 3Fe+CH₄↑

Fe₃C+H₂O 3Fe+ CO↑ +H₂↑

Fe₃C+CO₂ 3Fe+2CO↑

GB/T6394

7.5 2

[2]

250 [3]
Ac₁

[2]

Ac₁

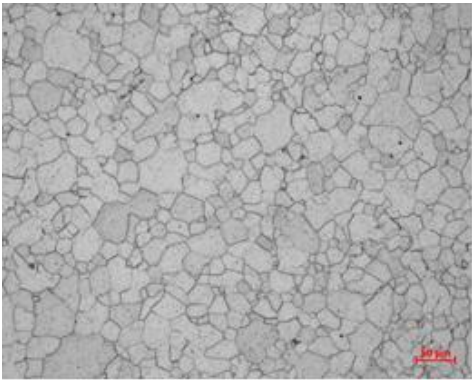


Ac₁ Ac₁
20 70 min

4 %



1 20Cr1Mo1VTiB 200X



2 20Cr1Mo1VTiB + 200X



Ac₁

20

20

20

Ac₁

Ac₁

1

4 %

GB/T6394

9

3

2

715

20

Ac₁

735

[5]

1

4 %

GB/T6394

9

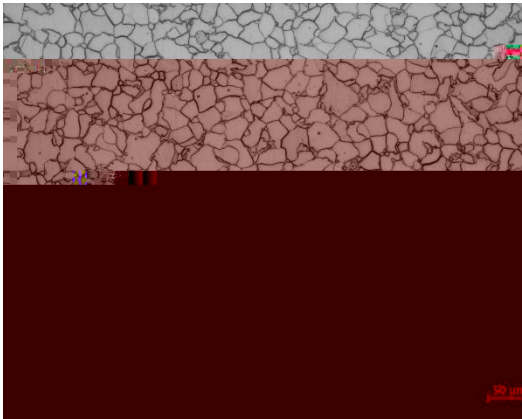
4

20

9

20

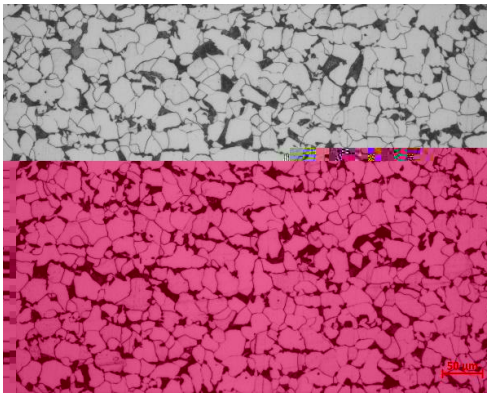
Ac₁



4 20G + + 200X



4 %



3 20G + 200X

202111019122.1

[1] , , [J]. , 2012 27 4 12-16

[2] . 65Mn [J]. 2013 11 8-12

[3] , . [J]. , 2004 6 162-163

[4] . [M].

[5] , . [M]. . 2020

8 17

基于一种实用型的分布式柴光互补电站的应用

75

TM732

A

1001-9006 2022 03-0070-06

One of the Practicable Application on Distributed Hybrid Power Plant

F M

Dongfang Electric International Corporation, 611731, Chengdu, China

Abstract: With China's proposal and commitment to the goal of "carbon neutrality" at the 75th United Nations General Assembly, the relevant renewable industry once again ushered in opportunities for rapid development. Restricting the installed capacity or carrying out system configuration transformation on traditional energy sector has become one of the possible ways to achieve the goal of carbon neutrality. This article provides a successful reference practice with distributed and hybrid solution, which has implemented in one of country of Africa and has been proven cost-effectively for solving the existing traditional energy consumption problems and the electricity accessing in remote areas.

Key words: distributed; engine-solar hybrid; isolated operation mode; investment cost

2025

7.2 GW^[1]

2021-11-17

1985

2012

1

+ + 3

+ 2

2 3

6~7

2

3 CO₂

NO_x

4

5

5 MW

PVSYST

5 3 5.26

9 5.99 5.61

9 MWh

25 2 700

[3] 1 750

kW

2

1/3

6

3 1

1		
	1.0 MW	
1	PV +1.5 MW DG	200~500 kW
	2.0 MW	
2	PV +3.0 MW DG	600~900 kW
	2.0 MW	1 000~1 500
3	PV +3.0 MW DG	kW

5 MW



1

IEC

10 cm

[4]

3.2

“ ”

1

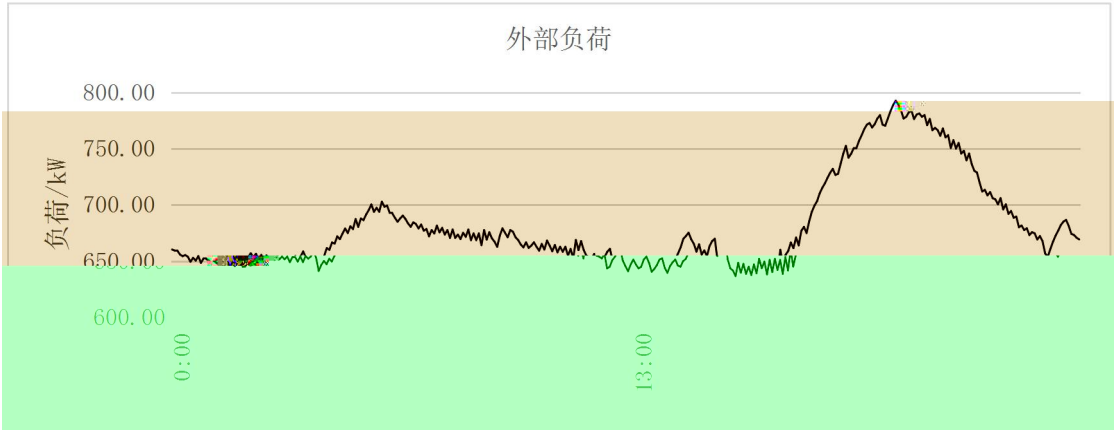
Φ

∅

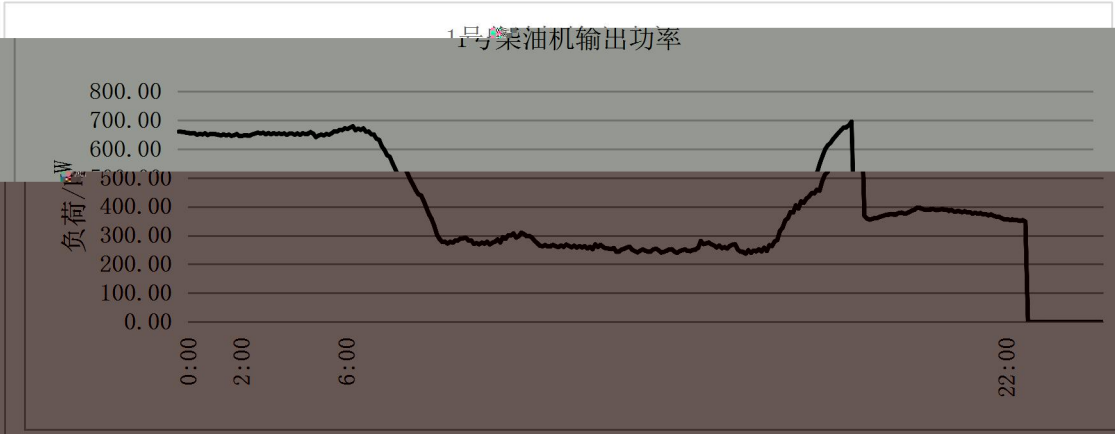


2

4



4



5 (1#)



6 (2#)



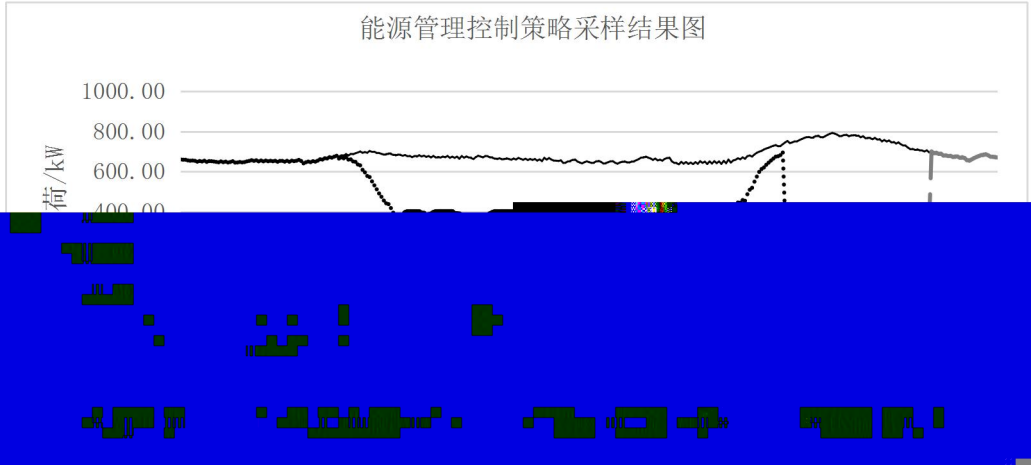
7

5 6 240 kW~700 kW 20 % 7 8 400 kW 3

[6]

4~

[7] 7 8



8.

1

2

5

+

+

3

[1] MINEA WORK GROUP. Atlas And National Strategy for New Renewable Energies [M]. Angola, Republic of Angola Ministry of Energy and Water, ISBN 978-989-97416-5-2

[2] Euclides de Brito. O Setor Elétrico De Angola E Os Desafios Para Aumentar O Acesso À Eletricidade A Um Número Crescente Da População [J]. Universidade Catolica De Angola, Centro De Estudos E Investigacao Cientifica, Relatorio Energia Em Angola, 2018/2019, Capítulo 6. ISBN 9613/2000,112-154

[3] , , . [J]. , 2021, 50(8): 24-29

[4] GB 50797-2012, [S]

[5] . + [J]. , 2021, 35(2):66-69

[6] . 3 [R/OL]. [2021-08-11], <https://baijiahao.baidu.com/s?id=1707793841845017906&wfr=spider&for=pc>.

[7] . [D]. : , 2012

(上接第 66 页)

[1] . [J]. , 1997(4):48-52

[2] , . [J]. , 2020, 6(2):71-73

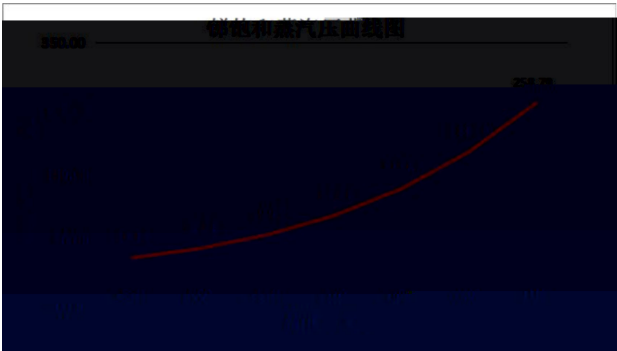
降低高纯锑中 、 杂质含量工艺研究

As
6N
7N
Na Si
Si
1
Na Si
K 1 [3]
K 0.1

1.1

1															
K	As	Sn	Bi	Pb	Cu	Ag	Ni	Ga	Si	In	Fe	Mg	Al	Se	Na
	0.64	0.3	0.2	0.06	0.02	0.01	0.02	0.1	0.1	0.1	0.03	0.03	0.06	0.5	0.1
	0.8	0.59	0.52	0.33	0.13	0.1	0.23	-	-	-	-	-	-	-	-

7N Si 0.08 ppm Na
0.03 ppm
99.999 %
GDMS
7N
1.5 kg
1 Pa 0.2 MPa
1



2			
/		/ppm	
650	Na	-	
	Si	-	
660	Na	0.1	-
	Si	0.008	
670	Na	0.02	-
	Si	0.005	
680	Na	0.03	
	Si	0.005	

12 mm/h
GDMS

		Na		Na
Na	0.005 ppm		0.005 ppm	Na
2.12 g/cm ³	6.697 g/cm ³			
739	130 Pa			
		[1]	. InSb	[D]. :
			, 2020	
		[2]	, , .	
			[J]. , 2020, 49(1): 56-60	
		[3]	. [D]. :	
			, 2004	
7N	Na Si			
		Si	[4]	[C].
0.005 ppm	Na		2008:400-404	
0.1	Na			

~~~~~

|    |    |    |              |      |
|----|----|----|--------------|------|
| 8  | 31 |    | 50 MW        |      |
|    |    |    | +            |      |
| +  |    |    |              | 1.1  |
|    | 3  | 8  |              |      |
|    |    |    |              | 1800 |
| 50 | 16 | 11 |              |      |
|    |    |    | 10 MW/20 MWh |      |

# 中美规范荷载效应组合对比研究

GB 50068-2018

GB50011-2010 2016

ASCE7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures

TU202

A

1001-9006 2022 03-0080-05

## Comparison of Load Combinations Between China and the United States Standard

$J G$   $1,2$ ,  $E M J$   $1,2^*$ ,  $A F L H$   $1,2$

1. Clean Combustion and Flue Gas Purification Key Laboratory of Sichuan Province, 611731, Chengdu, China;

2. Dongfang Boiler Group Co.,Ltd., 643001, ZiGong, Sichuan, China

Abstract: The similarities and differences in load combinations are compared on the Chinese standards GB 50068-2018, "Unified Standard for the Reliability Design of Building Structures" and GB50011-2010, "Seismic design code for buildings" (2016 edition) and the American standard ASCE7-16, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures". This paper presents helpful references for designers to use different specifications for structural design on the load combination.

Key words: Chinese standard; American standard; load combination

“ ”

ASCE7-16 Minimum Design Loads and  
Associated Criteria for Buildings and Other Structures

“ ”

GB 50068-2018  
GB50011-2010(2016 )

GB 50068-2018

“

” GB50011-2010 2016

1

2021-11-23

1991 2013

1982 2005

dbcjszx-jg@dbc.com.cn

1

8.2.8

S

R

1.0

1.1.2

i

1

j

1 j

j

1.1.1

1

2

$$S \leq R_1$$

2

2

$\pm 1.3$   $\pm 1.3$   $\pm 1.5$

$\pm 1.5$

$\pm 1.4$

$\pm 1.4$

1.0  $\pm(\leq 1.0)$

$(\quad)$

$\pm 1.4$

$\pm 1.4$

1. 1.0

2.

1.2  $\frac{S}{C} \leq 3$

C—

3 3

3

= + +

:1.



ASCE7-16

(strength limit state)  
serviceability limit state

C

2.1

|       |                               |                       |      |
|-------|-------------------------------|-----------------------|------|
| 2.2.1 | ASCE7                         | 1.3                   | 1.5  |
|       |                               | 1.4                   | 1.2  |
|       |                               | 1.6                   |      |
| 2.2.2 | C                             | 3                     | 1.0  |
|       |                               | 1.0                   | 1.0  |
|       |                               | 1.2                   | 0.9  |
|       |                               |                       | 1.0  |
|       | 5                             |                       |      |
|       | 5                             | 4                     |      |
|       |                               | 1.2                   | 1.0  |
|       | D+0.5L                        | D+L                   | 1.3  |
|       |                               | D+0.5S                | 1.2  |
|       |                               | D+0.5L+W <sub>a</sub> | 0.9  |
|       | C                             |                       | 0.28 |
|       |                               | 1.0                   |      |
|       |                               | 3.3                   |      |
| 3.1   |                               | 1                     |      |
|       |                               |                       | 1.0  |
|       |                               | 1.0                   | 0.5  |
|       |                               | 2                     |      |
|       | LRFD                          |                       | 1.0  |
| 3.2   |                               |                       | 1.0  |
|       | 1                             | 3.4                   |      |
|       |                               | LRFD                  |      |
|       | 2                             |                       | 6    |
|       |                               | 6                     |      |
|       | 1.3D                          | 1.4D                  |      |
|       | 1.3D+1.5L                     | 1.2D+1.6L             |      |
|       | 1.3D+1.05L+1.5W               | 1.2D+1.0L+1.0W        |      |
|       | 1.2D+0.84L+1.3Eh+0.5Ev +0.28W | 1.2D+L +Ev+Eh         |      |

|    |      |   |
|----|------|---|
| 1. | 1.08 |   |
| 2. |      |   |
| 3. |      |   |
| 4. | 1.2  | 1 |



I S ΓBE V2 \$ 0123 \$ I'0

# 金峰水库大坝坝坡稳定分析研究

89 m

Morgenstern-price

TV642 A 1001-9006 2022 03-0085-04

## Analysis of Dam Slope Stability of Jinfeng Reservoir Dam

J G M 1 A F 2 E 1

(1. Sichuan Water Resources and Hydroelectric Investigation & Design Institute Co., Ltd., 610072, Chengdu, China;  
2.Dongfang Turbine Co., Ltd., 618000, Deyang, Sichuan, China )

Abstract: The dam type of Jinfeng reservoir is a rolled asphalt concrete core rock-debris dam. The maximum height is 89 m, and the full section is filled with soft rock material, which is extremely rare in the existing dam projects. In order to verify the rationality of the parameters selected in the calculation of the dam design, the real and accurate calculation parameters are obtained through several tests. In order to analyse the safety and stability of dam slope under various working conditions, the steady and unsteady seepage fields under different working conditions are obtained by calculations, and then the Morgenstern-price method in limit equilibrium method is used to carry out the stability calculation of dam slope on the basis of the seepage field of the corresponding working conditions. The stability calculation of dam slope with seepage field better reflects the actual state of the dam under various working conditions, and provides an effective technical basic for the construction of the project.

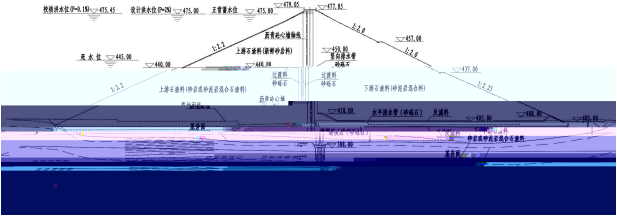
Key words: Jinfeng reservoir; rolled asphalt concrete core rock-debris dam; soft rock material for damming; stability calculation

0.98 89 m  
m<sup>3</sup> 1.5 EL.477 m 455 m 8 m  
km 2  
EL.475.45 m 1  
EL.475.00 m EL.445.00 m

2022-08-17

1976

1999



1

1

EL.475 m 785 32.7 EL.445 m

4

~

[1]



1.1

(AutoBank 7.7)

SL274-2020

Morgenstern-price [2-6]

[5-6]

1

$\tau = c' + \sigma' \tan \phi'$

1

$\tau$   $c'$   $\phi'$   
 $\sigma'$

1.2

4

1

2

3

4

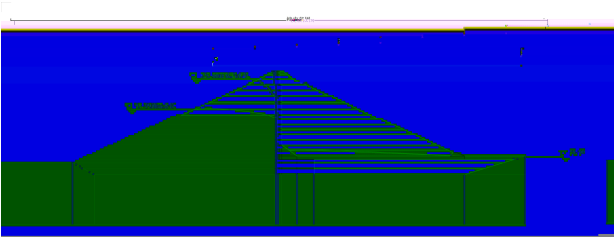
EL.346 m

44 m 0.5

129 m

129.45 m 99 m 59 m

2



2



15 m

1 [1-4]

| 1                    |       |     |                      |                      |            |             |
|----------------------|-------|-----|----------------------|----------------------|------------|-------------|
| (g/cm <sup>3</sup> ) | (%)   | (%) | (g/cm <sup>3</sup> ) | (cm/s)               | C<br>(MPa) | φ<br>(°)    |
| 1.98                 | 26.3  |     | 2.24                 | 5×10 <sup>-5</sup>   | CD         | 0.020 33.0  |
|                      |       |     |                      |                      | CU         | 0.020 31.0  |
| 2.02                 | 24.54 |     | 2.26                 | 5×10 <sup>-5</sup>   | CD         | 0.020 31.0  |
|                      |       |     |                      |                      | CU         | 0.020 30.0  |
| 2.27                 |       | 3.2 | 2.34                 | 1.0×10 <sup>-3</sup> | CD         | 0.030 37.0  |
|                      |       |     |                      |                      | CU         | 0.030 35.0  |
| 2.32                 |       | 3.3 | 2.40                 | 1.0×10 <sup>-2</sup> | CD         | 0.030 36.0  |
|                      |       |     |                      |                      | CU         | 0.030 35.0  |
| 2.40                 |       |     | 2.40                 | 1.0×10 <sup>-8</sup> | CD         | 0.2375 33.4 |



3.1  
3.1.1



1

$\varphi$

C

2

80 m

[1] , .  
[J]. , 2016, 37(1):14-17+39  
[2] [R]. ,  
T2012-001  
[3] [R].  
, YT2015-003  
[4] [R].  
, BT2020-035  
[5] SL 501-2010, [S]  
[6] SL 274-2020, [S]



+

8 25

+

+

2022

18 000 m<sup>2</sup>

10 MW/20

MWh

2

2

+

/



欢 迎 投 稿 ， 欢 迎 订 阅 ！