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1985 – 2012
sangzi@ dongfang. com

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1.3

1 TD6000

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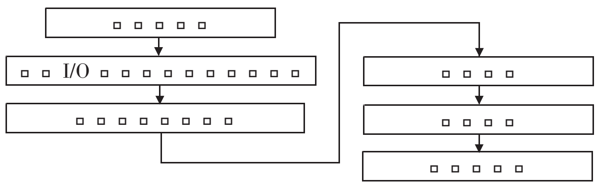

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I/O

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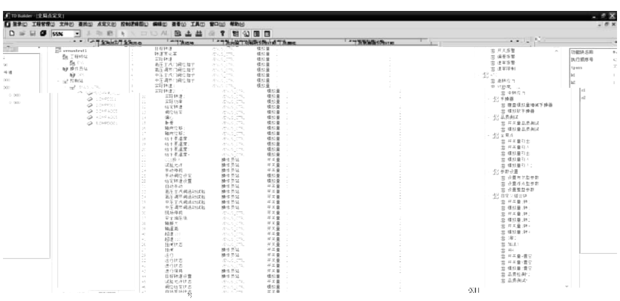

2 TD6000

Ovation Ovation Engineering

Tools Ovation Applications Ovation Utilities

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1 TD6000

TD Builder		
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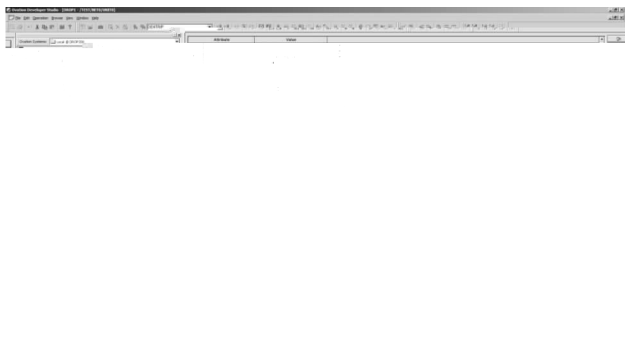
TD User Manager		



3 Ovation

Ovation

Ovation Developer Studio

I/O

OvationControl Builder

Ovation Graphics Builder

Ovation Developer

Studio

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2 Ovation

Ovation Developer Studio		
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Graphics		/
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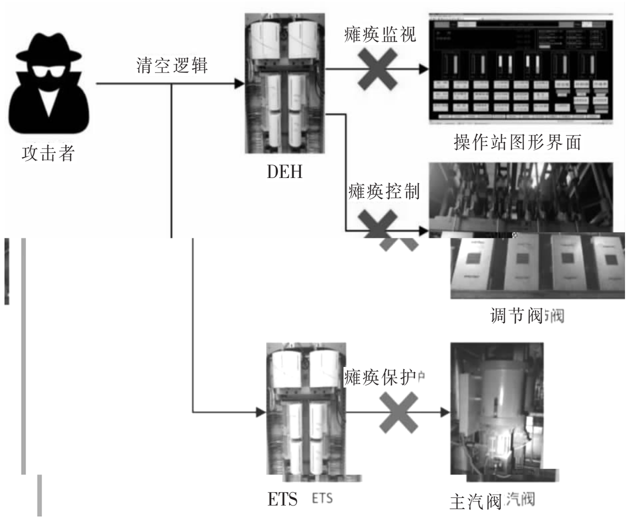

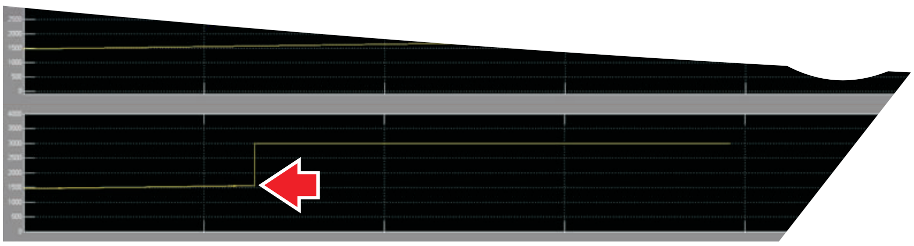

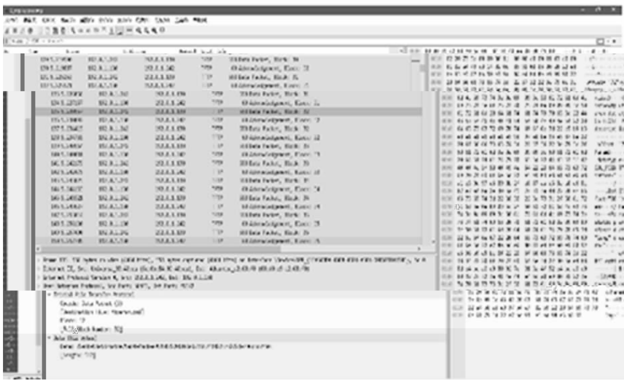

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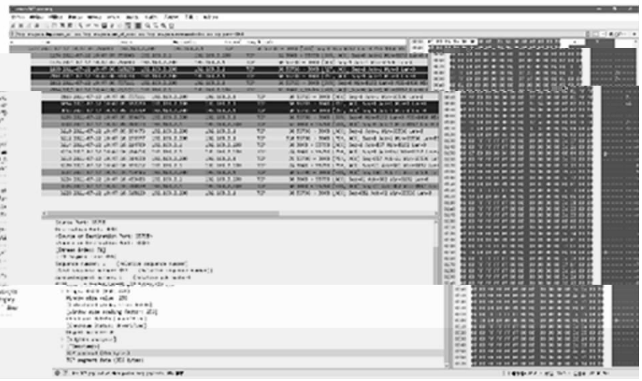

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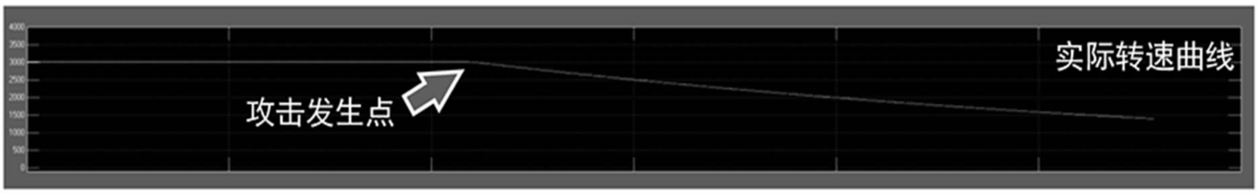

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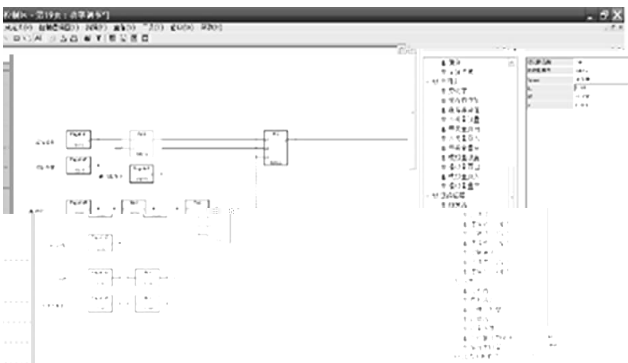

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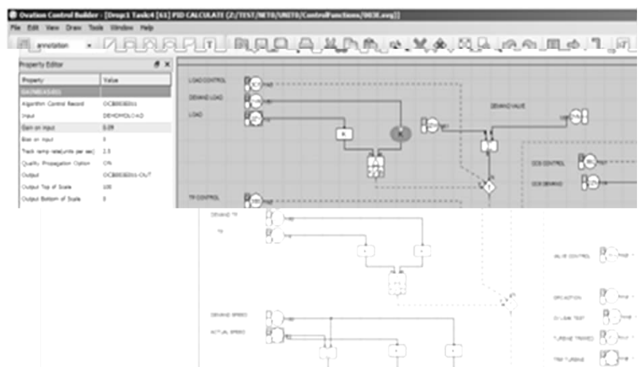

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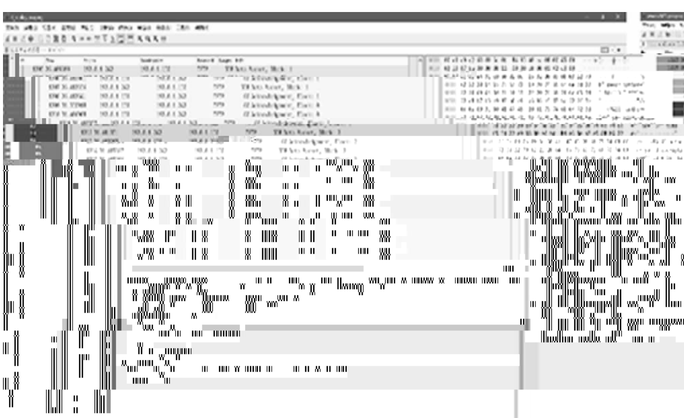

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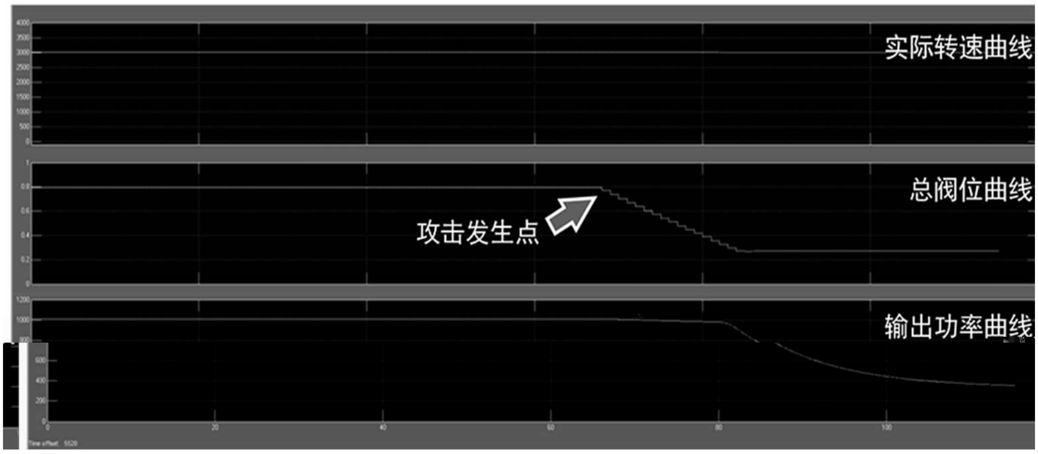

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1. 210094 2. 611731

PLC PLC
PLC

TP393.08 A 1001-9006 2021 03-0009-08

Formal Modeling for Programmable Logic Controller of Industrial Control Systems

MA Haiying[1], *YUAN Xiaoshu*[2*], *SANG Zi*[2*], *HE Lidong*[1]

(1. Nanjing University of Science and Technology, 210094, Nanjing, China;

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

Abstract: In recent years, the security threats of industrial control systems attracte widely attention. Unlike the traditional attacks against communication protocols, attackers gradually shift their focus to the controller itself. In order to deal with this new threat, scholars begin to study the model of the controller to describe and analyze this attack, and then to defend against the attack in time. However, traditional model as differential equation or difference equation is difficult to describe the overall control logic of the system, and it is difficult to analyze the security threats in the industrial control system. In summarizing the corresponding research, this paper briefly introduces the formal methods used to build the model, and the general industrial control system and the structure of the commonly used PLC. A PLC hardware and control logic model established by a formal method is proposed, and various common characteristics in the formal method are expounded through a simple PLC control case.

Key words: industrial control system; PLC; formal method

Industrial control system ICS [1]

ICS [2]

ICS

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PLC ICS

PLC
ICS

ICS

Formal method

Petri
3 4 5 6

① ②

$$x_1 \xrightarrow[1]{u} x'_1 \quad x_2 \xrightarrow[2]{u} x'_2$$

$$u \in U_1 \cap U_2 \quad x_1 \ x_2 \xrightarrow{u} x'_1 \ x'_2$$

$$\text{iff } x_1 \xrightarrow[1]{u} x'_1 \text{ and } x_2 \xrightarrow[2]{u} x'_2 \qquad (7)$$

2 1 U 1

$$x_1 \xrightarrow[1]{u} x'_1$$

$$u \in U_1 \backslash U_2 \quad x_1 \ x_2 \xrightarrow{u} x'_1 \ x_2 \quad \text{iff } x_1 \xrightarrow[1]{u} x'_1 \qquad (8)$$

3 2 U 2

$$x_2 \xrightarrow[2]{u} x'_2$$

$$u \in U_2 \backslash U_1 \quad x_1 \ x_2 \xrightarrow{u} x_1 \ x'_2 \quad \text{iff } x_2 \xrightarrow[1]{u} x'_2 \qquad (9)$$

1.3.3

LTS

LTS

AP

$$Trace\ T \subseteq 2^{AP} \ \omega \qquad (10)$$

P

$$T \models P \text{ if } Trace\ T \subseteq P \qquad (11)$$

$\models$

1.3.4 。

σ

$$P_{safe} \cap \ \sigma' \in \ 2^{AP} \ \omega \ \hat{\sigma} \text{ is a finite prefix of } \sigma' \ = \varnothing \qquad (12)$$

1.3.5

2 PLC

2.1

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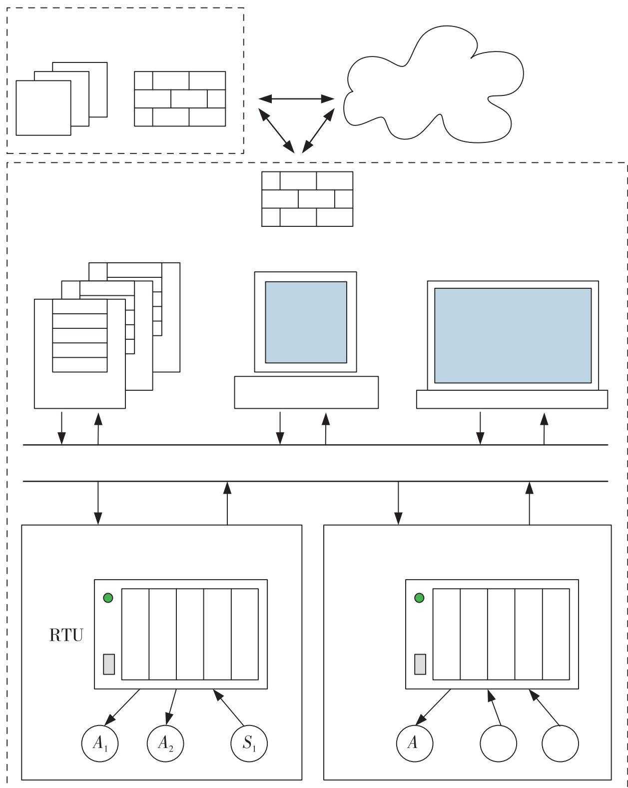

2. 3 PLC

PLC

PLC

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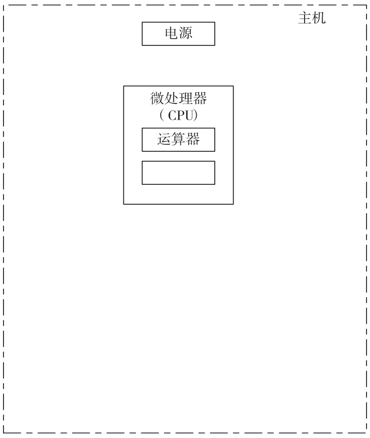

PLC

PLC

PLC

startCyc finCyc

3.1.2 PLC

PLC “

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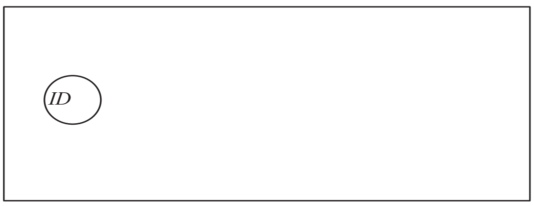

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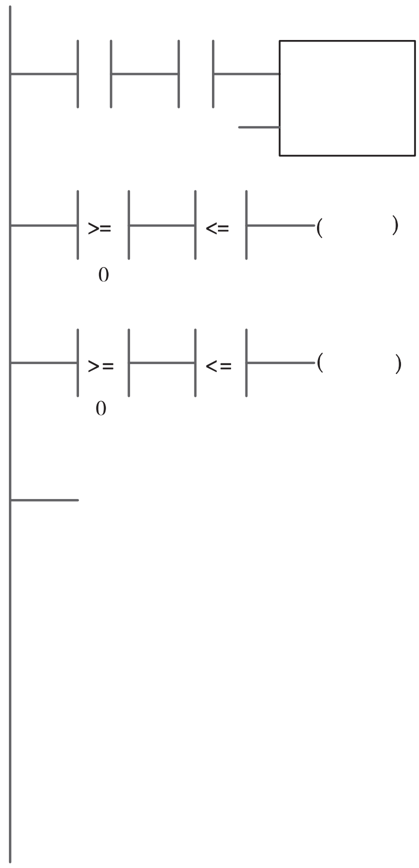

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1. 611731 2. 210094

TM73 TP393.08 A 1001-9006 2021 03-0017-08

Research on False Data Injection Attack of Power Plant Steam Turbine

YUAN Xiaoshu[1*], *ZHANG Yufei*[1], *YANG Bo*[1], *SANG Zi*[1], *XIE Yunyun*[2]

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

2. Nanjing University of Science and Technology, 210094, Nanjing, China)

Abstract: In recent years, with the frequent occurrence of power network security incidents and the development of smart energy technology, power system and its control system are facing more and more network security threats. In the network security attacks of power system, especially power grid, the false data injection attack is considered as a main attack mode. In previous studies, the network security attack is usually considered as a disturbance to the control system. Based on the false data injection attack, this paper analyzes and verifies the network security attack of steam turbine in power plant which is less studied in the past, and erified that the false data injection attack can threaten the safety of steam turbine operation in power plant. An idea is proposed that network security attack is considered as input to control system rather than disturbance.

Key words: false data injection; attack control system; network security; steam turbine

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1973－ 2013

yuanxs@dongfang.com

[2]

CPS

[3] false data injection attacks FDIAs

[4]

[5]

FDIAs [6-8]

[9]

[10]

[10]

FDLAs

FDLAs

FDLAs

FDLAs

1

1.1

DEH ETS

TSI

DEH

OPC

EST DEH

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TSI

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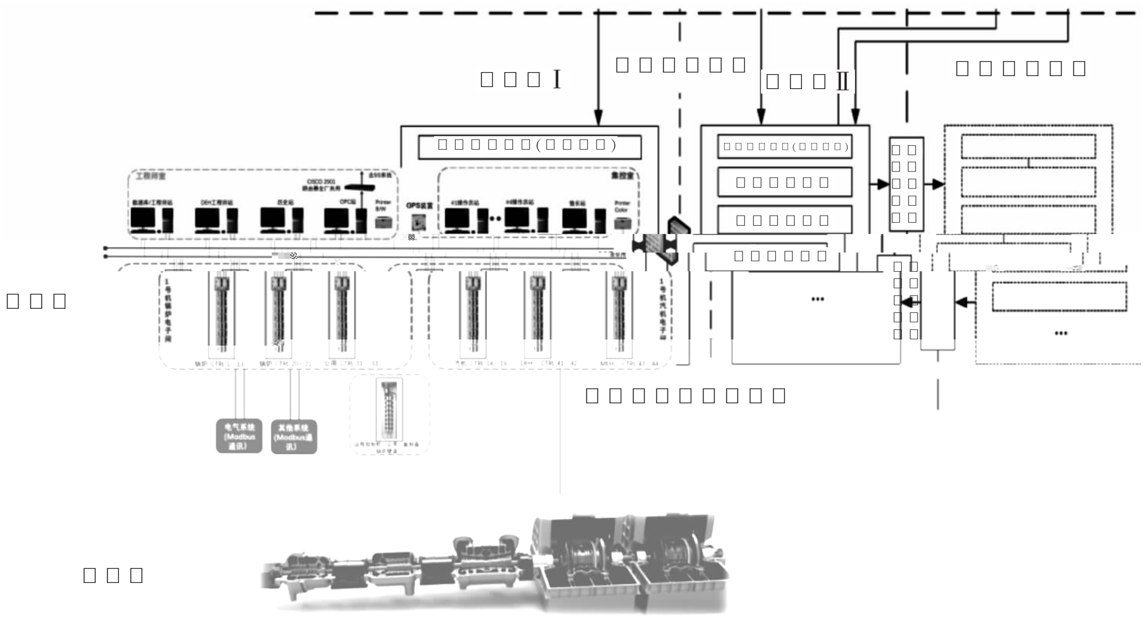

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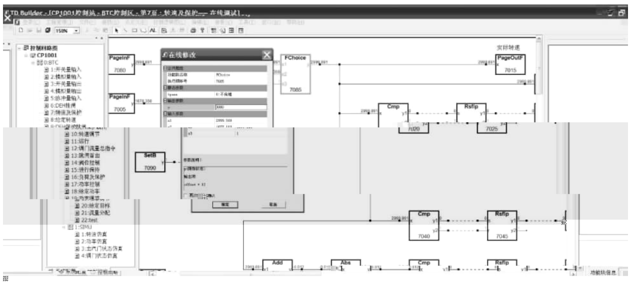

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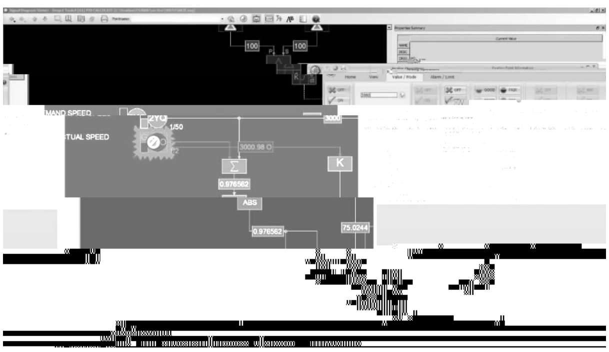

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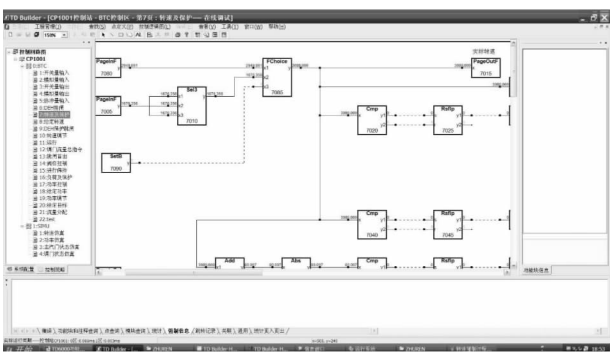
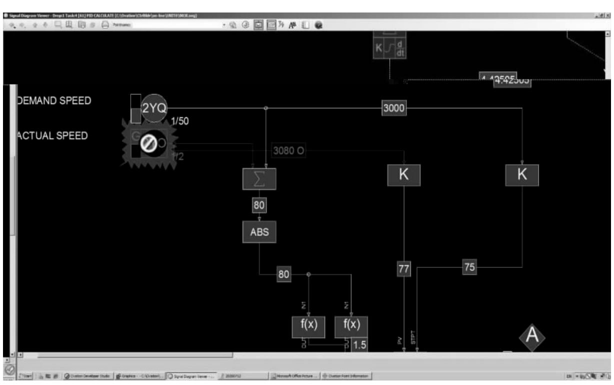


7 TD6000



8 OvationOCR 400

FDIAs

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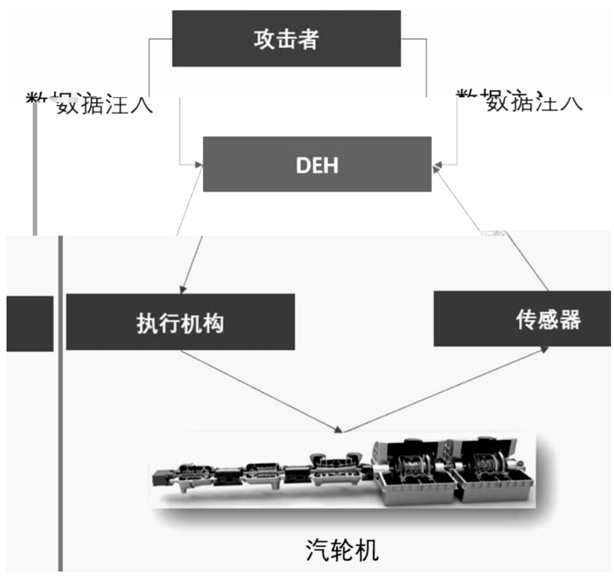
FDIAs 9



9 FDIAs

FDIAs

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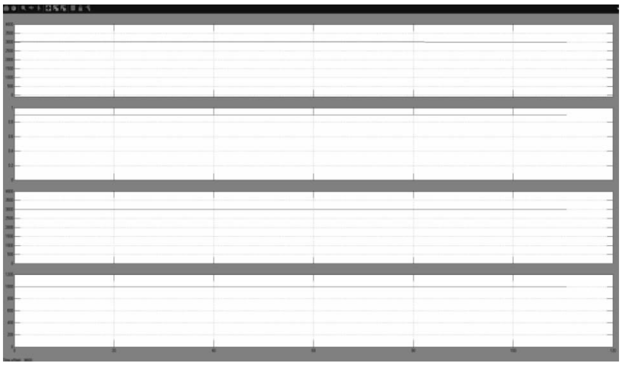


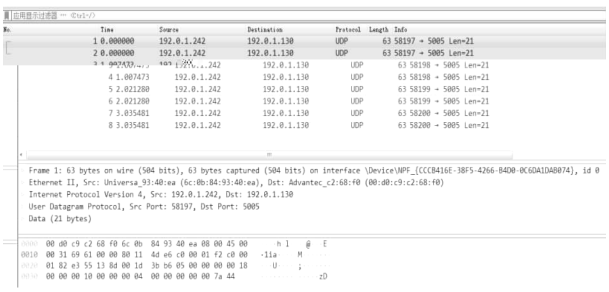
16

3 000

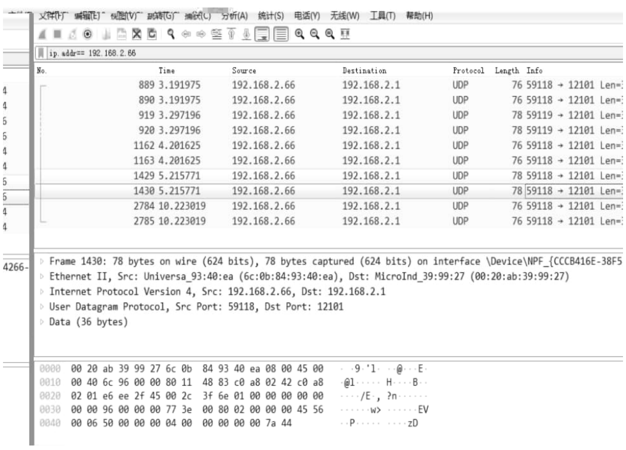
/ 90% 3 000

/ 1 000 MW

1 000 17 18



17 TD6000



18 OvationOCR 400

DEH 1 000 DEH

19 20

0 /

0

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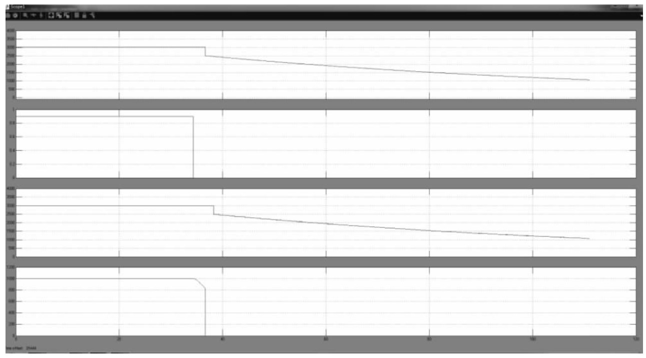
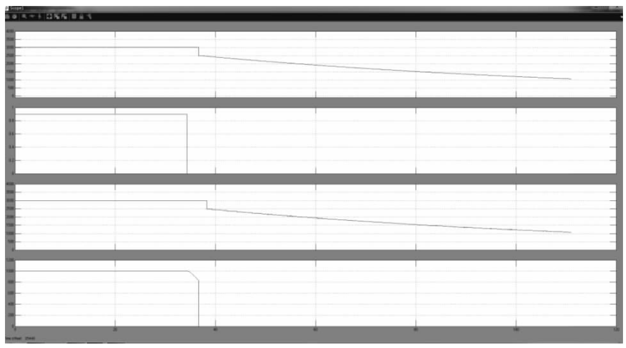


19 TD6000



20 Ovation OCR 400

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FDLAs

FDLAs

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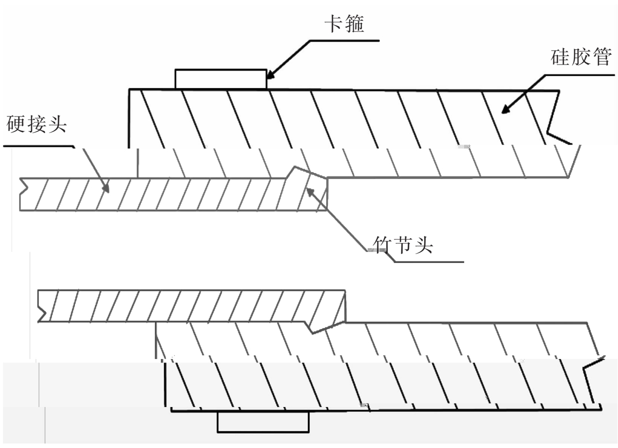

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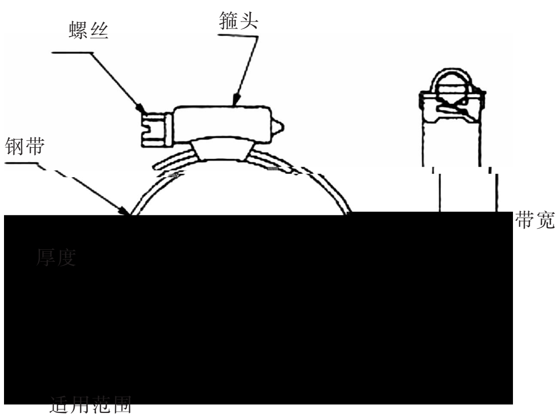

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2

1 [1]

$$U = \sum_{i+j=1}^{N} C_{ij}\left(I_1 - 3\right)^i\left(I_2 - 3\right)^j + \sum_{i=1}^{N}\frac{1}{D_i}\left(J_{el} - 1\right)^{2i} \quad (1)$$

U J_{el} I_1

I_2 C_{ij}

D_i

Mooney-Rivlin

Mooney-Rivlin

1

$N = 1$ 1 2

150%

$$U = C_1\left(I_1 - 3\right) + C_2\left(I_2 - 3\right) \quad (2)$$

C_1 C_2 3

$$E = 6\left(C_1 + C_2\right) \quad (3)$$

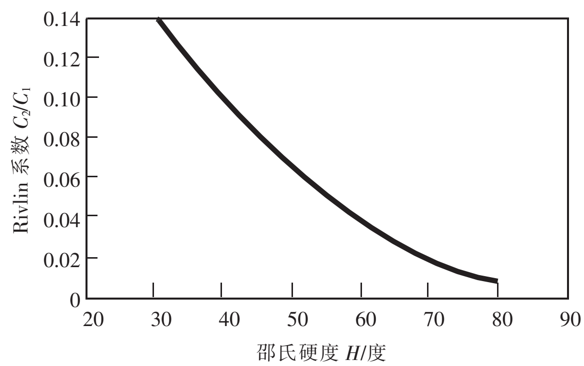
30 ~ 80 E

4 [2]

$$E = 6.72 \times 10^{-3}\sqrt{H^3} \quad (4)$$

H C_2/C_1

3



3 C_2/C_1

79 4 $E = 4.7186$ MPa

3 2 $C_1 = 0.7786$ $C_2 = 0.0078$

3

4

5

6 [3]

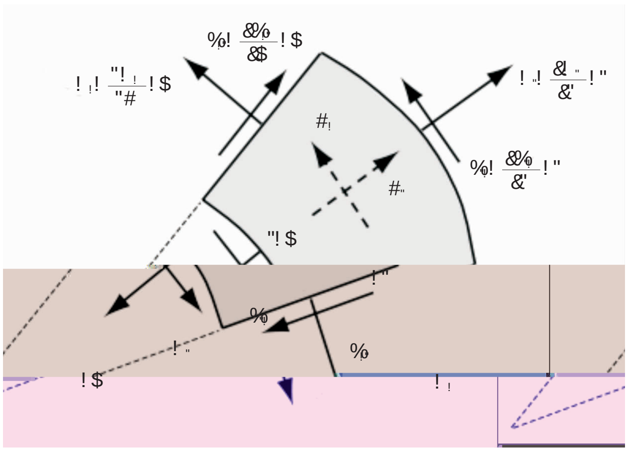
$$\frac{\partial \sigma_r}{\partial r} + \frac{\partial \tau_{r\theta}}{r\partial \theta} + \frac{\sigma_r - \sigma_\theta}{r} + f_r = 0 \quad (5)$$

$$\frac{\partial \tau_{r\theta}}{\partial r} + \frac{\partial \sigma_\theta}{r\partial \theta} + \frac{2\tau_{r\theta}}{r} + f_\theta = 0 \quad (6)$$

σ_r τ_{θ} σ_{θ}

r θ

f_r f_{θ}



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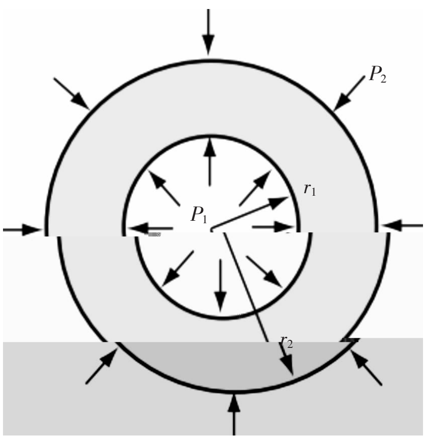
P_1 P_2



5

$r = r_1$ $\sigma_r = -P_1$ $\tau_{r\theta} = 0$

$r = r_2$ $\sigma_r = -P_2$ $\tau_{r\theta} = 0$

7

8

$$\sigma_r = \frac{r_1^2 r_2^2 (P_2 - P_1)}{r_2^2 - r_1^2} \frac{1}{r^2} + \frac{r_1^2 P_1 - r_2^2 P_2}{r_2^2 - r_1^2} \quad (7)$$

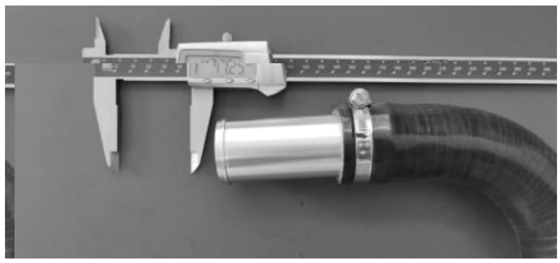
$$\sigma_{\theta} = -\frac{r_1^2 r_2^2 (P_2 - P_1)}{r_2^2 - r_1^2} \frac{1}{r^2} + \frac{r_1^2 P_1 - r_2^2 P_2}{r_2^2 - r_1^2} \quad (8)$$

4

6

7 1.5 ~ 3 N·m

3 N·m



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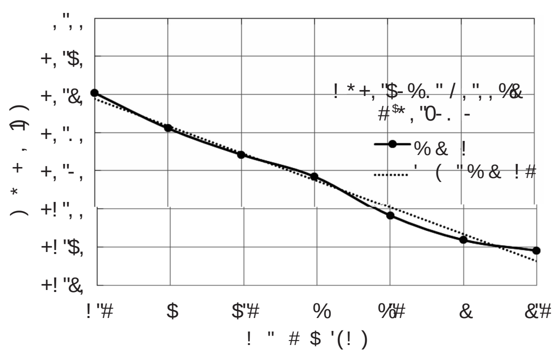

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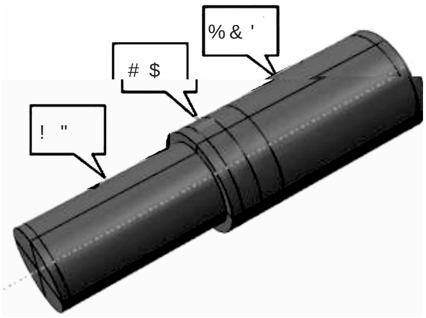

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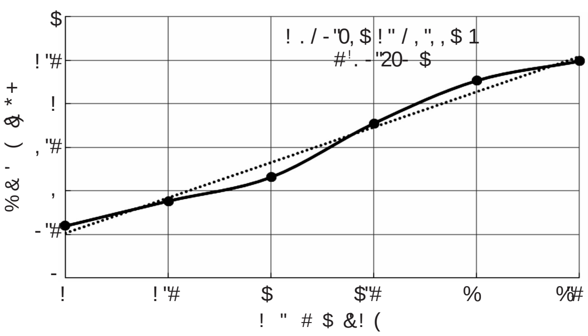
1 –

/N·m	2	2.5	3	3.5	4	4.5
/MPa	0.598	0.884	1.158	1.777	2.267	2.491



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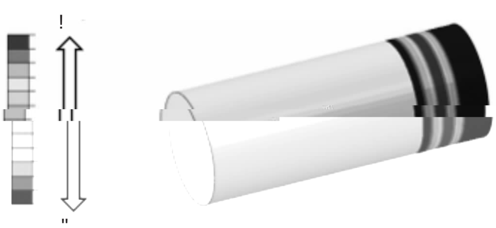

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14

3 N·m 1 min

270 kPa

1.5 40

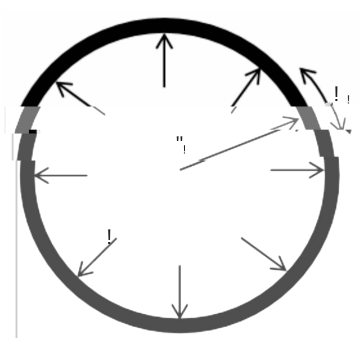
14

7

15

σ_θ P

9 [4]



15

$$\sigma_\theta \approx \frac{P \times r_0}{t} \tag{9}$$

32

PWM

611731

PWM

SVPWM

TM46 A 1001-9006 2021 03-0029-04

DC Capacitance Design of Battery-powered Three-phase PWM Converter

LIU Jingbo, WANG Duoping, TIAN Jun, YANG Jiawei, TANG Jian

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

Abstract: Battery-powered three-phase PWM converter are widely used, but the design of DC capacitor generally relies on experience to estimate or through test, which empirical estimation is biased, and test design efficiency is not high implementation and is not convenient. Based on the principle of topology and modulation, the current situation of DC side is analyzed, the RMS value and average value of DC current are derived. According to the transfer function of the dc side current, a more accurate design method of DC current capacity is proposed, and the proposed design method is verified by simulation.

Key words: DC capacity; converter; SVPWM; battery

PWM i_{dc}

1

1

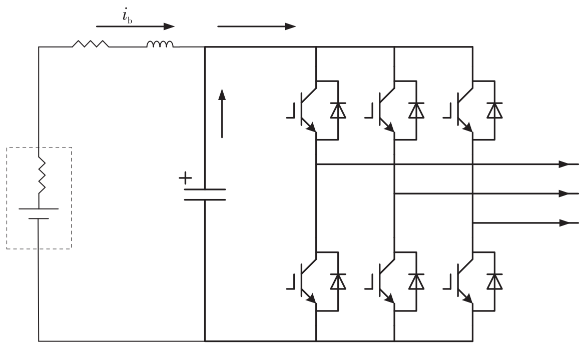
1 PWM

i_{dc}

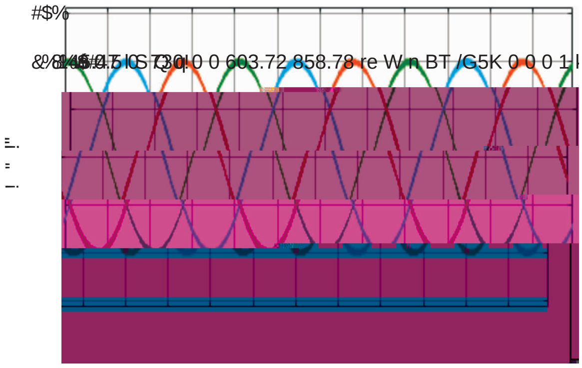
2021-04-02

2020YFG0350

1984- 2011


i_b
+

$I_m = 100$ A 1 7



1

2021－01－20

1988－ 2013

1

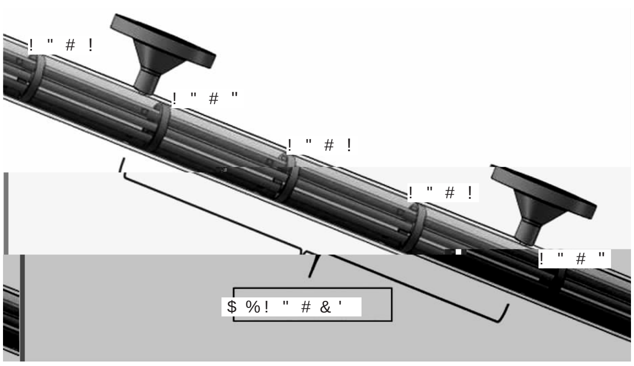
7

3

CFD

1

3



1

CFD

CFD 1

CFD

D_r m N_r

S_t m P_t

m D_w m H

m

3 Cheng-Todreas

Cheng Todreas

[6] 5 ~ 10

$Re \leqslant Re_L$

$$f = \frac{C_{fL}}{Re} \tag{5}$$

$Re \geqslant Re_T$

$$f = \frac{C_{fT}}{Re^{0.18}} \tag{6}$$

$Re_L \leqslant Re \leqslant Re_T$

$$f = \frac{C_{fL}}{Re}(1-\psi)^{1/3} + \frac{C_{fT}}{Re^{0.18}}\psi^{1/3} \tag{7}$$

$$\log\left(\frac{Re_L}{300}\right) = 1.7\left(\frac{P_t}{D_r} - 1.0\right) \tag{8}$$

$$\log\left(\frac{Re_T}{10000}\right) = 0.7\left(\frac{P_t}{D_r} - 1.0\right) \tag{9}$$

$$\psi = \frac{\log(Re) - (1.7(P_t/D_r) + 0.78)}{2.52 - (P_t/D_r)} \tag{10}$$

ψ C_{fL} C_{fT} 6

4

4 Soblev

Soblev 7

11

$$f = \left[1 + 600\left(\frac{D_r}{H}\right)^2\left(\frac{P_t}{D_r} - 1\right)\right] \times \left\{\frac{0.210}{Re^{0.25}}\left[1 + \left(\frac{P_t}{D_r} - 1\right)^{0.32}\right]\right\} \tag{11}$$

2

12

$$\Delta p_j = \zeta \frac{\rho V^2}{2} \tag{12}$$

ζ

1

13 ~ 14

$$\zeta = 0.5\left(1 - \frac{S_2}{S_1}\right) \tag{13}$$

$$\zeta = \left(\frac{S_1}{S_2} - 1\right)^2 \tag{14}$$

S_1 m^2 S_2

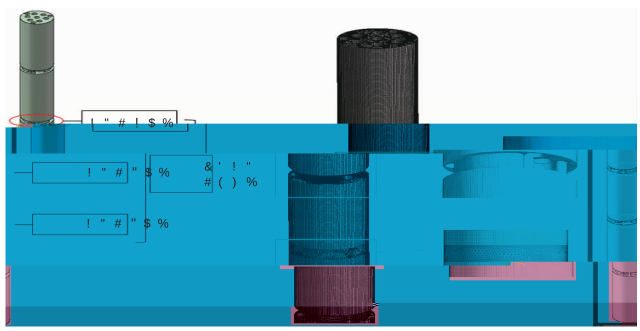
m^2

2.2 CFD

1

CFD 2

3



2 CFD 3

2

CFD

CFD

CFD

15 ~ 16

$$\nabla \cdot (\rho \vec{V}) = 0 \tag{15}$$

$$\nabla \cdot (\rho \vec{V}\vec{V}) = \nabla \cdot (\mu \nabla \vec{V}) - \nabla p + \rho g + S_p \tag{16}$$

CFD SST

[8] k-ω

k-ω SST

k-ω

k-ε

k ω

17 ~ 18

$$\frac{\partial \rho k}{\partial t} + \nabla \cdot (\rho \vec{V} k) = p_k - \beta^* \rho \omega k + \nabla \cdot \left[\left(\mu + \frac{\mu_t}{\sigma_k} \right) \nabla k \right] \quad (17)$$

$$\frac{\partial \rho \omega}{\partial t} + \nabla \cdot (\rho \vec{V} \omega) = a \frac{\omega}{k} p_w - \beta \rho \omega^2 + \nabla \cdot \left[\left(\mu + \frac{\mu_t}{\sigma_\omega} \right) \nabla \omega \right] \quad (18)$$

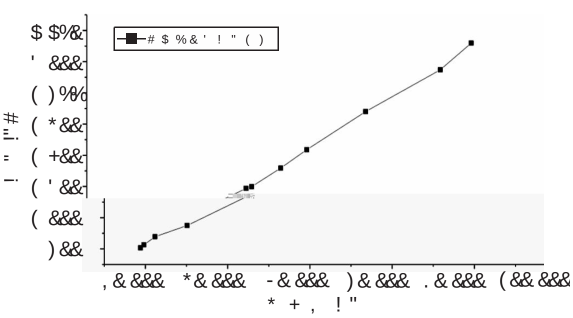
ρ $\vec{V}$ p μ

3

CFD

3.1

4



4

$$\Delta p = 4.09151 \times 10^{-5} \times Re^{1.55363} \quad (19)$$

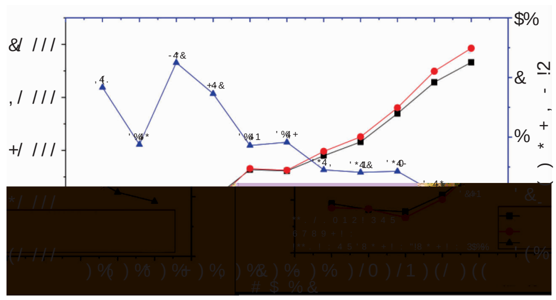
22

22

200 ℃

22

5



5

22

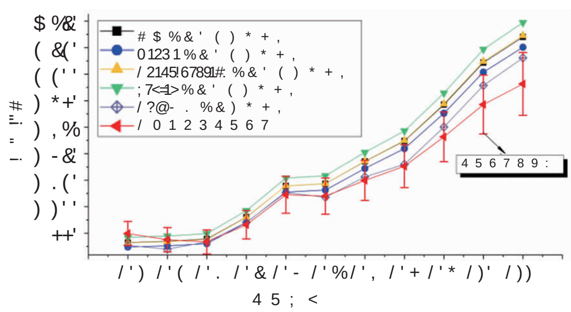
22

±6.5%

CFD

6

CFD



6

CFD CFD

CFD

CFD

6 CFD 7 $X=0$ $Z=0$ $X=-Z$

$X=Z$

Rehme 8

CFD

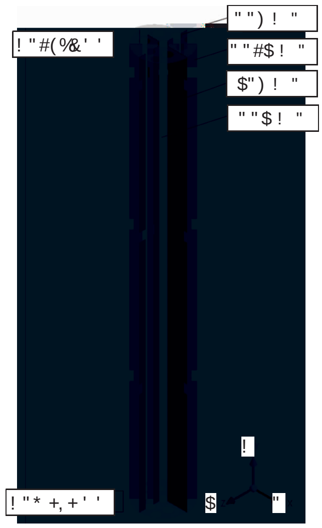
6

280 ℃

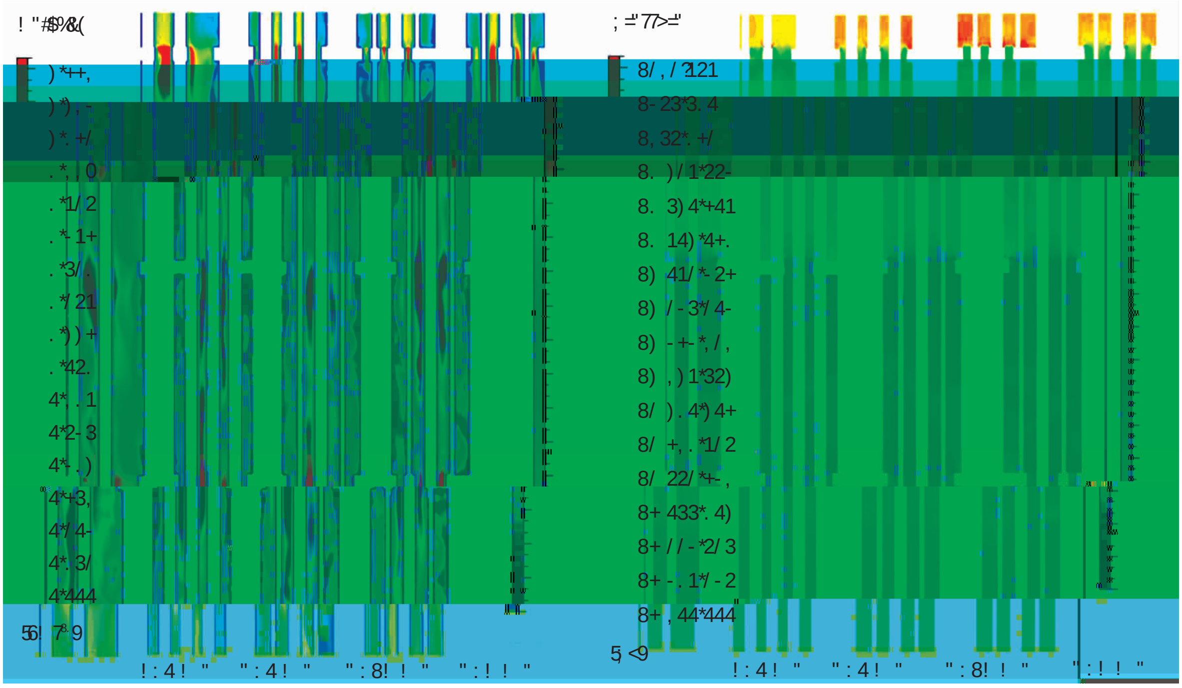
340 ℃

3.2

CFD



7 CFD



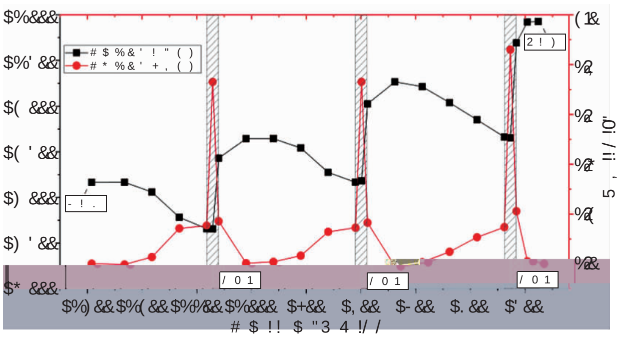
8 CFD

$-Y$

“ ”

7

9



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TK47 A 1001-9006 2021 03-0039-04

A Brief Analysis of l a a

2021 －07 －09

1982 － 2008

3 –4

1. 1

1. 2

1. 3

1. 4

GE

3

4

2

2. 1

2. 1. 1

2. 1. 2

2. 1. 3

3

A 2 3

1. 5 2

2. 2. 2

2. 2

2. 2. 1

3

1

2

100

1

2

618000

TG306 A 1001-9006 2021 03-0043-05

Study on the Cold-bending Forming Process of Copper Lead

YANG Zongming, YANG Jun, YIN Xiang
(Dongfang Electric Machinery Co., Ltd., 61800

2021－07－09

1976－ 2001 2015

5 mm 0.1 mm
$R8$ $R5$
$R8$ $R5$

ASME PT

1 $R8$ $R5$ 7

a $R8$ b $R5$

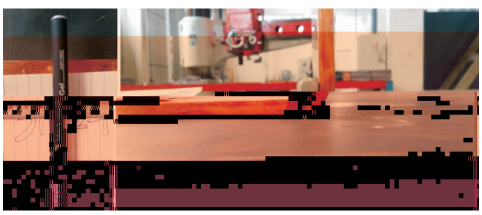
7

2 8

a $R8$ b $R5$

8

3 9



9

4 PT 10
ASME

10 R PT

R

PT

5

1

2 3 R_{min}

3 6

4

5

6

3

		/mm	/mm	/mm	≤0.2	≤0.4
1	CU-ETP-R300	5X100	20			
2	TU2Y	6X95	20			
3	ASTMB187	5X71	15			
4	SECUF25	8X105	15			
5	SECUF25	8X105	50			

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TM621 A 1001-9006 2021 03-0048-02

The Selection Calculation Method of Start-up Expansion Tank

LONG Qiong, YI Guangzhou, DENG ke

(Dongfang Boiler Group Co., Ltd., 611731, Chengdu, China)

Abstract: The selection calculation method of start-up expansion tank is closely related to the economic input cost in power plant. This article takes a certain project as a calculation model, and a suitable selection calculation method is obtained by comparing several selection calculation methods.

Key words: start-up expansion tank; the selection calculation method

600 MW

1

1.1 D

1 X

$$X = \frac{H - H'}{H'' - H'} \quad (1)$$

H kJ/kg H' kJ/kg H'' kJ/kg

2 W_s

$$W_s = WXa \quad (2)$$

W_s t/h W t/h a 1.03

3 A_{sd}

$$A_{sd} = \frac{W_s \times V_1}{3.6 \times \upsilon} \quad (3)$$

A_{sd} m^2 V_1 m^3 v m/s

4 D

$$D = \sqrt{\frac{4W_s \times V_1}{3.6\pi \upsilon}} \quad (4)$$

D mm

2021 - 07 - 09

1982 - 2007

1

< a >

8 /s 2.44 m/s 4 /s

1.22 m/s

< b > HG/T 20570.8-1995 –

$$u \leqslant V_t = \left[\frac{4g \times d \times (\rho_l - \rho_g)}{3C_W \rho_g}\right]^{0.5} \quad Re = \frac{d \times V_t' \times \rho_g}{\mu_g} \tag{5}$$

ρ_l kg/m³ ρ_g kg/m³ V_t m/s d μm μ_g Pa·s g 9.81 m/s² C_w Re

d 200 μm 350 μm

V'_t 10 m/s $Re \approx 1135$ C_w

5 $V_t \approx 0.74$ m/s $V_t' - V_t = 9.26$

$V_t \approx V_t'$ C_w Re

Re $C_w \approx 1$ $Re \approx 138.5$ $V_t \approx$ 0.49 m/s $V_t' - V_t = 0.73$ m/s < b >

< a >

1.22 m/s 1.22 m/s

2

10 MPa a

7 MPa a 250 ~ 311 ℃ 634 t/h 1.8 ± 0.2 MPa a ≤ 207 ℃ 1

1

	υ m/s	D mm
1	10	835
2	2.44	1 695
3	1.22	2 390

1.2

800 ~ 1 000 m³/ h·m³ [4] 2 000 ~ 3 000 m³/ h·m³ [4]

V_1

$$V_1 = \frac{1\ 000\ Ws}{R} \times v_1 \tag{6}$$

R m³/ h·m³ v_1 m³/kg

V_2

3 ~ 5

[4] 30%

$V = V_1 + V_2$

30%

2

2

	R m³/ h·m³	V_1 m³	V m³
1	800	24.6	32
2	1 000	19.7	25.6
3	2 000	9.86	12.8
4	3 000	6.58	8.55

2

HG/T 20570.8-1995 –

1.22 m/s

2 390 mm

10 m/s 835 mm

2.44 m/s

DN2100

1.58 m/s

0.99

800 m³/ h·m³

24.6 m³ 32 m³ V

D 9.24 m

62

VPI

618000

VPI ANSYS

VPI

TM31 A 1001-9006 2021 03-0050-04

The Study on the Influence of VPI Mock on Dielectric Loss of Stator Coil for AC Rotating Machine

YANG Shuai, HUANG Ze, ZHOU Jin, CHEN Sheng, ZUO Rui, HU Bo

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

Abstract: Through the structure analysis of stator coil and its mocks for vacuum press impregnation (VPI) of AC rotating machine, relative circuit model is established in this paper. The relationship including average thickness of varnish on the surface of conductive layer of coil, the length of neighborhood contact points between varnish and conductive layer, surface potential on the slot part of coil are simulated by ANSYS software. On the basis of results, the influence of surface potential on the slot part of coil on the measured value of dielectric loss of stator coil are analyzed. The results show that the measured value of dielectric loss of stator coil is affected by average thickness of varnish on the surface of conductive layer, the length of neighborhood contact points between varnish and conductive layer, the thickness of main insulation, dielectric constant of main insulation and so on.

Key words: AC rotating machine; VPI mock; stator coil; dielectric loss

[1-3]

GVPI

GVPI

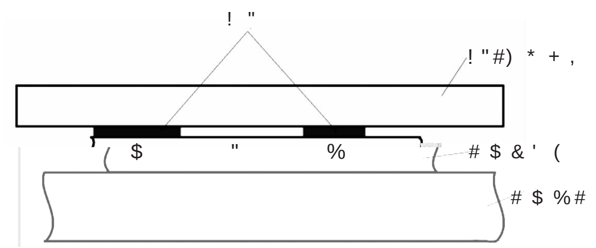
2021-07-09

1988- 2015

VPI

JB/T 50133 JB/T 56085

4



4

VPI

VPI

M N

6

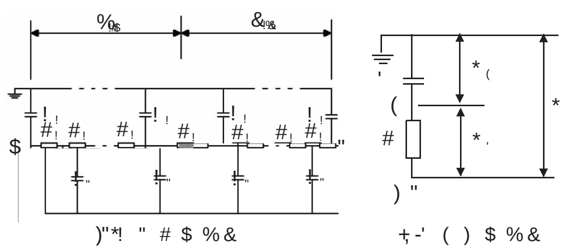
4 5 a

R_i

C_a C_a R_i

5 a

5 b



5 MN

C_i C_a

R_i C

MP NP R MP

NP

MN

P

P

1

$$|\vec{U}_p| = \frac{1}{\sqrt{1+(\omega CR)^2}}|\vec{U}| = \frac{1}{\sqrt{1+\left(\frac{\omega\varepsilon_0\varepsilon_r\rho_s L_i^2}{4d}\right)^2}}|\vec{U}| \quad (1)$$

d ε_r

ρ_s L_i

1.414 kV 0.1 mm ~ 1.0 mm

VPI

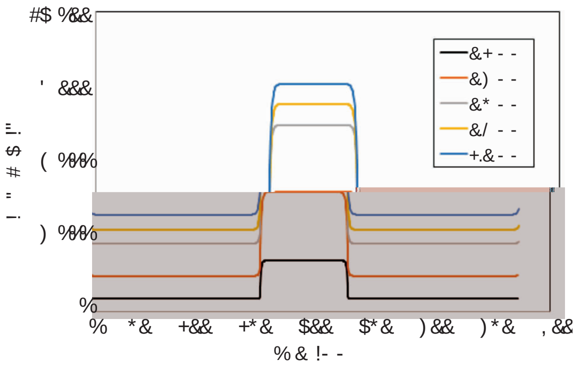
25 mm ~ 125 mm

3.2.1

VPI

75 mm 0.1 mm 1.0 mm

8



8

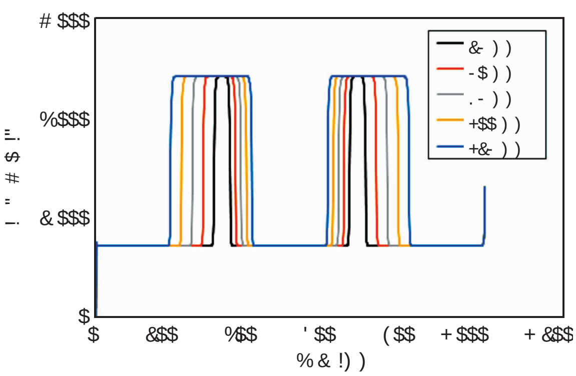
VPI

3.2.2

0.3 mm VPI

25 mm 125 mm

9



9

VPI

VPI

4

4.1 A

2 1 VPI

4.2 B

2 2

1

7-8

4.3 C

2 3

9

4.4 D

2 4

tan δ~ U

–

10

5

1 VPI

2

3 VPI

VPI

4 4 tan δ~ U

88

611731

PROE
ANSYS

TM621 TK124 A 1001-9006 2021 03-0054-04

Discussion of the Three-dimensional Design and Numerical Simulation for Rotary Air Preheater Heating Elements

HUANG Xuefei, WANG Xiaozhen

(Dongfang Boiler Group Co., Ltd., 611731, Chengdu, China)

Abstract: The paper discusses the three-dimensional design methods of corrugated heating elements of rotary air preheater by PROE software, for the purpose of the retrofits corrugated heating elements design. The three-dimensional models is used to the numerical simulation analysis by ANSYS software to evaluate the heat transfer coefficient and the fanning friction coefficient. It is also used to the structural optimize and the performance research of corrugated heating elements. The paper demonstrates the simulation analysis for not closed profiles, the calculation accuracy is approximate to the actual value.

Key words: rotary air preheater; corrugated heating elements; three-dimensional design; numerical simulation

[1]

/

/ /

[2-5]

/ α_h / α_u

/ β_h / β_u mm

2021-07-09

1972- 1995

SHS m^2/m^3 *SD* kg/m^3
DE mm σ

1 PROE

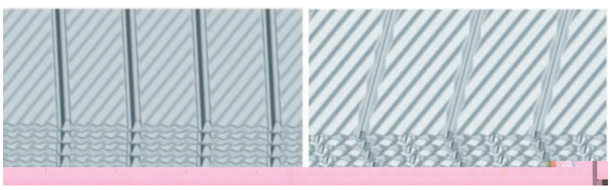
PROE
/

"FRONT " " " "RIGHT "
" " / " "

" "
" "
" "

" "
" "
" "
" " "
"

1



1

2

D01

Pitch 70 mm 56 mm 42 mm
D01

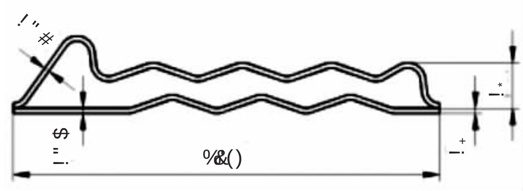
361.6 369.6 381.7 m^2/m^3 D01
360.1 m^2/m^3
2 3

1 200 mm DH + 1 200 mm
D01

k- ε

1
400 mm

inlet
outlet wall

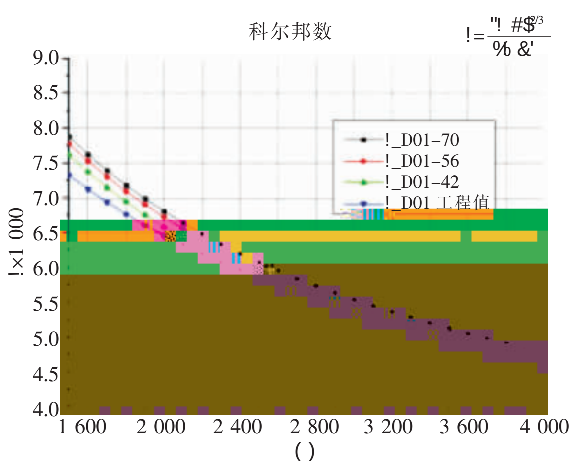


2 D01

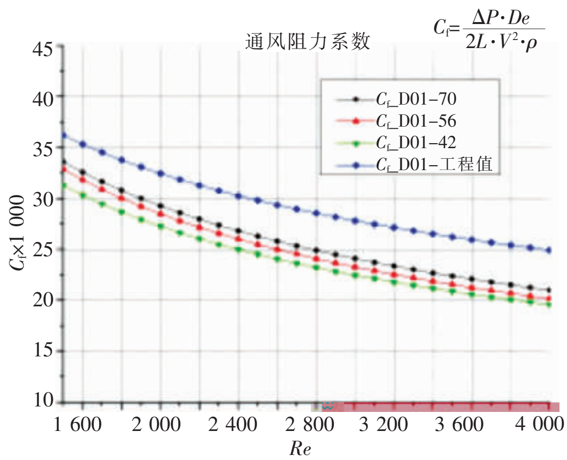
3

J

4 5



4 *J*



5 C_f

outlet 6

7

outlet

1 200 mmDH + 1 200 mmD01

θ 50°

55° 60° 65° 70° J C_f 10 11

1 000 ~ 4 000 J

θ θ J

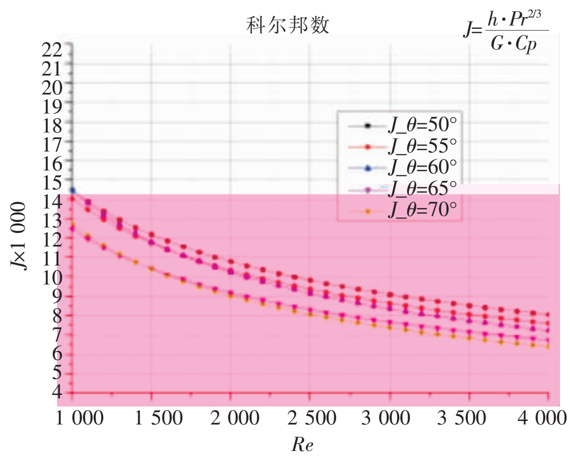
1 000 ~ 4 000 θ 50° 60°

C_f θ θ= 65° C_f

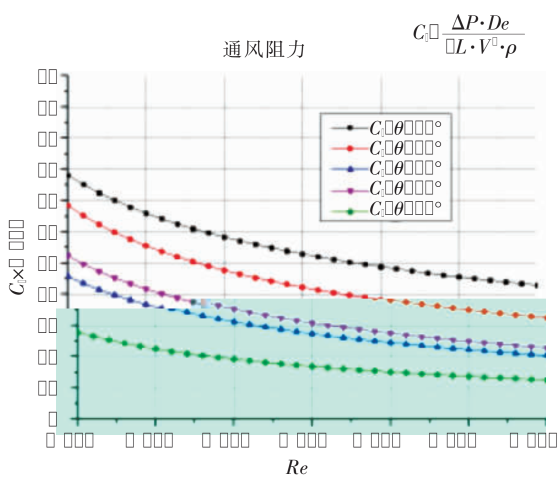
θ= 60° θ= 70°

50° ~ 65° 60° θ

θ



10 J



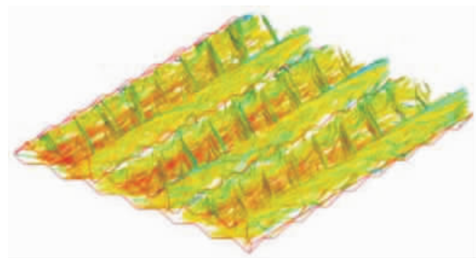
11 C_f

outlet 12

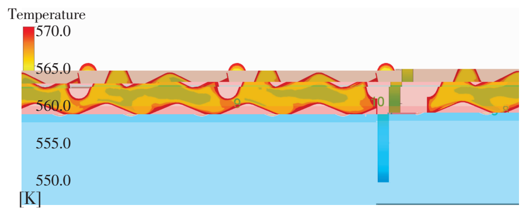
13

outlet

1 mm



12



13 outlet

4

ANSYS

1 . J . 2000 10 10 – 12

2 Muley A Manglik R. Experimental study of turbulent flow heat transfer and pressure drop in a plate heat exchanger with chevron plates J . Journal of Heat Transfer 1999 121 1 110 – 117

3 . 2

4 . J . 2007 1 18 – 23

5 . J . 2016 2 8 – 14

2021 －06 －15

1980 － 2003 ／

700 MW CFB M

1

1.1

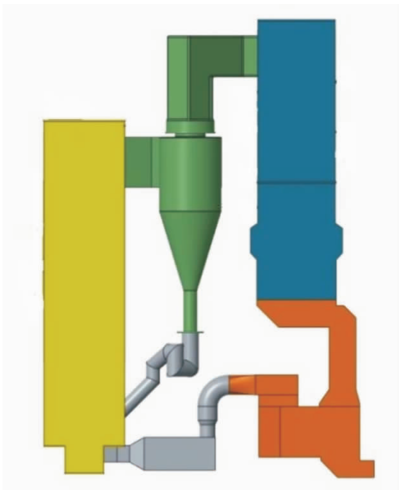
45% ~47% 6% ~7% 3% ~4% 1 700 MW CFB 600 MW CFB

1 700 MW CFB

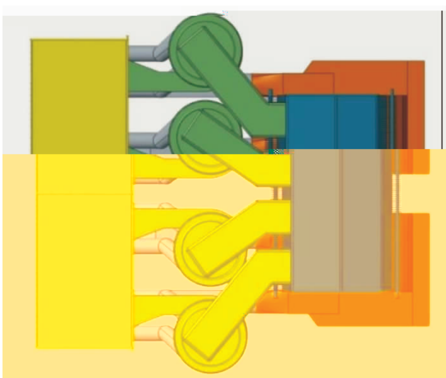
		700 MW CFB	600 MW CFB
	t/h	2 025	1 900
	MPa g	29.3	25.4
	℃	605	571
	MPa g	6.12	4.73
	℃	367	347

P

1 2



1 700 MW CFB



2 700 MW CFB

4

2

2. 1

5

350 MW ~ 660 MW CFB 700 MW
PC

1

2
700 MW CFB

2.3

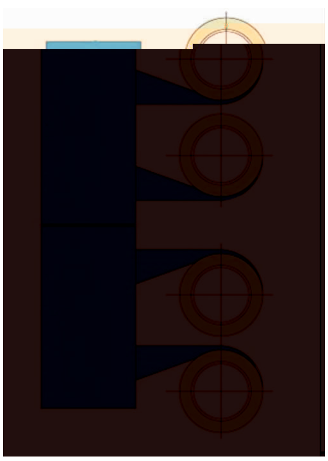
350 MW CFB

600 MW

350 MW CFB

30 m 40 m

[6]



3

1

2

CFB

3

4

3

4

300 MW

CFB 4

2

4

2

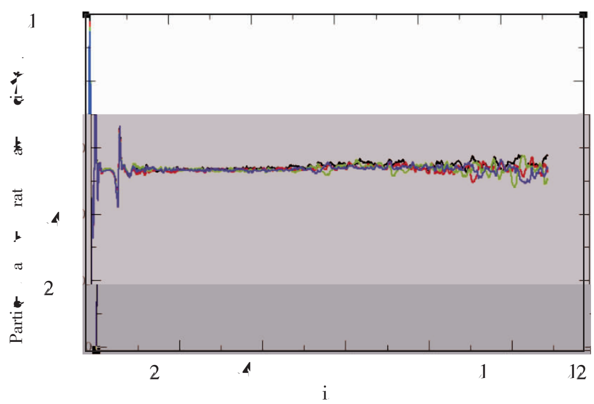
2

4

barracuda

4

10% 4



4

3

350 MW ~ 660 MW

CFB 700 MW PC

700 MW

M

4

CFB

1 .
J . 2016 49 12 1
2 .
CFB C
2013 2013 10
3 . 1 000
J . 2015 29
4 .
2003
5 .
J . 20

618000

TM311 A 1001-9006 2021 03-0063-03

Design of Jacking Oil for Heavy-duty Sliding Bearing

HE Jiangnan, YANG Ling, CHEN Honglian, CHEN Dan, MA Jun

(Dongfang Turbine Co., Ltd., 618000, Deyang, Sichuan, China)

Abstract: The structure features of circumferentially arranged multi-jacketed oil facility are introduced and the lifting oil pressure distribution of a heavy-duty sliding bearing adopted the structure is calculated, as well as the variation of lifting oil pressure and flow rate with the circumferential oil inlet angle under a certain load are analyzed. After comparing with the actual engineering, the results show that the lifting performance of the circumferentially arranged multi-jacketed oil facility is good, the calculation results provides reference for the relevant engineering design.

Key words: heavy-duty; circumferential arrangement; multi-jacketed oil; pressure

1

2

A B

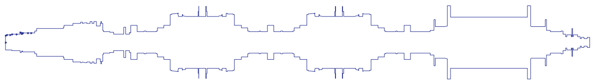
1

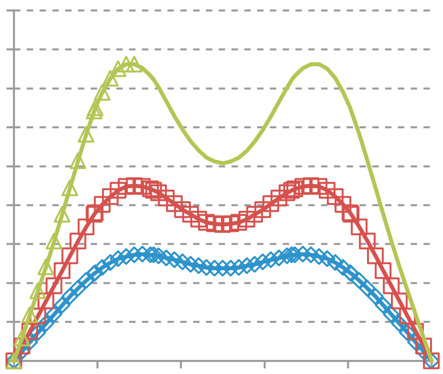
2021 - 07 - 09

1981 - 2007

4.5%

2 4 2





618000

TK263 A 1001-9006 2021 03-0066-04

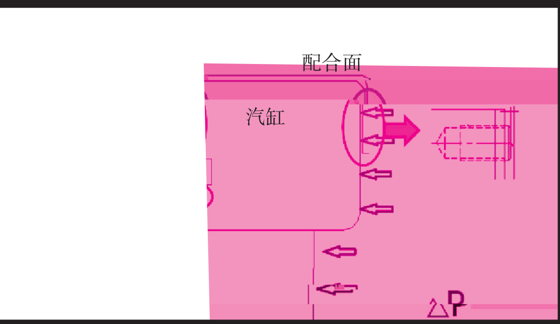
Study on the Influence of Diaphragm Structure of Cylindrical Casing on Its Deformation Characteristics

ZHANG Yan, LIU Dongqi, ZHAO Shizhi, CHEN Tiening

(Dongfang Turbine Co., Ltd., 61

2021 - 07 - 09

1983 - 2006

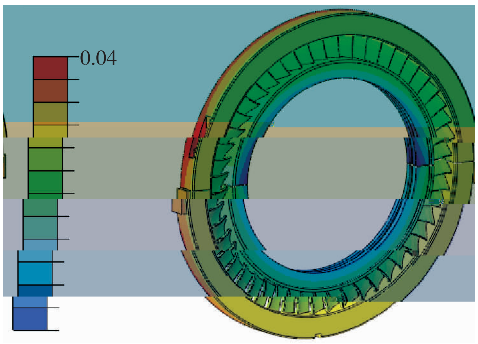

配合面
汽缸
△P

3

HP12 13

1 mm

	HP5	HP7	HP12	HP13
	0.068 ~ −0.34	0.068 ~ −0.443	0.021 ~ −0.431	0.015 ~ −0.416
	0.048 ~ −0.282	0.014 ~ −0.342	−0.013 ~ −0.272	0.014 ~ −0.407
	17%	22%		



6

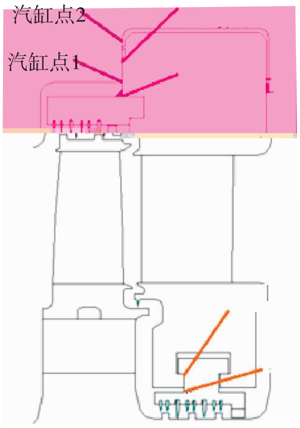
HP5

7 ①

②

③

0.6 ~ 0.9 0.8 ~ 1.1



[redacted]

540.404
520.693
5′

2021 - 04 - 19

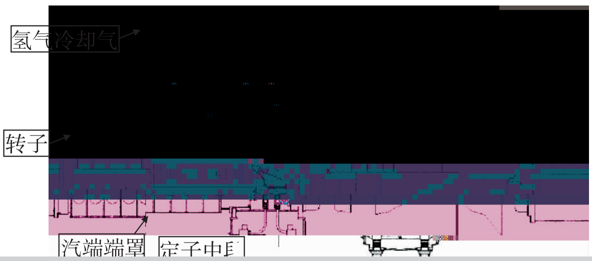
1987 - 2012

1971 - 1996

1980 - 2003 2014

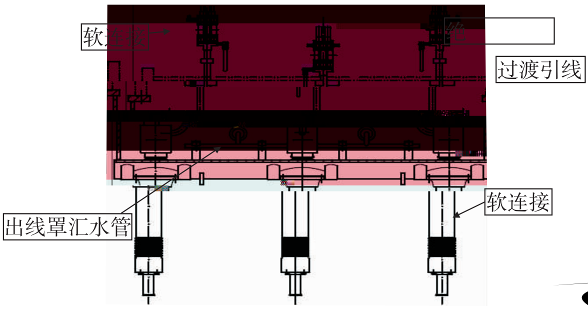
4

1 350 MW



350 MW

2



2021－05－11

1964－ 1996 K

“ ” ” ” 2019

170

“ ” 100

1 579.65 kW

8

800 MPa

99%

“ ”

2020 9 235 MW

3

1.2

75 MW

“ ”

22

8 50 MW

“ ”

1.3

“ ”

“

”

“6 + 6 ”

“

” “ ”

“ ”

1.4

2 170 MW

“

”

1.5

DF－300

“ ”

“ ”

2

“

”

VR VR

19.7 8.5% 1.64
“ ” 8 50 MW
21.7
m 27.2 m 27.9 m
50 MW

2013 10
2017 12 9 2018 10 21

70 2018 “ ”
8 11
“ ”

“ ”

3.5

230 km
35 km 2 115 MW 9 235
MW

1 650 MW 3
1 870 MW

1.4

4 “ ”

4.1

2017 1.7
11 945 1.7%
3 057 26.3% 1 182
78.6% 794
22.7%
2017—2020 3.41 3.7

“ ”

“

”

4.3

GE

GE

5 “ ”

5.1

5.2 “ ”

5.3

6

“ ”

2030 2060

200

“ ”

“ ”

2025

4.7 3.8

9 000

30

1 000 – 1 500 “ ”

611731

TL3 A 1001-9006 2021 03-0080-04

Project Management for Integrated Supply of Modular Miniature Nuclear Power Reactor

YANG Pinzheng

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

Abstract: This paper researches the development prospect of the modular miniature nuclear power reactor, and then analyses its characteristics. The paper focuses on the management model of the integrated supply project of modular miniature nuclear power reactor, introduces some specific management method.

Key words: modular miniature nuclear power reactor; integrated supply; project management

IAEA

300 MWe “ ” [1]

[2]

[3] B&W mPower

MSBWR IRIS -

50 LLC NuScale Power

Afrikantov OKBM

KLT - 40S

SMART

[2,4]

“ ”

“ ”

2021 - 07 - 09

1985 - 2010

5

1

6

1 LOCA

2 LOCA

3

ABV
ITIS NHR－200

4

5

2

HAF003

1

项目经理

项目执行

/

3.4

CFC
Work Ready

3.5

3.6

“
”

4

88

CAP1000

。

430223

CAP1000

TM623 A 1001-9006 2021 03-0084-05

Deformation Control Technology for Nozzle Welding of Internals Outlet in CAP1000 Nuclear Power Plant

DONG Mingliang, SHU Huaan, LI Ying, HAO Lei, WEI Huangzhen

(Dongfang Electric (Wuhan) Nuclear Equipment Co., Ltd., 430223, Wuhan, China)

Abstract: Core barrel is an important part of the reactor internals, and the design requirements are strict. The welding of the outlet nozzle is an important process in the manufacturing process of the barrel. According to the welding deformation mechanism, this paper analyzes the deformation law of the welding structure of the outlet nozzle, puts forward the deformation control method before, during and after welding, designs the welding anti deformation tooling and post welding sizing tooling, determines the reasonable welding sequence, and forms the complete anti deformation control technology of the outlet nozzle welding. The technology is successfully applied to CAP1000 stack products, and the effect of deformation prevention is achieved.

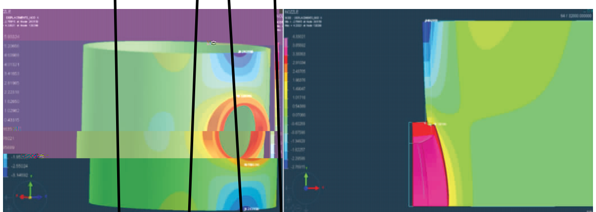
Key words: nuclear power; core barrel; welding deformation; control of deformation

SC－3 QSA1 Ⅰ 3 m 50 mm 8 m 4 3

2021－07－09
1988－ 2010
1973－ 1997
1988－ 2010

向收缩变

2



2

4

3

26.5 mm 1 540 ± 3.2 mm 5.03 mm

2

3

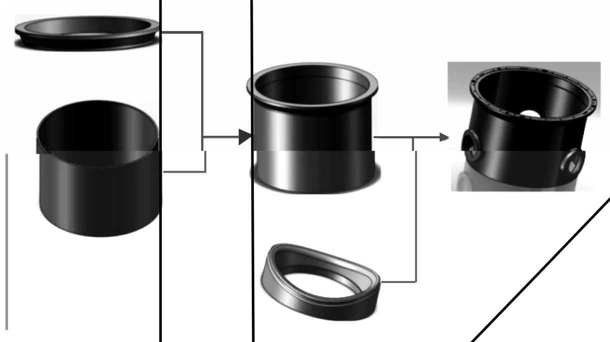
CAP1000

4.1

1

3

4



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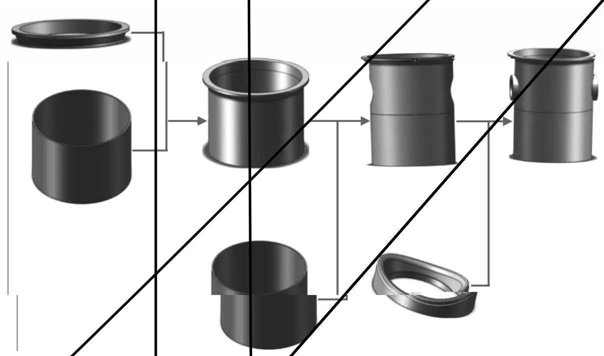

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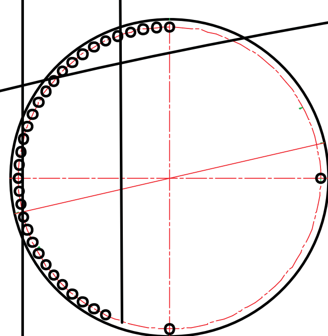

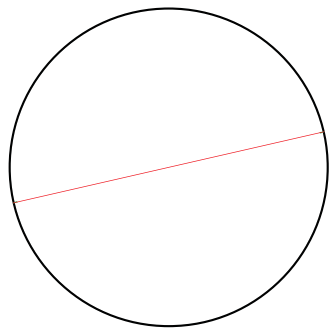

5

CAP1000

1 . M . 1986
2 .
C . · 3 2009 6

53

1 . J .
2002 5 37 - 38 + 40
2 . J . 1999
2 32 - 37
3 赟 .
C .
2017 328 - 332
4 .
J . 2008 3 243 - 245
5 .
C . 2017
389 - 394
6 .
J . 2010 43 2 54 - 56
7 .
J . 2014 3 53 - 56
8 . M . 1995 70 - 75
9 .
J . 2014 4 25 - 31
10 .
J . 2012 47 2 25 - 29

83

1 IAEA-TECDOC-1451. Innovative small and medium sized reactors Design features safety approaches and R&D trends R . Vienna. 2005
2 赟. J .
2012 33 5 136 - 139
3 .
J . 2015 34 2 30 - 31
4 . J .
2015 49 1 40 - 47
5 . J .
2013 34 2 153 - 156
6 . J . 2012
6 14 - 17

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