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检测
TESTING
CNAS L1020



实验室名称：苏州电器科学研究院股份有限公司
国家电器产品质量检验检测中心

Lab Name: Suzhou Electrical Apparatus Science Research Institute Co., Ltd.
China National Center for Quality Inspection and Test of Electrical
Apparatus Products

No 22M1259-S

检验（试验）报告 Test Report

委托单位：江苏新特变科技股份有限公司

Client: Jiangsu Xin Tebian Science & Technology CO., LTD.

产品名称：有载调压整流变压器

Name of Product: RECTIFIER TRANSFORMER
WITH ON LOAD TAP CHANGER

产品型号：ZHSSPT-6300/35

Product Type: ZHSSPT-6300/35

检验类别：委托试验

Test Category: Commission test

本实验室对出具的检验（试验）结果负责，未经实验室书面同意，不得部分地复制本报告。

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Test Report

№: 22M1259-S

Total 20 Page 01

Client	Jiangsu Xin Tebian Science & Technology CO., LTD.	Test category	Commission test
Manufacturer	Jiangsu Xin Tebian Science & Technology CO., LTD.	Date of sample receiving	May 07, 2022
Name of sample	RECTIFIER TRANSFORMER WITH ON LOAD TAP CHANGER	Type of sample	ZHSSPT-6300/35
Address of manufacturer	No.833, West Tangshi Street, Zhangjiagang Economic Technology Development Zone, Jiangsu	Original number or date of production	2109025
Date of test	From May 10, 2022 to May 18, 2022	Number of sample	1 set
Test items	Measurement of d.c. insulation resistance between each winding to earth and between windings Measurement of dissipation factor ($\tan\delta$) of the insulation system capacitances Measurement of voltage ratio and check of phase displacement Measurement of winding resistance Applied voltage test Induced voltage withstand test Measurement of no-load loss and current Measurement of no-load loss and current at 90% and 110% of rated voltage Measurement of short-circuit impedance and load loss Insulating liquid test Temperature-rise test	Test standards	GB/T 1094.1—2013 GB/T 1094.2—2013 GB/T 1094.3—2017 GB/T 18494.1—2014 IEC 60076-1:2011 IEC 60076-2:2011 IEC 60076-3:2013+AMD1:2018 Commission requirements
Test conclusion	The test results of measurement of d.c. insulation resistance between each winding to earth and between windings, measurement of dissipation factor ($\tan\delta$) of the insulation system capacitances, measurement of voltage ratio and check of phase displacement, measurement of winding resistance, applied voltage test, induced voltage withstand test, measurement of no-load loss and current, measurement of no-load loss and current at 90% and 110% of rated voltage, measurement of short-circuit impedance and load loss, insulating liquid test and temperature-rise test of the rectifier transformer with on load tap changer (type: ZHSSPT-6300/35) are in accordance with test standards and commission requirements. The sample has passed the above tests. Signing and issuing date: 2022.05.20 Note: the conclusion is valid only for the inspected and tested sample.		
Remarks	/		

Compiled by:

J. J. J.

Proofread by:

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Checked by:

陈明

Approved by:

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Test Report

Suzhou Electrical Apparatus Science
Research Institute Co., Ltd.

№: 22M1259-S

Total 20 Page 02

1. Sample parameters

Rated power: 6300kVA

Rated voltage: $35/2 \times 0.275\text{kV}$ Rated current: $103.9/2 \times 6613\text{A}$

Rated frequency: 50Hz

Number of phases: 3

Tapping ranges: /

Connection symbol: Ya0, Yd11-Dd0

Cooling method: OFWF

Thermal class of insulation: A

Insulation level:	line side	$U_m/\text{LI/LIC/AC}$	40.5/200/220/85kV
	valve side	U_m/AC	$\leq 1.1/5\text{kV}$

2. Test standards

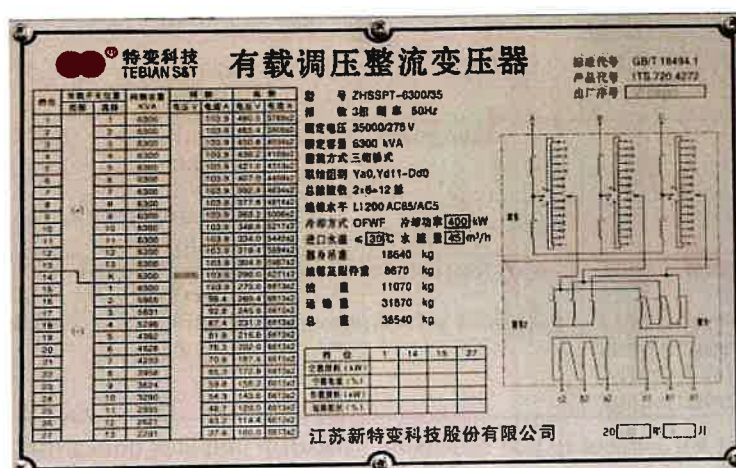
GB/T 1094.1—2013 *Power transformers—Part 1: General*GB/T 1094.2—2013 *Power transformers—Part 2: Temperature rise for liquid-immersed transformers*GB/T 1094.3—2017 *Power transformers—Part 3: Insulation levels, dielectric tests and external clearances in air*GB/T 18494.1—2014 *Converter transformers—Part 1: Transformers for industrial applications*IEC 60076-1: 2011 *Power transformers—Part 1: General*IEC 60076-2: 2011 *Power transformers—Part 2: Temperature rise for liquid-immersed transformers*IEC 60076-3: 2013+AMD1: 2018 *Power transformers—Part 3: Insulation levels, dielectric tests and external clearances in air*

Commission requirements

3. Sample description

The rectifier transformer with on load tap changer is for outdoor use and the type of transformer used in this report meets the requirement of JB/T 3837—2016 *Identification method of transformer's product type*. External photos of the sample have been attached.

A large industrial machine, likely a vacuum furnace, is shown in a laboratory or industrial setting. The machine features a large, dark, rectangular body with several vertical panels and a cylindrical chamber on top. A thick, flexible hose is connected to the side of the machine. The machine is mounted on a sturdy metal frame. The background shows a window and some other equipment, suggesting a workshop or laboratory environment.



Test Report		Suzhou Electrical Apparatus Science Research Institute Co., Ltd.		№: 22M1259-S Total 20 Page 04	
Summary of test results					
No	Test items	Specified value	Measured value	Concl- usion	
		Standards (commission requirements)			
1	Measurement of d.c. insulation resistance between each winding to earth and between windings (routine test)	Providing value of insulation resistance (GΩ) Providing absorption ratio (R ₆₀ /R ₁₅)	See 4.1	/	
2	Measurement of dissipation factor (tanδ) of the insulation system capacitances (special test)	Providing dielectric dissipation factor tanδ at 20°C (%): ≤1.5	See 4.2	PASS	
3	Measurement of voltage ratio and check of phase displacement (routine test)	Voltage ratio tolerance of principal tapping: obtaining the lower of the following values between ±0.5% of declared ratio and ±1/10 of the actual percentage impedance Connection symbol: Ya0,Yd11-Dd0	See 4.3	PASS	
4	Measurement of winding resistance* (routine test)	Maximum resistance unbalance rate Line resistance: ≤1%	Line side (line): 0.12% Valve side 1(line): 2.86% Valve side 2(line): 1.36%	Meet the requirem- ents	
5	Applied voltage test (routine test)	Line side: 85kV 60s Valve side 1: 5kV 60s Valve side 2: 5kV 60s	85kV 60s 5kV 60s 5kV 60s	PASS	
6	Induced voltage withstand test (routine test)	Applied voltage (kV): 2U _r Induced voltage (kV): 70 Duration (s): 120(f _n /f) Frequency (Hz): >50	0.550 70.0 40 150	PASS	
7	Measurement of no-load loss and current (routine test)	I ₀ (%): measured P ₀ (kW): measured	0.21 5.7123	PASS	
8	Measurement of no-load loss and current at 90% and 110% of rated voltage (type test)	I ₀ (%): measured P ₀ (kW): measured	90% 110% 0.15 0.29 4.6703 6.8316	/	
9	Measurement of short-circuit impedance and load loss (routine test)	t: 75°C Z(%): measured P _k (kW): measured P _{total} (kW): measured Providing split factor:	16.58 112.5582 118.2705 3.82	/	
10	Insulating liquid test (routine test)	Breakdown voltage (kV): ≥40 tanδ (90°C): ≤1.0%	59.6 0.17%	PASS	
		Providing gas chromatograph analysis: Hydrogen: <30μL /L Acetylene: 0 Total hydrocarbon: <20μL /L	See 4.10		
11	Temperature-rise test (type test)	Top oil temperature-rise limit (K): 60 Winding temperature-rise limit (K): 65	Top oil temperature-rise: 13.2 Line side winding temperature-rise: 27.6 Average valve side winding temperature-rise: 27.0	PASS	
*: According to client's clarification, winding resistance unbalance rate exceeding the specified value is caused by lead structure.					
Blank below					

Test Report	Suzhou Electrical Apparatus Science Research Institute Co., Ltd.		No: 22M1259-S Total 20 Page 05
4. Test items and results			
4.1 Measurement of d.c. insulation resistance between each winding to earth and between windings (routine test)			
Test date: May 10, 2022 Relative humidity: 46%; Oil temperature: 20.9°C			
Measured part	R ₁₅ (GΩ)	R ₆₀ (GΩ)	Absorption ratio (R ₆₀ /R ₁₅)
Line side—valve side 1, valve side 2 and earth	9.27	11.3	1.22
Valve side 1—line side, valve side 2 and earth	26.9	35.6	1.32
Valve side 2—line side, valve side 1 and earth	28.7	37.1	1.29
Line side and valve side 1, valve side 2—earth	3.35	4.04	1.21
4.2 Measurement of dissipation factor (tanδ) of the insulation system capacitances (special test)			
Test date: May 10, 2022 Relative humidity: 46%; Oil temperature: 20.9°C			
Measured part	Dielectric dissipation factor (tanδ) (%)	Dielectric dissipation factor tanδ(%) corrected to 20°C	
Line side—valve side 1, valve side 2 and earth	0.28	0.27	
Valve side 1—line side, valve side 2 and earth	0.43	0.42	
Valve side 2—line side, valve side 1 and earth	0.42	0.41	
Line side—valve side 1, valve side 2	0.55	0.54	

Test Report		Suzhou Electrical Apparatus Science Research Institute Co., Ltd.				№: 22M1259-S Total 20 Page 06		
4.3 Measurement of voltage ratio and check of phase displacement (routine test)					Test date: May 10, 2022			
Line side winding		Valve side winding		Transformer ratio by calculation	Measured voltage ratio tolerance (%)			Connection symbol
Tapping position	Voltage (kV)	Tapping position	Voltage (kV)		AB/a1b1	BC/b1c1	CA/c1a1	
1	35.000	/	0.4800	72.92	0.10	0.11	0.11	Dd0
2			0.4654	75.20	0.11	0.12	0.12	
3			0.4508	77.64	0.10	0.12	0.12	
4			0.4362	80.24	0.10	0.11	0.11	
5			0.4216	83.02	0.10	0.11	0.12	
6			0.4070	86.00	0.09	0.10	0.10	
7			0.3924	89.19	0.11	0.12	0.12	
8			0.3778	92.64	0.11	0.12	0.12	
9			0.3632	96.37	0.10	0.11	0.12	
10			0.3486	100.40	0.11	0.12	0.13	
11			0.3340	104.79	0.11	0.12	0.13	
12			0.3194	109.58	0.13	0.13	0.13	
13			0.3048	114.83	0.12	0.14	0.13	
14			0.2900	120.69	0.07	0.07	0.07	
15			0.2750	127.27	-0.08	-0.07	-0.07	
16			0.2604	134.41	-0.05	-0.04	-0.05	
17			0.2458	142.39	-0.08	-0.06	-0.05	
18			0.2312	151.38	-0.06	-0.05	-0.05	
19			0.2166	161.59	-0.10	-0.07	-0.07	
20			0.2020	173.27	-0.08	-0.06	-0.06	
21			0.1874	186.77	-0.09	-0.07	-0.06	
22			0.1728	202.55	-0.12	-0.07	-0.07	
23			0.1582	221.24	-0.11	-0.11	-0.11	
24			0.1436	243.73	-0.14	-0.09	-0.09	
25			0.1290	271.32	-0.15	-0.12	-0.12	
26			0.1144	305.94	-0.14	-0.11	-0.14	
27			0.1000	350.00	0.11	0.11	0.11	

Test Report		Suzhou Electrical Apparatus Science Research Institute Co., Ltd.				№: 22M1259-S Total 20 Page 07		
Line side winding		Valve side winding		Transformer ratio by calculation	Measured voltage ratio tolerance (%)			Connection symbol
Tapping position	Voltage (kV)	Tapping position	Voltage (kV)		AB/a2b2	BC/b2c2	CA/c2a2	
1	35.000	/	0.4800	72.92	0.14	0.12	0.14	Yd11
2			0.4654	75.20	0.15	0.13	0.15	
3			0.4508	77.64	0.14	0.13	0.14	
4			0.4362	80.24	0.14	0.12	0.15	
5			0.4216	83.02	0.14	0.13	0.14	
6			0.4070	86.00	0.14	0.14	0.15	
7			0.3924	89.19	0.16	0.15	0.16	
8			0.3778	92.64	0.15	0.14	0.16	
9			0.3632	96.37	0.16	0.15	0.16	
10			0.3486	100.40	0.17	0.16	0.17	
11			0.3340	104.79	0.17	0.16	0.16	
12			0.3194	109.58	0.17	0.16	0.17	
13			0.3048	114.83	0.18	0.17	0.17	
14			0.2900	120.69	0.12	0.12	0.12	
15			0.2750	127.27	-0.02	-0.03	-0.02	
16			0.2604	134.41	-0.03	-0.04	-0.03	
17			0.2458	142.39	-0.04	-0.04	-0.04	
18			0.2312	151.38	-0.03	-0.05	-0.03	
19			0.2166	161.59	-0.06	-0.06	-0.05	
20			0.2020	173.27	-0.05	-0.06	-0.04	
21			0.1874	186.77	-0.08	-0.07	-0.06	
22			0.1728	202.55	-0.07	-0.07	-0.07	
23			0.1582	221.24	-0.11	-0.11	-0.06	
24			0.1436	243.73	-0.09	-0.09	-0.09	
25			0.1290	271.32	-0.12	-0.12	-0.08	
26			0.1144	305.94	-0.11	-0.11	-0.08	
27			0.1000	350.00	0.09	0.09	0.09	

Test Report		Suzhou Electrical Apparatus Science Research Institute Co., Ltd.			No: 22M1259-S Total 20 Page 08
4.4 Measurement of winding resistance (routine test)					Test date: May 10, 2022 Oil temperature: 21.2℃
Winding	Tapping position	Measured resistance (Ω)			Resistance unbalance rate (%)
		A~B a1~b1 a2~b2	B~C b1~c1 b2~c2	C~A c1~a1 c2~a2	
Line side	1	1.0532	1.0528	1.0539	0.10
	2	1.0443	1.0438	1.0448	0.10
	3	1.0349	1.0345	1.0354	0.09
	4	1.0252	1.0248	1.0257	0.09
	5	1.0151	1.0145	1.0155	0.10
	6	1.0042	1.0038	1.0048	0.10
	7	0.9931	0.9926	0.9936	0.10
	8	0.9813	0.9808	0.9816	0.08
	9	0.9691	0.9686	0.9696	0.10
	10	0.9562	0.9557	0.9566	0.09
	11	0.9427	0.9422	0.9430	0.08
	12	0.9286	0.9279	0.9289	0.11
	13	0.9137	0.9129	0.9139	0.11
	14	0.8962	0.8956	0.8966	0.11
	15	0.9134	0.9132	0.9139	0.08
	16	0.9285	0.9282	0.9289	0.08
	17	0.9429	0.9424	0.9431	0.07
	18	0.9565	0.9559	0.9567	0.08
	19	0.9693	0.9689	0.9695	0.06
	20	0.9817	0.9812	0.9819	0.07
	21	0.9933	0.9928	0.9935	0.07
	22	1.0046	1.0039	1.0046	0.07
	23	1.0150	1.0146	1.0153	0.07
	24	1.0252	1.0246	1.0255	0.09
	25	1.0350	1.0344	1.0351	0.07
	26	1.0443	1.0438	1.0446	0.08
	27	1.0533	1.0523	1.0536	0.12
Valve side	/	0.3438×10 ⁻³	0.3415×10 ⁻³	0.3514×10 ⁻³	2.86
		0.3440×10 ⁻³	0.3486×10 ⁻³	0.3439×10 ⁻³	1.36

Test Report	Suzhou Electrical Apparatus Science Research Institute Co., Ltd.	No: 22M1259-S Total 20 Page 09
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4.5 Applied voltage test (routine test)

Test date: May 10, 2022

Relative humidity: 57%; Ambient temperature: 20.1°C; Oil temperature: 20.9°C; Air pressure: 101.1kPa

Part of applied voltage	Test voltage (kV)	Test duration (s)	Result
Line side—valve side 1, valve side 2 and earth	85	60	PASS
Valve side 1—line side, valve side 2 and earth	5	60	
Valve side 2—line side, valve side 1 and earth	5	60	

4.6 Induced voltage withstand test (routine test)

Test date: May 18, 2022

Relative humidity: 65%; Ambient temperature: 21.9°C; Oil temperature: 21.7°C; Air pressure: 101.1kPa

Tapping position	Applied voltage (kV)	Induced voltage (kV)	Induced multiple	Frequency (Hz)	Test duration (s)	Result
	Valve side	Line side				
15	0.550	70.0	2	150	40	PASS

4.7 Measurement of no-load loss and current (routine test)

Test date: May 11, 2022

Voltage multiple	Applied voltage (kV)		No-load current		No-load loss (kW)	
	Average value	r.m.s. value	(A)	(%)	Measured value	Corrected value
90%Ur	0.2478	0.2476	20.12	0.15	4.6654	4.6703
100%Ur	0.2700	0.2742	27.61	0.21	5.8028	5.7123
110%Ur	0.2904	0.3009	37.94	0.29	7.0876	6.8316

Remarks: at 100%Ur, the difference between r.m.s. voltage and average voltage is within 3%.

4.8 Measurement of no-load loss and current at 90% and 110% of rated voltage (type test)

See 4.7

Test Report

Suzhou Electrical Apparatus Science
Research Institute Co., Ltd.№: 22M1259-S
Total 20 Page 10

4.9 Measurement of short-circuit impedance and load loss (routine test)

Test date: May 11, 2022

Oil temperature: 21.3°C

Winding	Tapping position	Applied current I		Measured voltage (kV)	Measured load loss (kW)	Short-circuit impedance (for each phase)		Load loss (kW)	Total loss (kW)
		(A)	I/I _r (%)			HV impedance (Ω)	(%)	Corrected value	Corrected value
						t=75°C I=I _r	t=75°C I=I _r	t=75°C I=I _r	t=75°C I=I _r
Line side valve side 1 valve side 2	1	57.04	54.88	1.6339	14.686	16.55	8.51	52.5457	58.2580
	14	54.14	52.10	2.7343	25.937	29.17	15.00	100.1725	105.8848
	15	53.01	51.00	2.9594	28.172	32.24	16.58	112.5582	118.2705
	27	20.48	54.18	11.831	44.043	333.44	62.36	142.2806	147.9929
Line side valve side 1	1	30.06	57.85	1.3899	6.7558	26.72	13.74	/	/
	14	28.55	54.94	2.8166	13.860	56.97	29.30	/	/
	15	27.99	53.87	3.0559	14.954	63.04	32.42	/	/
	27	10.33	54.67	10.150	18.679	567.32	106.10	/	/
Line side valve side 2	1	27.77	53.43	1.2794	5.6243	26.62	13.69	/	/
	14	27.44	52.80	2.6942	12.436	56.72	29.17	/	/
	15	27.12	52.20	2.9501	13.659	62.82	32.31	/	/
	27	9.72	51.42	9.508	16.141	564.86	105.64	/	/
Valve side 1 valve side 2	/	191.96	/	2.525	/	/	63.26	/	/

Split factor: 3.82, unbalance rate of semi-crossing impedance: 0.34%

Test Report	Suzhou Electrical Apparatus Science Research Institute Co., Ltd.		№: 22M1259-S Total 20 Page 11				
4.10 Insulating liquid test (routine test) Test date: May 10, 2022 Relative humidity: 57%; Ambient temperature: 22.8°C							
Dielectric dissipation factor(90°C)			Breakdown voltage (kV)				
0.17%			59.6				
Gas chromatograph analysis (before temperature-rise test) Test date: May 10, 2022 μL/L							
H₂	CO	CO₂	CH₄	C₂H₆	C₂H₄	C₂H₂	Total hydrocarbon
0.00	9.56	338.13	1.22	12.06	0.07	0.00	13.35
Gas chromatograph analysis (after temperature-rise test) Test date: May 18, 2022 μL/L							
H₂	CO	CO₂	CH₄	C₂H₆	C₂H₄	C₂H₂	Total hydrocarbon
0.00	10.38	360.81	1.22	13.32	0.17	0.00	14.71

Test Report			Suzhou Electrical Apparatus Science Research Institute Co., Ltd.						№: 22M1259-S Total 20 Page 12		
4.11 Temperature-rise test (type test)											
Test date: May. 17, 2022											
The method of temperature-rise is the equivalent test in short-circuit connection. The cooling method is OFWF.											
The tapping position is 15. Test duration is 7h of which the stabilization time is 3h.											
Measurement of top oil temperature-rise: it is required to apply 118.2705kW of total loss and 120.7300kW is actually applied during testing.											
Measurement of winding temperature-rise: 103.94A current is required and 105.40A current is actually applied during testing.											
The cooling water flow specified in temperature-rise test: 45m ³ /h.											
The inlet temperature of cooling water: ≤ 30°C.											
Measured data											
Top oil temperature-rise and average oil temperature-rise			Measurement of average temperature-rise windings to oil							Inlet temperature of cooling water (°C)	Ambient temperature (°C)
Top oil temperature (°C)	Average oil temperature (°C)	Total loss injection/specified total loss (%)	Current injection/rated current (%)	Cold resistance (Ω)		Average oil temperature (°C)		Average winding temperature (°C)		Total loss	Measurement of cold resistance
35.2	32.7	102.08	101.40	Line side	0.9134	At the instant of shutdown	32.8	Line side	49.9	21.7	21.2
				Valve side 1	0.3438 × 10 ⁻³	At the end of cooling curve	31.0	Valve side 1	49.2		
				Valve side 2	0.3440 × 10 ⁻³			Valve side 2	49.5		
Calculations of temperature-rise											
Top oil temperature-rise (K)				13.2							
Winding temperature-rise (K)				Line side		27.6					
				Valve side average value		27.0					
Remarks: the calculated results of temperature-rise are the corrected values under specified total loss and rated current.											

Test Report

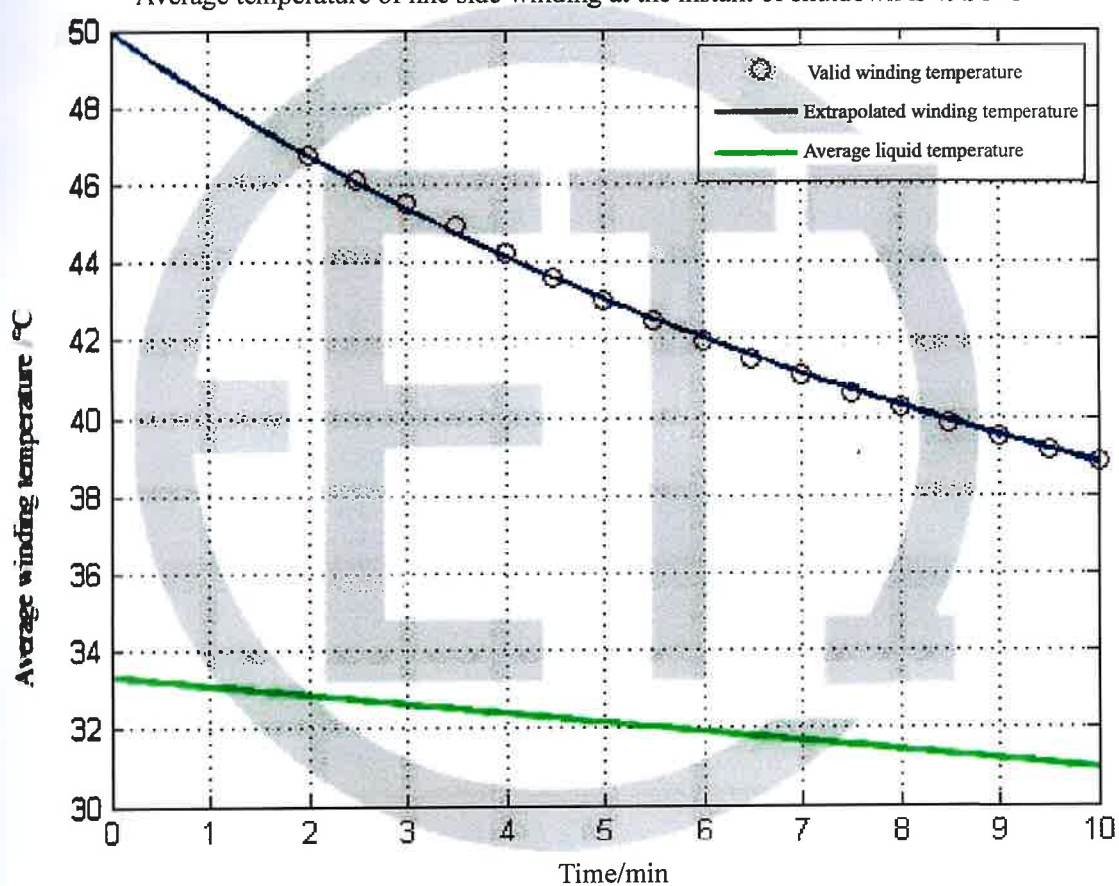
Suzhou Electrical Apparatus Science
Research Institute Co., Ltd.№: 22M1259-S
Total 20 Page 13

Winding temperature curve

Average winding temperature data

Average line side winding temperature	49.9°C
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Average temperature of line side winding at the instant of shutdown is 49.93°C



Test Report

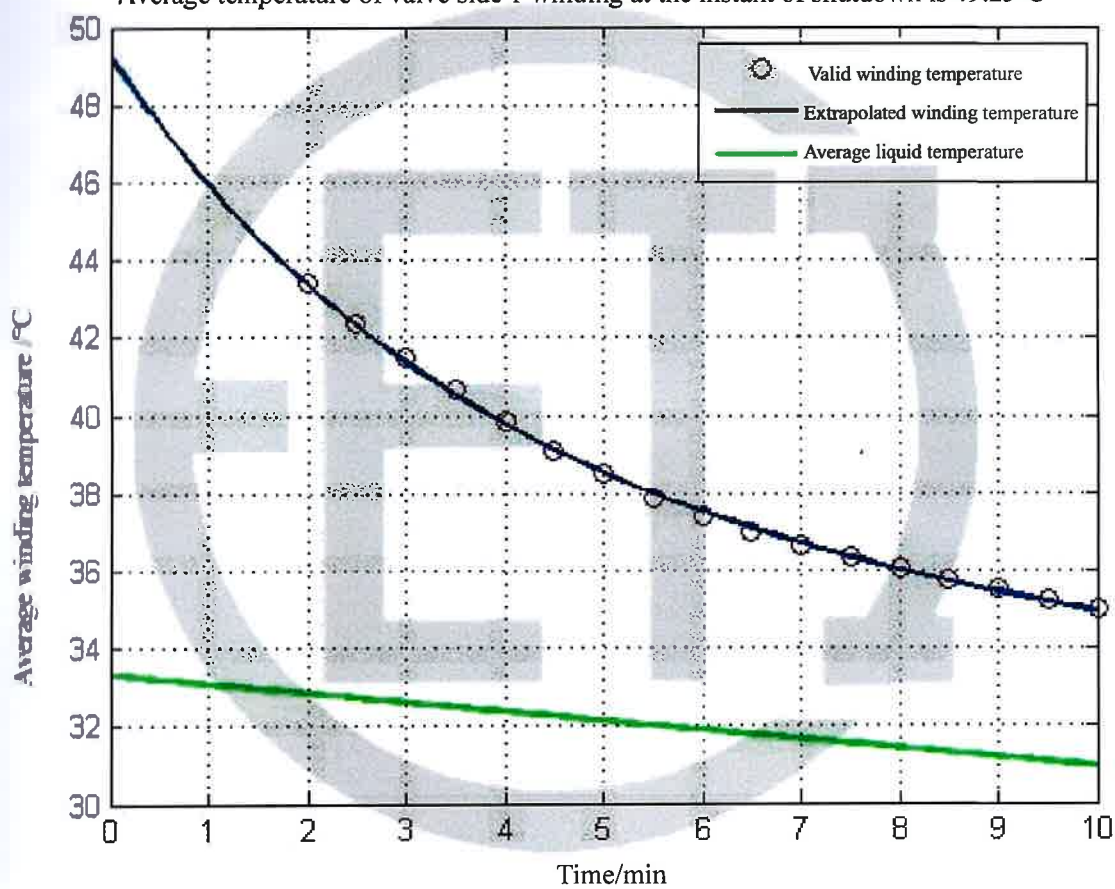
Suzhou Electrical Apparatus Science
Research Institute Co., Ltd.№: 22M1259-S
Total 20 Page 14

Winding temperature curve

Average winding temperature data

Average valve side 1 winding temperature	49.2°C
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Average temperature of valve side 1 winding at the instant of shutdown is 49.25°C

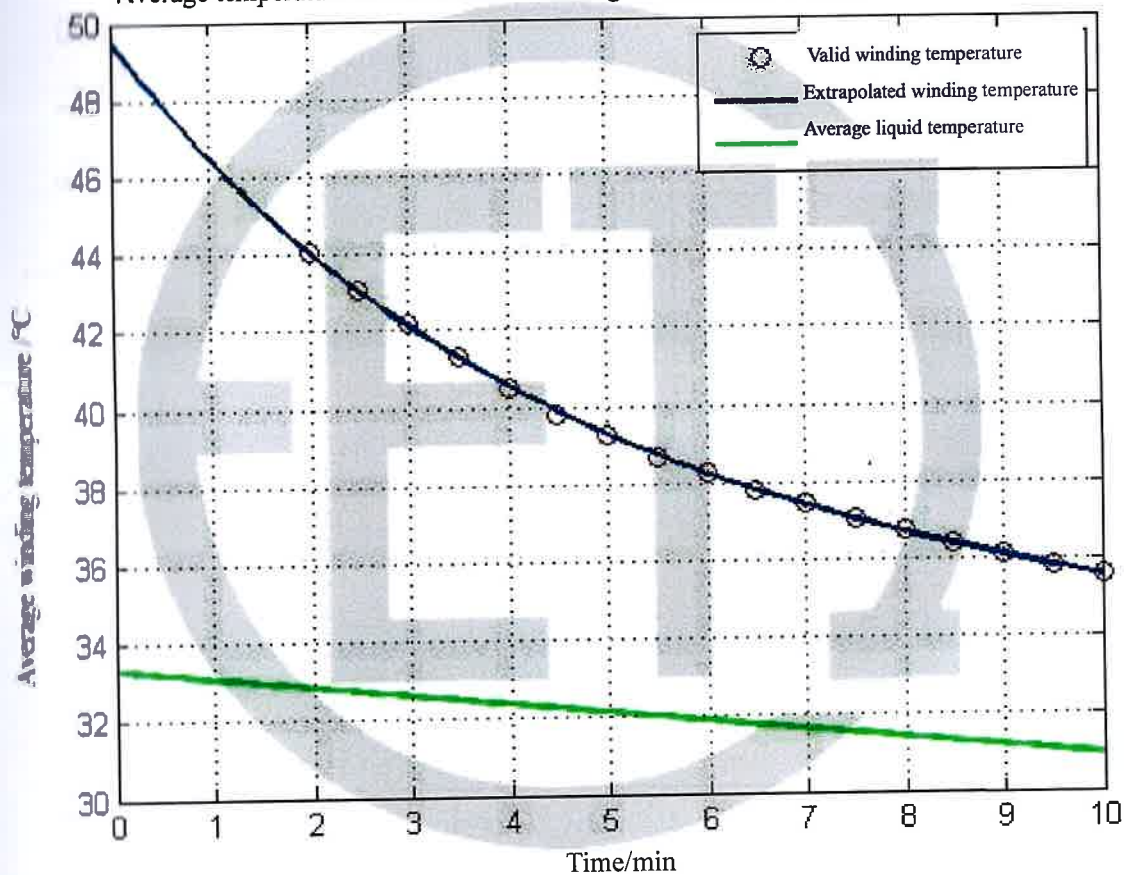


Winding temperature curve

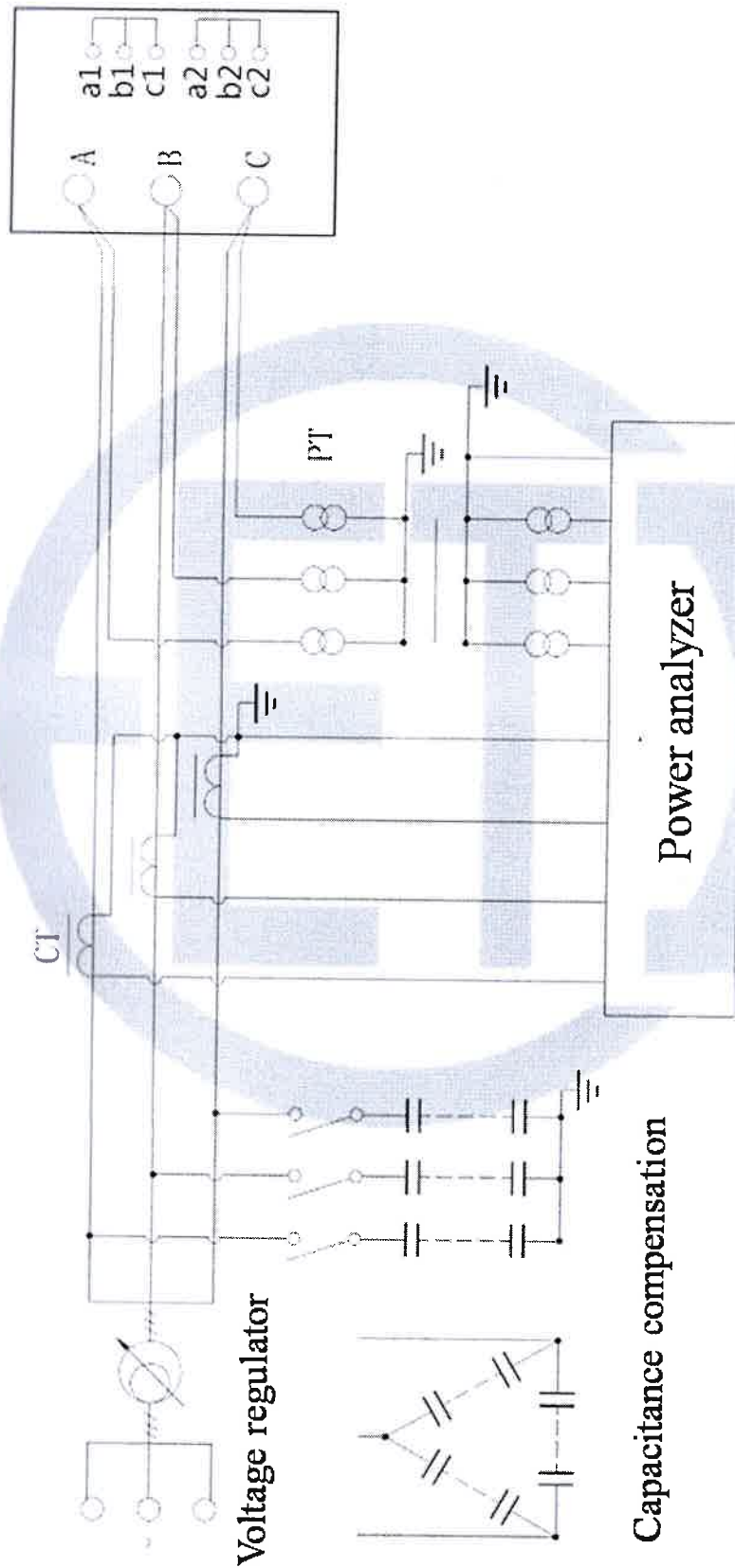
Average winding temperature data

Average valve side 2 winding temperature	49.5°C
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Average temperature of valve side 2 winding at the instant of shutdown is 49.53°C

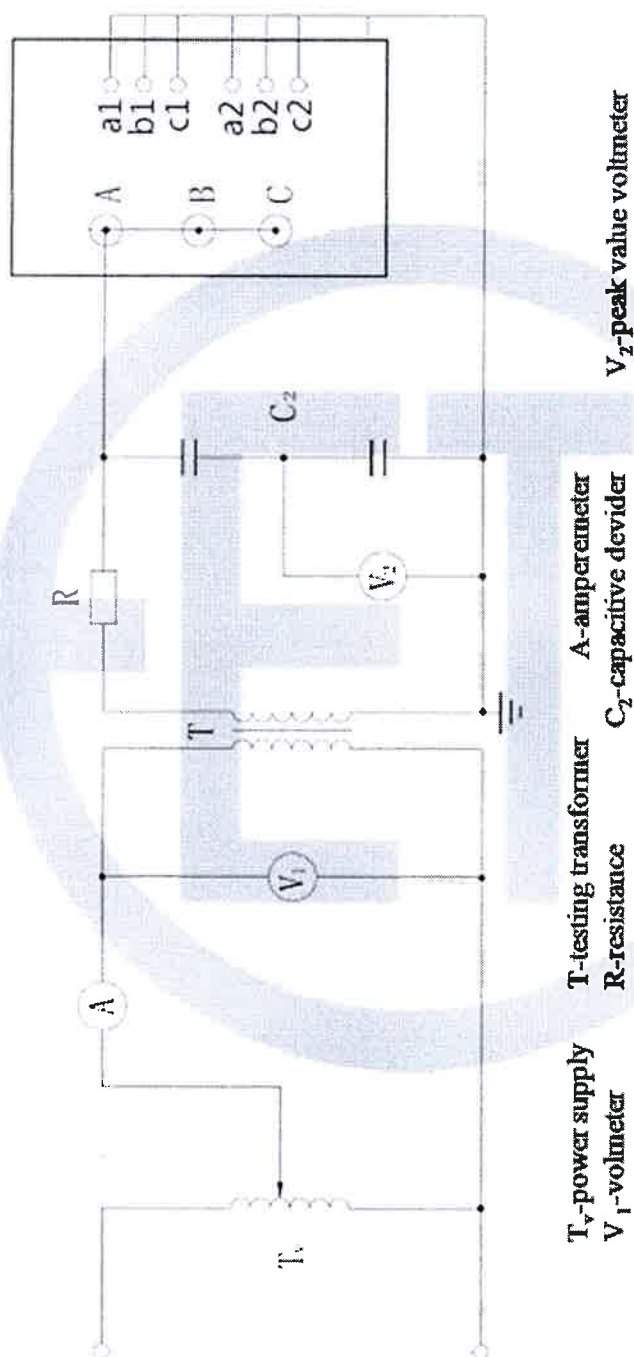






CT-current transformer PT-voltage transformer

Schematic diagram of measurement of short-circuit impedance and load loss



Schematic diagram of applied voltage test



Test Report		Suzhou Electrical Apparatus Science Research Institute Co., Ltd.		No: 22M1259-S Total 20 Page 20
Instruments used in the tests				
No	Test items	Name & type of instrument	Number & validity	Accuracy class
1	Measurement of d.c. insulation resistance between each winding to earth and between windings	Digital mega-ohm meter F1550C	ER17-013 2023-03-25	200k~5/10/20/50/100 G Ω class 5, others class 20
2	Measurement of dissipation factor (tanδ) of the insulation system capacitances	Movable insulation diagnostic and analysis system MIDAS2880	ER19-008 2023-03-03	Capacitance: ±0.3%rdg±0.3pF Inductance: ±0.5%rdg±0.5mH
3	Measurement of winding resistance	DC resistance tester JYR(50C)	ER16-032 2022-08-04	0.2%±0.2μΩ
4	Measurement of voltage ratio and check of phase displacement	Transformer ratio tester BBC6638	RI15-032 2023-03-14	/
5	Measurement of short-circuit impedance and load loss	Transformer power loss test system TMS580	749-1137 2023-05-13	100V~100kV, accuracy; 0.12% 1A~2000A, accuracy; 0.15%
6	Measurement of no-load loss and current			
7	Measurement of no-load loss and current at 90% and 110% of rated voltage			
8	Applied voltage test	Power-frequency partial discharge-free test power supply 2400kV/8000kVA	745-076 2024-04-06	/
		Power frequency withstand voltage tester PFT-5C	745-102 2022-10-12	/
9	Induced voltage withstand test	Transformer power loss test system TMS580	749-1137 2023-05-13	100V~100kV, accuracy;0.12% 1A~2000A, accuracy; 0.15%
10	Insulating liquid test	Dielectric strength automatic tester NRYNY-1004	ER18-005 2022-11-15	±3%
		High precision full-automatic capacitance, inductance and dielectric loss measuring bridge 2840-Combi	ER18-003 2022-07-19	±0.2%rdg±0.01pF; ±0.5%rdg±1×10-5
		Gas chromatogram analyzer 7890B	749-1732 2022-11-15	/
11	Temperature-rise test	Transformer power loss test system TMS580	749-1137 2023-05-13	100V~100kV, accuracy;0.12% 1A~2000A, accuracy; 0.15%
		Thermocouple type T	TT33-031/032/033/034/ 035/036 2023-05-30	/
		Data acquisition/switch unit 34970A	TT11-035 2023-05-30	V±5.25%, A±1.5%, T±1℃, Ω±0.81%
		DC resistance tester JYR(50C)	ER16-055 2022-09-12	0.2%±0.2μΩ
		DC resistance tester JYR(50C)	ER16-056 2022-09-12	0.2%±0.2μΩ
		Electronic stopwatch PC396	HT15-010 2023-03-01	/
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DECLARATION

1. The report is invalid without special seal for testing and page combining seal on the report;
2. The report is invalid if altered;
3. The report is invalid without signatures of persons for drawing up,
proof-reading, reviewing and approval;
4. The report is valid only for the inspected and tested samples.
5. The client shall be responsible for the information provided by the client and the authenticity
of which cannot be verified by our laboratory.

NOTICE

1. In case there is any objection to this report, please raise it to the laboratory within fifteen
days starting from the date of receiving the report. Thank you for your cooperation.
2. In case there is no objection, please take back the samples within one month starting from
the date of receiving the report, when the manufacturer is going to take back the samples,
certificate for sample taking should be brought in presence, only then the samples could be
taken back. On time due, the samples will be in the laboratory's own disposal.

The test report is in total 20 pages including 7 figures and 1 photo

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