AdZ Tecnología

A GLENCORE COMPANY

AZSA CELLHOUSE A AND B EQUIPMENT INVENTORY:

TRANSFORMER RECTIFIERS

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1. SCOPE

In July 2022, the new Cellhouse E was started in the facilities of Asturiana de Zinc S.A.U. in San Juan de Nieva, Asturias, Spain, to replace two old cellhouses, namely Cellhouse A and Cellhouse B. The production capacity of new Cellhouse E is slightly greater than Cellhouse A and Cellhouse B production capacity together.

Cellhouse A and Cellhouse B will be dismantled shortly. The purpose of this document is to describe the features of the transformer rectifiers sets that are available for reuse.

2. GENERAL DESCRIPTION

A total of 10 transformer rectifier units have been decommissioned from Cellhouses A and B. All rectifiers are identical in their features. With regards to the transformers, seven of them are fed at 10 kV and the remaining three are fed at 132 kV.

A description of the T/R sets characteristics follows.

General technical data

Rated DC current of rectifier group[1]: 26 kA

Rated DC current per rectifier unit: 26 kA

Rated DC voltage: 710 V

Control range by means of OLTC and transducer 710 - 300 V

Circuit arrangement: 1 x three phase bridge

Phase effect per rectifier unit 6-pulse

Phase effect of rectifier group [1]: 6-pulse

Phase effect of total rectifier plant (5 rectifier groups [1]) To be clarified during

site meeting

Efficiency of rectifier group [1,2]: ~ 98 %

Cos (□) of rectifier group [1,2] without compensation: > 0,94

Summary of individual losses per rectifier group

(Tolerance +15 % of individual losses) [2]

Transformer Combination (sinus wave) 228 kW

Rectifier equipment 91 kW

Aux. power total Appr. 20 kW

1) 1 rectifier group = 1 transformer + 1 rectifier unit

2) The above mentioned losses, the efficiency and the power factor apply to rated current and full voltage output setting, i.e. transductors saturated and high voltage supply of constant voltage and frequency according to IEC.

Auxiliaries per rectifier group (to be supplied by purchaser) Total

Three phase AC 400 V □ 5%, 50 Hz < 30 kVA

Cooling-water flow

- max. inlet temperature 27°C

- max. outlet temperature 35°C

approx. 43 m3 / h

Cooling water quality requirements:

Chlorides < 150 mg/ll

Sulphates < 325 mg/ll

pH > 7

Free of dirt and particulate material > 0.5 mm

Transformer general description

The three phase oil filled rectifier transformer arrangement is designed for outdoor installation and consists of one step-down transformer and one rectifier transformer in back to back design as well as the OFWF cooling equipment, protection and monitoring auxiliaries.

The transformer is equipped with an on-load tap changer in order to optimize the power factor of the system and to minimize the distortions to the feeding power network.

The phase shifting of the new transformers should be clarified in the project kick-off meeting.

The mechanical arrangement of the low voltage bushings will be identical to the transformers supplied by Siemens for Rectifier groups AC and EG. This way the new transformers are interchangeable

with the transformers installed in group AC and EG.

Operating conditions

Type: Three-phase oil-immersed

rectifier transformer assembly

Standards (electr.): Acc. to section 2

Location: Outdoor

Altitude: □ 1000 m a.s.l.

Ambient temperature -20 … +40 °C

Cooling OFWF

Oil temperature rise 60 K

Winding temperature rise 65 K

Number of coolers per unit: 2 x 100 %

Number of pumps: 2

Power per pump: 9 kW

Electrical data

Nominal power: 22456kVA

Nominal frequency: 50 Hz

Operation: 1 x DB (Three phase bridge)

Vector Group To be defined

No-load ratio:

- Primary:

- Secondary:

10.5 kV +/- 5 %

0,611 – 0,268 V

Tap changer

Manufacturer

Type

Number of positions

Reinhausen

on-load

35

No-load losses at U_{N1}:

at 10,5 / 0,611 kV

23 kW (Tol. +15 %)

Short-circuit losses[1]:

at 22,456 MVA and 10,5 / 0,611 kV

with 75°C winding temperature,

with short-circuit secondary winding and

primary side supply with maximum nominal current.

without transductors.

205 kW (Tol. +15 %)

Short-circuit voltage1:

at 22,456 MVA and 10,5 / 0,611 kV

with short-circuit of secondary winding and

primary side supply with nominal current

without transductors.

10 % (tol. +/-7.5 %)

1) These values are guaranteed values at sinusoidal supply voltage!

Tolerances acc. to DIN EN 60076

Connections

Primary side

Primary Star point

3 x CONNEX Quadruple Contact

Elbow Bushings, Size 3,Pfisterer type

1 x D 24 – 1000

Siemens type

Secondary: 6 flat copper bar bushings

Siemens type

Dimensions (approx.)

Overall length:

(incl. cooling system)

4400 mm

Overall width

(incl. LV-bushings and HV-bushings)

3800 mm

Height (incl. expansion tank): 4650 mm

Weight (approx.)

Total weight (incl. Oil and Cooling system) 59 t

Weight of oil: 15 t

Transformer tank

Transformer tank: Vacuum proof steel plate tank

Expansion tank: Vacuum proof connected to transformer

Monitoring and protection devices Standard control, monitoring and protection devices, including:

Double float Buchholz relay

Tap changer protection relay

Dial type oil temperature indicator

Magnetic oil level gauge

Silicagel breather

Rectifier Unit and Rectifier Cooling General description

Each rectifier group consists of one rectifier unit forming a 6-pulse three phase bridge connection. The unit is arranged on one long side of the rectifier transformer.

The rectifier design will be identical to the design of the rectifiers supplied by Siemens for the groups AG, AC, BH, EG and IN. This limits the variety of spare parts and the training of client ´s personnel to a minimum.

The rectifier unit consists of two-phase assemblies. Each assembly comprises one DC-busbar - on which the semiconductors and specially designed semiconductor fuses are mounted - and three AC connection terminals (one per phase). The bus-bars consist of extruded aluminum with cooling sections through which de-ionized water flows.

The disc-type semiconductors are mounted directly on the bus-bars and are therefore directly cooled by the de-ionized water on one side while the other side of the semiconductors is cooled by means of an aluminum heat sink. The fuses are mounted directly on the far sides of these heat sinks and therefore are water cooled at one side as well. On the other side of the fuses flexible connections are installed to connect the fuses to six AC phase assembly plates forming the AC input-terminals of the rectifier. Semiconductor, heat sink, fuse and

copper flexible are clamped together and to the DC bus-bar by a common leaf spring. This kind of construction ensures minimum losses and a high mechanical strength as well.

The AC terminals to the rectifier transformer are at the rear side of the unit and the outgoing DC terminals could be arranged either on the left side or on the right side. The AC terminals consist of copper, the DC terminals of aluminum. The electrical connection from the rectifier to the transformer is executed by using copper bus-bars bolted on both sides. The AC- terminal bus-bars of the rectifier consist of copper as well in order to ensure minimum and long term stable ohmic resistances across the contacts. For the connection of the rectifier unit to the DC bus bar, welded connections are foreseen.

The individual phases of the rectifier unit are compartmented by glass-fiber-reinforced polyester panels, likewise the star points at the plus and minus potential. Insulation to the base frame is achieved by means of 10 kV post insulators.

For protection against accidental contact with live parts, the rectifier unit is covered by means of removable transparent MAKROLON panels.

The DC bus-bars form the P and N outputs of the rectifier unit (three phase bridge connection). RC elements are provided for protection against over-voltages occurring during commutation as a result of the hole-storage-effect. These elements are installed inside the rectifier.

The cooling of the rectifier is realized by the use of de-ionized water. Only corrosion-resistant materials are employed for the components of the de-ionized water circuit: Aluminum alloys, stainless steel, thermally stabilized polypropylene (PP). The de-ionized water cooling system comprises several parallel cooling water circuits which terminate in two manifolds for the supply and return circuits and for connection to the cooling unit. The manifolds and the aluminum bus-bars are connected by flexible high-pressure vinylan tubes.

General technical Data

Standards (electr.): Acc. to section 2

Semiconductors: Diodes

Rated DC current per rectifier unit: 26 kA

Rated DC voltage: 710 V

Degree of protection: IP00

Rectifier cooling: de-ionized water

Class of duty: Class I, 100% continuous duty at nominal load,

24 hours every day

Dimensions (W x D x H): approx. 1800 x 800 x 1900 mm

Diodes

Diodes parallel per phase: 6

Number of Diodes per rectifier unit: 36 (6 x 6)

Type of Diodes: EUPEC D4201

Max. repetitive peak off-state or reverse voltage: 1800 V

Operating reverse voltage: 830 V

(Safety factor: 2.2)

Peak value of maximum DC current:

(under existing cooling conditions)

7500 A for 120° el. Corresponding to: 4330 A (RMS)

N – Operation

Operating current (at 26 KA)

4330 A for 120° el. Corresponding to: 2500 A (RMS)

(Safety factor:1.73)

Max. permissible junction temperature: 160° C

Junction temperature at operating current: 99° C

Fuses

Number of fuses per rectifier unit: 36

Number of fuses per semiconductor: 1

Manufacturer of fuses: Mersen or Bussmann

Rated voltage: 660 V

Rated current:

6060 A for 120° el. corresponding to: 3500 A (RMS)

Protection

- Iron-coreless transformers for over-current time protection, reverse current relay and branch current supervision
- Temperature supervision for semiconductor bus-bars
- R/C damping circuits

Over-voltage protection circuits

Rectifier cooling system. *General description*

The cooling unit contains all necessary components for rectifier cooling and for monitoring of the cooling-water circuits. All components are installed on a common rack to be located indoors nearby the rectifier unit.

The cooling system comprises two circuits:

- The internal de-ionized water circuit is gathering the heat from the rectifier.
- A heat exchanger is transferring the heat to the cooling water.
- The heat losses produced in the rectifier (semiconductors, fuses, bus-bars) are transferred directly to the de-ionized water by means of the cooling bus-bars and heat sinks.

The de-ionized water is circulated by two redundant single-stage centrifugal pumps.

All parts which come into contact with the de-ionized water are made of stainless steel.

In order to keep anode erosion away from the de-ionized water circuit components which are at DC potential, the conductivity of these circuits must be kept within certain limits. Therefore the cooling unit comprises an ion- exchanger which can be switched on if the conductivity becomes too high. The ion exchanger is filled with polymerized styrene resins which have the property of giving off their hydrogen- and hydroxyl ions and absorbing the ions from the dissolved substances instead. The conductivity will be supervised by a conductivity meter installed in the cooling unit and connected to the alarm system.

An expansion tank in the cooling set serves to compensate changes in the de-ionized water volume and also increases the thermal time constant of the de-ionized water circuit. Brief irregularities in the cooling water supply therefore have no effect on the uniform cooling of the rectifier.

Technical data

Cooling water flow rate per cooling unit:

max. inlet temperature 27°C

max. outlet temperature 35°C

9.8 m³/ h

Heat exchanger

Cooling method WFWF (Water to water)

Cooling medium De-ionized water

Number of water to water heat exchangers per

cooling system:

2 pcs (2 x 100%)

Dissipated power of heat exchanger: 95 kW

Heat exchanger material Stainless steel

Pumps

Number of pumps per cooling system: 2 pcs. (2 x 100%)

Power per pump: approx. 4 kW

Pump Skid

Dimensions of the pump skid (W x D x H):

(incl. Heat exchanger)

appr. 2000 x 1400 x 2200 mm

Material: Painted steel

Terminals: Flanges in accordance with DIN – Standard

Monitoring and protection

(internal de-ionized water circuit)

- Conductivity measuring instrument with sensor

- Water level monitor in expansion tank

- Pressure gauge with contact

- Electronic temperature supervision (1 x analogue value, 1 x contact)

- Flow meter with LED and contact

Ambient Air Cooling System. G*eneral description*

A cooling unit will be foreseen for each rectifier room. It serves to dissipate the part of the rectifier heat losses which will be dissipated to the ambient air as well as the losses of those sections of the AC and DC bus bars located in the rectifier room. The cooling unit is equipped with an air duct in order to draw the hot air from the top of the room and to blow the cold air to the bottom.

Technical data

Desired room temperature inside rectifier housing □ 50 °C

Cooling method: Air / Water

Number of heat exchangers per cooling unit: 1

Dissipated power per heat exchanger: 24 kW

Cooling water flow rate per cooling unit:

max. inlet temperature 27°C

max.outlet temperature 35°C

Appr. 2.5 m³/ h