UTE TSK TÉCNICAS REUNIDAS ASHUGANJ NORTH	**Ashuganj Power Station Company Ltd. (APSCL)**	

ASHUGANJ COMBINED CYCLE POWER PLANT PROJECT (NORTH)

UTS PROJECT NO. 7485	**UNIT: 20**
PURCHASE ORDER NUMBER (P.O.R) 0748501030	**EQUIPMENT : GAS PERFORMANCE HEATER**

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DATE: 24/07/2015

DOCUMENT VENDOR IDENTIFICATION:

Forain

PREMATECNICA
Equipos e instalaciones para las industrias de proceso y energía

DOCUMENT TITLE: **INSTALLATION, SITE ERECTION, O&M INSTRUCTION MANUALS**

VENDOR DOCUMENT No: **44F490-OMM**	REV: **2**	CODE: **MAN-0001**
UTS DOCUMENT No: **V-0748501030-0021**	REV: **2**	
KKS DOCUMENT No.: **07485-20-EKC-MMP-PRE-001**	REV: **2**	

INSTALLATION, SITE ERECTION, O&M INSTRUCTION MANUALS

PROJECT : ASHUGANJ 450 MW CCPP (North)

MAIN CONTRACTOR : TSK-TECNICAS REUNIDAS

CONTRACT No. : 0748501030

EQUIPMENT : PERFORMANCE HEATER & COALESCING FILTER

ITEM No. : 20EKB10 AT001 ; 20EKC10 AC001

DOC. No. : 44F490-OMM

DATE : 16.04.2015

REV.	DESCRIPTION	PREP'D	CHECK'D	DATE
2	ISSUE FOR APPR.	NP	IC	26.06.15
1	ISSUE FOR APPR.	NP	IC	21.05.15
0	ISSUE FOR APPR.	NP	IC	16.04.15

COMPILATO DA NP
DRAWN UP BY

REV. 2 **DATA** 26.06.15
REV. DATE

RIF. 44F490-OMM
REF.

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Milano - Italy

INSTRUCTION FOR INSTALLATION AND MAINTENANCE
OF
FORAIN VERTICAL ABSOLUTE SEPARATORS TYPE "SA"
COALESCING FILTER ITEM "20EKB10AT001"

A. PRINCIPLE OF OPERATION

The Coalescing Filter (our type "SA") is a two-stage equipment which guarantees a high efficiency in removing the liquid and solid particles present in the gas stream. The first stage a vane type separator is foreseen for a first removal, and at the second stage a set of coalescent filter elements. When the gas enters the vessel, it goes towards the first stage, placed in the low part of the same. The liquid particles (and the solid ones) are then separated and collected in the lower part of the vessel, while the high efficiency final separation takes place in the second stage consisting of coalescent filter elements; after that, the clean gas goes out of the vessel.

B. INSTALLATION

The most important thing to be considered during installation of an absolute separator type SA is the right gas direction in the vessel (the filter element is crossed from internal to external). The installation must be made so that the gas flow passes at first across the first stage and then across the filter elements. To do this, refer to absolute separator drawing (see our doc. N° 44F490-9071, your ref. 07485-EKC-MDP-PRE-001) or eventual nameplate or flow arrows. The absolute separator type SA is supplied with the required filter elements. Before putting into operation it is necessary to check that the filter elements are properly installed and that the wing nuts are well tight for a perfect seal. The maximum tolerances for vertical leveling of the equipment is ± 10mm.

CAUTION!!!

The filter elements are made of material sensible to high temperatures. When a welding on the vessel is required, the elements must be removed and replaced only after the welding has been completed.

C. OPERATION

The Coalescing Filter type SA is designed for a certain gas flow rate at stated conditions, considering a certain initial pressure drop through the clean filter elements (see data sheet our doc. N° 44F490-DSFS, your ref. 07485-20-EKC-MHP-PRE-002). The filter elements have a practically unlimited duration in the presence of liquid entrainments in the gas flow. In case there are solid entrainments, there will be an increase of the pressure drop in the long run. The Coalescing Filter can operate without efficiency decrease of solid and liquid particles removal until a pressure drop of about 1,5 bar. With a pressure drop of more than 2 bar, the filtering element will collapse. The Coalescing Filter is equipped with two nozzles for installation of an instrument for differential pressure metering, the nozzle near the inlet is for high pressure connection, the other one is for low pressure. The Coalescing Filter does not require any particular precaution. Only during the start-up, when the line downstream the filter is not pressurized, you must take care that the gas enters the separator slowly not to subject the filter element to an excessive internal pressure (in this case, the filter element could get damaged). The Coalescing Filter is supplied complete with all the connections for valves and instruments required by the customer (vent, drain, level gauge, safety valve and so on see data sheet our doc. N° 44F490-DSFS, your ref. 07485-20-EKC-MHP-PRE-002). The absolute separator SA does not require any particular precaution. Only during the start-up, when the line downstream the filter is not pressurized, you must take care that the gas enters the separator slowly not to subject the filter element to an excessive internal pressure (in this case, the filter element could get damaged). The absolute separator SA is supplied complete with all the connections for valves and instruments required by the customer (vent, drain, level gauge, safety valve and so on).

D. MAINTENANCE

The maintenance of the Absolute Separator SA is restricted to the replacement of the filter elements when the pressure drop overcomes the foreseen values. Another suggested operation is the periodic cleaning inside the vessel with suitable fluids (water, steam, solvents and so on).
The access to filter elements is through the quick opening closure placed in the higher part of the vessel.
Please, compare the replaced filtering elements with the new ones and be sure of correct replacement.

To replace the filter elements, follow the following instructions (see page 4):

1. Vent the vessel and remove the top cover
2. Unscrew nut A holding bolt E fixed, take away washer B and gasket C
3. Clean the filter element D, by blowing compressed air towards the inside or replace it
4. Re-position the cleaned / new filter element
5. Be sure that the filter element lays properly against the support plate F
6. Carry out operations 2 – 1 in the opposite way

Spare parts available by: F O R A I N S.r.l.
Via G. B. Boeri, 11
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Tel : 02 / 84.67.345
Fax : 02 / 84.65.325
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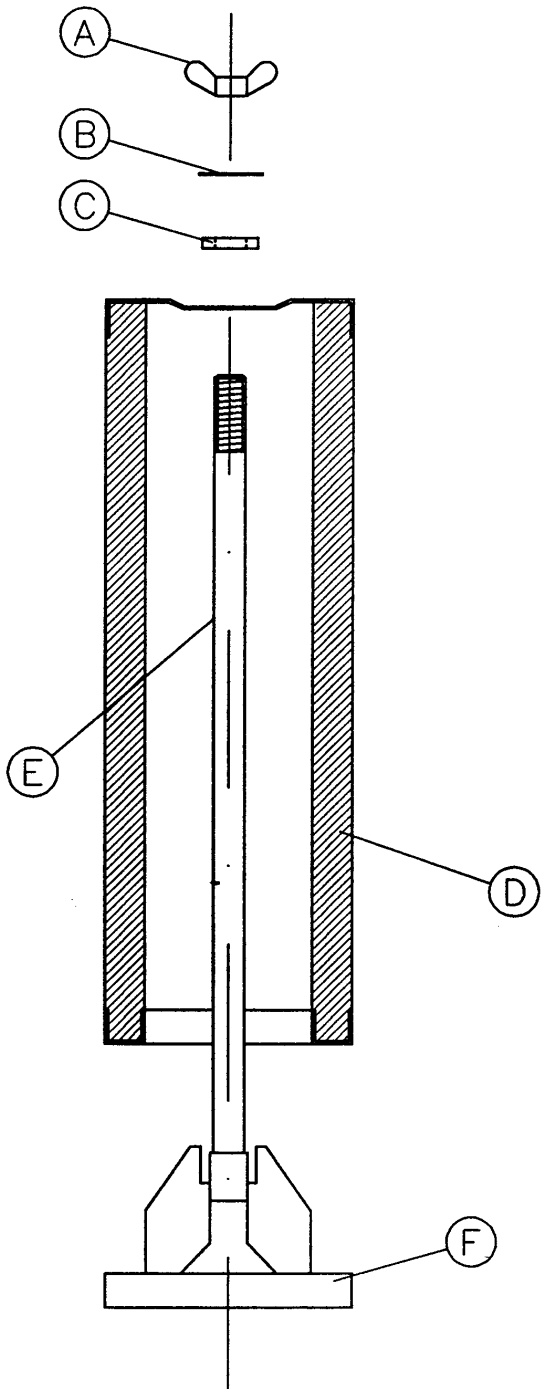
For Spare parts list see doc. No. 07485-20-EKC-MLJ-PRE-001 (Forain No. 44F490-SP)

Cartridges FORAIN code (see equipment drawing our doc. N° 44F490-9071, your ref. 07485-EKC-MDP-PRE-001)



F O R A I N S.r.l.
Milano - Italy

INSTALLATION AND OPERATING INSTRUCTIONS
FOR
HEAT EXCHANGER TYPE "BEM"
PERFORMANCE HEATER ITEM "20EKC10AC001"

A. HOW THE HEAT EXCHANGER WORKS

The Gas Fuel Performance Heater consists of two stacked shell and tube heat exchangers in series, gas and water side isolation valves, vent and drain valves, and instrumentation required to support the operation of the gas fuel heater (See Figure 1). The heat exchangers are single pass, fixed tubesheet type, and include expansion bellows on the shell. The heat exchangers are mounted on saddles. The heat exchanger is designed for the intermediate pressure feedwater to flow within the tubes and the lower pressure gas fuel to flow through the shell. With water pressure being higher than gas pressure, this configuration insures that gas will not enter the feedwater system following tube leak or rupture. The design of the system incorporates various safeguards designed to prevent water entering the gas from being admitted to the gas turbine combustion system. Each heat exchanger is furnished with a drain pot at one end of the shell. These drain pots house level instrumentation that provide early indication of tube leak/rupture prior to and during gas turbine operation. The physical configuration of the heat exchanger has the gas inlet at the side of the first stage heat exchanger and the outlet at the top of the second stage heat exchanger. The nozzles oriented in this manner prevent water from collecting in the inlet or outlet piping following a tube rupture event. The Gas Fuel Heater is sized to accommodate temperature downstream of the heat exchanger and will be able to supply the desired temperature for all operating conditions. The heat exchanger belongs to a family of shell and tube heat exchangers sized by following TEMA regulations. It consists of a cylindrical body, the shell, È costituito da un corpo cilindrico, il mantello, in which natural gas circulates. It includes shell and tube where there is water, the thermal exchange comes through the sides of the internal pipes. The pipe ends are connected to the tube plates which allow the fluid separation shell side from that one pipe side. The shell and tube is equipped with baffles having shape of a circular segment which allow to increase the turbulences inside the fluid shell side and consequently to obtain more higher coefficients of thermal exchange.The baffles have also the task to constraint and to support pipes inside shell. The gas, along the whole exchanger, describes as per figure 2 an undulating path. In this way it is possible to maximize the thermal exchange since the fluid, being many times in an orthogonal direction towards the bundle of tubes, succeds in easily receiving the energy coming from the hot water.

The pressure equipment has no openings for internal inspection. It is possible to dismount the cover on tube side to carry out the inspection of internal channel.

B. ASSEMBLY

The FORAIN heat exchanger BEM is shipped ready to operate. Before putting the heat exchanger into operation, check the bolts thightening (see par. F) and the sealing between tube-sheet and main flange on both shell side and tube side

The installation of heat exchanger must be such as to allow the maximum access facility to the mechanical means for its maintenance.

For normal maintenance, please note the following recommendation :

- Check and verify the stud bolts and nuts tightening either every 6 months or according to the plant maintenance programme
- In case the gaskets are replaced due to lacking presence, check that the gaskets seats and the rods are accurately cleaned by using acetone or solvents with cleaned rags before closing the flanges. Check and verify the bolts and the nuts thightening

The maximum tolerances for vertical leveling of the equipment is ±10 mm.

C. DISASSEMBLY

To carry out this operation, follow the following steps:
- Depressurize the heat exchanger
- Vent the gas from the shell
- Drain the water from the channel cover
- Disconnect the inlet and outlet flange of main line
- Sling the heat exchanger distributor with suitable rope and secure to the hook of a suitable crane (for the dimensions of heat exchanger, please refer to drawing N. 44F490/9070 your ref. 07485-20-EKC-MDP-PRE-002)
- Remove the bolts of the tube sheet flange and remove the distributor
- After checking and repairing, reassemble (follow the steps in the opposite way)
- For bolts tightening instructions see section F

D. MAINTENANCE

Cleaning is necessary when is noticed a relevant reduction of performance due to dirt (any solid deposits). Before starting cleaning exceeding normally scheduled operations, it is necessary to check the efficiency of any thermostatic bypass device, the regular opening of valves, correct running of pumps etc. as main reasons for the reduction of performance.
It is difficult to foresee how often cleaning operations are needed, because this time is function of the nature of interested fluids, of the type of service (continuous or discontinuous), of temperature and of other parameters not determinable previously.
It is possible to perform the checks dictated by cycle of programmed maintenance related to the unit in which the equipment is installed.
Before starting maintenance operations it is necessary to stop running, discharge process fluids, and then to completely drain and vent. For heat exchangers internal cleaning is performed by a pressure water-jet or by water-steam, then it will be necessary to dry it with compressed air.
It will be necessary to replace main gaskets each time reassembly of headers/covers take place. It is recommended to reassembly headers/covers and to tighten bolting with the required care in order to avoid damage to main gaskets: proceed to alternative tightening of bolts placed on opposite sides, in order to progressively distribute loads, paying attention to manually tighten bolts up to their end and later completing the sealing with suitable tools.
For pressure vessels, internal cleaning is performed by circulating with appropriate decaling agents diluted in water only after having adopted all safety fundamental requirements as well as above mentioned arrangements.

E. CAUTION!!!

During lifting and handling, it is necessary to avoid any bumping of component against other objects (pillars, parts of the means of transport, platform etc.) in order not to damage components.
The lifting of the heat exchanger shall be carried out through metallic ropes fixed to the lifting lugs of the component.
To avoid fouling of the components, it is suggestible a storage under cover.

F. BOLTS THIGHTENING

1. The operations of maintenance of pressure vessels must be carried out when the equipment is isolated, drained and depressurized and with ambient temperature.
2. The maintenance must be carried out with suitable safety and lifting equipments.
3. Please, check the good condition of gaskets; in case these are damaged, they must be replaced with gaskets of the same type and dimensions (according to drawing).
4. Please, verify the contact surfaces of flanged connections.
   Also be sure that the frames have no corrosion and that the surfaces are clean.

5. Check the correct tightening of fixing bolts, by following the values of tightening couple described as follows:

GASKET INSTALLATION AND BOLT-TIGHTENING

- Place the gasket on the flange surface to be sealed.
- Bring the opposing flange into contact with the gasket.
- Place the bolts into the bolt holes.
- Finger-tighten the nuts.
- Follow the bolting sequence in the diagrams below.
- Doing so will cause cocking of the flange and the gasket will be crushed.
- Upon reaching the recommended torque requirements, do a clockwise bolt-to-bolt torque check to make certain that the bolts have been stressed evenly.
- Due to creep and stress relaxation, it is essential to prestress the bolts to ensure adequate stress load during operation.

BOLTING SEQUENCE DIAGRAM

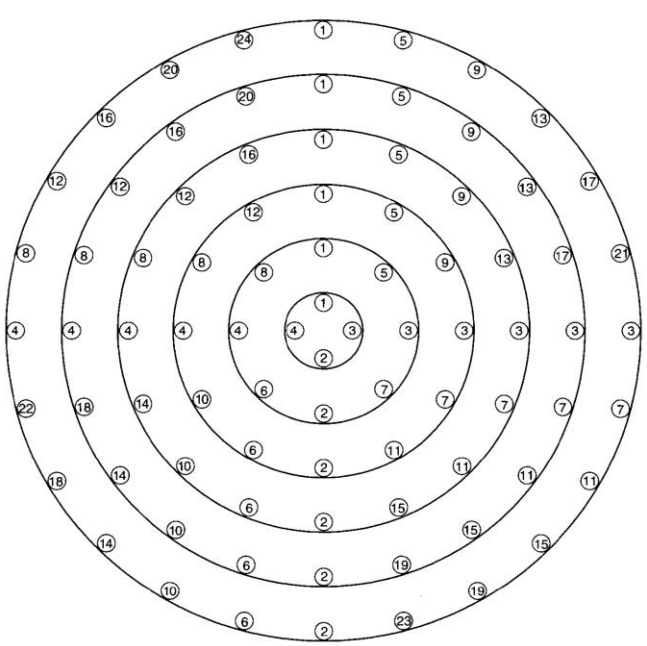


Figure 2-25. Sequence for tightening of flange bolts. *Note:* Bolts should be tightened to 1/3 of the final torque value at a time in the sequence illustrated in the figure. Only on the final pass is the total specified torque realized.

BOLT TORQUE REQUIRED FOR SEALING FLANGES

Acc. to Dennis Moss Design Manual

Notation

A_b = cross-sectional area of bolts, in.^{2}
A_g = actual joint-contact area of gasket, in.^{2}
b = effective gasket seating width, in.
d = root diameter of threads, in.
d_m = pitch diameter of threads, in.
G = diameter at location of gasket load reaction, in.
M = external bending moment, in.-lb
m = gasket factor
N = gasket width, in.
n = number of bolts
E_b = modulus of elasticity of bolting material at temperature, psi
E_g = modulus of elasticity of gasket material at temperature, psi
P = internal pressure, psi
P_e = equivalent pressure including external loads, psi
P_r = radial load, lb
P_T = test pressure, psi
F = restoring force of gasket (decreasing compression force) from initial bolting strain, lb
F_{bo} = initial tightening force, lb
ℓ_b = effective length of bolt, mid nut to mid nut, in.
W = total tightening force, lb
$W_{m1} = H + H_p$ = required bolt load, operating, lb
W_{m2} = required bolt load, gasket seating, lb
y = gasket unit seating load, psi
H = total hydrostatic end force, lb
H_P = total joint-contact surface compression load, lb
T = initial tightening torque required, ft-lb
t_g = thickness of gasket, in.
t_n = thickness of nut, in.
K = total friction factor between bolt/nut and nut/ flange face
w = width of ring joint gasket, in.

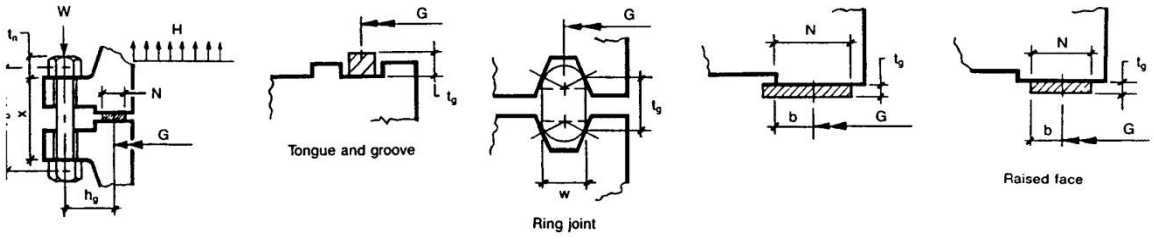


Figure 2-23. Flange and joint details.

Calculations

- *Equivalent pressure, P_e, psi.*

$$P_e = \frac{16M}{\pi G^3} + \frac{4P_r}{\pi G^2} + P = 1048.49\ psi$$

- *Hydrostatic end force, H, lb.*

$$H = \frac{\pi G^2 P_e}{4} = 365151\ lb$$

- *Total joint-contact-surface compression load, H_p, lb.*

$$H_P = 2b\pi GmP_e = 81903.1\ lb$$

- *Minimum required bolt load for gasket seating, W_{m2}, lb.*

$$W_{m2} = \pi bGy = 130197\ lb$$

- *Actual joint area contact for gasket, A_g, in.^{2}*

$$A_g = 2\pi bG = 26.04\ in.^2$$

- *Decreasing compression force in gasket, ΔF, lb.*

$$\Delta F = \frac{H}{1 + \frac{A_b E_b t_g}{A_g E_g l_b}} = 339939\ lb$$

- *Initial required tightening force (tension), F_{bo}, lb.*

$$F_{bo} = H_p + \Delta F = 421843\ lb$$

- *Total tightening force required to seal joint, W, lb.*

$$W = \text{greater of } F_{bo} \text{ or } W_{m2} = 421843\ lb$$

- *Required torque, T, ft-lb.*

$$T = \frac{KWd_m}{12n} = 427.99\ ft\text{-}lb$$

Required torque = minimum 1060 N·m
maximum 3050 N·m

- Only torque wrenches that have been calibrated should be used. The proper bolt tightening pattern must be followed with the desired ultimate torque value arrived at in a minimum of three equal increments. All bolts in the flange should then be checked in consecutive order in a counterclockwise direction. See “Gasket Installation”.
- No provisions have been made in these table to account for vibration effects on the bolts. These table are based on ambient conditions. If conditions different from these exist, we suggest that further analysis be performed to determine the appropriate torque values.

G. ESSENTIAL SAFETY REQUIREMENTS

Vessels are designed, manufactured and tested with the scope of ensuring compliance of their safety requirements, if started according to the prescriptions of this manual (which also gives the essential prescriptions to be followed for a correct installation).
Design of all pressure parts is performed in accordance with the design codes reported in the general drawing, taking into consideration the maximum allowable internal pressure, the minimum and maximum operating temperature, the hydrotest conditions and corrosion.

H. SPARE PARTS

Spare parts are available from:

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For Spare parts list see doc. No. 07485-20-EKC-MLJ-PRE-001 (Forain No. 44F490-SP).