



Hofung Sulphur
Technology

DATA SHEET
SHELL-TUBE HEAT EXCHANGERS

Project No. : HF220803

Waste Heat Boiler, 1st & 2nd Sulfur Condenser

E-0501, E-0502, E-0503

Rev.	Issue Data	Revision Description	Prepared by	Checked by	Approved by	Client approval
1	29/06/2023	Final PDP				
0	24/03/2023	For PDP				

Client	: Jiangsu Sopo (Group) Co., Ltd.
Plant	: Sulfur Recovery Unit
Location	: Zhenjiang, Jiangsu, P.R. China
Equipment	: Waste Heat Boiler, 1st & 2nd Sulfur Condenser
Sheet	1 of 17
Equipment No.	: E-0501, E-0502, E-0503
Data No.	: HF220803-P07.2-EDS-10



GENERAL DATA

Exchanger No. : E-0501 6)	Shell-and-Tube heat exchanger : Horizontal Shell
Equipment title : Waste Heat Boiler	Case identification : Design
Number requirement : One	Calculation type : Design
TEMA type : Special	Duty : 1575 kW
Mech. cleaning required	Overcapacity on
- shell side : No	- duty : - %
- tube side : Yes	- surface : - %

PROCESS DATA

Location	Shell side		Tube side		Unit
	BFW / Steam		Process gas / Sulfur		
Flow rate - total	3827 1) 2)		4696		kg/h
- liquid in / out	100	5	0	12.99	wt%
- vapour in / out	0	95	100	93.24 3)	wt%
Temperature - in / out	128	170	1032	185 4)	°C
Pressure at inlet	7.0		0.49		bar g
Pressure drop - calculated / allowed	Negl.	Negl.	0.04	0.04	bar
Fouling resistance	0.00017		0.00090		m ² .K/W
Average wall temperature	170		180		°C
Vapour properties	in	out	in	out	
- density			0.45	1.16	kg/m ³
- viscosity			0.047	0.021	cp
- specific heat			1.281	0.858	kJ/kg.K
- therm. conductivity			0.098	0.148	W/m.K
Liquid properties	in	out	in	out	
- density				1761	kg/m ³
- viscosity				118	cp
- specific heat				0.850	kJ/kg.K
- therm. conductivity				0.1452	W/m.K
Total heat duty : 1575 kW	Total surface per unit :				m ²
Effective temperature difference : 209.1 °C	Effective surface per unit :				m ²
Overall coefficient clean : W/m ² .K	Required surface per unit : 112.3				m ²
Overall coefficient fouled : 67.1 5) W/m ² .K	Number of tubes submerged : 200				
Total number of shells per unit : One					
Connected - in series : -					
- in parallel : -					

NOTES

- 1) BFW quantity includes 5% blow-down.
- 2) BFW / steam data refer to total duty of WHB and Condensers after subtraction of heat losses.
- 3) Including 1.95 wt% of sulfur mist.
- 4) Liquid sulfur is cooled more than process gas. And the temperature of liquid sulfur is about 178°C.
- 5) Empirical value.
- 6) E-0501, E-0502 and E-0503 are combined in one shell.

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Sheet 2 of 17

Equipment No. : E-0501, E-0502, E-0503

Data No. : HF220803-P07.2-EDS-10



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**DATA SHEET
SHELL-TUBE HEAT EXCHANGERS**

Project No. : HF220803

GENERAL DATA

Exchanger No.	: E-0502 5)	Shell-and-Tube heat exchanger	: Horizontal Shell
Equipment title	: 1st Sulfur Condenser	Case identification	: Design
Number requirement	: One	Calculation type	: Design
TEMA type	: Special	Duty	: 226 kW
Mech. cleaning required		Overcapacity on	
- shell side	: No	- duty	: - %
- tube side	: Yes	- surface	: - %

PROCESS DATA

Location	Shell side		Tube side		Unit
	BFW / Steam 1)		Process gas / Sulfur		
Flow rate - total			4110		kg/h
- liquid in / out			0	8.05	wt%
- vapour in / out			100	91.95 2)	wt%
Temperature - in / out			327	183 3)	°C
Pressure at inlet			0.39		bar g
Pressure drop - calculated / allowed			0.04	0.04	bar
Fouling resistance			0.00090		m ² .K/W
Average wall temperature	170		175		°C
Vapour properties	in	out	in	out	
- density			0.86	0.998	kg/m ³
- viscosity			0.026	0.021	cp
- specific heat			1.213	1.229	kJ/kg.K
- therm. conductivity			0.05	0.038	W/m.K
Liquid properties	in	out	in	out	
- density				1705	kg/m ³
- viscosity				118	cp
- specific heat				0.860	kJ/kg.K
- therm. conductivity				0.1449	W/m.K
Total heat duty	: 226	kW	Total surface per unit	:	m ²
Effective temperature difference	: 57.9	°C	Effective surface per unit	:	m ²
Overall coefficient clean	:	W/m ² .K	Required surface per unit	: 55.8	m ²
Overall coefficient fouled	: 69.9 4)	W/m ² .K	Number of tubes submerged	: 109	
Total number of shells per unit	: One				
Connected - in series	: -				
- in parallel	: -				

NOTES

- 1) BFW / steam data refer to sheet 2.
- 2) Including 0.77 wt% of sulfur mist.
- 3) Liquid sulfur is cooled more than process gas. And the temperature of liquid sulfur is about 177°C.
- 4) Empirical value.
- 5) E-0501, E-0502 and E-0503 are combined in one shell.

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Equipment No. : E-0501, E-0502, E-0503

Data No. : HF220803-P07.2-EDS-10



GENERAL DATA

Exchanger No.	: E-0503 5)	Shell-and-Tube heat exchanger	: Horizontal Shell
Equipment title	: 2nd Sulfur Condenser	Case identification	: Design
Number requirement	: One	Calculation type	: Design
TEMA type	: Special	Duty	: 73 kW
Mech. cleaning required		Overcapacity on	
- shell side	: No	- duty	: - %
- tube side	: Yes	- surface	: - %

PROCESS DATA

Location	Shell side		Tube side		Unit
	BFW / Steam 1)		Process gas / Sulfur		
Flow rate - total			3759		kg/h
- liquid in / out			0	2.29	wt%
- vapour in / out			100	97.71 2)	wt%
Temperature - in / out			220	175 3)	°C
Pressure at inlet			0.29		bar g
Pressure drop - calculated / allowed			0.04	0.04	bar
Fouling resistance			0.00090		m ² .K/W
Average wall temperature	170		172		°C
Vapour properties	in	out	in	out	
- density			0.89	0.919	kg/m ³
- viscosity			0.022	0.020	cp
- specific heat			1.242	1.245	kJ/kg.K
- therm. conductivity			0.042	0.038	W/m.K
Liquid properties	in	out	in	out	
- density				1758	kg/m ³
- viscosity				125	cp
- specific heat				0.840	kJ/kg.K
- therm. conductivity				0.1438	W/m.K
Total heat duty : 73 kW			Total surface per unit :	m ²	
Effective temperature difference : 19.6 °C			Effective surface per unit :	m ²	
Overall coefficient clean : W/m ² .K			Required surface per unit :	57.9 m ²	
Overall coefficient fouled : 64.3 4) W/m ² .K			Number of tubes submerged :	105	
Total number of shells per unit : One					
Connected - in series : -					
- in parallel : -					

NOTES

- 1) BFW / steam data refer to sheet 2.
- 2) Including 0.21 wt% of sulfur mist.
- 3) Liquid sulfur is cooled more than process gas. And the temperature of liquid sulfur is about 173°C.
- 4) Empirical value.
- 5) E-0501, E-0502 and E-0503 are combined in one shell.

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Equipment No. : E-0501, E-0502, E-0503

Data No. : HF220803-P07.2-EDS-10



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**DATA SHEET
SHELL-TUBE HEAT EXCHANGERS**

Project No. : HF220803

Exchanger No. : E-0501
Equipment title : Waste Heat Boiler

CONSTRUCTION DATA PER SHELL

Shell inside diameter	: 2800 6)	mm	Num. of tube holes per tubesheet	: 200	
Bundle diameter outer tube limit	: 799	mm	Type of tubes	: Bare	
Number of passes shell side	: One		Tube OD (plain end)	: 32	mm
Number of passes tube side	: One		Tube wall thickness	: 5.0	mm
Baffle type	: Support		Tube length	: 5700	mm
Baffle cut	:	%	Tube pitch	: 48	mm
Baffle orientation	: Vertical		Tube lay-out angle	: 90 7)	°
Tube attachment	: Strength welded		Tube sheet thickness	: ≤30 8)	mm
Impingement protection below inlet nozzle			Baffle spacing central	:	mm
	: No		Baffle spacing inlet/outlet	:	mm
Number of cross passes	:				

MAIN CONSTRUCTION MATERIAL 1)

Part	Material	Part	Material
Shell	Carbon Steel	Channel flange - shell side	
Channel - shell	Carbon Steel	- cover side	
- head	Carbon Steel	Nozzles - shell side	Carbon Steel
Fixed tube sheet	Carbon Steel	- tube side	Carbon Steel
Tubes	Carbon Steel	Cladding / lining - shell side	
Shell flange - channel side		- tube side	see sheet 9
Baffles and support plates	Carbon Steel	- tube sheets 6)	see sheet 11, 12, 13

DESIGN DATA

	Shell side	Tube side	Tube sheets	Unit
Cladding / lining		See sheet 9	See sheet 11, 13	
Corrosion allowance	1.5	3.0 2)	4.5 (3.0 + 1.5)	mm
Design pressure	11 / FV	3.0 3)		bar g
Design temperature	200	220 4)		°C
Max. H2 partial pressure				bar g
Max. H2S partial pressure				bar g
Insulation required	Against heat loss	Against heat loss 5)		

NOTES

- 1) For additional material requirements see 'Material Specification' doc.no. : HF220803-P04-MLS.
- 2) Except for tubes.
- 3) Mechanical strength of inlet channel E-0501 to be based on a pressure of 7.0 barg at a stress of 0.9 hot yield.
- 4) Design temperature of inlet channel E-0501 is 340 °C, and that of sulfur condensers is 370°C.
- 5) Except of inlet channel E-0501.
- 6) Only applicable for Waste Heat Boiler E-0501.
- 7) Refer to sheet 10 for tube layout.
- 8) See note 1 on sheet 11 & 13.

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Sheet 5 of 17

Equipment No. : E-0501, E-0502, E-0503

Data No. : HF220803-P07.2-EDS-10



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**DATA SHEET
SHELL-TUBE HEAT EXCHANGERS**

Project No. : HF220803

Exchanger No. : E-0502

Equipment title : 1st Sulfur Condenser

CONSTRUCTION DATA PER SHELL

Shell inside diameter	: 1)	mm	Num. of tube holes per tubesheet	: 109
Bundle diameter outer tube limit	: 471	mm	Type of tubes	: Bare
Number of passes shell side	: One		Tube OD (plain end)	: 32 mm
Number of passes tube side	: One		Tube wall thickness	: 3 mm
Baffle type	: Support		Tube length	: 5700 mm
Baffle cut	:	%	Tube pitch	: 40 mm
Baffle orientation	: Vertical		Tube lay-out angle	: 60 2) °
Tube attachment	: Strength welded		Tube sheet thickness	: 1) mm
Impingement protection below inlet nozzle			Baffle spacing central	: mm
	: No		Baffle spacing inlet/outlet	: mm
Number of cross passes	:			

MAIN CONSTRUCTION MATERIAL 1)

Part	Material	Part	Material
Shell		Channel flange - shell side	
Channel - shell		- cover side	
- head		Nozzles - shell side	
Fixed tube sheet		- tube side	
Tubes		Cladding / lining - shell side	
Shell flange - channel side		- tube side	
Baffles and support plates		- tube sheets	

DESIGN DATA 1)

	Shell side	Tube side	Tube sheets	Unit
Cladding / lining				
Corrosion allowance				mm
Design pressure				bar g
Design temperature				°C
Max. H2 partial pressure				bar g
Max. H2S partial pressure				bar g
Insulation required				

NOTES

1) See sheet 5.
2) Refer to sheet 10 for tube layout.

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	Equipment No. : E-0501, E-0502, E-0503
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**DATA SHEET
SHELL-TUBE HEAT EXCHANGERS**

Project No. : HF220803

Exchanger No. : E-0503

Equipment title : 2nd Sulfur Condenser

CONSTRUCTION DATA PER SHELL

Shell inside diameter	: 1)	mm	Num. of tube holes per tubesheet	: 104
Bundle diameter outer tube limit	: 463	mm	Type of tubes	: Bare
Number of passes shell side	: One		Tube OD (plain end)	: 32 mm
Number of passes tube side	: One		Tube wall thickness	: 3 mm
Baffle type	: Support		Tube length	: 5700 mm
Baffle cut	:	%	Tube pitch	: 40 mm
Baffle orientation	: Vertical		Tube lay-out angle	: 60 2) °
Tube attachment	: Strength welded		Tube sheet thickness	: 1) mm
Impingement protection below inlet nozzle			Baffle spacing central	: mm
	: No		Baffle spacing inlet/outlet	: mm
Number of cross passes	:			

MAIN CONSTRUCTION MATERIAL 1)

Part	Material	Part	Material
Shell		Channel flange - shell side	
Channel - shell		- cover side	
- head		Nozzles - shell side	
Fixed tube sheet		- tube side	
Tubes		Cladding / lining - shell side	
Shell flange - channel side		- tube side	
Baffles and support plates		- tube sheets	

DESIGN DATA 1)

	Shell side	Tube side	Tube sheets	Unit
Cladding / lining				
Corrosion allowance				mm
Design pressure				bar g
Design temperature				°C
Max. H2 partial pressure				bar g
Max. H2S partial pressure				bar g
Insulation required				

NOTES

- 1) See sheet 5.
- 2) Refer to sheet 10 for tube layout.

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Equipment No. : E-0501, E-0502, E-0503
Data No. : HF220803-P07.2-EDS-10



NOZZLES DATA

Mark	Number	Nom. Diameter	Service	Remarks
N1	1	ID 1450	Gas inlet	1) 5)
N2	1	250	Gas outlet	
N3	1	40	BFW inlet	2)
N4	1	150	Steam outlet	
N5	1	50	Blow down	
N6	2	5)	Relief valve	
N7	1	50 x 20	Vent	
N8	1	50	Blow down / drain	3)
N9	1	50	Steam inlet	4)
N10	1	80 x 100	Sulfur outlet	
N11	1	250	Gas inlet	
N12	1	250	Gas outlet	
N13	1	80 x 100	Sulfur outlet	
N14	1	250	Gas inlet	
N15	1	250	Gas outlet	
N16	1	80 x 100	Sulfur outlet	

INSTRUMENT CONNECTIONS

K1	2	5)	LC (H/L)	7)
K2	2	5)	LZ (LL)	7)
K3	2	5)	LG	7)
K4	2	5)	LG	7)
K5	1	5)	PG	7)
K6	2	5)	Pressure tap	6)

MANHOLES ETC.

A1	1	600	Manhole	Blinded with davit

NOTES

- 1) Inside diameters of channel and refractory to be equal to those of the Main Combustion Chamber.
- 2) With perforated distributor pipe (design by manufacturer).
- 3) On DN150 pad type nozzle.
- 4) With perforated distributor pipe (design by manufacturer). For heating up only.
- 5) To be determined during detailed engineering.
- 6) Located above centerline of inlet channel.
- 7) With stilling wells, located near the back end of the boiler.

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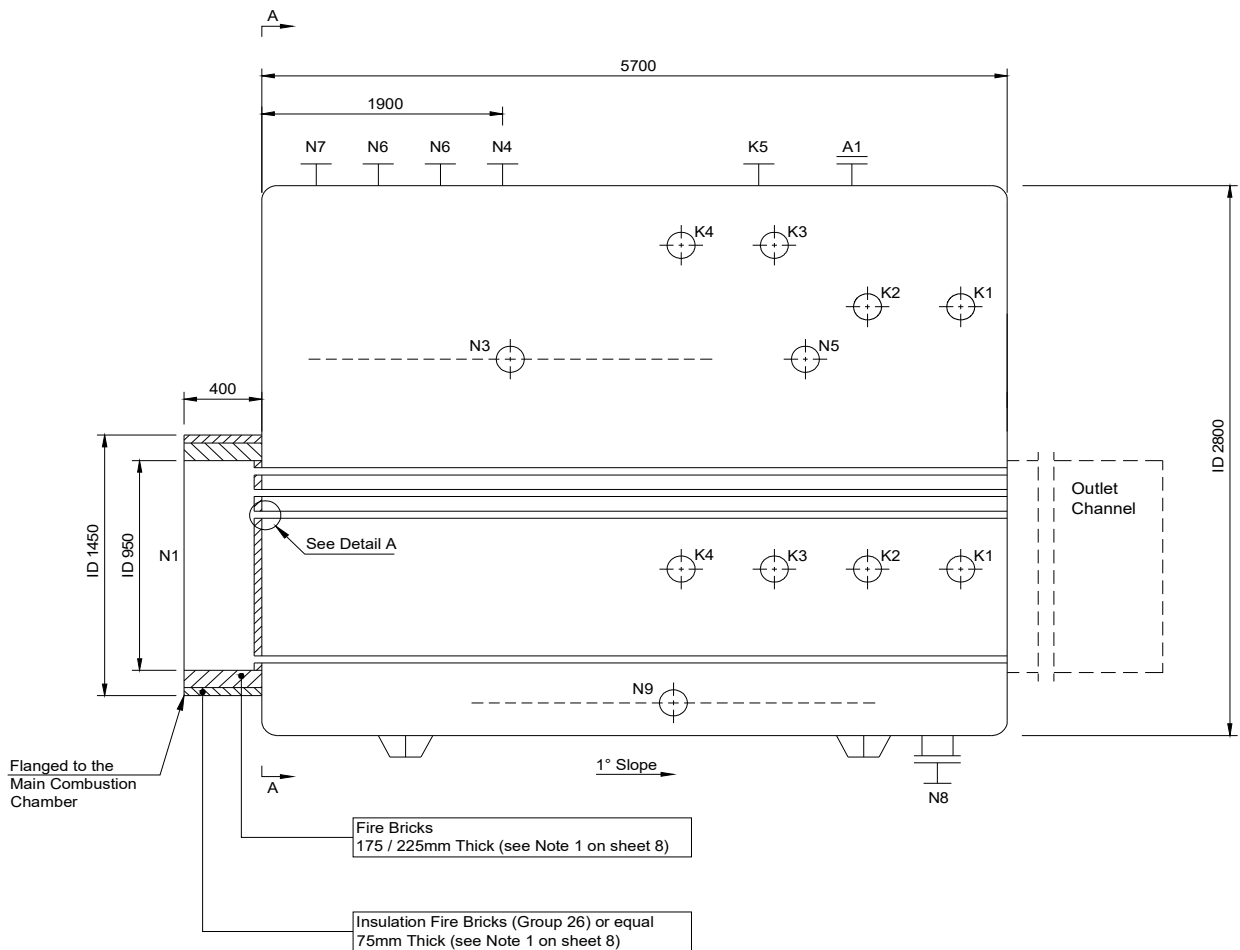
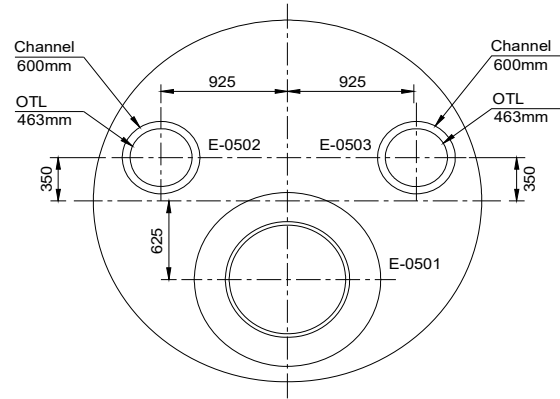
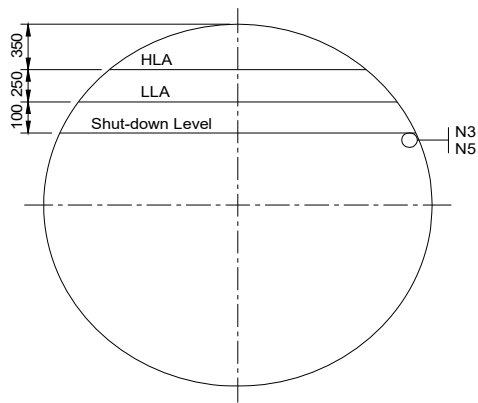
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Equipment No. : E-0501, E-0502, E-0503

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SECTION A-A

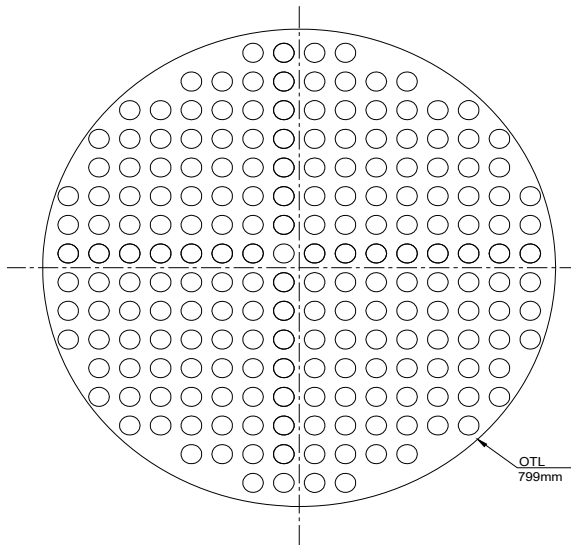


Note: Hold for nozzle position.

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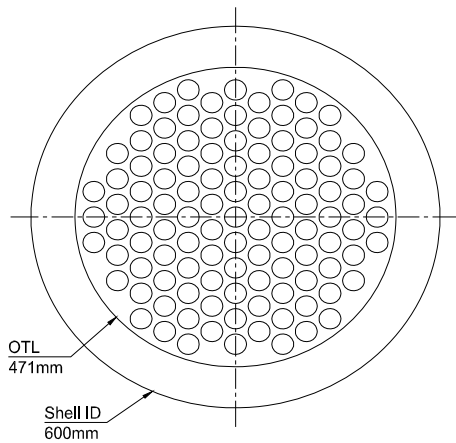
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Equipment No. : E-0501, E-0502, E-0503
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TUBE LAY-OUT



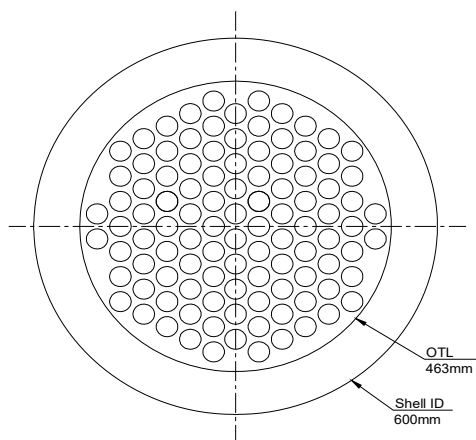
E-0501

Outer tube limit	:	799	mm
Tube diameter	:	32	mm
Tube pitch	:	48	mm
Tube lay-out angle	:	90	°
No. of tubes	:	200	



E-0502

Outer tube limit	:	471	mm
Tube diameter	:	32	mm
Tube pitch	:	40	mm
Tube lay-out angle	:	60	°
No. of tubes	:	109	



E-0503

Outer tube limit	:	463	mm
Tube diameter	:	32	mm
Tube pitch	:	40	mm
Tube lay-out angle	:	60	°
No. of tubes	:	104	

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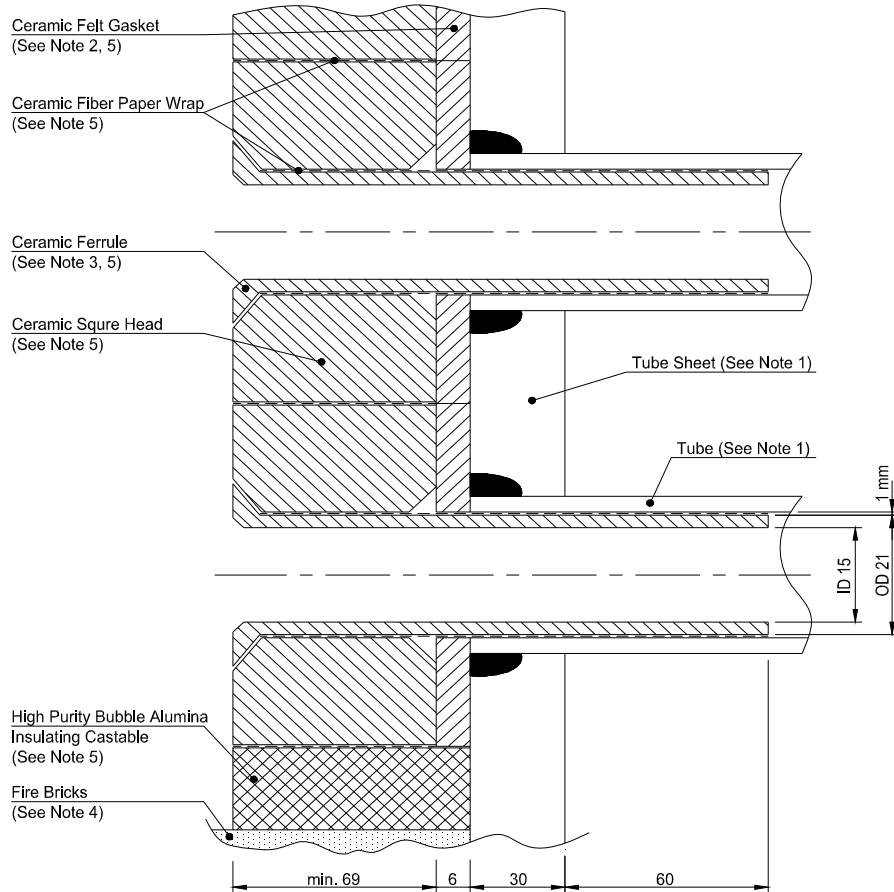
Sheet 10 of 17

Equipment No. : E-0501, E-0502, E-0503

Data No. : HF220803-P07.2-EDS-10

RECOMMENDED TUBESHEET PROTECTION FOR WASTE HEAT BOILER

Detail A
(2-Piece Square Head Ferrule)



NOTES

- 1) The maximum inlet tube sheet thickness, including corrosion allowance should be 30 mm for the part covered with insulating lining. The maximum tube/tube sheet temperature shall not exceed 340 °C at specified operating data and specified protective materials. Any deviation from the above requirements shall be approved by Hofung Sulphur Technology.
- 2) The gaskets are part of supply ferrules.
- 3) The wall thickness of the ferrules shall be 3.0 mm.
- 4) Refractory identical to refractory of Main Combustion Chamber.
- 5) Specification of the refractory materials as indicated on the sketch.

Tubesheet lining	: High purity bubble alumina insulating castable : $Al_2O_3 = 94 - 95\%$ Max. service temperature has to be min. 1750 °C
Ceramic ferrule	: Material : $Al_2O_3 = 85-94\%$ Max. service temperature has to be min. 1750 °C
Ceramic felt gasket	: Alumina-Silica fibres, density ca. 190 kg/m ³ Service temperature for continuous use has to be min. 1260 °C
Ceramic fibre paper	: Alumina-Silica fibres. Service temperature for continuous use has to be min. 1260 °C.
- 6) Recommended type of ferrule : 2 piece square head.

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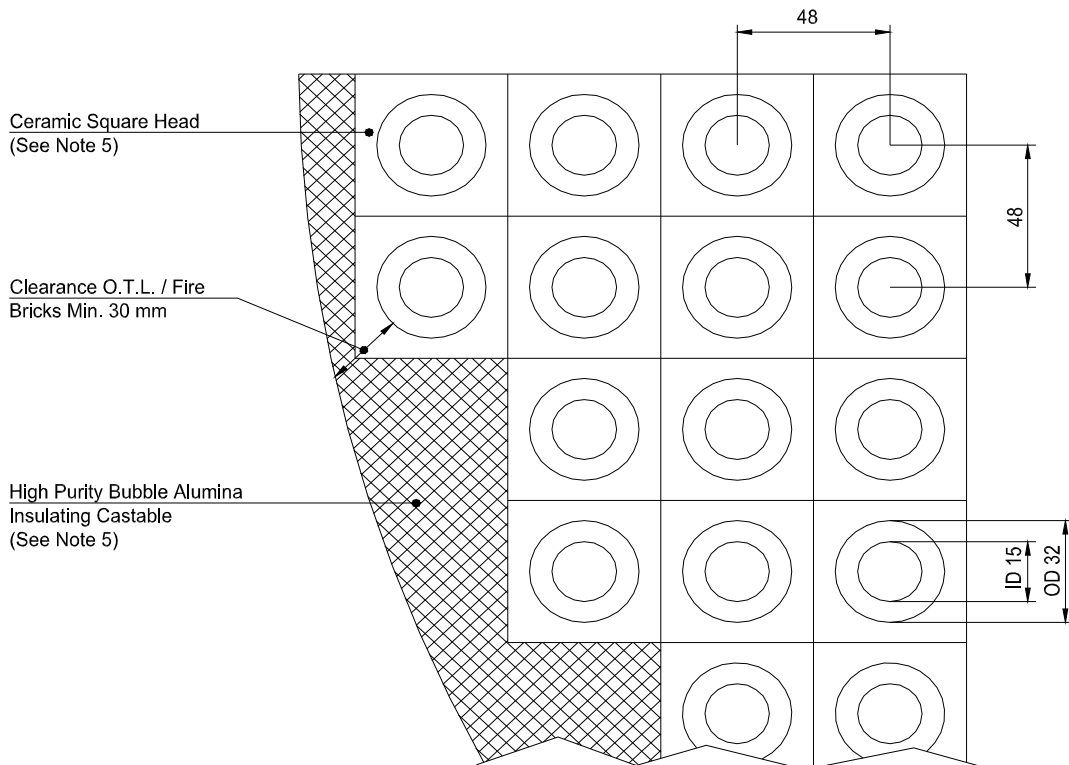
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Equipment No. : E-0501, E-0502, E-0503

Data No. : HF220803-P07.2-EDS-10

2-PIECE SQUARE HEAD TUBE SHEET PROTECTION

Front Tube Sheet Detail



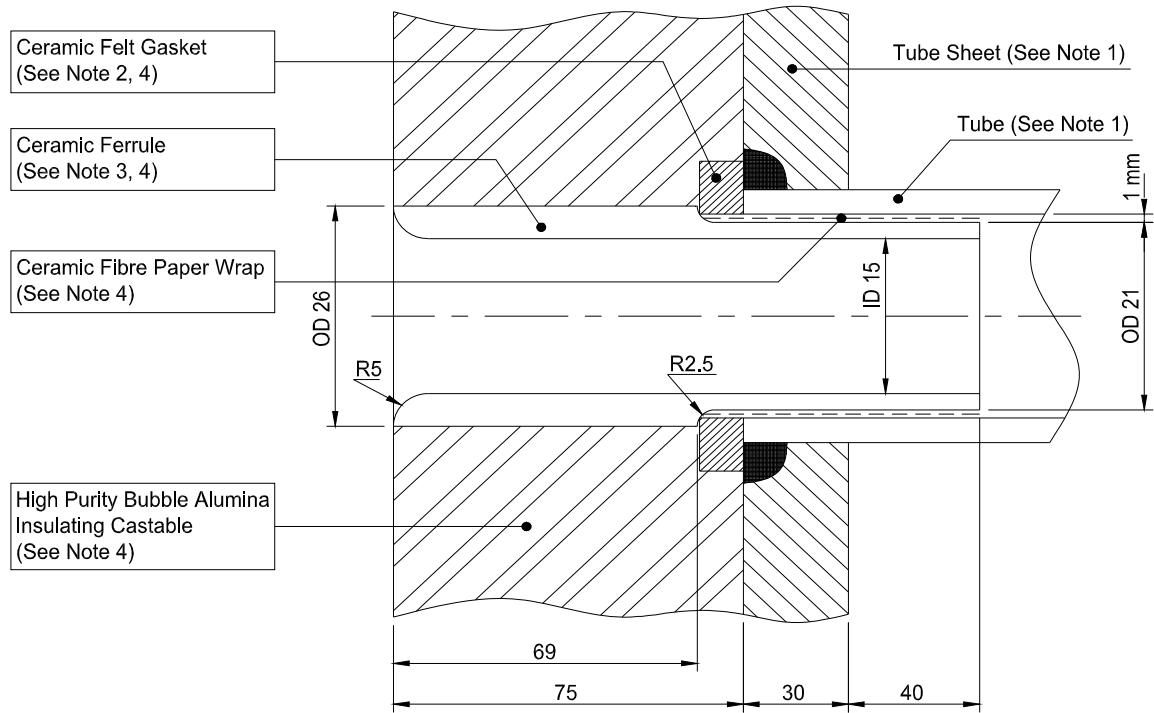
For notes see sheet 11.

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Sheet	12	of	17
Equipment No. :	E-0501, E-0502, E-0503		
Data No. :	HF220803-P07.2-EDS-10		

ALTERNATIVE TUBE SHEET PROTECTION FOR WASTE HEAT BOILER

Detail A



NOTES

- 1) The maximum inlet tube sheet thickness, including corrosion allowance should be 30 mm for the part covered with insulating lining. The maximum tube/tube sheet temperature shall not exceed 340 °C at specified operating data and specified protective materials. Any deviation from the above requirements shall be approved by Hofung Sulphur Technology.
- 2) Dimensions of gaskets are 36 mm OD / 23 mm ID and 6 mm thick. Any deviation from these requirements shall be approved by Hofung Sulphur Technology.
- 3) The wall thickness of the ferrules shall be 3.0 mm for the part inserted in the tubes.
- 4) Specification of the refractory materials as indicated on the sketch.

Tubesheet lining	: High purity bubble alumina insulating castable : Al ₂ O ₃ = 94 - 95%
	Max. service temperature has to be min. 1750 °C
Ceramic ferrule	: Material : Al ₂ O ₃ = 85-94%
	Max. service temperature has to be min. 1750 °C
Ceramic felt gasket	: Alumina-Silica fibres, density ca. 190 kg/m ³
	Service temperature for continuous use has to be min. 1260 °C
Ceramic fibre paper	: Alumina-Silica fibres.
	Service temperature for continuous use has to be min. 1260 °C

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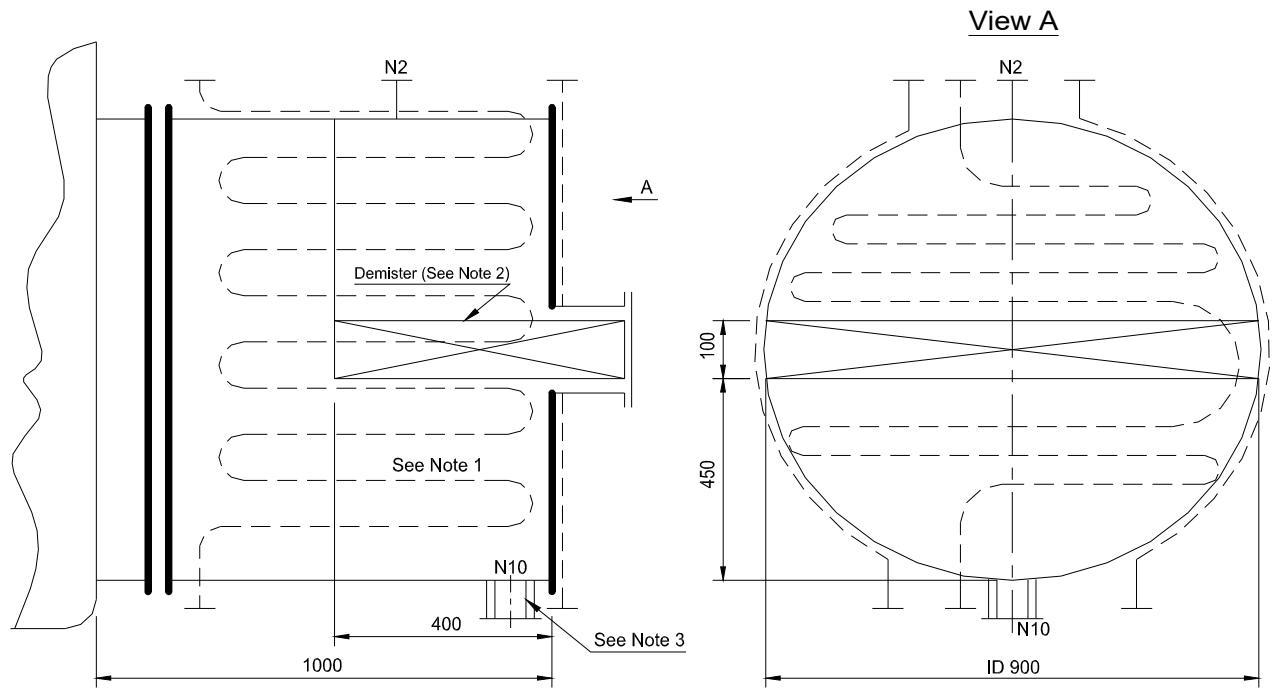
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Equipment No. : E-0501, E-0502, E-0503

Data No. : HF220803-P07.2-EDS-10

OUTLET CHANNEL OF E-0501



Hold for nozzle position.

NOTES

- 1) Outlet channel to be provided with 1" steam tracing, 300 mm pitch, tracing by manufacturer.
- 2) Demister removable from drawer.
- 3) Sulfur outlet N10 shall be at the bottom of outlet channel close to the end plate.

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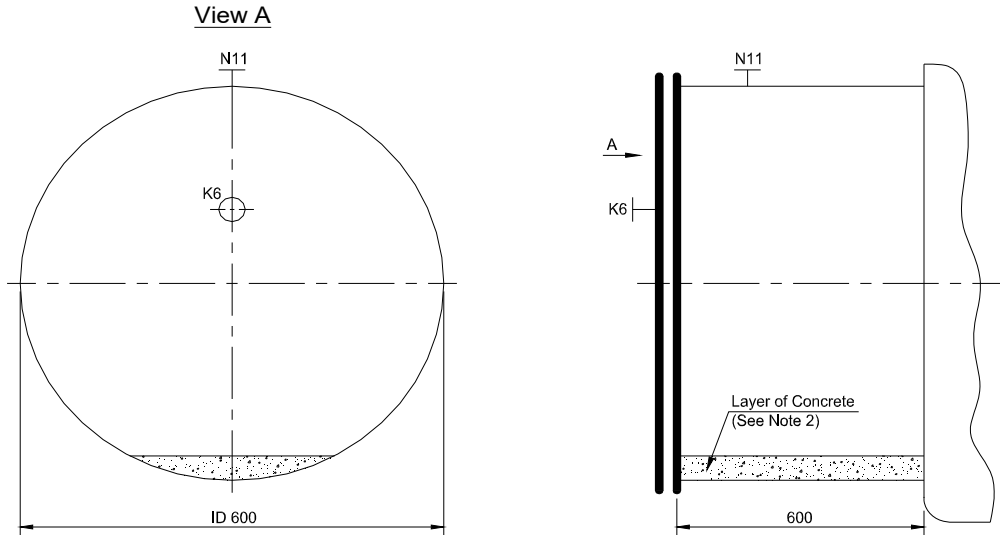
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Equipment No. : E-0501, E-0502, E-0503

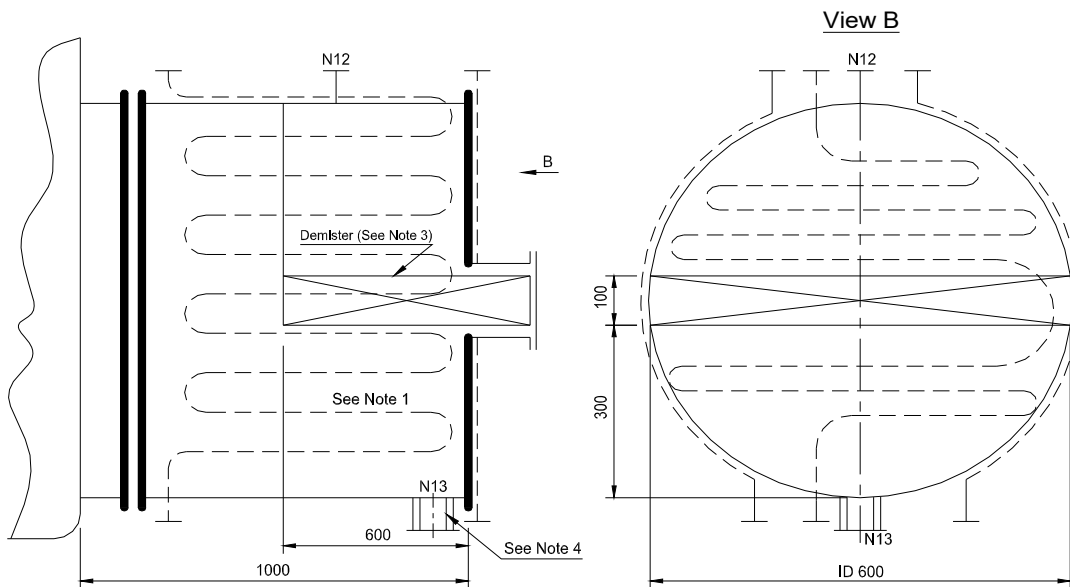
Data No. : HF220803-P07.2-EDS-10

INLET AND OUTLET CHANNEL OF E-0502

Inlet Channel



Outlet Channel



Hold for nozzle position.

NOTES

- 1) Outlet channel to be provided with 1" steam tracing, 300 mm pitch, tracing by manufacturer.
- 2) Layer of concrete to be flush with inside of lowest tubes.
- 3) Demister removable from drawer.
- 4) Sulfur outlet N13 shall be at the bottom of outlet channel close to the end plate.

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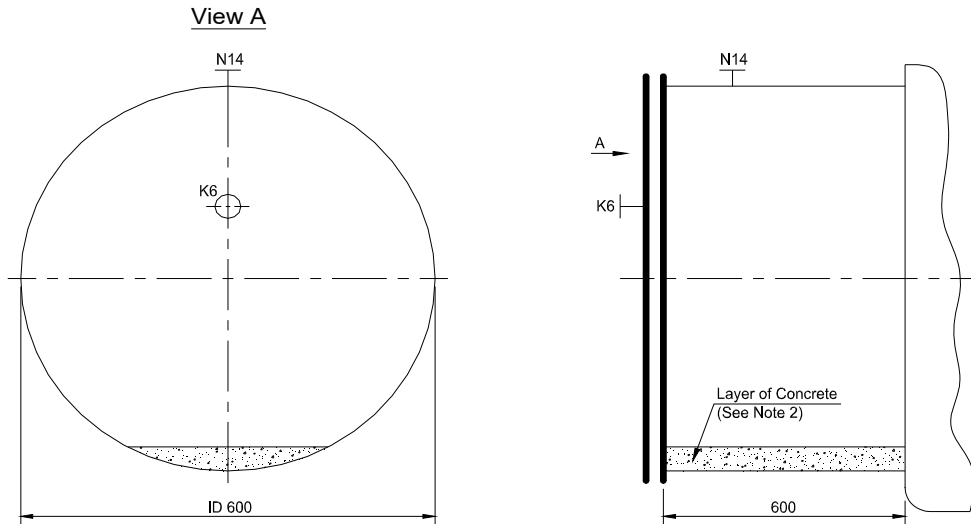
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Equipment No. : E-0501, E-0502, E-0503

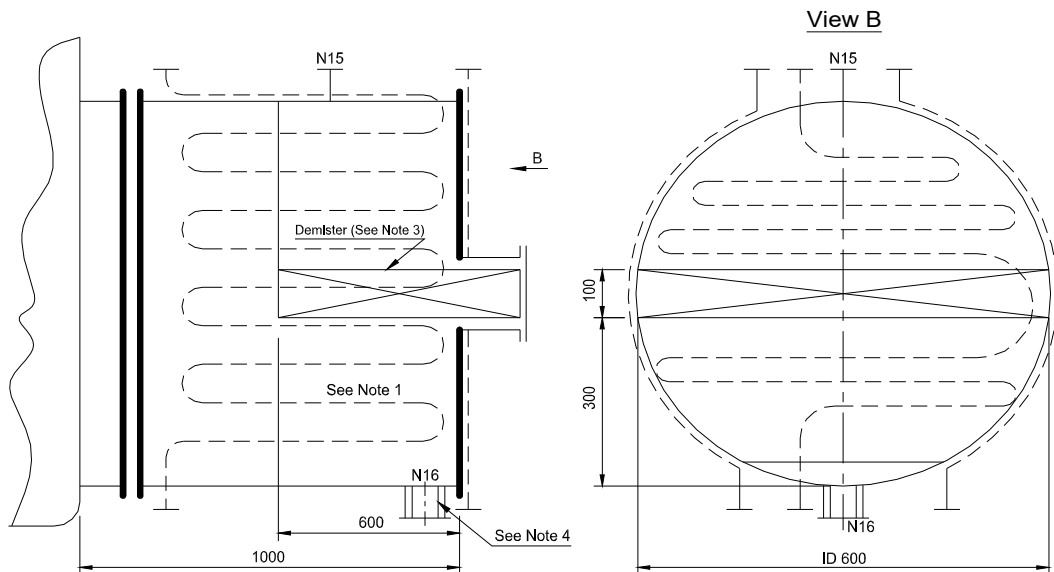
Data No. : HF220803-P07.2-EDS-10

INLET AND OUTLET CHANNEL OF E-0503

Inlet Channel



Outlet Channel



Hold for nozzle position.

NOTES

- 1) Outlet channel to be provided with 1" steam tracing, 300 mm pitch, tracing by manufacturer.
- 2) Layer of concrete to be flush with inside of lowest tubes.
- 3) Demister removable from drawer.
- 4) Sulfur outlet N16 shall be at the bottom of outlet channel close to the end plate.

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Equipment No. : E-0501, E-0502, E-0503

Data No. : HF220803-P07.2-EDS-10



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**DATA SHEET
SHELL-TUBE HEAT EXCHANGERS
(WIRE MESH DEMISTERS)**

Project No. : HF220803

GENERAL

Drawing	:
Inside diameter	mm :
All parts of demister to pass through Drawer	mm : See sheet 14, 15 & 16

WIRE MAT (wire mesh filling)

Location	Outlet Channel E-0501	Outlet Channel E-0502	Outlet Channel E-0503
Number required	One	One	One
Demister effective diameter mm	Refer to sheet 14	Refer to sheet 15	Refer to sheet 16
Wire material	AISI 316	AISI 316	AISI 316
	York Mesh Style 709	York Mesh Style 709	York Mesh Style 709
Total mat thickness mm	100	100	100
Wire thickness mm	By manufacturer	By manufacturer	By manufacturer
Free volume of mat %	By manufacturer	By manufacturer	By manufacturer
Wire surface area m ² /m ³	By manufacturer	By manufacturer	By manufacturer

WIRE MESH SCREENS

Material	AISI 316	AISI 316	AISI 316
Upper/lower woven wire mesh			

GRIDS (upper and lower grating)

Grids to be supplied	Yes	Yes	Yes
Material	Carbon Steel	Carbon Steel	Carbon Steel
Free area m ³	min. 97 %	min. 97 %	min. 97 %
Design acc. to Manuf. standards			
Design acc. to drawing			

REFERENCES AND NOTES

1) Total three demisters are required.

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