European Industrial Insulation Foundation

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TIPCHECK

Training 18
FIW München Laboratories

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TIPCHECK report

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TIPCHECK details:
Report number: LLB - 2016001
Object description: Steam Pipe – 114,3 -150°C

Client:
General Assembly EiiF

Executing TIPCHECK engineer:
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Table of Contents

1. Project description and tasks

This TIPCHECK aims to determine the potential energy savings in a steam pipe of 120m length including valves and flanges:

The first task:

To identify the current energy losses through the current insulation system with 30mm of aged insulation with steel spacers on the pipe and no insulation on the valves and flanges.

The second task:

To evaluate the difference between the new customer specifications for the pipe, flanges and valves of 60mm Mineral Wool Mat material with the current situation (30mm/uninsulated).

Infrared technology was used to determine the surface temperature on the cladding (pipe) and on the bare surfaces (flanges and valves). These measured surface temperatures were taken to calculate the current heat losses.

Description of the investigated components:

Component 1 – **1 Pipe:**	120m Ø 114,3 mm; comparison of installed 30 mm insulation with 60 mm insulation
Component 2 – **10 Flanges:**	Ø 114,3 mm uninsulated Vs 60 mm insulation mattress
Component 3 – **4 Valves:**	Ø 114,3 uninsulated Vs 60mm insulation mattress

2. Starting point of the appraisal

2.1 Calculation parameters

Component	Operation Temp.	Measured Surface Temp.	Ambient Temp.	Wind Speed	Insulation	Cladding
Comp. 1 – 1 Pipe	150°C	53 °C	10°C	1m/s	30mm	Alu. Oxi.
Comp. 2 - 10 Flanges	150°C	150°C	10°C	1m/s	non	rusted steel
Comp. 3 - 4 Valves	150°C	150°C	10°C	1m/s	non	rusted steel

For others parameters and boundaries conditions for calculations, please consult Annex A.

2.2 Equipment

- Anemometer
- Thermometer
- Infrared camera
- TIPCHECK calculator software, v2.0.0.14

3. Conclusions

3.1 Comparison of the existing situation with the corporate new standard of 60mm Mineral Wool Mat

Heat loss calculations based on the measured surface temperatures give an **energy saving potential of 2.517 MWh or 75.512, - TCC**[1] during 10 years life time (considering an energy price of 0,03 TCC/kwh fix during 10 years and an annual operational period of 8760 h/a). **CO_2 emissions will be also cut by 4.455 tons** along the 10 years life time.

The investment to install the proposed **insulation solutions sums up to 5.123,- TCC** (material and installation without depreciation, maintenance or any other additional cost),

offering a payback shorter than 9 months:

Component		Heat loss in W		Savings		Insulation Cost	Payback time
		Ref.	60mm	kWh/a	TCC/a	TCC	d
1	1 Pipe	28.794	8.281	179.696	5.391	3.533	239
2	10 Flanges	4.863	297	40.006	1.200	883	269
3	4 Valves	3.891	237	32.005	960	707	269
	Total	**37.548**	**8.815**	**251.707**	**7.551**	**5.123**	**248**

3.2 Evaluation of the corporate new standard of 60mm Mineral Wool Mat with the most economic solutions

According to VDI 2055 for an expected 10 years life time and considering 1% annual energy price variation, 1% interest rate and 1% for additional cost, the most economic thickness insulation is:

For component 1 – **1 Pipe:** 120 mm Mineral Wool Mat insulation thickness instead of the specified 60mm. **An additional investment of 1810 TTC will additionally save 249 MWh or 7470, - TCC** during 10 years life time. Reducing also CO_2 emissions by 108 tons.

For Component 2 and 3 **– 10 Flanges and 4 Valves :** The specified 60mm Mineral Wool Mat insulation thickness represents the most economical solution for these components.

Component		Heat loss in W		Savings		Insulation Cost		Payback time in days	
		60mm	120mm	kWh/a	TCC/a	60mm	120mm	120mm Vs 60mm	120mm Vs Ref
1	1 Pipe	8.281	5.437	24.913	747	3.533	5.342	884	318

[1] TCC = TIPCHECK Currency

Annex A – Component description and boundary conditions used for calculations.

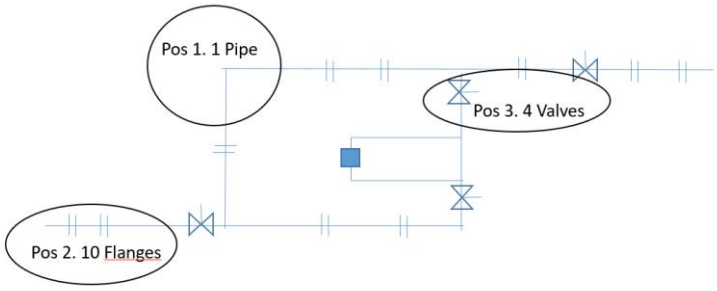
Annex A – Component description and calculation boundary conditions.

	Component	Outer diameter	Length	Number	Medium temp	Ambient temp	Insulant	Selection thickness	Reference	Measured surface temp.	Reference thickness
		mm	m		°C	°C		mm		°C	mm
1	1 Pipe	114,3	120	1	150,00	10,00	Mineral Wool Mat	80	Measured surface temperature °C	53	30
2	10 Flanges	114,3	0,5	10	150,00	10,00	Mineral Wool Mat	60	No insulant/bare surface	-	0
3	4 Valves	114,3	1	4	150,00	10,00	Mineral Wool Mat	60	No insulant/bare surface	-	0

	Component	Support structure	Ftot	Orientation	Cladding	ε	Emissivity no insulant	Air velocity	Heat price	Annual operation period
		W/(m·K)						m/s	€/kWh	h/a
1	1 Pipe	0,01	1,10	horizontal	Aluminium. oxidized	0,13	0,80	1	0,03	8760
2	10 Flanges	0	1,10	horizontal	Non-metallic surfaces	0,94	0,80	1	0,03	8760
3	4 Valves	0	1,10	horizontal	Non-metallic surfaces	0,94	0,80	1	0,03	8760

	Component	Expected service life	Interest rate	Maint. and general cost	Annual price variation	Price variation factor	Capital service factor	Fuel	Fuel CO2 Emission	Efficiency
		a	%/a	%/a	%/a		%/a		t/GWh	%
1	1 Pipe	10	1,00	1	1	1,05	0,12	coal import	342	80
2	10 Flanges	10	1,00	1	1	1,05	0,12	coal import	342	80
3	4 Valves	10	1,00	1	1	1,05	0,12	coal import	342	80

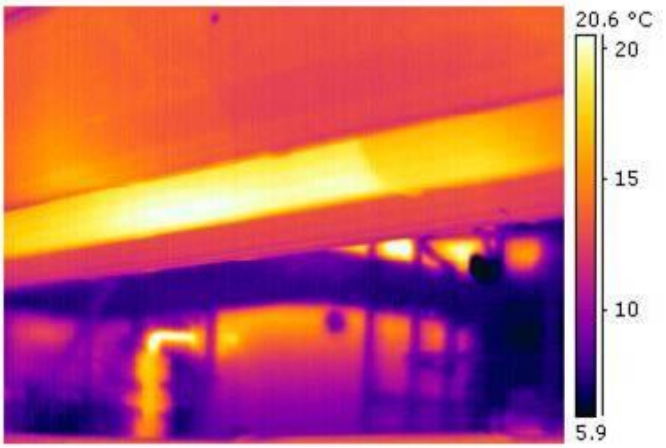
Annex B – Schematic drawing



Annex C – Digital and infrared pictures

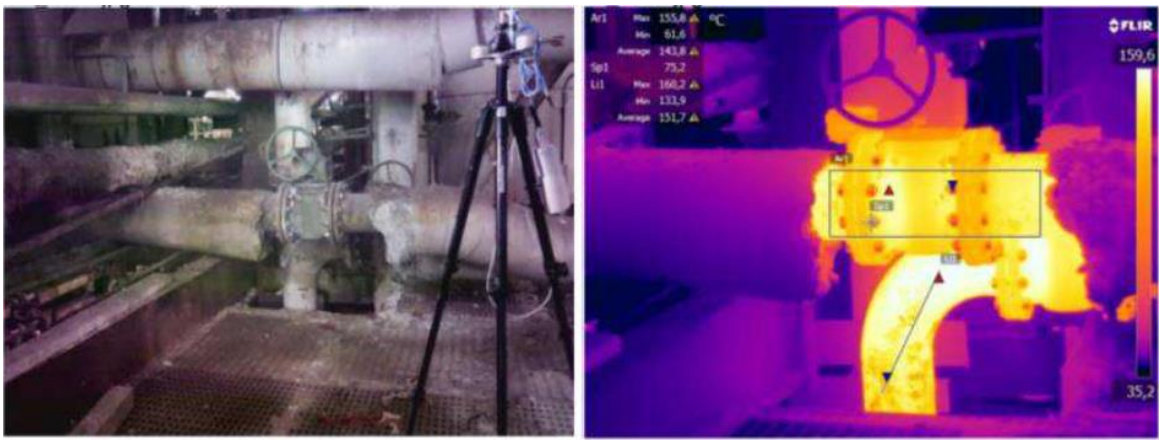
Component 1 – Pipe

Pipe - Measured surface temperature – 53 °C (emissivity 0.13 aluminium cladding)

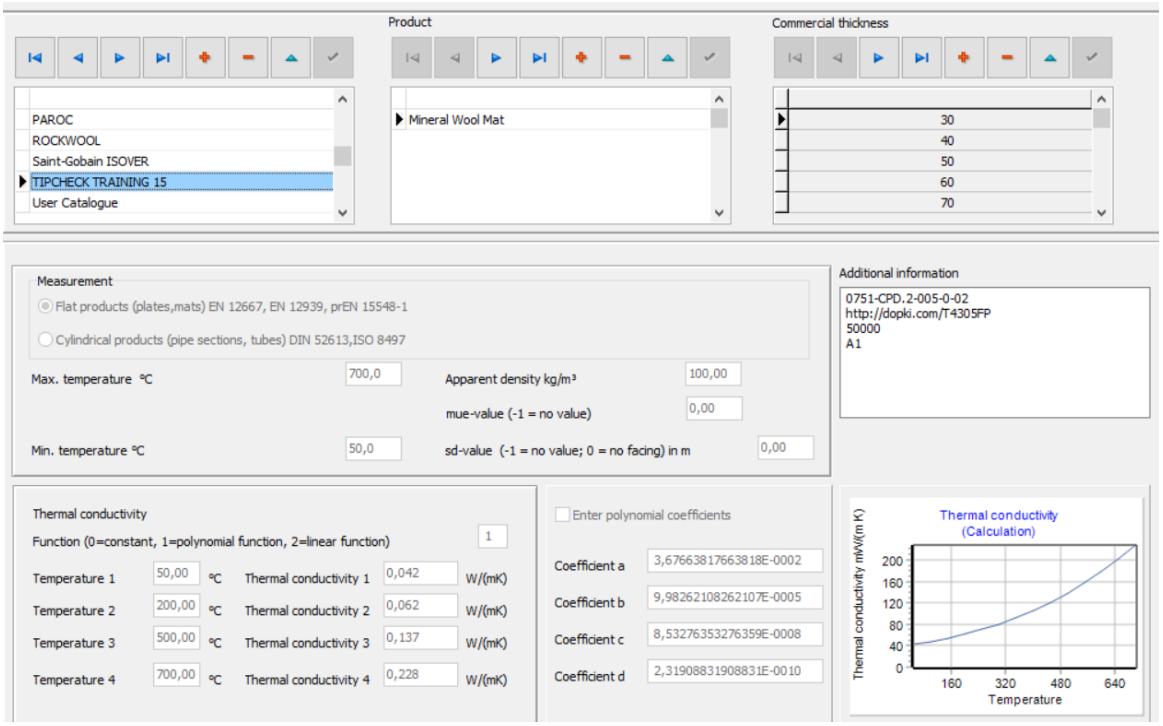


Component 2 – 10 Flange
Flange – Measured surface temperature – 150 °C (emissivity 0.8 rusted steel)

Component 3 – 4 Valve
Valve – Measured surface temperature – 150°C (emissivity 0.8 rusted steel)



Annex D – Insulation Material



Example of an insulation mattress to be used for the valves and flanges:

Annex E – Overview of results per insulation thickness

Component 1 – 1 Pipe

Insulation thickness	mm	0	50	60	70	80	90	100	110	120	130,00	140,00
Cost heat loss	€/(m·a)	267,2	21,4	19,0	17,2	15,8	14,7	13,8	13,1	12,5	11,9	11,4
Cost invest	€/(m·a)	0,0	3,1	3,4	3,7	4,0	4,3	4,6	4,9	5,2	6,5	6,9
Cost total	€/(m·a)	**267,2**	**24,5**	**22,4**	**20,9**	**19,8**	**19,0**	**18,4**	**17,9**	**17,6**	**18,4**	**18,3**
Cost heat loss	€/(m²a)	744,2	31,7	25,8	21,5	18,4	15,9	14,0	12,5	11,2	10,1	9,2
Cost invest	€/(m²a)	0,0	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6	5,6	5,6
Cost total	€/(m²a)	744,2	36,4	30,4	26,1	23,0	20,5	18,6	17,1	15,8	15,7	14,8
Surface temperature	°C	149,8	22,5	20,5	19,0	17,9	17,0	16,3	15,7	15,3	14,8	14,5
Heat flow rate	W/m²	2708,8	115,5	93,8	78,3	66,8	58,0	51,0	45,3	40,7	36,8	33,6
Longitudinal heat flow rate	W/m	972,7	77,7	69,0	62,6	57,6	53,6	50,3	47,6	45,3	43,3	41,6
Heat loss	W	**116721**	**9329**	**8281**	**7506**	**6907**	**6430**	**6039**	**5713**	**5437**	**5199**	**4991**
Max. rel. humidity	%											
Payback time	d		**231**	**239**	**250**	**262**	**276**	**289**	**303**	**318**	**399**	**416**
CO2 Emission	t/(m·a)	3,64	0,29	0,26	0,23	0,22	0,2	0,19	0,18	0,17	0,16	0,16
Coefficient hi	W/(m²K)	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000
Coefficient hse	W/(m²K)	19,4	9,3	9,0	8,7	8,5	8,3	8,1	7,9	7,8	7,6	7,5
h radiation	W/(m²K)	8,0	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7
h convection	W/(m²K)	11,4	8,5	8,2	8,0	7,8	7,6	7,4	7,2	7,1	6,9	6,8
Lambda-design (mean value)	W/(m·K)		0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06

Component 2 – 10 Flanges

Insulation thickness	mm	0	30	40	50	60	70	80	90	100	110	120
Cost heat loss	€/(m·a)	340,8	27,1	21,9	18,7	16,4	14,8	13,6	12,6	11,8	11,2	10,6
Cost invest	€/(m·a)	0,0	15,2	16,9	18,7	20,4	22,2	23,9	25,7	27,4	29,1	30,9
Cost total	€/(m·a)	**340,8**	**42,3**	**38,9**	**37,3**	**36,9**	**37,0**	**37,5**	**38,3**	**39,2**	**40,3**	**41,5**
Cost heat loss	€/(m²a)	949,0	49,6	35,9	27,7	22,3	18,6	15,8	13,6	12,0	10,6	9,5
Cost invest	€/(m²a)	0,0	27,7	27,7	27,7	27,7	27,7	27,7	27,7	27,7	27,7	27,7
Cost total	€/(m²a)	949,0	77,3	63,6	55,5	50,1	46,3	43,5	41,4	39,7	38,4	37,3
Surface temperature	°C	149,8	19,4	17,0	15,6	14,6	13,9	13,4	13,0	12,6	12,4	12,2
Heat flow rate	W/m²	3454,5	180,4	130,7	100,9	81,3	67,5	57,4	49,6	43,5	38,6	34,6
Longitudinal heat flow rate	W/m	1240,5	98,8	79,8	67,9	59,9	54,0	49,5	45,9	43,0	40,6	38,5
Heat loss	W	**6202**	**494**	**399**	**340**	**299**	**270**	**247**	**229**	**215**	**203**	**193**
Max. rel. humidity	%											
Payback time	d		**160**	**175**	**191**	**208**	**224**	**241**	**258**	**275**	**292**	**309**
CO2 Emission	t/(m·a)	4,65	0,37	0,3	0,25	0,22	0,2	0,19	0,17	0,16	0,15	0,14
Coefficient hi	W/(m²K)	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000
Coefficient hse	W/(m²K)	24,7	19,3	18,7	18,2	17,7	17,4	17,0	16,7	16,5	16,2	16,0
h radiation	W/(m²K)	8,0	5,1	5,0	5,0	5,0	4,9	4,9	4,9	4,9	4,9	4,9
h convection	W/(m²K)	16,7	14,2	13,6	13,2	12,8	12,4	12,1	11,8	11,6	11,3	11,1
Lambda-design (mean value)	W/(m·K)		0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

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Component 3 – 4 Valves

Insulation thickness	mm	0	30	40	50	60	70	80	90	100	110	120
Cost heat loss	€/(m·a)	340,8	27,1	21,9	18,7	16,4	14,8	13,6	12,6	11,8	11,2	10,6
Cost invest	€/(m·a)	0,0	15,2	16,9	18,7	20,4	22,2	23,9	25,7	27,4	29,1	30,9
Cost total	€/(m·a)	340,8	42,3	38,9	37,3	36,9	37,0	37,5	38,3	39,2	40,3	41,5
Cost heat loss	€/(m²a)	**949,0**	**49,6**	**35,9**	**27,7**	**22,3**	**18,6**	**15,8**	**13,6**	**12,0**	**10,6**	**9,5**
Cost invest	€/(m²a)	0,0	27,7	27,7	27,7	27,7	27,7	27,7	27,7	27,7	27,7	27,7
Cost total	€/(m²a)	949,0	77,3	63,6	55,5	50,1	46,3	43,5	41,4	39,7	38,4	37,3
Surface temperature	°C	149,8	19,4	17,0	15,6	14,6	13,9	13,4	13,0	12,6	12,4	12,2
Heat flow rate	W/m²	3454,5	180,4	130,7	100,9	81,3	67,5	57,4	49,6	43,5	38,6	34,6
Longitudinal heat flow rate	W/m	1240,5	98,8	79,8	67,9	59,9	54,0	49,5	45,9	43,0	40,6	38,5
Heat loss	W	**4962**	**395**	**319**	**272**	**239**	**216**	**198**	**184**	**172**	**162**	**154**
Max. rel. humidity	%											
Payback time	d		**160**	**175**	**191**	**208**	**224**	**241**	**258**	**275**	**292**	**309**
CO2 Emission	t/(m·a)	4,65	0,37	0,3	0,25	0,22	0,2	0,19	0,17	0,16	0,15	0,14
Coefficient hi	W/(m²K)	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000
Coefficient hse	W/(m²K)	24,7	19,3	18,7	18,2	17,7	17,4	17,0	16,7	16,5	16,2	16,0
h radiation	W/(m²K)	8,0	5,1	5,0	5,0	5,0	4,9	4,9	4,9	4,9	4,9	4,9
h convection	W/(m²K)	16,7	14,2	13,6	13,2	12,8	12,4	12,1	11,8	11,6	11,3	11,1
Lambda-design (mean value)	W/(m·K)		0,051	0,051	0,051	0,051	0,051	0,050	0,050	0,050	0,050	0,050

Annex F – Detailed overview of results per component

Please see the following pages.

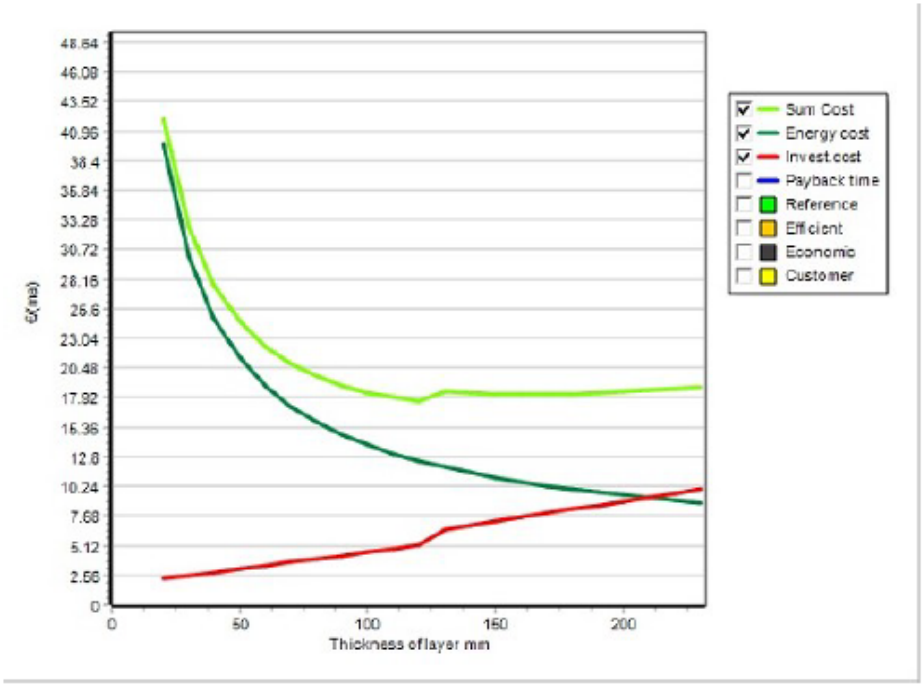
Component 1 – 1 Pipe

TIPCHECK

Object	TIPCHECK Report GA
Customer	General Assembly
TIPCHECK engineer/CertNr.	Luis --
Date	16/11/2016

Component: 1.Pos Pipe - 150 C pipe

Insulant	Mineral Wool Mat		
Outer diameter mm	114,30	Heat price €/kWh	0,0300
Length m	120,00	Annual operation period h/a	8760
Medium temperature °C	150,00	Expected service of life a	10,00
Ambient temperature °C	10,00	Interest rate %/a	1,00
Support construction W/(m·K)	0,01	Annual price variation %/a	1,00
Orientation	horizontal	Maintenance and general cost %/a	1,00
Emissivity	0,13	Price variation factor	1,05
Air velocity m/s	1,00	Capital service factor %/a	0,12
Allowable surface temp. °C			
Max. heat flow rate W/m			
Measured surface temp. °C	53,00		



TIPCHECK

Object TIPCHECK Report GA
Customer General Assembly

Component: 1.Pos Pipe - 150 C pipe

	Unit	Reference	Economic	Efficient	Customer	Bare surface
Insulation thickness	mm	30,00	120,00	210,00	80,00	0,00
Cost heat loss	€/(m·a)	65,92	12,45	9,26	15,81	267,22
Cost invest	€/(m·a)		5,15	9,31	3,98	
Cost total	€/(m·a)	65,92	17,59	18,58	19,80	267,22
Cost heat loss	€/(m²a)	120,39	11,18	5,52	18,35	744,16
Cost invest	€/(m²a)		4,62	5,55	4,62	
Cost total	€/(m²a)	120,39	15,81	11,07	22,97	744,16
Surface temperature	°C	53,00	15,25	12,96	17,89	149,84
Heat flow rate	W/m²	438,21	40,70	20,09	66,79	2708,76
Longitudinal heat flow rate	W/m	239,95	45,31	33,72	57,56	972,67
Max. rel. humidity	%					
Payback time	a		0,87	1,49	0,72	
CO2 Emission	t/(m·a)	0,90	0,17	0,13	0,22	3,64
Coefficient hi	W/(m²K)	100000,00	100000,00	100000,00	100000,00	100000,00
Coefficient he	W/(m²K)	10,19	7,75	6,80	8,46	19,35
h radiation	W/(m²K)	0,83	0,69	0,68	0,70	7,99
h convection	W/(m²K)	9,36	7,06	6,12	7,76	11,37
Lambda-design (mean value)	W/(m·K)	0,0615	0,0605	0,0604	0,0607	
--	--	--	--	--	--	--
Heat loss	W	28794,34	5436,62	4046,72	6906,91	116720,85
Heat losses money saving	€/a	Base	--	--	5752,02	--
Total costs money saving	€/a	Base	--	--	5534,88	--

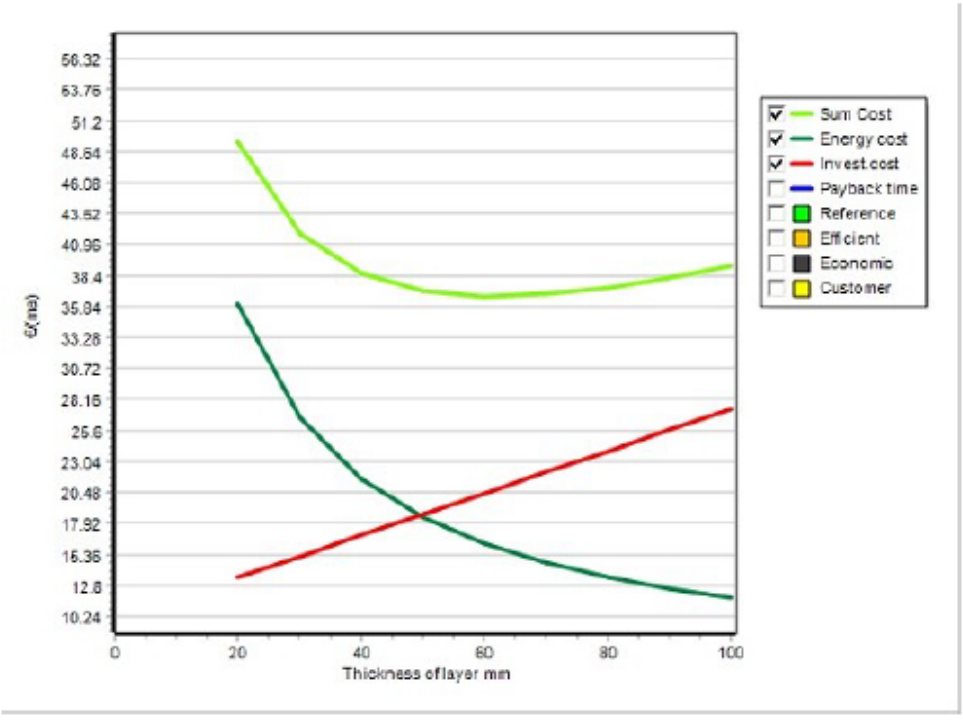
Component 2 – 10 Flanges

TIPCHECK

Object	TIPCHECK Report GA
Customer	General Assembly
TIPCHECK engineer/CertNr.	Luis --
Date	16/11/2016

Component: 2.Pos 10 flanges - non insulated

Insulant	Mineral wool mat		
Outer diameter mm	114,30	Heat price €/kWh	0,0300
Length m	0,50	Annual operation period h/a	8760
Medium temperature °C	150,00	Expected service of life a	10,00
Ambient temperature °C	10,00	Interest rate %/a	1,00
Support construction W/(m·K)		Annual price variation %/a	1,00
Orientation	horizontal	Maintenance and general cost %/a	1,00
Emissivity	0,94	Price variation factor	1,05
Air velocity m/s	1,00	Capital service factor %/a	0,12
Allowable surface temp. °C			
Max. heat flow rate W/m			
Measured surface temp. °C			



TIPCHECK

Object TIPCHECK Report GA
Customer General Assembly

Component: 2.Pos 10 flanges - non insulated

	Unit	Reference	Economic	Efficient	Customer	Bare surface
Insulation thickness	mm	0,00	60,00	100,00	60,00	0,00
Cost heat loss	€/(m·a)	267,22	16,29	11,75	16,29	267,22
Cost invest	€/(m·a)		20,42	27,39	20,42	
Cost total	€/(m·a)	267,22	36,71	39,14	36,71	267,22
Cost heat loss	€/(m²a)	744,16	22,13	11,89	22,13	744,16
Cost invest	€/(m²a)		27,74	27,74	27,74	
Cost total	€/(m²a)	744,16	49,87	39,64	49,87	744,16
Surface temperature	°C	149,84	16,09	13,52	16,09	149,84
Heat flow rate	W/m²	2708,76	80,56	43,30	80,56	2708,76
Longitudinal heat flow rate	W/m	972,67	59,30	42,75	59,30	972,67
Max. rel. humidity	%					
Payback time	a		0,74	0,97	0,74	
CO2 Emission	t/(m·a)	3,64	0,22	0,16	0,22	3,64
Coefficient hi	W/(m²K)	100000,00	100000,00	100000,00	100000,00	100000,00
Coefficient he	W/(m²K)	19,35	13,22	12,30	13,22	19,35
h radiation	W/(m²K)	7,99	5,00	4,93	5,00	7,99
h convection	W/(m²K)	11,37	8,22	7,37	8,22	11,37
Lambda-design (mean value)	W/(m·K)		0,0506	0,0504	0,0506	
--	--	--	--	--	--	--
Heat loss	W	4863,37	296,50	213,76	296,50	4863,37
Heat losses money saving	€/a	Base	--	--	1200,17	--
Total costs money saving	€/a	Base	--	--	1152,53	--

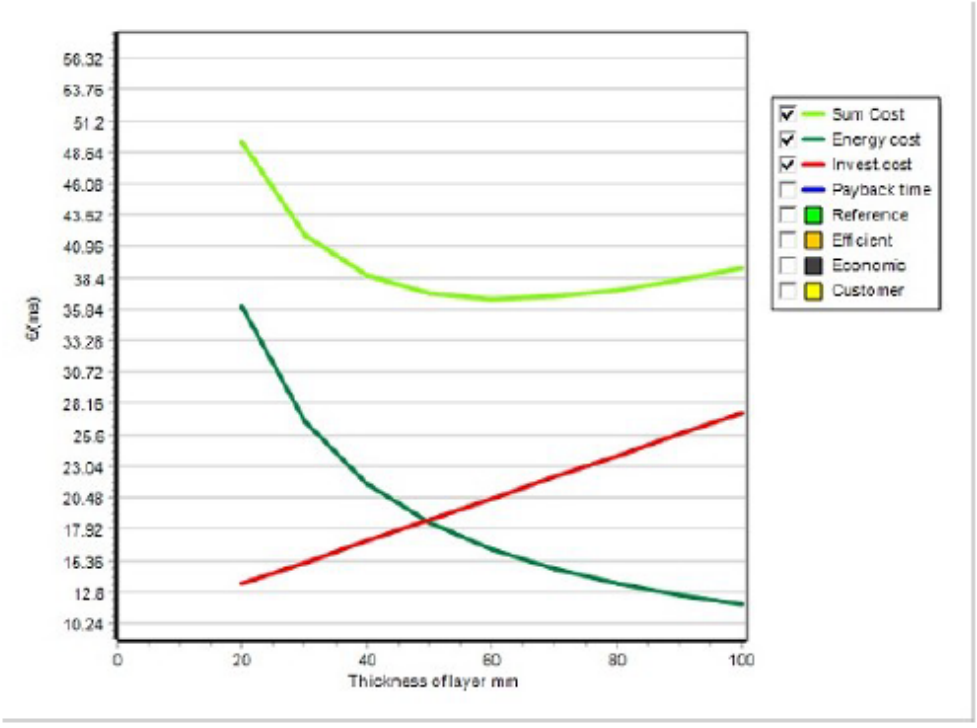
Component 3 – 4 Valves

TIPCHECK

Object	TIPCHECK Report GA
Customer	General Assembly
TIPCHECK engineer/CertNr.	Luis --
Date	16/11/2016

Component: 3.Pos 4 valves - non insulated

Insulant	Mineral wool mat		
Outer diameter mm	114,30	Heat price €/kWh	0,0300
Length m	1,00	Annual operation period h/a	8760
Medium temperature °C	150,00	Expected service of life a	10,00
Ambient temperature °C	10,00	Interest rate %/a	1,00
Support construction W/(m·K)		Annual price variation %/a	1,00
Orientation	horizontal	Maintenance and general cost %/a	1,00
Emissivity	0,94	Price variation factor	1,05
Air velocity m/s	1,00	Capital service factor %/a	0,12
Allowable surface temp. °C			
Max. heat flow rate W/m			
Measured surface temp. °C			



TIPCHECK

Object TIPCHECK Report GA
Customer General Assembly

Component: 3.Pos 4 valves - non insulated

	Unit	Reference	Economic	Efficient	Customer	Bare surface
Insulation thickness	mm	0,00	60,00	100,00	60,00	0,00
Cost heat loss	€/(m·a)	267,22	16,29	11,75	16,29	267,22
Cost invest	€/(m·a)		20,42	27,39	20,42	
Cost total	€/(m·a)	267,22	36,71	39,14	36,71	267,22
Cost heat loss	€/(m²a)	744,16	22,13	11,89	22,13	744,16
Cost invest	€/(m²a)		27,74	27,74	27,74	
Cost total	€/(m²a)	744,16	49,87	39,64	49,87	744,16
Surface temperature	°C	149,84	16,09	13,52	16,09	149,84
Heat flow rate	W/m²	2708,76	80,56	43,30	80,56	2708,76
Longitudinal heat flow rate	W/m	972,67	59,30	42,75	59,30	972,67
Max. rel. humidity	%					
Payback time	a		0,74	0,97	0,74	
CO2 Emission	t/(m·a)	3,64	0,22	0,16	0,22	3,64
Coefficient hi	W/(m²K)	100000,00	100000,00	100000,00	100000,00	100000,00
Coefficient he	W/(m²K)	19,35	13,22	12,30	13,22	19,35
h radiation	W/(m²K)	7,99	5,00	4,93	5,00	7,99
h convection	W/(m²K)	11,37	8,22	7,37	8,22	11,37
Lambda-design (mean value)	W/(m·K)		0,0506	0,0504	0,0506	
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Heat loss	W	3890,69	237,20	171,01	237,20	3890,69
Heat losses money saving	€/a	Base	--	--	960,14	--
Total costs money saving	€/a	Base	--	--	922,02	--