

Carbon Steel 과 Stainless Steel 그리고 코팅시의 열전달 계수의 비교

가장 열전도도가 낮은 Si14E의 열전도도는 2.65 w/mc 이므로

$$2.65 \text{ w/m}^{\circ}\text{C} \times 0.86 \frac{\text{Kcal/mh}^{\circ}\text{C}}{\text{w/m}^{\circ}\text{C}} = 2.279 \text{ Kcal/mh}^{\circ}\text{C}$$

Si14E Coat 200μ과 Carbon Steel 2.1mm 의 Tube를 Carbon Steel 로 만으로
구성되었다고 가정으로 그때의 혼합 열전도도를 환산하면

$$\frac{46.00 \text{ Kcal/mhc} \times 2.10 \text{ mm} + 2.28 \text{ Kcal/mhc} \times 0.20 \text{ mm}}{2.30} = 42.19817 \text{ Kcal/mh}^{\circ}\text{C}$$

재 질	열전도도 Kcal/mhc	두께 mm	
STS304	14.00	2.1	
SS400	46.00	2.1	
Si14E	2.28	0.2	
STS304 + Si14E	42.20	2.3	

STAINLESS STEEL 과 CARBON STEEL의 열전도도차이가 워낙많이나고 코팅의 두께가 200μ(0.2 MM)로 워낙 얇아 STAINLESS STEEL 에서 CARBON STEEL + SaeKaphen Si14E 코팅시 오히려 열전도율이 증가되어 열전달계수가 증가됩니다.

열전달계수 증가 내용

구분	STS304	STB340	STB340 + Si14E	Unit	
필요전열계수	453.85	453.85	453.85	Kcal/m ³ hc	
실제전열계수	453.85	480.99	477.17	Kcal/m ³ hc	
여유(전열계수)	0	27.14	23.32	Kcal/m ³ hc	
여유율	0.000%	5.980%	5.138%		

결론

이계산은 실제의 Water To Water Shell & Tube 계산의 예이며(Data Sheet 첨부) 이보다 더 많은 차이가 날 수있습니다.

실제의 적용에서는 Fouling Resistance가 적용되어 5~10%의 여유가 아닌 50~200%의 전열면적여유(STAINLESS STEEL 과 CARBON STEEL 공히)가 있으므로 재질변경에 따른 열교환기 효율 저하문제는 전혀 고려할 필요가 없으며 STAINLESS STEEL 에서 CARBON STEEL + SaeKaphen Si14E로 변경할경우 오히려 효율이 올라갈수 있습니다.

HEAT EXCHANGER SPECIFICATION SHEET									
								MKH Units	
				Job No.					
Customer				Reference No.					
Address				Proposal No.					
Plant Location				Date		2007-09-14		Rev	
Service of Unit				Material		304 STAINLESS STEEL (18 CR, 8 NI)		Item No.	
Size		500.000 x 2806.97 mm		Type	BEU		Horz.	Connected In	1 Parallel 1 Series
Surf/Unit (Gross/Eff)		50.44 / 49.59 m2		Shell/Unit	1		Surf/Shell (Gross/Eff) 50.44 / 49.59 m2		
PERFORMANCE OF ONE UNIT									
Fluid Allocation		Shell Side				Tube Side			
Fluid Name									
Fluid Quantity, Total		kg/hr		173138		28771.0			
Vapor (In/Out)									
Liquid				173138		173138		28771.0 28771.0	
Steam									
Water				173138		173138		28771.0 28771.0	
Noncondensables									
Temperature (In/Out)		C		32.00		37.00		90.00 60.00	
Specific Gravity				0.9957		0.9940		0.9662 0.9841	
Viscosity		cP		0.7644		0.6914		0.3146 0.4665	
Molecular Weight, Vapor									
Molecular Weight, Noncondensables									
Specific Heat		kcal/kg-C		0.9986		0.9985		1.0045 0.9992	
Thermal Conductivity		kcal/hr-m-C		0.5316		0.5375		0.5793 0.5602	
Latent Heat		kcal/kg							
Inlet Pressure		kgf/cm2A		6.000		11.000			
Velocity		m/s		0.71		0.33			
Pressure Drop, Allow/Calc		kgf/cm2		0.500		0.227		0.500 0.036	
Fouling Resistance (min)		m2-hr-C/kca		0.000800		0.000400			
Heat Exchanged		kcal/hr 863841		MTD (Corrected)		38.4 C			
Transfer Rate, Service		453.85 kcal/m2-hr-C Clean		1124.99 kcal/m2-hr-C		Actual		453.83 kcal/m2-hr-C	
CONSTRUCTION OF ONE SHELL					Sketch (Bundle/Nozzle Orientation)				
		Shell Side		Tube Side					
Design/Test Pressure		kgf/cm2G		10.546 / 10.546 /					
Design Temperature		C							
No Passes per Shell		1		2					
Corrosion Allowance		mm							
Connections Size & Rating	In	mm	1 @ 258.877	1 @ 77.927					
	Out	mm	1 @ 258.877	1 @ 77.927					
	Intermediate		@	@					
Tube No.		142U OD 19.050 mm Thk(Avg) 2.108 mm		Length 2807. mm		Pitch 25.000 mm		Layout 30	
Tube Type		Plain		Material 304 STAINLESS STEEL (18 CR, 8 NI)					
Shell		ID 500.000 mm OD mm		Shell Cover					
Channel or Bonnet				Channel Cover					
Tubesheet-Stationary				Tubesheet-Floating					
Floating Head Cover				Impingement Plate None					
Baffles-Cross		Type SINGLE-SEG.		%Cut (Diam) 25.0		Spacing(c/c) 500.000		Inlet 284.277 mm	
Baffles-Long				Seal Type					
Supports-Tube				U-Bend		Type			
Bypass Seal Arrangement				Tube-Tubesheet Joint					
Expansion Joint				Type					
Rho-V2-Inlet Nozzle		838.86 kg/m-s2		Bundle Entrance 4700.41		Bundle Exit 240.83		kg/m-s2	
Gaskets-Shell Side				Tube Side					
-Floating Head									
Code Requirements				TEMA Class					
Weight/Shell		1718.14		Filled with Water 2380.36		Bundle 845.63		kg	
Remarks:									
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HEAT EXCHANGER SPECIFICATION SHEET										MKH Units	
					Job No.						
Customer					Reference No.						
Address					Proposal No.						
Plant Location					Date	2007-09-14	Rev				
Service of Unit Material STB340											
Size	500.000 x 2806.97 mm		Type	BEU	Horz.	Connected In	1 Parallel		1 Series		
Surf/Unit (Gross/Eff)	50.44 / 49.59 m2		Shell/Unit	1		Surf/Shell (Gross/Eff)	50.44 / 49.59 m2				
PERFORMANCE OF ONE UNIT											
Fluid Allocation			Shell Side			Tube Side					
Fluid Name											
Fluid Quantity, Total			kg/hr		173138		28771.0				
Vapor (In/Out)											
Liquid			173138		173138		28771.0		28771.0		
Steam											
Water			173138		173138		28771.0		28771.0		
Noncondensables											
Temperature (In/Out)			C		32.00		37.00		90.00		
Specific Gravity					0.9957		0.9940		0.9662		
Viscosity			cP		0.7644		0.6914		0.3146		
Molecular Weight, Vapor											
Molecular Weight, Noncondensables											
Specific Heat			kcal/kg-C		0.9986		0.9985		1.0045		
Thermal Conductivity			kcal/hr-m-C		0.5316		0.5375		0.5793		
Latent Heat			kcal/kg								
Inlet Pressure			kgf/cm2A		6.000		11.000				
Velocity			m/s		0.71		0.33				
Pressure Drop, Allow/Calc			kgf/cm2		0.500		0.227		0.500		
Fouling Resistance (min)			m2-hr-C/kca		0.000800		0.000400				
Heat Exchanged			kcal/hr		863841		MTD (Corrected)		38.4 C		
Transfer Rate, Service			453.86 kcal/m2-hr-C		Clean		1308.10 kcal/m2-hr-C		Actual		
									480.99 kcal/m2-hr-C		
CONSTRUCTION OF ONE SHELL											
			Shell Side		Tube Side		Sketch (Bundle/Nozzle Orientation)				
Design/Test Pressure			kgf/cm2G		10.546 /		10.546 /				
Design Temperature			C								
No Passes per Shell			1		2						
Corrosion Allowance			mm								
Connections			In mm		1 @ 258.877		1 @ 77.927				
Size & Rating			Out mm		1 @ 258.877		1 @ 77.927				
			Intermediate		@		@				
Tube No.	142U	OD	19.050 mm	Thk(Avg)	2.108 mm	Length	2807. mm	Pitch	25.000 mm	Layout	30
Tube Type	Plain					Material STB340					
Shell	ID 500.000 mm	OD	mm		Shell Cover						
Channel or Bonnet					Channel Cover						
Tubesheet-Stationary					Tubesheet-Floating						
Floating Head Cover					Impingement Plate None						
Baffles-Cross	Type	SINGLE-SEG.		%Cut (Diam)	25.0	Spacing(c/c)	500.000	Inlet	284.277 mm		
Baffles-Long					Seal Type						
Supports-Tube					U-Bend		Type				
Bypass Seal Arrangement					Tube-Tubesheet Joint						
Expansion Joint					Type						
Rho-V2-Inlet Nozzle	838.86	kg/m-s2	Bundle Entrance		4700.41	Bundle Exit	240.83	kg/m-s2			
Gaskets-Shell Side					Tube Side						
-Floating Head											
Code Requirements										TEMA Class	
Weight/Shell	1702.15	Filled with Water				2364.37	Bundle	829.64	kg		
Remarks:											
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HEAT EXCHANGER SPECIFICATION SHEET										MKH Units
					Job No.					
Customer					Reference No.					
Address					Proposal No.					
Plant Location					Date		2007-09-14		Rev	
Service of Unit					Material		STB340E + Saekaphen Si14E		Item No.	
Size		500.000 x 2806.97 mm		Type	BEU		Horz.	Connected In	1 Parallel	1 Series
Surf/Unit (Gross/Eff)		50.44 / 49.59 m2		Shell/Unit	1		Surf/Shell (Gross/Eff)		50.44 / 49.59 m2	
PERFORMANCE OF ONE UNIT										
Fluid Allocation			Shell Side				Tube Side			
Fluid Name										
Fluid Quantity, Total			kg/hr		173138		28771.0			
Vapor (In/Out)										
Liquid			173138		173138		28771.0		28771.0	
Steam										
Water			173138		173138		28771.0		28771.0	
Noncondensables										
Temperature (In/Out)			C		32.00		37.00		90.00	
Specific Gravity					0.9957		0.9940		0.9662	
Viscosity			cP		0.7644		0.6914		0.3146	
Molecular Weight, Vapor										
Molecular Weight, Noncondensables										
Specific Heat			kcal/kg-C		0.9986		0.9985		1.0045	
Thermal Conductivity			kcal/hr-m-C		0.5316		0.5375		0.5793	
Latent Heat			kcal/kg							
Inlet Pressure			kgf/cm2A		6.000		11.000			
Velocity			m/s		0.71		0.35			
Pressure Drop, Allow/Calc			kgf/cm2		0.500		0.227		0.500	
Fouling Resistance (min)			m2-hr-C/kca		0.000800		0.000400			
Heat Exchanged			kcal/hr		863841		MTD (Corrected)		38.4 C	
Transfer Rate, Service			453.86 kcal/m2-hr-C		Clean		1302.97 kcal/m2-hr-C		Actual	
									477.17 kcal/m2-hr-C	
CONSTRUCTION OF ONE SHELL										
			Shell Side		Tube Side		Sketch (Bundle/Nozzle Orientation)			
Design/Test Pressure			kgf/cm2G		10.546 /		10.546 /			
Design Temperature			C							
No Passes per Shell			1		2					
Corrosion Allowance			mm							
Connections			In mm		1 @ 258.877		1 @ 77.927			
Size & Rating			Out mm		1 @ 258.877		1 @ 77.927			
			Intermediate		@		@			
Tube No.			142U		OD 19.050 mm		Thk(Avg) 2.300 mm		Length 2807. mm	
Tube Type			Plain						Pitch 25.000 mm	
									Layout 30	
Shell			ID 500.000 mm		OD mm		Shell Cover			
Channel or Bonnet							Channel Cover			
Tubesheet-Stationary							Tubesheet-Floating			
Floating Head Cover							Impingement Plate		None	
Baffles-Cross			Type SINGLE-SEG.		%Cut (Diam) 25.0		Spacing(c/c) 500.000		Inlet 284.277 mm	
Baffles-Long					Seal Type					
Supports-Tube					U-Bend		Type			
Bypass Seal Arrangement					Tube-Tubesheet Joint					
Expansion Joint					Type					
Rho-V2-Inlet Nozzle			838.86 kg/m-s2		Bundle Entrance 4700.41		Bundle Exit 240.83		kg/m-s2	
Gaskets-Shell Side					Tube Side					
-Floating Head										
Code Requirements							TEMA Class			
Weight/Shell			1760.39		Filled with Water 2415.17		Bundle 887.88		kg	
Remarks:										
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