

Příloha č. 1 – Přehled výstupních veličin z programu HTRI

HTRI		Output Summary				Page 1
Released to the following organization:						
Vysoke uceni technicke v Brne						
Vysoke uceni technicke v Brne						
Xist E Ver. 6.00 SP1 23.4.2013 9:04 SN: 1600211770						SI Units
Design - Horizontal Multipass Flow TEMA BEU Shell With Single-Segmental Baffles						
See Data Check Messages Report for Warning Messages.						
See Runtime Message Report for Warning Messages.						
Process Conditions		Hot Shellside		Cold Tubeside		
Fluid name		Olej		Voda		
Flow rate	(kg/s)	17,3601		26,9401		
Inlet/Outlet Y	(Wt. frac vap.)	0,000	0,000	0,000	0,000	
Inlet/Outlet T	(Deg C)	93,00	56,00	35,00	46,72	
Inlet P/Avg	(kPa)	1000,02	986,957	1000,02	993,734	
dP/Allow.	(kPa)	26,114	30,000	12,560	30,000	
Fouling	(m2-K/W)	0,000528		0,000352		
Exchanger Performance						
Shell h	(W/m2-K)	526,14	Actual U	(W/m2-K)	305,57	
Tube h	(W/m2-K)	2902,35	Required U	(W/m2-K)	287,50	
Hot regime	(--)	Sens. Liquid	Duty	(MegaWatts)	1,3308	
Cold regime	(--)	Sens. Liquid	Area	(m2)	160,356	
EMTD	(Deg C)	28,9	Overdesign	(%)	6,29	
Shell Geometry			Baffle Geometry			
TEMA type	(--)	BEU	Baffle type	(--)	Single-Seg.	
Shell ID	(mm)	650,000	Baffle cut	(Pct Dia.)	20,95	
Series	(--)	1	Baffle orientation	(--)	Perpend.	
Parallel	(--)	1	Central spacing	(mm)	288,660	
Orientation	(deg)	0,00	Crosspasses	(--)	18	
Tube Geometry			Nozzles			
Tube type	(--)	Plain	Shell inlet	(mm)	101,600	
Tube OD	(mm)	19,050	Shell outlet	(mm)	101,600	
Length	(m)	5,000	Inlet height	(mm)	36,085	
Pitch ratio	(--)	1,2500	Outlet height	(mm)	48,775	
Layout	(deg)	60	Tube inlet	(mm)	101,600	
Tubecount	(--)	518	Tube outlet	(mm)	101,600	
Tube Pass	(--)	2				
Thermal Resistance; %		Velocities; m/s		Flow Fractions		
Shell	58,08	Shellside	0,29	A	0,167	
Tube	11,76	Tubeside	0,46	B	0,540	
Fouling	28,15	Crossflow	0,46	C	0,041	
Metal	2,01	Window	0,63	E	0,252	
				F	0,000	

Příloha č. 2 – Přehled výstupních veličin z Kernovy metody

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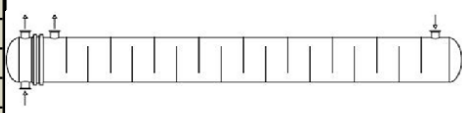
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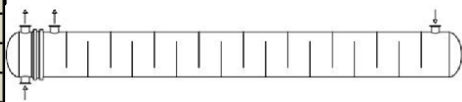
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A	B	C	D	E	F	G	H	I	J	K	L												
<div><div></div><div><div>ÚSTAV PROCESNÍHO A EKOLOGICKÉHO INŽENÝRSTVÍ</div><div>FAKULTA STROJNÍHO INŽENÝRSTVÍ</div><div>VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ</div></div></div> <div><table><tr><td>Type</td><td colspan="3">BEU</td></tr><tr><td>Size</td><td>601,62</td><td>x</td><td>5,0119</td></tr><tr><td>Date</td><td colspan="3">21.5.2013</td></tr></table></div>								Type	BEU			Size	601,62	x	5,0119	Date	21.5.2013			Shell-and-tube heat exchanger			
Type	BEU																						
Size	601,62	x	5,0119																				
Date	21.5.2013																						
Connection in				Parallel		1		Series		1													
Performance of the unit																							
1	Fluid allocation			Shell side				Tube side															
2	Fluid name			Oil (ISO VG32)				Water															
3	Fluid quality total			kg/s	17,3597			26,9361															
4	Vapour (In/Out)			wt%	0	0			0	0													
5	Liquid			wt%	100	100			0	0													
6	Steam			wt%	0	0			0	0													
7	Water			wt%	0	0			100	100													
8	Noncondesable			wt%	0	0			0	0													
9	Temperature (In/Out)			°C	93	56			35	46,8282													
10	Density			kg/m3	833,547	856,571			994,52	989,87													
11	Viscosity			mPa.s	4,57469	14,1373			0,71955	0,57777													
12	Specific Heat			J/kg-°C	2141,75	2001,85			4175,9	4177,98													
13	Thermal Conductivity			W/m-°C	0,12725	0,13059			0,623	0,63721													
14	Inlet Pressure			kPa (abs.)	11000				11000														
15	Velocity			m/s	0,450				0,459														
16	Pressure Drop, Allow./Calc.			kPa	30	26,121			30	12,56													
17	Heat Transfer Coefficient			W/sq m-°C	599,351				2875,624														
18	Fouling Resistance			sq m-°C/W	0,000528				0,000352														
19	Overdesign			%	12,720																		
20	Duty, Allow./Calc.			1500	1330,74	kW	LMTD (corrected)		29,433	°C													
21	OHTC			328,005		W/sq m-°C	Area		155,374	sq m													
Shell Geometry				Sketch (Bundle/Nozzle Orientation)																			
23	Shell ID			m	0,6016																		
24	Pitch			m	0,0238																		
25	Baffle cut			m	0,1260																		
26	Baffle spacing			m	0,3790																		
27	Crosspasses			-	12																		
Tube geometry				Material																			
29	Tube OD			mm	19,05	P235GH			shell														
30	Tube thickness			mm	1	X6CrNiTi18-10			tube														
31	Length			m	5,01	DN 4' Class 150 for oil			flange EN 1759-1,E														
32	Pitch ratio			-	1,25	DN 4' Class 150 for water			flange EN 1759-1,E														
33	Layout			deg	60																		
34	Tube no., Prelim./Calc.			-	518	518	Material thermal conductivity																
35	Tube Pass			-	2	Tube		15	W/m-°C														
Dimensionless value																							
37	Reynolds no. - shell			-	640,1																		
38	Reynolds no. - tube			-	12054,5																		
39	Nusselts no. - shell			-	197,1																		
40	Nusselts no. - tube			-	77,8																		

Příloha č. 3 – Přehled výstupních veličin z metody Bell-Delaware

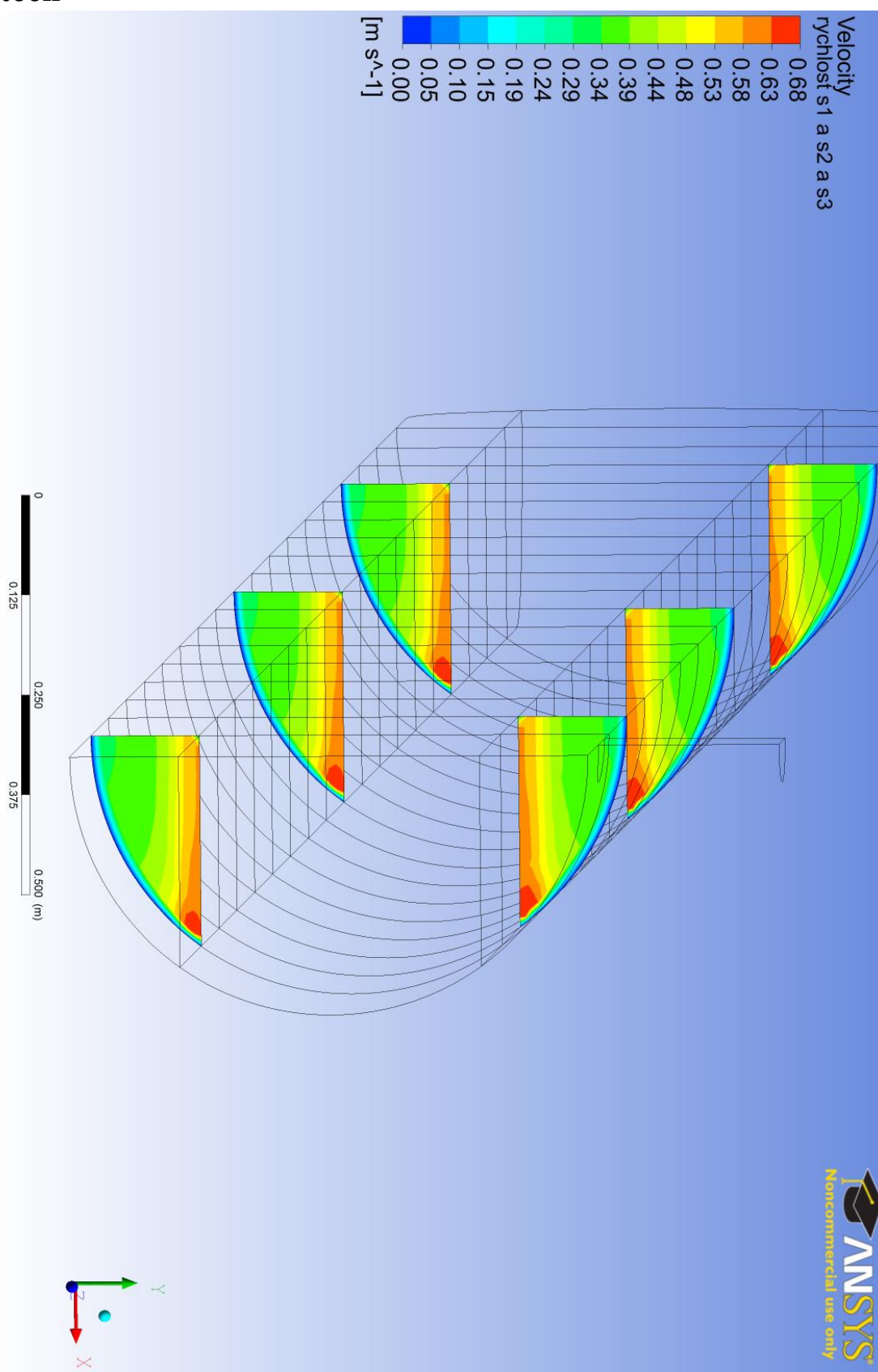
A	B	C	D	E	F	G	H	I	J	K	L
2	<div></div> <div>ÚSTAV PROCESNÍHO A EKOLOGICKÉHO INŽENÝRSTVÍ FAKULTA STROJNÍHO INŽENÝRSTVÍ VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ</div>							Shell-and-tube heat exchanger			
3								Type	BEU		
4								Size	601,62	x	5,3784
5								Date	21.5.2013		
7	Connection in					Parallel		1	Series		1
8	Performance of the unit										
9	1	Fluid allocation				Shell side			Tube side		
10	2	Fluid name				Oil (ISO VG32)			Water		
11	3	Fluid quality total		kg/s	17,3597			26,9361			
12	4	Vapour (In/Out)		wt%	0	0		0	0		
13	5	Liquid		wt%	100	100		0	0		
14	6	Steam		wt%	0	0		0	0		
15	7	Water		wt%	0	0		100	100		
16	8	Noncondesable		wt%	0	0		0	0		
17	9	Temperature (In/Out)		°C	93	56		35	46,8282		
18	10	Density		kg/m3	833,547	856,571		994,52	989,87		
19	11	Viscosity		mPa.s	4,57469	14,1373		0,71955	0,57777		
20	12	Specific Heat		J/kg-°C	2141,75	2001,85		4175,9	4177,98		
21	13	Thermal Conductivity		W/m-°C	0,12725	0,13059		0,623	0,63721		
22	14	Inlet Pressure		kPa (abs.)	11000			11000			
23	15	Velocity		m/s	0,374			0,459			
24	16	Pressure Drop, Allow./Calc.		kPa	30	26,121		30	12,56		
25	17	Heat Transfer Coefficient		W/sq m-°C	528,718			2875,624			
26	18	Fouling Resistance		sq m-°C/W	0,000528			0,000352			
27	19	Overdesign		%	12,720						
28	20	Duty, Allow./Calc.		1500	1330,74	kW	LMTD (corrected)		29,433	°C	
29	21	OHTC		305,658	W/sq m-°C		Area	166,734	sq m		
30	22	Shell Geometry					Sketch (Bundle/Nozzle Orientation)				
31	23	Shell ID		m	0,6016						
32	24	Pitch		m	0,0238						
33	25	Baffle cut		m	0,1260						
34	26	Baffle spacing		m	0,3189						
35	27	Crosspasses		-	16						
36	28	Tube geometry					Material				
37	29	Tube OD		mm	19,05	P235GH		shell			
38	30	Tube thickness		mm	1	X6CrNiTi18-10		tube			
39	31	Length		m	5,38	DN 4' Class 150 for oil		flange EN 1759-1,E			
40	32	Pitch ratio		-	1,25	DN 4' Class 150 for water		flange EN 1759-1,E			
41	33	Layout		deg	60	Material thermal conductivity					
42	34	Tube no., Prelim./Calc.		-	518	518	Tube		15	W/m-°C	
43	35	Tube Pass		-	2	Correction factors			J	0,697	
44	36	Dimensionless value					Baffle cut and spacing		J _c	1,075	
45	37	Reynolds no. - shell		-	531,4	Leakage effects		J _l	0,678		
46	38	Reynolds no. - tube		-	12054,5	Byppas flow C,F streams		J _b	0,963		
47	39	Nusselts no. - shell		-	172,9	Variable baffle spacing		J _s	0,993		
48	40	Nusselts no. - tube		-	77,8	Temperature gradient		J _r	1,000		

VYTVORENO VE VYUKOVEM PRODUKTU SPOLECNOSTI AUTODESK

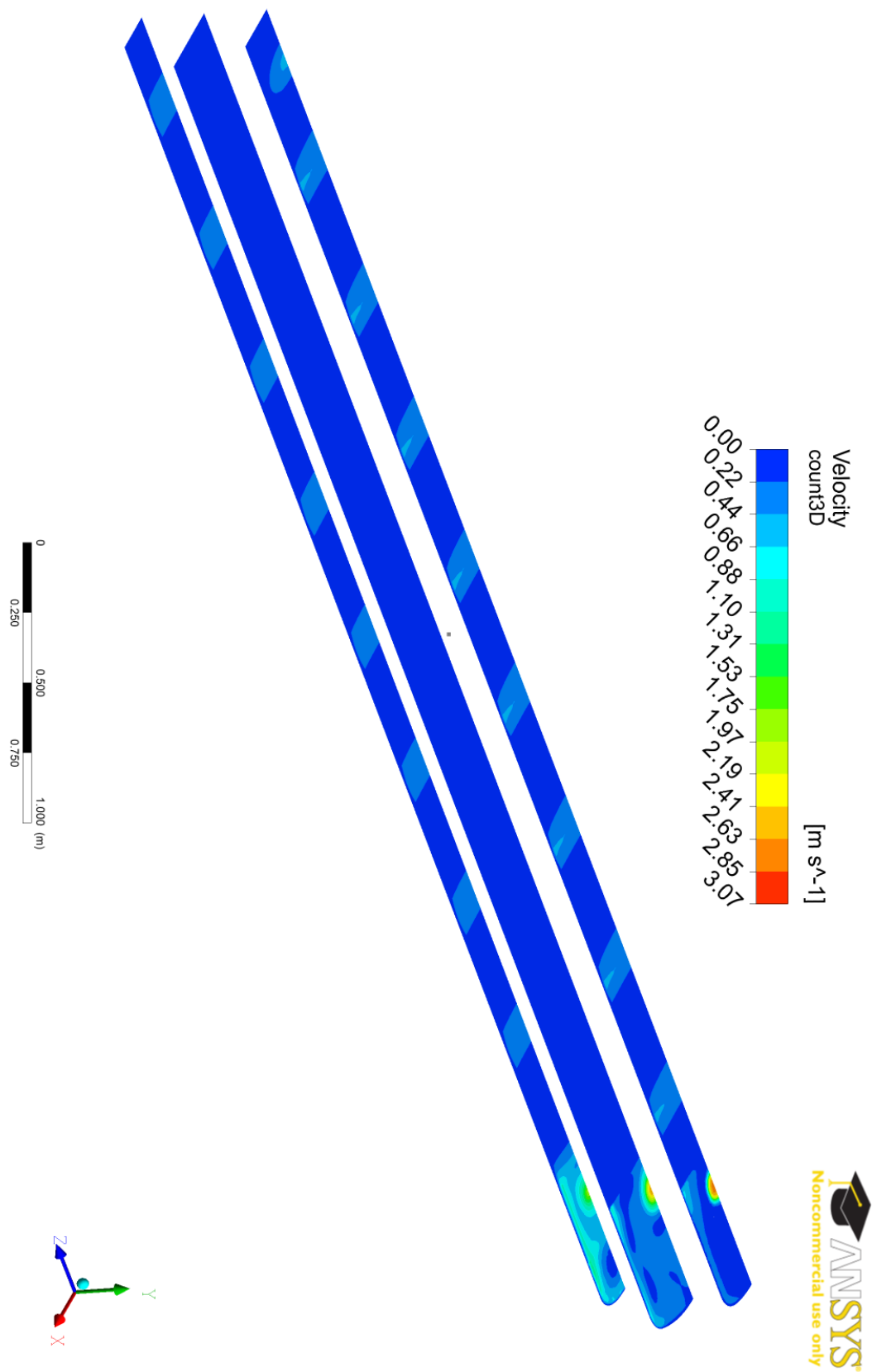
VYTVOŘENO VE VÝUKOVÉM PRODUKTU SPOLEČNOSTI AUTODESK



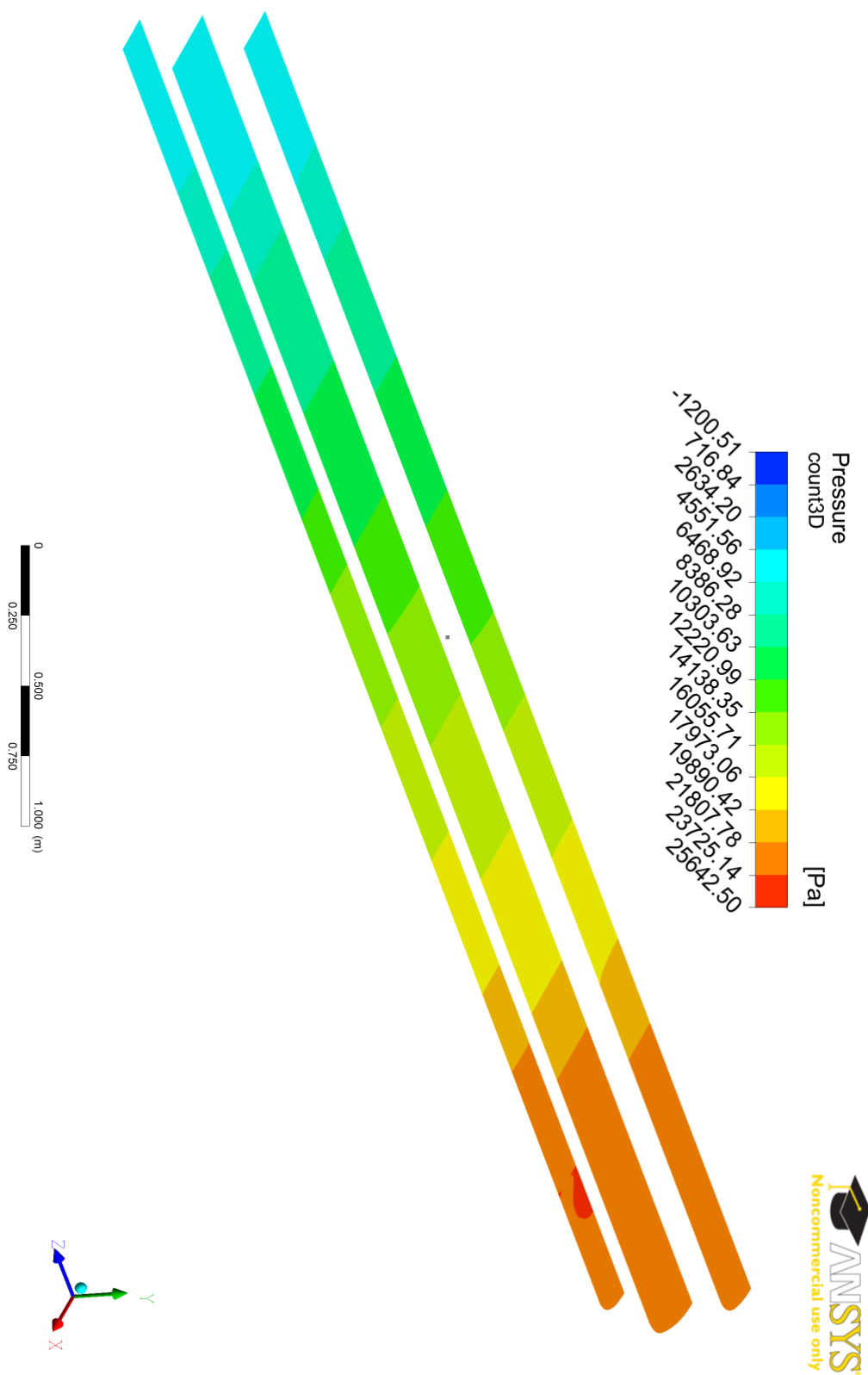
Příloha č. 5 a) – CFD, hodnota podélných rychlosti v kontrolních místech



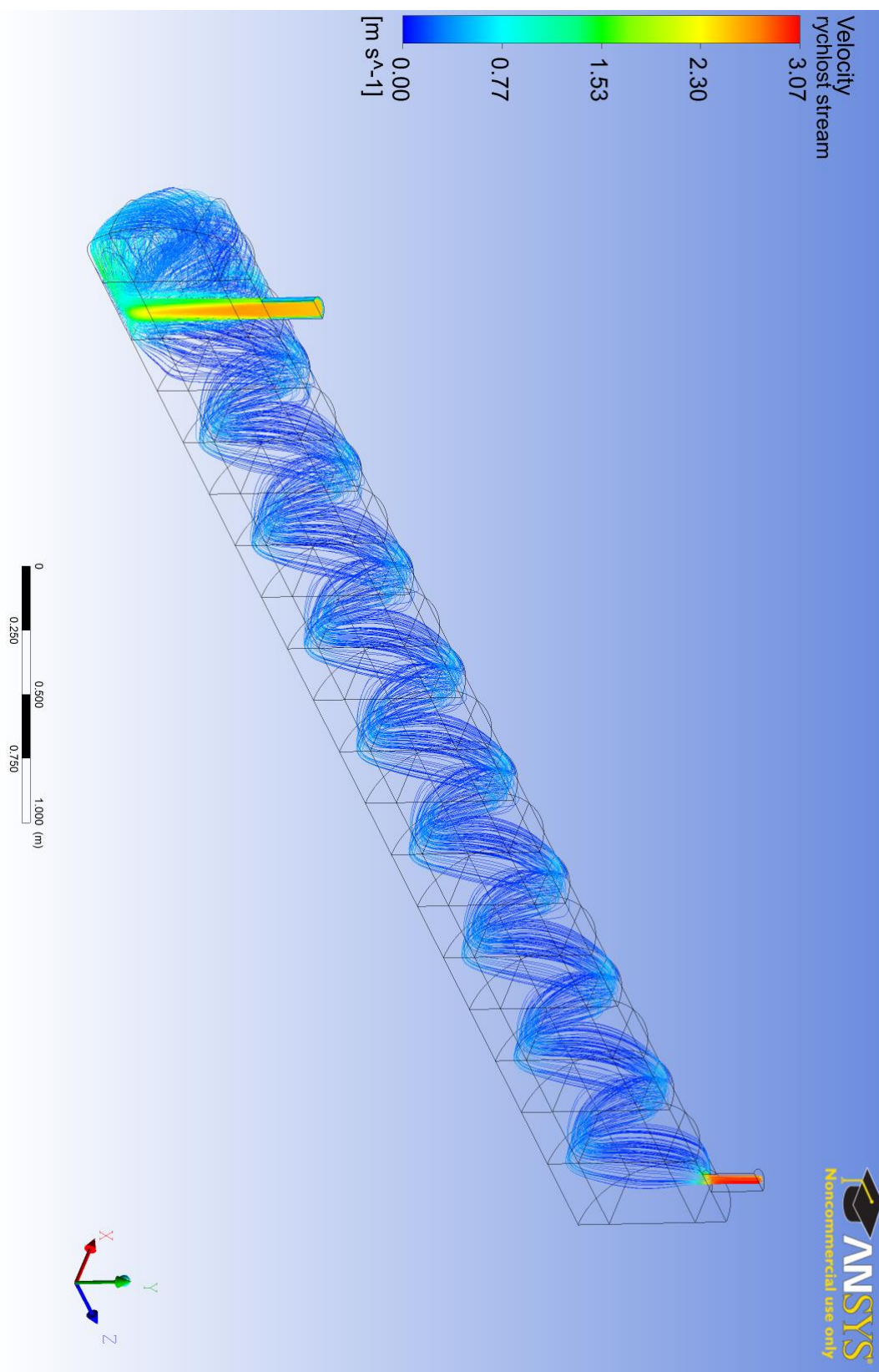
Příloha č. 5 b) – CFD, hodnoty příčných rychlostí



Příloha č. 5 c) – CFD, změny otevřených hodnot v příčných řezech



Příloha č. 5 d) – Rychlostní proudnice



Příloha č. 5 e) – Rychlost na vstupu do mezitrubkového prostoru

